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Inflation Targeting, Asset Prices, and Financial Imbalances: Conceptualizing the Debate*

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Abstract

This paper attempts to conceptualize the debate regarding the role of asset prices and perceived financial imbalances in the formation of monetary policy from the perspective of theoretically optimal policy responses. While much of the disagreement can be reconciled within the framework of flexible inflation targeting, defined as a commitment to a targeting rule, pre-emptive policy actions against the build-up of financial imbalances cannot be motivated within such a framework without modification either to the targeting rule or the underlying model. Given standard forecasting models, such actions are shown to be operationally equivalent to targeting financial imbalances explicitly in the central bank loss function.

JEL Classification: E42, E44, E52, E58

Keywords: Inflation targeting, asset prices, financial imbalances, policy horizon

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1. Introduction

The ongoing debate on what role asset prices and perceived financial imbalances more generally should play in the setting of monetary policy is structured on two distinctly opposed views. One is that monetary policy should react to financial imbalances only insofar as they impact on inflation and output, the primary goals of central banks. The other calls for the central bank to take actions against perceived imbalances as they build up, even when the outlook for inflation and growth in the near term appears sound, as the unwinding of such imbalances can be swift and costly to the real economy. In the context of inflation targeting, as reflected in Bean (2003), there appears to be a shift to the middle ground with the debate centering more not on whether considerations of asset prices and financial imbalances are consistent with such a framework, but rather how to operationally utilize and respond to the information content of these variables. That said, many of the key issues remain unresolved with the discussion often hindered by the lack of a consistent framework within which the various arguments can be judged.[1]

This paper attempts to address this shortcoming by casting the debate from the perspective of optimal monetary policy and a more precise characterization of inflation targeting than that often used in the literature. In doing so, the underlying sources of disagreement become clearer. While much of the literature, as typified by Bernanke and Gertler (1999) and Cecchetti et al. (2000), is based on comparing outcomes conditioned on monetary policy following some variant of the Taylor rule, this paper takes one step back and derives the optimal policy response explicitly. It is shown that within the context of a standard model of the transmission mechanism where policymakers' judgments are allowed, any conceivable response to asset prices and financial imbalances *that is justified through their impact on output and inflation* can be accommodated without fundamental changes to the framework of monetary policy. In this way, much of the disagreement can be reconciled within the framework of flexible inflation targeting, defined as a commitment to a targeting rule. However, a response to financial imbalances motivated by a desire to pre-empt the risks associated with their implosion necessarily entails a fundamental change to the way in which optimal policy is formulated. From the perspective of the model adopted in this paper, such policy actions are shown to be operationally justifiable only with an explicit consideration of financial imbalances in the central bank's loss function, in addition to output and inflation concerns.

While the central aim is not to evaluate the relative merits of each view, the discussion highlights some of the practical difficulties that are likely to be associated with a

[1] Extensive references to the literature can be found in Borio et al. (2003), Bean (2003), Filardo (2003a), Detken and Smets (2004), and Borio and White (2004).

more proactive monetary policy. Most directly, the theoretical results suggest that optimal policy in the face of uncertainty with respect to the determination of asset returns and their role in the transmission mechanism should be less rather than more activist. More generally, a concern for financial imbalances implies that the speed with which inflation is returned to target is slower. Too much emphasis on such concerns can, therefore, compromise the central bank's macroeconomic goals. Finally, when a concern for financial imbalances is identified with a modification of policymakers' operational objectives, it becomes apparent that central banks that are known to be influenced by such considerations some of the time—often in an arbitrary way—are likely to be less transparent and impart greater uncertainty to the public since the basis for policy actions is less clear.

The paper also analyzes in more detail proposals for modification of inflation targeting to better incorporate the risks posed by financial imbalances, namely i) a lengthening of the policy horizon; and ii) greater emphasis on 'balance of risk' considerations. These modifications have been suggested somewhat loosely and when viewed against the framework in this paper, it becomes apparent that they are fundamentally reflecting a dissatisfaction not with inflation targeting *per se*, but rather the underlying model used to formulate policy and the communication strategy that has been adopted in practice.

The paper is organized as follows. Section 2 provides a formal characterization of inflation targeting and sets out the model that will be used as a basis for the discussions. Section 3 contextualizes the debate on the appropriate role of asset prices and financial imbalances in monetary policy from the perspective of theoretically optimal reaction functions where policymaker's judgments are incorporated. It also examines how optimal policy is affected by uncertainty with respect to the role of asset prices in the transmission mechanism. The case for pre-emptive policy actions against the risks posed by financial imbalances and the associated implications for optimal policy are evaluated in section 4. Section 5 concludes and some technical details are collected in an appendix.

2. The Policy Regime

The key step in evaluating the debate on how asset prices and financial imbalances should enter into monetary policy decisions involves a precise definition of the framework for monetary policy. Accordingly, this section sets out the precise characterization of inflation targeting, the operational decision making process involved, as well as the central bank's assumed baseline model of the economy.

2.1 Flexible Inflation Targeting

In its true essence, inflation targeting involves the formulation of clear objectives for monetary policy and the establishment of an institutional commitment to achieving those objectives. Typically, the primary objective is an explicit commitment to a numerical rate of inflation, π^*, to be achieved over some horizon. The way in which this goal of price stability should be accomplished is not uniquely specified—indeed, the manner in which inflation targeting is implemented in practice differs substantially across countries—although an emphasis on a high degree of transparency with respect to how policy decisions are formulated is always a key element. To facilitate the analysis, it will be useful to introduce some formalism to the monetary policymaking procedure. While any theoretical characterization of such complex decision-making process must necessarily involve substantial simplifications, it will be assumed throughout this paper that an inflation targeting central bank, to a first approximation, can be operationally characterized by a 'targeting rule', as described further below.

Although much of the formal discussion of monetary policy is couched in terms of a commitment to alternative instrument rules—a reduced form relation between the central bank's instrument and a set of macro variables that are deemed relevant for policy as typified, for example, by the Taylor-rule—this is in many ways an overly simple way to characterize actual policy decisions and often leads to misconceptions about inflation targeting as a framework for monetary policy. The true optimal reaction function of the central bank in practice will involve specific responses to a large number of variables with weights that are changing over time as revisions to the underlying model used to formulate policy are undertaken and policymakers' views are updated. The characterization of monetary policy through a specific instrument rule with constant weights therefore not only presumes a particular model to be the 'true' one all the time, but also removes much of the judgmental element and extra-model information that are inextricably linked to policy decisions in practice.

As argued by Svensson (2003a) and Woodford (2004), a better description of inflation targeting is a commitment to a targeting rule. The targets in this case are operational goal variables that enter the loss function of the central bank whose deviations from prescribed values are to be minimized. A central bank committed to a general targeting rule therefore explicitly specifies only the operational objectives and the loss function to be minimized. Such a characterization of policy formulation is quite general and is consistent with a broad range of response functions whose 'optimality' is determined by the underlying model of the economy and policymakers' judgments when the decision is made. It is a much less restrictive description of monetary policy than an instrument rule and captures the significant degree of flexibility endowed to central banks in practice.

With this approach, the first step is to specify the operational objectives of the central bank bearing in mind that a commitment to long-run price stability, of course, does not preclude consideration of other objectives in the short-run, most importantly that of output stabilization. This is the sense in which inflation targeting is characterized as 'flexible' and represents a description of inflation targeting which is reflective of the way they are actually implemented in practice. More concretely, let the central bank's loss function in period t be given by

$$L_t = \frac{1}{2}\left[(\pi_t - \pi^*)^2 + u_x x_t^2\right] \tag{2.1}$$

where π_t is the inflation rate at time t, x_t the output gap (log deviations), and $u_x > 0$ the weight on output gap stabilization relative to inflation stabilization.[2]

A general targeting rule then commits the monetary authorities to choosing at time t a sequence of short-term interest rates, $\{i_{t+s}\}_{s=0}^{\infty}$, to minimize the expected sum of discounted current and future losses,

$$\mathrm{E}_t \sum_{i=0}^{\infty} \delta^i L_{t+i} \tag{2.2}$$

where $0 < \delta < 1$ is the discount factor, subject to a model of the transmission mechanism. Operationally, the central bank undertakes optimization each period conditional on its most reliable model of the economy and all relevant available information. While the resulting prescription for the instrument will be consistent with a particular form of the reaction function that can be quite complex, the latter need not be made explicit nor followed mechanically. In this way, such a characterization of inflation targeting is closer to actual practice and considerably more robust.[3]

2.2 The Central Bank's Model Economy

To aid in the conceptualization of the key issues, it will be useful to couch the discussion on the basis of a very simply model that can nevertheless capture much of the intuition contained in more elaborate settings. The basic setup is consistent with that used in Svensson (1997, 2003a) and Ball (1999), extended to incorporate a role for asset prices

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[2] When $u_x = 0$, the regime is commonly termed as 'strict inflation targeting'.

[3] That said, the benchmark for optimal policy from the perspective of targeting rules depends, in essence, on the structural model over which optimization is carried out as well as the loss function adopted. Their level of generality, therefore, is limited by the particular specification chosen.

in the transmission mechanism. The fact that a similar setup has been utilized to analyze the interplay between monetary policy and asset prices also facilitates comparison of the results to the existing literature.[4]

Suppose that the central bank's model of the economy is described by

$$\pi_{t+1} = \pi_t + \alpha_x x_t + \alpha_z z_{t+1} + \varepsilon_{t+1} \tag{2.3}$$

$$x_{t+1} = \beta_x x_t - \beta_r (i_t - \pi_{t+1,t}) + \beta_q \Delta q_t + \beta_z z_{t+1} + \eta_{t+1} \tag{2.4}$$

$$q_{t+1} = q_t + \omega_x x_{t+2,t+1} - \omega_r (i_{t+1} - \pi_{t+2,t+1}) + \omega_b b_{t+1} \tag{2.5}$$

$$d_{t+1} = d_t + \theta_x x_{t+2,t+1} - \theta_r (i_{t+1} - \pi_{t+2,t+1}) + \theta_q \Delta q_{t+1} \tag{2.6}$$

where $\alpha_z z_{t+1}$ and $\beta_z z_{t+1}$ are scalar products of two exogenous vectors discussed further below, i_t represents the short-term nominal interest rate under the control of the central bank, q_{t+1} denotes (log) real asset prices, and d_{t+1} the (log) level of real household debt. The shocks ε_{t+1} and η_{t+1} are assumed to be i.i.d. with zero mean and variances σ_ε^2 and σ_η^2, respectively. All coefficients are positive, while β_x is further restricted to be less than one (so that output gaps converge to zero). Finally, for any variable a, $a_{t+i,t}$ denotes $\mathrm{E}_t a_{t+i}$, the central bank's expectation of a_{t+i} conditional on information available in period t, while $\Delta a_t \equiv a_t - a_{t-1}$.

Equation (2.3) is the Phillips curve where the change in inflation is increasing in lagged output gap and a 'cost push' shock. With a unit coefficient on lagged inflation, the long-run Phillips curve is vertical. Aggregate demand is represented by (2.4) under the assumption that the output gap is serially correlated, decreasing in lagged real short-term interest rate and positively related to lagged changes in real asset prices (capital gains). The latter can be thought to capture wealth and balance sheet effects on consumption and investment arising from asset prices in the spirit of more complicated 'financial accelerator' models (see Bernanke and Gerlter (1999)).

The evolution of asset prices is described by (2.5) and is driven by two components. Fundamental real asset returns are assumed to be positively correlated with expected output gap in the future and negatively with the current real interest rate. In addition, non-fundamental factors are allowed to influence real returns through b_{t+1}. These could include a speculative bubble or other departures from the efficient markets hypothesis more generally. The key element being that b_{t+1} is independent of other variables in the model. Finally, (2.6) describes the evolution of household debt which is

[4] See, for example, Filardo (2001, 2003) as well as Gruen et al. (2003) although these papers are based on simulation results rather than closed-form solutions.

assumed to be increasing in expected output gap next period, decreasing in current real interest rates, and positively influenced by real asset returns in the current period.[5] Although household debt plays no role in the transmission mechanism at this stage, it will facilitate discussions of financial imbalances in the context of optimal monetary policy later in the paper.

Following Svensson (2003a), z_{t+1} is a column vector of exogenous variables in period t+1 that are deemed by the policymaker to influence inflation and output gaps. They represent judgments about ways in which the dynamics of inflation and output gap can differ from the simple model above with $z_{t+1} = 0$ and thus capture policymakers' beliefs about possible model perturbations. In this context, α_z and β_z are row vector of coefficients that pick up the corresponding impact of the variables in z_{t+1} on inflation and the output gap, respectively. The central bank's estimate of past and future deviations at time t, $\{z_{t+i,t}\}_{i=-\infty}^{\infty}$, represents judgmental elements that are always present in the formation of policy since any explicit model only serves to approximate the true model of the economy as best it can. In the context of this paper, the focus will be on policymakers' judgment about how asset prices and the build-up of perceived financial imbalances can affect future inflation and output, and thus the optimal policy setting.

Note that the lag structure of the model implies that monetary policy affects asset prices and debt contemporaneously, output with a one-period lag, and inflation with a lag of two periods. When the period is thought to be 3 quarters, the control lags are reasonably consistent with empirical evidence of the transmission mechanism.[6] With this setup, output in the current period t is predetermined, as is inflation in periods t and t+1 given expected deviations next period,

$$\pi_{t+1,t} = \pi_t + \alpha_x x_t + \alpha_z z_{t+1,t} \tag{2.7}$$

2.3 The Central Bank's Problem

Given a quadratic loss function, a linear model, and only additive uncertainty, certainty-equivalence applies. The intertemporal loss function can then be recast in terms of mean forecasts of future target variables conditional on the central bank's current information and a specific future path of the instrument. The central bank's stochastic

[5] The dependence on output and interest rates reflect traditional determinants of savings, while the link with asset prices capture balance sheet and credit market effects. For example, in the case of house prices, since houses are often used as collateral against borrowing, an increase in the price of houses makes more collateral available to homeowners, which may encourage greater borrowing in the form of mortgage equity withdrawal to finance investment or consumption.

[6] See Rudebusch and Svensson (1999) for evidence in the case of US data.

optimization problem at time t of minimizing (2.2) can then be written as a deterministic optimization problem of minimizing

$$\sum_{i=0}^{\infty}\delta^i \frac{1}{2}\left[(\pi_{t+i,t}-\pi^*)^2+u_x x_{t+i,t}^2\right] \quad (2.8)$$

subject to the forecasting model (2.3)-(2.5). This is the essence of 'inflation forecast-targeting' formalized in detail in Svensson (2003a) and Svensson and Woodford (2003). The central bank makes conditional forecasts of inflation and output gaps conditional on different paths of the instrument using all relevant information, its 'best' model of the economy, and judgments. The optimal instrument path to be implemented is then the one whose corresponding conditional forecasts minimizes (2.8). In this way, forecasts of target variables effectively become intermediate target variables.

Combining (2.4) and (2.5), taking expectations and substituting the result back into (2.4) yields

$$x_{t+1}=\frac{1}{\tilde{\beta}_q}\left[\beta_x x_t-\tilde{\beta}_r(i_t-\pi_{t+1,t})+\beta_q\omega_b b_t\right]+\beta_z z_{t+1}+\frac{\beta_q\omega_x}{\tilde{\beta}_q}\beta_z z_{t+1,t}+\eta_{t+1} \quad (2.10)$$

where $\tilde{\beta}_q \equiv 1-\beta_q\omega_x>0$ and $\tilde{\beta}_r \equiv (\beta_r+\beta_q\omega_r)>0$. The one-period ahead conditional forecast of the output gap is then given by

$$x_{t+1,t}=\frac{1}{\tilde{\beta}_q}\left[\beta_x x_t-\tilde{\beta}_r(i_t-\pi_{t+1,t})+\beta_q\omega_b b_t+\beta_z z_{t+1,t}\right] \quad (2.11)$$

The reduced-form forecasting model is described by (2.7) and (2.11). Since π_t, x_t, and $\pi_{t+1,t}$ are predetermined at time t given the policymaker's judgments, the choice of the policy rate today, i_t, ties down $x_{t+1,t}$ completely and the expected output gap can be thought of as the effective instrument (that is, a sufficient statistic to characterize the instrument rule). The central bank's problem can then be simplified to one of choosing optimal forecasts of inflation and output gaps to minimize (2.8) subject to (2.7) only. Given desired forecasts of the output gap, the implicit optimal interest rate setting can then be inferred from (2.11).

3. Asset Prices, Financial Imbalances, and Inflation Targeting

Within this basic setup, the closed-form solution for the central bank's optimal interest rate setting can be used to assess the appropriate role of asset prices in monetary policy. This section shows that a flexible inflation targeting framework can accommodate most of the rationales for looking at asset prices in setting policy. Moreover, in line with a frequently voiced objection to a monetary response to asset prices, the section also investigates how optimal policy is affected by uncertainty surrounding the effects of asset prices in the transmission mechanism. It should, of course, be kept in mind that a focus on optimal policy implies that the analyses depend fundamentally on the model and loss function adopted presently. While this provides much needed consistency and discipline in discussions of this topic, it also limits the scope of the results, as will be highlighted in section 4.

3.1 Optimal Policy Response

Appendix A shows that the reaction function that solves the problem in section 2.3 is given by

$$i_t = \pi^* + m_\pi(\pi_t - \pi^*) + (\alpha_x m_\pi + \frac{\beta_x}{\tilde{\beta}_r})x_t + \frac{\beta_q \omega_b}{\tilde{\beta}_r} b_t + (\alpha_z m_\pi + \frac{\beta_z}{\tilde{\beta}_r}) z_{t+1,t} + (m_\pi - 1)\alpha_z \tilde{z}_{t+2,t} \quad (3.1)$$

where $m_\pi \equiv 1 + \frac{\tilde{\beta}_q (1-\lambda_1)}{\tilde{\beta}_r \alpha_x} > 1$, $\tilde{z}_{t+2,t} \equiv \sum_{s=0}^{\infty} (\lambda_1 \delta)^s z_{t+2+s,t}$ is a discounted sum of expected future model deviations (judgments) starting two periods ahead, and λ_1 is an increasing function of u_x which fulfils $\lim_{u_x \to 0} \lambda_1 = 0$ and $\lim_{u_x \to \infty} \lambda_1 = 1$. The optimal interest rate setting in period *t* therefore has the form of an augmented Taylor rule with a positive response to current inflation and output gaps.[7] In addition, the reaction function depends on the non-fundamental component of asset price changes, b_t, as well as all expected future judgments.

Before proceeding, a few implications of (3.1) should be noted. First, as β_q, the strength of asset prices in the transmission mechanism, increases, the weights on inflation and output are reduced while that on b_t is increased. Second, even if asset prices are assumed to be fully driven by fundamentals ($\omega_b = 0$) so that no *direct* response to asset prices is warranted, optimal policy still incorporates the effects of asset prices *indirectly* through the weights on inflation and output gaps.[8] Finally, optimal policy involves 'leaning against the wind' in the sense that the interest rate is varied pro-cyclically with respect to changes in asset prices that are deemed to be non-fundamental. The simulation results of

[7] Since $m_\pi > 1$, it also conforms to the Taylor principle.

[8] In this respect, estimates of Taylor rules that show insignificant independent response to asset prices, as found by Bernanke and Gertler (1999) for example, does not necessarily mean that policymakers were not responding to asset prices. They may have been reacting only to the fundamental component of asset price returns and did not factor the effects of potential misalignments into their policy setting.

Filardo (2003a) based on a variant of the model adopted here yield broadly similar conclusions.

These observations are quite illuminating with respect to the debate on monetary policy and asset prices. In particular, the instrument setting depends on all current and predetermined variables that help to predict future variables. Thus the fact that the non-fundamental component of real asset returns appears in (3.1) is not because it is targeted but because it helps to predict output, and therefore inflation, in the future.[9] In the context of a Taylor rule, therefore, optimal policy implies a response to asset prices over and above that indicated by output and inflation gaps *only insofar as they contain information that have marginal bearing on future movements in output and inflation.* This represents the theoretical counterpart to Bernanke and Gertler's (1999, 2001) conclusion that no additional response of monetary policy to asset price fluctuations is necessary once their predictive content for inflation has been accounted for.[10] Such a view is entirely consistent with monetary policy leaning against a suspected asset price bubble insofar as they may impact on future output and inflation.

It is also consistent with the results of Cecchetti et al. (2000) despite frequent portrayals to the contrary. Using the same model as Bernanke and Gertler (1999), they attempt to benchmark the simulation results to preferences of the central bank and point out that from this metric, interest rates should generally respond directly to movements in asset prices in a Taylor-type policy rule. Their exercise basically amounts to a numerical derivation of the optimal interest rate reaction function given a model of the economy where a bubble is known to exist and influence the economy— the numerical counterpart to (3.1). Viewed in this light and given that the bubble process in their model yields information about inflation and output, it is not surprising that a positive coefficient on asset prices appears in the optimal policy rule.[11]

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[9] This is a reflection of the well known insight that it is better for the instrument to respond to the determinants of the target variables than to the target variables themselves.

[10] It is also in line with the conclusion of Gruen et al. (2003) that differences in interest rates recommended by 'activist' and 'sceptic' policymakers in the context of asset price bubbles depends only on differences in their assessments of the expected effect of the bubble on future output.

[11] In Bernanke and Gertler (1999), the addition of an explicit term for asset prices did not yield much benefit since the non-fundamental component cannot be identified by policymakers. However, given that the stochastic process driving the bubble is known, there is some predictive power in asset prices which is reflected in the finding that adding a small response to asset prices sometimes leads to slightly better outcomes. The class of policy rules evaluated are nonetheless not optimal making it difficult to draw firm conclusions about the 'right' policy response. See Filardo (2003a) for further elaboration on this point.

However, Cecchetti et al. (2000) go on to assert 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). This does not follow directly from their simulation results. As shown above, that asset prices may appear optimally in a Taylor-type rule is because they help to predict future output and inflation. It has nothing to do with pre-empting the cyclical instability often associated with drastic swings in asset prices. As discussed further in section 4, without a fundamental modification of the model, such policy actions can only be justified in the current context through a change in the targeting rule associated with inflation targeting.

Before proceeding further, it is useful to examine how the optimality conditions in the economy described above can shed light on the tradeoffs that policymakers face with respect to asset prices under an inflation targeting framework. As shown in appendix A, the consolidated first order condition of the problem in section 2.3 is given by

$$\pi_{t+i+1,t} - \pi^* = \frac{u_x}{\delta\,\alpha_x}\left(\delta x_{t+i+1,t} - x_{t+i,t}\right) \qquad (3.2)$$

which can be thought of as a 'specific targeting rule' that gives more detailed guidance about how policy should be implemented practically while implicitly satisfying optimality under the general targeting rule criteria described in section 2.1. Given the target inflation rate, π^*, the optimal monetary policy is one where interest rates are set so that the expected gap between inflation $i+1$ periods ahead and π^* is proportional to the discounted one period change in the output gap forecast, where the coefficient of proportionality embodies the relative weight on output gap stabilization in the loss function (u_x) and the slope of the short-run Phillips curve (α_x) weighted by the discount factor.[12]

Importantly, the specific targeting rule is independent of all parameters of the aggregate demand relation, (2.10). Thus the inclusion of asset prices as part of the transmission mechanism and the allowance of judgmental elements have no direct bearing on the general way in which optimal policy should be formulated. They come into play only in determining the actual instrument-rate decision to be implemented at each policy cycle. Put differently, (3.2) highlights the *absence of any trade-off* between asset price or financial stability on the one hand, and price and output stability on the other in the present setup. Asset prices are subsumed in the transmission mechanism and are of second order importance to the central bank's inflation and output stabilization goals.

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12 As elaborated in Svensson (2003a), (3.2) represents an equality of the marginal rate of transformation of the output gap into inflation from the Phillips curve and the marginal rate of substitution of inflation for the output gap implicit in the intertemporal loss function.

3.2 The Role of Judgment in the Conduct of Monetary Policy

It is of course entirely plausible for policymakers to be concerned about factors, including financial imbalances, that are not directly in the model. For example, they might be worried that booming asset prices may lead to more inflationary pressure in the future *over and above* that implied by the model, either in the upward direction when the boom is expected to continue or a downward direction if a large reversal is expected. Or they may be concerned that a rapid build-up of household debt will come to a stop in the near future and bring about a marked slowdown in growth as well as lower inflation. While not directly in the model, such concerns can nevertheless be incorporated into the optimal interest rate setting through judgmental adjustments to forecasts of inflation and output.

In the case where a rapid build-up of financial imbalances is believed to be masking underlying inflationary pressure that is expected to surface in period $t+i$, then the corresponding judgment term $z_{t+i,t}$ in (3.1) will entail an offsetting positive adjustment to interest rates now. Similarly if financial imbalances are expected to implode sometime in the future with negative consequences for output and inflation, the corresponding judgment term will exert a negative influence in interest rates today. Thus any conceivable policy action to *cushion the expected impact* of asset prices or financial imbalances on output and inflation in the future can be accommodated through judgmental factors in a way that is completely consistent with the framework of flexible inflation targeting as characterized by the targeting rule (3.2). The optimal instrument setting implicitly incorporate all relevant information, be it through the transmission mechanism or judgmentally, in an optimal way given the central bank's assumed model of the economy.[13] This is the sense in which inflation targeting, as characterized by a targeting rule, reflects a comprehensive approach to policy which 'looks at everything'.

That said, inflation targeting imposes a certain degree of discipline on the use of judgment and extra-model information in that changes to policy must be justified *quantitatively* on the basis of how such information affects conditional forecasts of inflation and output. In this way, inflation targeting as a framework for 'constrained discretion' provides some protection against the arbitrariness in use and temptations of abuse that might arise in a purely discretionary framework. If a judgment cannot be expressed in terms of its impact on conditional forecast of target variables, then the policy setting should not be affected by that judgment since the necessary change in the optimal policy response is not tied down. By forcing policymakers to express their concerns

[13] Therefore in the context of an unchanged specific targeting rule, the optimal interest rate setting may nevertheless vary considerably and sometimes in a non-linear fashion as judgments about future risks shift suddenly.

through the lens of goal variables, discretionary changes in policy based on whims or hunches are generally not allowed.

3.3 Model Uncertainty

A considerable part of the debate on how to utilize information contained in asset prices in the setting of policy centers on the degree of uncertainty surrounding such information. Separating out fundamental from non-fundamental components of asset price movements is extremely tricky and even if one could come up with a judgment in this regard, calibrating policy in response to such information is hampered by the considerable unpredictability as to how asset prices will respond to policy. Indeed, as argued by Goodfriend (2003), the correlation between asset prices and interest rates is at best tenuous and the potential for policy mistakes are severe enough that direct reaction to asset prices should not be undertaken.

To analyze the impact of such uncertainty on optimal policy, this section introduces uncertainty with respect to both the non-fundamental component of real asset returns as well as the response of asset prices to policy. Specifically, suppose that the central bank's model of the economy is now described by (2.3) and (2.4) as before but that the asset price equation is replaced by

$$q_{t+1} = q_t + \omega_x x_{t+2,t} - \omega_{r,t+1}(i_{t+1} - \pi_{t+2,t+1}) + \omega_{b,t+1} b_{t+1} \qquad (3.3)$$

where $\omega_{r,t+1} = \omega_r + v_{r,t+1}$ and $\omega_{b,t+1} = \omega_b + v_{b,t+1}$. The disturbances $v_{r,t+1}$ and $v_{b,t+1}$, which do not become known until period t+2, are assumed to be i.i.d. with zero means, variances of σ_r^2 and σ_b^2, respectively, and covariance of σ_{rb}. Moreover, let $v_{r,t+1}$ and $v_{b,t+1}$ be bounded below by $-\omega_r$ and $-\omega_b$, respectively, so that the uncertainty is only with respect to the size of the multipliers and not with the sign. For simplicity, the judgmental elements of the model will be suppressed.

Substitution of (3.3) into (2.4) yields an expression for the output gap of

$$x_{t+1} = \frac{1}{\tilde{\beta}_q}\left[\beta_x x_t - \tilde{\beta}_r(i_t - \pi_{t+1,t}) + \beta_q \omega_b b_t\right] - \beta_q v_{r,t}(i_t - \pi_{t+1,t}) + \beta_q v_{b,t} b_t + \eta_{t+1} \qquad (3.4)$$

Compared to (2.10), the policymaker in period t now faces additional uncertainty with respect to how asset prices will impact on next period's output gap. This uncertainty derives partly from uncertainty associated with the non-fundamental component of asset returns as well as from the policy multiplier on asset prices.

In the presence of both additive and multiplicative uncertainty, certainty equivalence no longer holds and variances and co-variances will affect the optimal interest rate choice. To illustrate the key points in this context while maintaining tractability, the analysis will focus on the case of strict inflation targeting ($u_x = 0$). Given the two period control lag on inflation, the solution to the intertemporal problem in this setting is equivalent to the period-by-period problem of

$$\underset{i_t}{\text{minimize}} \ \frac{1}{2}\delta^2 \mathrm{E}_t[(\pi_{t+2} - \pi^*)^2]$$

subject to (2.3) and (3.4).[14] Combining the latter two and using the definition of variances, the problem can be expressed alternatively as one of

$$\underset{i_t}{\text{minimize}} \ \frac{\delta^2}{2}\left\{[\mathrm{E}_t(\pi_{t+2} - \pi^*)]^2 + \mathrm{Var}(\pi_{t+2} - \pi^*)\right\} \tag{3.5}$$

subject to

$$\pi_{t+2} = \pi_{t+1,t} + \varepsilon_{t+1} + \alpha_x x_{t+1,t} - \alpha_x \beta_q v_{r,t}(i_t - \pi_{t+1,t}) + \alpha_x \beta_q v_{b,t} b_t + \alpha_x \eta_{t+1} + \varepsilon_{t+2} \tag{3.6}$$

where $x_{t+1,t} = \frac{1}{\tilde{\beta}_q}\left[\beta_x x_t - \tilde{\beta}_r(i_t - \pi_{t+1,t}) + \beta_q \omega_b b_t\right]$.

Appendix B shows that the solution to this problem is characterized by a reaction function of the form

$$\begin{aligned} i_t = \pi^* + \tilde{m}_\pi(\pi_t - \pi^*) + \left(\alpha_x \tilde{m}_\pi + \frac{\alpha_x \beta_x V}{(1 + \sigma_r^2(\alpha_x\beta_q)^2 V^2)\tilde{\beta}_q}\right) x_t \\ + \frac{V}{1 + \sigma_r^2(\alpha_x\beta_q)^2 V^2}\left[\frac{\alpha_x \beta_q \omega_b}{\tilde{\beta}_q} + (\alpha_x\beta_q)^2 V \sigma_{rb}\right] b_t \end{aligned} \tag{3.7}$$

where $\tilde{m}_\pi \equiv 1 + \frac{V}{1 + \sigma_r^2(\alpha_x\beta_q)^2 V^2}$ and $V \equiv \frac{\tilde{\beta}_q}{\alpha_x \tilde{\beta}_r}$. It can be verified that in the absence of model uncertainty, $\tilde{m}_\pi = m_\pi$, and (3.7) reduces to (3.1) with $u_x = 0$.

As illustrated in (3.7), uncertainty about how asset returns are affected by the central bank's instrument, $\sigma_r^2 > 0$, results in a higher degree of 'policy conservatism' in the spirit of Brainard (1967). Specifically, the optimal reaction to the inflation gap, output gap, and perceived non-fundamental influence on asset prices is smaller. Moreover, while the additive uncertainty with respect to the non-fundamental component of asset returns has no bearing on the optimal weights, it will impact on policy if that uncertainty is correlated with uncertainty on the policy multiplier. In practice, it is often the case that at times when

[14] See Svensson (1997) on the equivalence to period-by-period optimization.

the influence of non-fundamental factors on asset returns is particularly large $(v_{b,t} > 0)$, for example in the context of a runaway bubble or collapse of one that involves significant undershooting, the effectiveness of policy on countering asset price movements is also reduced $(v_{r,t} < 0)$ and *vice versa*. Thus one would expect σ_{rb} to be generally negative. In this case (3.7) implies that policy should respond *less* to perceived misalignments in asset prices. Indeed, it is possible that the optimal weight on b_t is close to zero for certain values of σ_{rb}.

Finally, note that (B.1) and (B.2) in appendix B implies that the two-year-ahead forecast of inflation conditional on policy being set optimally is given by

$$\pi_{t+2,t} = \pi^* + \frac{\sigma_r^2(\alpha_x\beta_q)^2V^2}{1+\sigma_r^2(\alpha_x\beta_q)^2V^2}\left[(\pi_{t+1,1} - \pi^*) + \frac{\alpha_x\beta_x}{\tilde{\beta}_q}x_t + \frac{\alpha_x\beta_q\omega_b}{\tilde{\beta}_q}b_t\right] - (\alpha_x\beta_q)^2V^2\sigma_{rb}b_t$$

which states that the central bank should attempt to bring inflation back to target only gradually *despite* the absence of any concern about output stabilization in the loss function. This reinforces the fact that optimal policy in the face of uncertainty with respect to the determination of asset returns should be less activist. Overall, these results provide some theoretical support for the arguments often made against a proactive response to asset price movements.[15]

4. Pre-emptive Policy and Inflation Targeting

As highlighted above, the notion that central banks should take into account information—be it from asset price movements or perceived financial imbalances—that have incremental bearing on the macroeconomic goals of monetary policy is subject to little disagreement. The more substantive debate centers on the question of what to do when asset price movements or developments in financial imbalances do not contain obvious incremental information in this regard but nonetheless may contain the seeds of future disruption to the economy should their developments prove to be out of line with fundamentals. The majority view among monetary economists in this case is that central banks should not move policy directly in response to these factors, except in situations where financial stability is threatened. Indeed, by raising rates in response to expected future increases in inflation signaled by asset prices or increased debt accumulation, an inflation targeting central bank is already implicitly slowing down the build-up of these vulnerabilities. Thus in many ways, financial imbalances and the risks posed by them are

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[15] For example, Bernanke (2002), Fergusson (2003), and Goodfriend (2003).

implicitly addressed, though incompletely, through a focus on conditional forecasts of output and inflation.

That said, it has been argued that a policy response may be warranted even if these financial imbalances do not give rise to implications that can be expressed directly in terms of the macroeconomic goals of policy in the near future.[16] The reason is that growing imbalances, if left unchecked, could have adverse consequences for the goals of policy if and when they implode. While the focus of the debate was initially on bubbles and whether they can be identified or not, more recent arguments are premised on the identification of a set of conditions that heighten the risk of an asset price reversal which could interact with vulnerable balance sheets to produce serious dislocations of the real economy.[17] It is important to note that under this view, which will be referred to as 'proactive', monetary policy is used not to cushion the expected fallout from financial imbalances in the future, but to pre-emptively lower the probability of a disruption occurring in the first place.

This distinction needs to be emphasized. Although the targeting rule in section 3 allows for a *response* to expected developments in financial imbalances in the future, they are not consistent with a *pre-emptive strike* designed to prevent these developments from occurring altogether. For example, a looser policy stance today can be justified on the basis of an expected collapse of asset prices in the future which will depress output and lower inflation, as outlined in section 3.2, whereas a *tighter* stance currently to prevent the collapse from occurring in the first place cannot. The simple reason is that *a pre-emptive strike involves policy being motivated by something that is not within the model* and thus absent from conditional forecasts of output and inflation, the basis from which all policy actions must be justified.

The main concern of the proactive view is that the economy could be left to grow at an unsustainable pace if monetary authorities do not respond to developing financial imbalances. The argument hinges on the proposition that excess aggregate demand pressures may not be reflected as visibly in inflation and output dynamics as in the past, and a belief that monetary policy can forestall *potential* disruptions to the real economy that may occur sometime in the distant future by acting to moderate the accumulation of

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[16] See Borio and Lowe (2002), Cecchetti et al. (2002), Issing (2003), Mussa (2003), Borio and White (2004), and Borio and Lowe (2004).

[17] Indeed as made clear by (3.1), monetary policy should react to both fundamental and non-fundamental influences of asset returns when both contain information about future evolution of the goals of policy. In this broad sense, whether asset prices are misaligned or not is of little importance.

imbalances today. Thus an additional channel in the transmission mechanism is presumed to exist whereby an increase in the interest rate can reduce the risk of financial instability in the future.

Such a channel is not present in the model in this paper nor in most operational models used by central banks. While it is relatively straightforward to incorporate this ex-ante channel of transmission in a highly stylized setting, as done for example by Kent and Lowe (1997) and Bordo and Jeanne (2002) both in a two-period context, doing so in a fully-fledged intertemporal model that can moreover be used operationally is much more difficult. Filardo (2003a) makes a first step in this respect by adopting an asset price bubble component that is endogenous to policy. The calibration results suggest some novel opportunistic policy actions, but at the same time, highlights the fact that constructing a dynamic stochastic general equilibrium model which can generate conditional forecasts of output and inflation that incorporate the complex trade-offs associated with pre-emptive monetary policy in a *reliable enough manner to be used in practice* is extremely difficult.

Given that the nature of the risks associated with financial imbalances cannot be readily captured in the forecasting model, proponents of the proactive view are effectively arguing for a response to something outside the framework of inflation targeting as set out in section 3. In the context of the model in this paper—which although highly stylized, nevertheless captures the key elements of the transmission mechanism present in most central banks' operational models—it amounts to an *explicit consideration for financial imbalances in the loss function of the central bank*, in addition to that of output and inflation.

This does not imply, of course, that financial imbalances are the ultimate target of policy *per se.* It is clear that the underlying motivation for responding to financial imbalances arises fundamentally from macro considerations, but the overwhelming difficulty in expressing these concerns in explicit macro terms nevertheless implies that policy formulation is *operationally* equivalent to a separate consideration for financial imbalances in the central banks' objective function. Advocates of the proactive view are inherently concerned about prevention and it is natural that such considerations be thought of as a separate constraint on policy that binds some of the time since they have more to do with the structure of the economy rather than the state.[18]

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[18] Prevention can be seen as fulfilling a separate objective of promoting resilience to shocks. For example, policymakers may be concerned that the level of debt taken out by households makes them sensitive to any adverse future shock to their employment or income prospects.

Finally, it is worth noting that in popular discussions of these issues, there is an identification of financial imbalances with financial instability that is perhaps too strong. The former refers to the seizing up of financial markets due to some shock, most commonly a liquidity shock, which have serious implications for the payment system and could be quite disruptive to economic activity. Financial imbalances, on the other hand, is a subjective notion about the health of balance sheets or pricing of assets that are deemed to be somehow undesirable, either because they depart substantially from fundamentals or expose the economy to risks of a severe downturn. Such concerns are much less urgent than that of financial instability since they do not have immediate consequences for the economy. That said, when financial imbalances implode, they do have the potential to trigger financial instability if financial institutions' balance sheets are materially exposed to such risks, and it is this possibility that drives the association of financial instability with financial imbalances. In the context of monetary policy, however, it is important to maintain the distinction between the two since the trade-offs and horizons involved are very different.

That financial stability—as distinct from financial imbalances—should be part of a central bank's objective at the basic level is not controversial. There is little disagreement that in exceptional circumstances when a large shock threatens the smooth functioning of markets, policy actions may be taken to preserve the integrity of the system. In terms of prevention, there also appears to be a consensus on the importance of a sound regulatory and supervisory regime in bringing about a strong and resilient financial sector capable of withstanding large shocks. A concern with financial imbalances, on the other hand, reflects a desire to moderate the occurrence of boom-bust cycles associated with unsustainable swings in asset prices and deteriorating balance sheet positions. It has more to do with achieving a certain structure of the economy rather than addressing immediate macroeconomic developments. The next section explores the implications that this has for optimal policy, followed by a discussion of two modifications to the inflation targeting framework that have been suggested in response to concerns about financial imbalances, namely longer horizons and balance of risk considerations.

4.1 Financial Imbalances and Optimal Policy

It has been argued that considerations of financial imbalances that imply pre-emptive policy actions to ward off the risk of them imploding cannot be rationalized within the model adopted in this paper, which although highly stylized, contains the key elements typical of many central banks' model of the economy. The only way in which such policy actions can be justified within this framework is through the explicit inclusion of concerns for financial imbalances directly in the loss function. That is, so long as a *reliable and operational* model of the economy which can generate conditional forecasts of output and inflation that incorporate the kind of complex trade-offs highlighted by Bordo and Jeanne (2002) and Filardo (2003a) remain elusive, any policy move associated with developments in financial imbalances justified by a prevention motive necessarily entails a change in the general targeting rule describing central bank behavior. Thus even at the level of generality adopted in this paper, such considerations are not consistent with a flexible inflation targeting framework unless a redefinition of 'flexible' to incorporate a concern not only for output stabilization but sometimes also for the structure or 'health' of the economy is adopted.

To see the implications of such a modification, this section will solve for the optimal interest rate setting when these concerns are present. In line with arguments made by Borio and Lowe (2004), the measure of financial imbalances adopted by the authorities, f_t, is assumed to be a weighted average of asset prices and household debt, the latter reflecting primarily bank credit extension. Specifically,

$$f_t \equiv \alpha\, q_t + (1-\alpha) d_t \tag{4.1}$$

for some $0 < \alpha < 1$. It will be further assumed that concerns about financial imbalances become material only once they have surpassed some arbitrary threshold, $\bar{f}$, determined by the central bank. The focus on financial imbalances reflects a perception on the part of policymakers of an implicit link between them and the probability of some severe economic dislocation in the future. The greater the perceived degree of imbalance (higher f_t), the greater the risk that they may implode.

To keep things simple, the basic insights of including financial imbalances in the loss function will be illustrated by focusing only on the period-by-period optimization problem. Thus the central bank, in period *t*, solves the problem of

$$\underset{i_t}{\text{minimize}}\ \frac{1}{2}\left[\delta^2(\pi_{t+2,t} - \pi^*)^2 + \delta u_x x_{t+1,t}^2 + u_f (f_t - \bar{f})^2\right] \tag{4.2}$$

subject to (2.3)-(2.6) and disregarding the effects of current period policy setting on next period's loss function.[19] The weight on financial imbalances, u_f, is assumed to be a step function of the perceived degree of financial imbalances,

$$u_f \begin{cases} = 0 & \text{if } (f_t - \bar{f}) \le 0 \\ > 0 & \text{if } (f_t - \bar{f}) > 0 \end{cases} \tag{4.3}$$

[19] Note that (4.2) reflects the implicit assumption in the model that policy can affect financial imbalances contemporaneously, output with a one-period lag, and inflation with a lag of two periods.

There is thus an element of non-linearity in the loss function reflecting the fact that concerns about financial imbalances only become important once enough 'warning signs' are present. In practice, the weight given to financial imbalances is likely to depend on the perceived costs of an implosion in the future.

In this context, and ignoring judgmental elements for simplicity, appendix C shows that the optimal interest rate setting is given by

$$i_t = \pi^* + f_\pi(\pi_t - \pi^*) + f_x x_t + f_b b_t + f_f(f_{t-1} - \bar{f}) \tag{4.4}$$

where f_π, f_x, f_b, and f_f are all positive and satisfy $\frac{\partial f_\pi}{\partial u_f} < 0$, $\frac{\partial f_x}{\partial u_f} < 0$, $\frac{\partial f_b}{\partial u_f} < 0$, and $\frac{\partial f_f}{\partial u_f} > 0$. Equation (4.4) implies that when financial imbalances are deemed severe enough, the optimal interest rate setting responds explicitly to the degree of perceived misalignment with a positive coefficient. Moreover, the greater the weight attached to financial imbalances, u_f, the lower the weights on output and inflation. Therefore, as opposed to the discussion in section 3, a trade-off now exists between price and output stability on the one hand, and financial imbalances on the other. A central bank formulating policy in this context will adhere to a specific targeting rule of the form (C.2) in appendix C, where coefficients on the demand side as well as the state of financial imbalances now appear explicitly. The additional objective on the latter thus makes the decision problem more complex and implies that monetary policy is more ambitious. Consequently, and as discussed further below, commitment and verification is likely to be more difficult, reducing transparency.

The reaction function of a central bank adhering to this regime will be non-linear. When financial imbalances are not a concern, $(f_t - \bar{f}) < 0$, the optimal interest rate setting will not respond directly to the level of debt and asset prices. Once perceived imbalances are deemed to be severe enough, there will be a non-linear change in the form of the optimal reaction function. This, in some sense, captures the argument made by Svensson (2003b) that concerns about financial instability act like a constraint on the central bank that binds only some of the time. The central bank's goals of financial stability and monetary stability are complementary most of the time and the constraint binds only when a trade-off arises.

More insight can be had by examining the two-period ahead inflation forecast conditional on policy being set optimally, which is given by (C.4) in appendix C as

$$\pi_{t+2,t} = \pi^* + v_\pi(\pi_t - \pi^*) + v_x x_t + v_b b_t - v_f(f_{t-1} - \bar{f}) \tag{4.5}$$

where v_π, v_x, v_b, and v_f are all positive.[20] Two things are noteworthy here. First, a concern for financial imbalances implies that the speed with which inflation is returned to its long-run target is slower.[21] Thus explicit consideration of financial imbalances, in much the same way as a concern for output stabilization, introduces an extra trade-off for policy that implies greater tolerance for inflation gaps. The longer horizon over which inflation is brought back to target is a fundamental reflection of changes in the central bank objective function. It is often argued by proponents of the proactive view that dealing with the risks posed by financial imbalances involves the central bank tolerating some departure from the fundamental goal of price stability in the short-term. Operationally, (4.5) shows that this is precisely the outcome of a central bank that formulates policy with an explicit target for financial imbalances.

Secondly, the last term of (4.5) indicates that the higher the perceived degree of imbalance, the lower is the operational target for inflation because reducing financial imbalances requires higher interest rates. In some sense, this represents a form of 'negative inflation bias'. Indeed, when financial imbalances are perceived to be a concern even when macroeconomic conditions appear sound (when inflation and output gaps are zero for example) and the non-fundamental component of real asset returns is negligible, (4.5) indicates that optimal policy involves targeting a *negative* inflation gap. While such a response is optimal given the current model and loss function, it reflects a concern sometimes voiced that too much emphasis on financial imbalances when the immediate macroeconomic outlook is benign may be undesirable. In the words of Ferguson (2003), "…a financial stability objective that is accorded too much weight could, at the margin, impair the conduct of monetary policy in achieving macro ends" (p. 11). This naturally raises the question of whether the loss function adopted here is optimal from a social welfare perspective. This discussion is deferred until section 4.4.

While the analysis so far has not taken into account private sector expectations directly, doing so would highlight an additional problem that proactive policy is likely to face. In a situation where a central bank is known to *sometimes* move policy in direct response to financial imbalances, private agents will also have to figure out the central bank's threshold for these imbalances which would trigger a non-linear change in the

[20] It can be easily verified that when the central bank cares only about inflation, $u_x = u_f = 0$, (4.5) collapses to $\pi_{t+2,t} = \pi^*$ and inflation targeting is 'strict' in the sense that the central bank always tries to bring inflation back to target as quickly as possible.

[21] Since $\frac{\partial v_\pi}{\partial u_f} > 0$ as can be verified in appendix C.

reaction function. The conditions under which financial imbalance concerns will start to bind and result in deviation from normal policy will necessarily depend on the prevailing state of the economy in a highly subjective manner. A central bank that is known to be influenced by considerations other than inflation and output forecasts some of the time may therefore be perceived as being less transparent, with potentially adverse implications for credibility.[22]

Finally, an implicit assumption underlying the inclusion of a measure of financial imbalances in the objective function is that the risk of economic dislocation posed by these imbalances is more or less proportional to the policy setting. As emphasized by Bernanke (2002), it is not realistic to expect such a smooth and predictable relationship in practice. Even if one could identify with reasonable confidence that things are materially out of line, calibrating the appropriate policy response is still quite a daunting task given that the risks involved cannot be expressed precisely in terms of output and inflation forecasts. In the Bordo and Jeanne (2002) model, for example, proactive monetary policy is desired only when the risk of a bust is perceived as sufficiently large and the costs, in terms of lower output and inflation immediately, is relatively low. Given that the timing of a possible bust as well as the lags of policy is uncertain, the window of opportunity in practice—even if it can be identified—is likely to be quite small.[23]

4.2 Longer Horizons

It has been suggested that one potential shortcoming of inflation targeting and its ability to handle financial imbalances in practice stems from the fact that the typical policy horizon is too short.[24] The concern is that if policy is formulated primarily on forecasts up to two years ahead, the risks of financial imbalances imploding sometime in the more distant future may not be internalized. While such criticisms, taken at face value, may seem to suggest that an extension of the forecast horizon would be sufficient to address the problem, this would be a misinterpretation. As discussed below, these proposals

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[22] It could be argued though that such 'constructive ambiguity' might help to avoid moral hazard on the part of private agents (see Borio and Lowe (2002)).

[23] In general, it is likely that once policymakers can identify with reasonable confidence that a problem exists, the imbalances are already quite large and to be raising rates in this situation is like doubling up. It involves taking the gamble that tighter policy could still prevent a crash (and therefore a large gain to policymakers) but could end up exacerbating the situation if the crash occurs anyway (at large costs to the policymaker). In tightening, therefore, the risk of a downturn can actually *increase* and it is not always appropriate to think of this trade-off in certainty-equivalence terms (as in Bordo and Jeanne (2002)).

[24] See, for example, Borio and Lowe (2002), Bean (2003), and Borio and White (2004).

fundamentally reflect a dissatisfaction that really has nothing to do with policy horizons or inflation targeting *per se*. They have more to do with the underlying model used to formulate policy as well as the communication strategy used to explain policy actions. The problem is that much of the discussions are not based upon a precise definition of what is meant by 'the policy horizon' in an inflation targeting framework.

Too often, inflation targeting is identified with a mechanical adherence to a simple procedure whereby interest rates are set at the level which, given current conditions and expectations, brings inflation forecasts to the target over some fixed horizon (say, two years). This is partly the outcome of the heavy focus on transparency and accountability associated with inflation targeting frameworks which required a communication strategy that stressed the need for public understanding of the policy formation process as well as a clearly defined criterion for assessing the central bank's performance. The fact is, no major inflation targeting central bank formulates policy in such a simplistic and mechanical way. Nor do the mandates in most of them stipulate fixed horizons for the attainment of inflation targets.[25] The key essence of flexible inflation targeting, as set out for example in Bernanke (2004), is a commitment to a long-run numerical target for inflation that is consistent with the output and price stability goals of the central bank. The inflation rate target is explicitly a long-run objective with *no fixed time frame* for which it is to be reached. In practice, however, it is useful to focus policy on a horizon which is consistent with the lags of monetary policy and yet at the same time not too far ahead so as to maintain a reasonable degree of confidence about the forecasts. In practice, two years is often chosen as a reasonable horizon that satisfies these two criteria.

More formally, in the context of optimal policy analyzed in section 2, equations (2.7) and (A.12) in the appendix imply that the two-period ahead inflation forecast consistent with the interest rate at time t being set optimally is given by

$$\pi_{t+2,t} = \pi^* + \lambda_1(\pi_{t+1,t} - \pi^*) - (1-\lambda_1)\alpha_z \tilde{z}_{t+2,t} + \alpha_z z_{t+2,t} \qquad (4.6)$$

The optimal instrument setting is such that the deviation of the two-year conditional forecast of inflation from the long-run target is eliminated only gradually.[26] The fact that the two-period ahead conditional forecast of inflation becomes the intermediate target is because it corresponds to the horizon for assumed control lags in the model. It is the

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[25] The Reserve Bank of Australia and the Reserve Bank of New Zealand are good examples of the general flexibility accorded to inflation targeting central banks in the attainment of their inflation targets.

[26] This highlights an often neglected fact that flexible inflation forecast targeting implies only that the operational target be the conditional forecast of inflation, it does not imply that the latter has to be set equal to the target.

appropriate horizon to focus policy on simply because it is the horizon over which policy is believed to have its maximum impact. Outcomes at later dates can be influenced by later decisions. That said, judgments about future price pressures *beyond* the two period transmission lag do influence the policy setting today through the term $\tilde{z}_{t+2,t}$.[27]

Flexible inflation targeting, as characterized formally, therefore involves setting policy so that projected inflation at the horizon where policy is believed to have its greatest impact is converging to the medium-term target at a rate that optimally incorporates all relevant information that have marginal bearing on the central bank's goal variables in all future periods. It is a far cry from policy being set so that some fixed horizon inflation forecast is at the target. When inflation targeting is understood and defined closer to the way in which it is practiced, as a targeting rule, then much of the criticism that centers on its supposed rigidity no longer holds.

The above discussion highlights the importance of differentiating between the *horizon* chosen to calibrate policy and the *information* used to determine the policy stance. The latter can include judgments about factors that may affect output and inflation way out into the future. Given such information, however, it is useful operationally and communicatively to focus on how they affect the speed with which inflation is brought back to target at the horizon which policy has its greatest impact. A focus on a particular horizon for *calibrating* policy does not mean that information that have bearing on inflation further into the future is ignored. It is important to maintain a distinction between these two concepts in thinking about proposals for longer horizons.

The concept of horizon discussed so far, and indeed the only one that applies in the current setup, is that of the speed over which a given deviation of inflation from target is eliminated.[28] An alternative definition is the number of periods ahead which an inflation forecast should be formed in a 'forecast-based' instrument rule of the form

$$i_t = c + c_\pi(\pi_{t+T,t} - \pi^*) \qquad (4.7)$$

where c is a constant and $c_\pi > 1$. This corresponds to Batini and Nelson's (2001) definition of the 'optimal feedback horizon'. Adopting a longer horizon in this case

[27] Note that (4.6) is a forecast of inflation conditional on policy being set optimally. Such a forecast may not fully show the risks of overheating emanating from asset prices because they have already been incorporated in the choice of optimal policy. This should be clearly differentiated from inflation forecasts published by many inflation central banks that are based on unchanged policy.

[28] From (4.6), the rate at which inflation is brought back to target, λ_1, is a function policymaker's underlying preference (discount factor and relative weight on output gap stabilization) and the slope of the Phillips curve. As such, the optimal rate of convergence is essentially imposed in the specification of the model. There is thus no 'optimal' horizon as such in this type of setup.

implies setting T sufficiently large so that the risks of financial imbalances imploding can be captured.[29] Such a reaction function, however, is not optimal in the context of this paper. As discussed in Svensson (2003a), (4.7) also has several other undesirable features, not least of which is that it is associated with a loss function that is unlikely to be consistent with optimal welfare from society's point of view.

In any case, and irrespective of the way in which the policy horizon is defined or the inflation rate measured, tinkering with the time horizon over which policy is formulated will not address the underlying concern of those who actually call for longer horizons. That is because the real dissatisfaction does not really stem from the time horizon of policy, but rather the underlying model used to formulate policy. In fact, purely extending the horizon for inflation, regardless of the way in which it is done, will not capture the risks of financial imbalances imploding. *They must still be introduced into the forecasting model.* Given that the types of risks at issue here cannot be readily incorporated into central forecasts because the sizeable uncertainty in assessing the timing and magnitude of such extreme (tail-probability) events, what the argument for extending the horizon really boils down to is the incorporation of some concern that is not contained in the model. It reflects the fact that current forecasting models do not do a good enough job of capturing the dynamics of financial imbalances and their interplay with policy.

Recall that the optimal interest rate setting in (3.1) is a function not only of current state variables but also a discounted sum of expectations into the infinite future. The horizon considered in setting policy is therefore already quite long, and any concern about inflation in the future can in principle be incorporated into the decision-making process. In doing so, however, *the transmission mechanism must remain invariant.* Thus without making the risks associated with financial imbalances endogenous to policy, a pre-emptive tightening cannot be accommodated within the current setup because it would go against the assumed transmission mechanism. In this respect, the call for a longer horizon is really a call for policy to be based upon a different forecasting model that can incorporate the risks of financial imbalances imploding.[30]

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[29] Filardo (2003b) showed that for a given loss function, the optimal T depends positively on the persistence of shocks hitting the economy.

[30] Indeed, the case for a longer policy horizon would not hold up in the Bordo and Jeanne (2002) model, which involves only two periods, since the relevant financial imbalance effect is already built-in.

4.3 Balance of Risk Considerations

Another suggestion has been for central banks to focus more on balance of risk considerations.[31] While it is acknowledged that central banks typically already do so through consideration of the whole probability distribution of forecasts, the feeling was that not enough emphasis was placed on the possibility of boom-bust cycles. Given the assumption of certainty equivalence—associated with linear models and additive uncertainty—the focus of policy in this paper is on mean forecasts and such considerations are not directly supported by the current framework. Nevertheless, one can think of judgmental adjustments to the mean forecasts of output and inflation as reflecting these balance of risks concerns. When downside risks to the forecasts are substantial enough, for example, the forecasts are adjusted downwards through the vector $z_{t+i,t}$ in (3.1) and policy is loosened. Thus inflation targeting as described by targeting rules, in some respects, already do incorporate balance of risks considerations, *so long as they can be filtered through forecasts of the goal variables.*

That said, the model in this paper cannot accommodate the nature of balance of risks considerations proposed by advocates of the proactive view which are aimed at justifying pre-emptive policy. While the possibility of an asset price collapse in the future may, for example, lead to greater downside risks on inflation and output, it cannot motivate an *increase* in interest rates today to ward off that risk. As discussed previously, such policy actions can only be motivated through a fundamental change in the assumed transmission mechanism. From the perspective of this paper, therefore, the call for greater emphasis on balance of risks considerations is then again a reflection of a dissatisfaction with existing forecasting models used to guide policy. Against the backdrop of certainty equivalence, the dissatisfaction arises from the inability of mean forecasts to capture risks posed by financial imbalances, either because uncertainty about the model is thought to be non-additive or the transmission mechanism to contain large nonlinearities. As with calls for a lengthening of the policy horizon, greater consideration of balance of risk alone is not sufficient to motivate a policy action to pre-empt the risk of financial imbalances imploding unless the underlying model used to compute the probability distribution is modified also.

4.4 Towards a Synthesis

The preceding discussion highlights the fact that the proactive view is fundamentally a reflection of a discontent with the underlying model of the economy used

[31] See, for example, Borio and Lowe (2002), and Borio and White (2004).

to formulate policy. It is based on a view of the world where boom-bust cycles are not only inextricably linked to financial imbalances, but also that the likelihood and severity of an implosion can be influenced by policy. There are essentially two ways of incorporating such considerations within a policy framework. The first is to modify the model directly along the lines of Bordo and Jeanne (2002) and Filardo (2003) to capture this additional channel of transmission. As already argued, the technical challenges in this respect are quite formidable. The second way is through a modification of the loss function to explicitly include a concern for financial imbalances. This has been the approach of this paper and is conceptually equivalent to Svensson's (2003b) suggestion that concerns about financial instability be viewed as an additional constraint that binds only some of the time.

That a central bank which is predisposed towards policy actions to pre-empt the risks associated with developing financial imbalances would be guided by a separate operational objective on the latter, on top of output and inflation concerns, can be seen as a more practical alternative to constructing a complex model that makes these risks endogenous to policy. When financial imbalances are thought of as a form of intermediate target that has bearing on concerns of future economic instability, it may become easier for policymakers to form judgments on the appropriate policy action since the link between policy and financial imbalances are presumably more precise than that between policy and the probability of a crisis in the distant future. Thus in much the same way that inflation and output forecasts become intermediate targets in a forward looking flexible inflation targeting regime, a concern about future financial instability implies that financial imbalances become an additional intermediate target, which is traded-off against inflation and output forecasts.

Irrespective of how pre-emptive policy actions are motivated within a monetary policy framework, however, the practical implication is that greater tolerance will be accorded to departures of inflation from target because the central bank has to take into account an additional trade-off between price and output stability on the one hand, and financial imbalances on the other, either implicitly in the transmission mechanism or explicitly through the loss function. Viewed in this way, calls for longer horizons and greater consideration of balance of risks should really be seen as a *communication strategy* to justify a slower rate of convergence of inflation to target. Indeed, much of the criticism of the proactive view is really directed towards the rhetoric of inflation targeting central banks in practice that place heavy emphasis on justifying all policy actions with respect to a fixed-horizon inflation forecast. The Bank of England, for example, may have left the impression that inflation targeting is about setting policy in the mechanical manner described at the beginning of section 4.2 while actual policy formulation is much more complex. Consequently, when the relevant inflation forecast is within target, it becomes difficult to explain responses to factors that cannot be incorporated readily into these forecasts at the horizon emphasized.[32] It is very important, therefore, to ensure that the central bank's communication strategy does not lead to a situation where the maintenance of credibility becomes an unnecessary constraint on the flexibility of monetary policy. In this light, taking proposals for longer horizons and greater balance of risk considerations too literally may lead to a misinterpretation of their true intentions.

Finally, it is also worth pointing out that while the loss function adopted here is consistent with a utility-based approach to welfare analysis motivated from a micro-founded model with nominal rigidities (see Woodford (2003)), it is nevertheless ad-hoc in the context of this paper. Thus the reaction function obtained may not necessarily reflect optimality from a social welfare perspective. Indeed, within a framework in which financial imbalances can potentially exert large negative influence on consumption, it is not inconceivable that a loss function of the form (4.2) where concerns for financial imbalances appear explicitly would be the appropriate one from a utility-based welfare perspective. That said, since this paper is concerned more with the operational aspects of monetary policy and how central banks may respond to the risks posed by financial imbalances, the distinction is not of direct relevance to the key issues discussed here.

5. Conclusion

The central goal of this paper was not to make a case for or against the greater incorporation of asset prices and/or financial imbalances in monetary policy formulation. Rather, the emphasis has been on highlighting the underlying basis from which the answer to this question should really be made. Using the benchmark of optimal policy rules, the underlying motivation for incorporating asset prices or considerations of financial imbalances into policy was underscored and shown to be highly contingent on views not only about the transmission mechanism, but also the ability to extract from these imbalances information that are relevant to future macroeconomic developments. From this perspective, there is certainly a case to be made for developing better ways of accomplishing the latter. This would be in keeping with the 'look at everything' element of inflation targeting.

Nevertheless, while responding to information contained in financial imbalances that have direct bearing on future macro developments is relatively uncontroversial and can be motivated within a standard characterization of inflation targeting, the same cannot

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[32] This situation is reminiscent of the concern for output stabilization objectives which used to be, and in some cases still are, the 'dirty little secret' among central banks. See Mishkin (2004).

be said about acting to minimize the risks of them imploding. This paper has argued that given standard beliefs about the transmission mechanism, such actions are operationally equivalent to central banks targeting financial imbalances explicitly in their objective function. The fact that responding to financial imbalances in a pre-emptive way necessarily entails a modification of the loss function is essentially a consequence of the absence in the model of a link between policy and the possibility of financial imbalances imploding. Calls for a lengthening of the policy horizon or more attention to balance of risk considerations are fundamentally a reflection of a dissatisfaction with this aspect of available forecasting models rather than the framework of inflation targeting *per se*. Indeed, the paper reinforces the fact that these proposals are intended more as a communication device for justifying a rebalancing of policy priorities in the short-run towards concerns related to financial imbalances. That said, the practical aspect of extracting the relevant information from financial imbalances in a way that allows pre-emptive policy to be implemented remains extremely difficult.

Appendix A

The derivation of the solution is analogous to that of Svensson (2003a). The Lagrangian to the optimization problem in section 2.3 at time t can be formulated as

$$\mathcal{L}_t = \sum_{i=0}^{\infty} \delta^i \left\{ \frac{1}{2} \left[(\pi_{t+i,t} - \pi^*)^2 + u_x x_{t+i,t}^2 \right] + \delta \Psi_{t+i+1,t} \left(\pi_{t+i+1} - \pi_{t+i} - \alpha_x x_{t+i,t} - \alpha_z z_{t+i+1,t} \right) \right\} \quad \text{(A.1)}$$

where $\Psi_{t+i+1,t}$ is the Lagrange multiplier of constraint (2.7). Given assumed policy lags, the optimization is applicable only for $i \geq 1$ and the first-order conditions with respect to $\pi_{t+i+1,t}$ and $x_{t+i,t}$ are given, respectively, by

$$\pi_{t+i+1,t} - \pi^* + \Psi_{t+i+1,t} - \delta \Psi_{t+i+2,t} = 0 \quad \text{(A.2)}$$

and

$$u_x x_{t+i,t} - \delta \, \alpha_x \Psi_{t+i+1,t} = 0 \quad \text{(A.3)}$$

Combining (A.2) and (A.3) yields the consolidated first-order condition of

$$\pi_{t+i+1,t} - \pi^* = \frac{u_x}{\delta \, \alpha_x} \left(\delta x_{t+i+1,t} - x_{t+i,t} \right) \quad \text{(A.4)}$$

Substituting in for the output gap terms in (A.4) using (2.7) and rearranging yields a second-order difference equation of the form

$$(\pi_{t+i+2,t} - \pi^*) - k(\pi_{t+i+1,t} - \pi^*) + \frac{1}{\delta}(\pi_{t+i,t} - \pi^*) = -\frac{\alpha_z}{\delta}(z_{t+i+1,t} - \delta z_{t+i+2,t}) \quad \text{(A.5)}$$

where $k \equiv 1+\frac{1}{\delta}+\frac{\alpha_x^2}{u_x}$. Using the lag operator, L, (A.5) can be written more succinctly as

$$(1-kL+\frac{1}{\delta}L^2)(\pi_{t+i+2,t}-\pi^*)=-\frac{\alpha_z}{\delta}(z_{t+i+1,t}-\delta z_{t+i+2,t}) \qquad \text{(A.6)}$$

The polynomial in L can be factorized as

$$(1-kL+\frac{1}{\delta}L^2)=(1-\lambda_1 L)(1-\lambda_2 L)=1-(\lambda_1+\lambda_2)L+\lambda_1\lambda_2 L^2 \qquad \text{(A.7)}$$

Equating powers of L yields

$$k=\lambda_1+\lambda_2 \qquad \text{and} \qquad \frac{1}{\delta}=\lambda_1\lambda_2 \qquad \text{or} \qquad \frac{1}{\lambda_1\delta}=\lambda_2 \qquad \text{(A.8)}$$

Note that λ_1 and λ_2 are the roots of the characteristic equation

$$a^2-ka+\frac{1}{\delta}=0$$

and thus satisfy

$$a=\frac{k\pm\sqrt{k^2-\frac{4}{\delta}}}{2}.$$

Without loss of generality, let λ_1 be the smaller root. Then (A.8) implies that $0<\lambda_1<1<\frac{1}{\delta}<\lambda_2$. It can also be verified that λ_1 is an increasing function of u_x which fulfils $\lim_{u_x\to 0}\lambda_1=0$ and $\lim_{u_x\to\infty}\lambda_1=1$.

With this factorization, the difference equation (A.6) can be written as

$$(1-\lambda_1 L)(1-\lambda_2 L)(\pi_{t+i+2,t}-\pi^*)=-\frac{\alpha_z}{\delta}(z_{t+i+1,t}-\delta z_{t+i+2,t}) \qquad \text{(A.9)}$$

To ensure that the sums are finite, the unstable root, $\lambda_2>\frac{1}{\delta}$, must be solved forward. Applying the forward inverse of $(1-\lambda_2 L)$ on both sides of (A.9) yields

$$(1-\lambda_1 L)(\pi_{t+i+2,t}-\pi^*)=\frac{\alpha_z(\lambda_2 L)^{-1}}{\delta((1-(\lambda_2 L)^{-1})}(z_{t+i+1,t}-\delta z_{t+i+2,t}) \qquad \text{(A.10)}$$

where the arbitrary constant on the unstable root has been set to zero to ensure that the infinite sum on the right hand side remains finite. Finally using the fact that $\frac{1}{\lambda_1\delta}=\lambda_2$, this can be rewritten as

$$(\pi_{t+i+2,t} - \pi^*) = \lambda_1(\pi_{t+i+1,t} - \pi^*) + \alpha_z m_{t+i+1,t} \tag{A.11}$$

where

$$\begin{aligned} m_{t+i+1,t} &\equiv \lambda_1 \sum_{s=0}^{\infty} (\lambda_1 \delta)^s (z_{t+i+1+s,t} - \delta\ z_{t+i+2+s,t}) \\ &= \lambda_1 z_{t+i+1,t} - \lambda_1 \delta (1-\lambda_1) \sum_{s=0}^{\infty} (\lambda_1 \delta)^s z_{t+i+2+s,t} \\ &= z_{t+i+1,t} - (1-\lambda_1) \tilde{z}_{t+i+1,t}, \end{aligned}$$

with $\tilde{z}_{t+i,t} \equiv \sum_{s=0}^{\infty} (\lambda_1 \delta)^s z_{t+i+s,t}$.

Using (2.7) and (A.11), the output gap forecast can be expressed as

$$x_{t+i,t} = -\frac{(1-\lambda_1)}{\alpha_x} [(\pi_{t+i,t} - \pi^*) + \alpha_z \tilde{z}_{t+i+1,t}] \tag{A.12}$$

Substituting this expression into (2.10), the optimal interest rate setting in period t is given by

$$i_t = \pi_{t+1,t} + \frac{1}{\tilde{\beta}_r} \left[\beta_x x_t - \tilde{\beta}_q x_{t+1,t} + \beta_q \omega_b b_t + \beta_z z_{t+1,t} \right] \tag{A.13}$$

$$i_t = \pi_{t+1,t} + \frac{1}{\tilde{\beta}_r} \left[\beta_x x_t + \tilde{\beta}_q \frac{(1-\lambda_1)}{\alpha_x} [(\pi_{t+1,t} - \pi^*) + \alpha_z \tilde{z}_{t+2,t}] + \beta_q \omega_b b_t + \beta_z z_{t+1,t} \right]$$

$$\begin{aligned} i_t &= \pi^* + \left(1 + \frac{\tilde{\beta}_q (1-\lambda_1)}{\tilde{\beta}_r \alpha_x} \right) (\pi_{t+1,t} - \pi^*) + \frac{1}{\tilde{\beta}_r} \left[\beta_x x_t + \beta_q \omega_b b_t + \beta_z z_{t+1,t} \right] \\ &+ \frac{\tilde{\beta}_q (1-\lambda_1)}{\tilde{\beta}_r \alpha_x} \alpha_z \tilde{z}_{t+2,t} \end{aligned} \tag{A.14}$$

which can finally be transformed using the central bank's one-period ahead inflation forecast using (2.7) to yield

$$\begin{aligned} i_t &= \pi^* + m_\pi (\pi_t - \pi^*) + (\alpha_x m_\pi + \frac{\beta_x}{\tilde{\beta}_r}) x_t + \frac{\beta_q \omega_b}{\tilde{\beta}_r} b_t + (\alpha_z m_\pi + \frac{\beta_z}{\tilde{\beta}_r}) z_{t+1,t} \\ &+ (m_\pi - 1) \alpha_z \tilde{z}_{t+2,t} \end{aligned} \tag{A.15}$$

where $m_\pi \equiv 1 + \frac{\tilde{\beta}_q (1-\lambda_1)}{\tilde{\beta}_r \alpha_x} > 0$.

Appendix B

The problem of the central bank is to

$$\underset{i_t}{\text{minimize}}\ \frac{\delta^2}{2}\left[(\pi_{t+2,t}-\pi^*)^2+2\sigma_\varepsilon^2+(\alpha_x\beta_q)^2[(i_t-\pi_{t+1,1})^2\sigma_r^2+b_t^2\sigma_b^2-b_t(i_t-\pi_{t+1,1})\sigma_{rb}]+\alpha_x\sigma_\eta^2\right]$$

where σ_{rb} is the covariance between $v_{r,t}$ and $v_{b,t}$. The first order condition with respect to the interest rate is given by

$$(\pi_{t+2,t}-\pi^*)=\frac{\tilde{\beta}_q(\alpha_x\beta_q)^2}{\alpha_x\tilde{\beta}_r}\left[(i_t-\pi_{t+1,1})\sigma_r^2-b_t\sigma_{rb}\right] \tag{B.1}$$

Substituting in for $\pi_{t+2,t}$ using (3.6) and rearranging yields

$$i_t=\pi_{t+1,t}+\frac{V}{1+\sigma_r^2(\alpha_x\beta_q)^2V^2}\left[(\pi_{t+1,t}-\pi^*)+\frac{\alpha_x\beta_x}{\tilde{\beta}_q}x_t+\frac{\alpha_x\beta_q\omega_b}{\tilde{\beta}_q}b_t+(\alpha_x\beta_q)^2Vb_t\sigma_{rb}\right] \tag{B.2}$$

where $V\equiv\dfrac{\tilde{\beta}_{\mathrm{q}}}{\alpha_{\mathrm{x}}\tilde{\beta}_r}$.

Substituting in for $\pi_{t+1,t}$ above yields the optimal interest rate setting of

$$i_t=\pi^*+\tilde{m}_\pi(\pi_t-\pi^*)+\left(\alpha_x\tilde{m}_\pi+\frac{\alpha_x\beta_xV}{(1+\sigma_r^2(\alpha_x\beta_q)^2V^2)\tilde{\beta}_q}\right)x_t$$
$$+\frac{V}{1+\sigma_r^2(\alpha_x\beta_q)^2V^2}\left[\frac{\alpha_x\beta_q\omega_b}{\tilde{\beta}_q}+(\alpha_x\beta_q)^2V\sigma_{rb}\right]b_t$$

where $\tilde{m}_\pi\equiv1+\dfrac{V}{1+\sigma_r^2(\alpha_x\beta_q)^2V^2}$.

Appendix C

The central bank's measure of financial imbalances can be rewritten using (2.5) and (2.6) as

$$f_t=a_xx_{t+1,t}-a_r(i_t-\pi_{t+1,t})+a_bb_t+f_{t-1} \tag{C.1}$$

where $a_x\equiv(1-\alpha)(\theta_x+\theta_q\omega_x)+\alpha\ \omega_x$

$a_r\equiv(1-\alpha)(\theta_r+\theta_q\omega_r)+\alpha\ \omega_r$ and

$a_b\equiv(1-\alpha)\theta_q\omega_b+\alpha\ \omega_b$

As before, given the one-to-one correspondence between i_t and $x_{t+1,t}$, the problem can be solved using the latter as the control. Proceed by substituting out for the real interest rate in (C1) using (2.11) to obtain

$$f_t = c_x x_{t+1,t} - \frac{a_r \beta_x}{\tilde{\beta}_r} x_t - c_b b_t + f_{t-1}$$

where $c_x \equiv a_x + \frac{a_r \tilde{\beta}_q}{\tilde{\beta}_r}$ and $c_b \equiv \frac{a_r \beta_q \omega_b}{\tilde{\beta}_r} - a_b$.

The first order condition associated with minimizing (4.2) with respect to $x_{t+1,t}$ is then given by

$$\alpha_x \delta^2 (\pi_{t+1,t} - \pi^*) + m_x x_{t+1,t} + u_f c_x (f_{t-1} - \frac{a_r \beta_x}{\tilde{\beta}_r} x_t - c_b b_t - \bar{f}) = 0 \qquad \text{(C.2)}$$

where $m_x \equiv \alpha_x^2 \delta^2 + u_x \delta + u_f c_x^2$. Substituting in for the one-period-ahead forecasts of inflation and output gap using (2.7) and (2.11) yields after some manipulation

$$i_t = \pi^* + f_\pi (\pi_t - \pi^*) + f_x x_t + f_b b_t + f_f (f_{t-1} - \bar{f}) \qquad \text{(C.3)}$$

where $f_\pi \equiv (1 + \frac{\alpha_x \delta^2 \tilde{\beta}_q}{m_x \tilde{\beta}_r}) > 0$, $f_x \equiv \frac{\tilde{\beta}_q}{m_x \tilde{\beta}_r} \left[\alpha_x^2 \delta^2 + \frac{m_x (\beta_x + \alpha_x \tilde{\beta}_r)}{\tilde{\beta}_q} - \frac{u_f c_x a_r \beta_x)}{\tilde{\beta}_r} \right] > 0$

$$f_b \equiv \frac{\tilde{\beta}_q}{m_x \tilde{\beta}_r} \left[\frac{m_x \beta_q \omega_b}{\tilde{\beta}_q} - u_f c_x c_b \right] > 0, \text{ and } f_f \equiv \frac{u_f c_x \tilde{\beta}_q}{m_x \tilde{\beta}_r} > 0$$

That f_x and f_b are positive can be verified through direct substitution of m_x, c_b, and c_x into the expressions. It can also be easily verified that $\frac{\partial f_\pi}{\partial u_f} < 0$, $\frac{\partial f_x}{\partial u_f} < 0$, $\frac{\partial f_b}{\partial u_f} < 0$, and $\frac{\partial f_f}{\partial u_f} > 0$.

Finally, the two-period ahead conditional inflation forecast is given by (2.7) and (C.3) as

$$\pi_{t+2,t} = \pi^* + v_\pi (\pi_t - \pi^*) + v_x x_t + v_b b_t - v_f (f_{t-1} - \bar{f}) \qquad \text{(C.4)}$$

where $v_\pi \equiv (1 - \frac{\alpha_x^2 \delta^2}{m_x}) > 0$ $\qquad v_x \equiv \alpha_x \left(v_\pi + \frac{u_f c_x a_r \beta_x}{m_x \tilde{\beta}_r} \right) > 0$

$$v_b \equiv \frac{u_f \alpha_x c_x c_b}{m_x} > 0 \quad \text{and} \quad v_f \equiv \frac{u_f \alpha_x c_x}{m_x} > 0.$$

References

Ball, L. (1999), "Efficient Rules for Monetary Policy ," *International Finance*, Vol. 2, No. 1, pp. 63-83.

Batini, N. and E. Nelson (2001), "Optimal Horizons for Inflation Targeting," *Journal of Economic Dynamics and Control* 25, pp. 891-910.

Bean, C. (2003), "Asset Prices, Financial Imbalances and Monetary Policy: Are Inflation Targets Enough?" BIS Working Paper, No. 140.

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

Bernanke, B. and M. Gertler (1999), "Monetary Policy and Asset Price Volatility," Federal Reserve Bank of Kansas City, *Economic Review*, Fourth Quarter, pp. 17-51.

______, (2001), "Should Central Banks Respond to Movements in Asset Prices?" *American Economic Review*, Vol. 91, No. 2, May, pp. 253-57.

Bordo, M. and O. Jeanne (2002), "Monetary Policy and Asset Prices: Does 'Benign Neglect' Make Sense?" *International Finance*, Vol. 5, No. 2, pp. 139-164.

Borio, C., B. English and A. Filardo (2003), "A Tale of Two Perspectives: Old or New Challenges for Monetary Policy?" BIS Working Paper, No. 127.

Borio, C. and W. White (2004), "Whither Monetary and Financial Stability? The Implications of Evolving Policy Regimes," BIS Working Paper, No. 147.

Borio, C. and P. Lowe (2002), "Asset Prices, Financial and Monetary Stability: Exploring the Nexus," BIS Working Paper, No. 114.

______, (2004), "Securing Sustainable Price Stability: Should Credit Come Back From the Wilderness?" BIS Working Paper, No. 157.

Brainard, W. (1967), "Uncertainty and the Effectiveness of Policy," *American Economic Review Papers and Proceedings*, Vol. 57, pp. 411-425.

Cecchetti, S., H. Genberg, J. Lipsky and S. Wadhwani (2000), *Asset Prices and Monetary Policy*, International Centre for Monetary and Banking Studies, London.

Cecchetti, S., H. Genberg and S. Wadhwani (2002), "Asset Prices in a Flexible Inflation Targeting Framework," NBER Working Paper 8970.

Detken, C. and F. Smets (2004), "Asset Price Booms and Monetary Policy," ECB Working Paper No. 364.

Ferguson, R. (2003), "Should Financial Stability Be an Explicit Central Bank Objective?", in *Monetary Stability, Financial Stability and the Business Cycle: Five Views*, BIS Paper, No. 18.

Filardo, A. (2001), "Should Monetary Policy Respond to Asset Price Bubbles? Some Experimental Results," in G. Kaufman (ed.), *Asset Price Bubbles: Implications for Monetary and Regulatory Policies*, Amsterdam, Elsevier Science.

______, (2003a), "Monetary Policy and Asset Price Bubbles: Calibrating the Monetary Policy Tradeoffs," BIS Working Paper, No. 155.

______, (2003b), "The Enduring Core of Business Cycles," mimeo, BIS.

Goodfriend, M. (2003), "Interest Rate Policy Should Not React Directly to Asset Prices," in Hunter, W., G. Kaufman and M. Pomerleano eds., *Asset Price Bubbles: The Implications for Monetary, Regulatory, and International Policies*, MIT Press, Cambridge.

Gruen, D., M. Plumb and A. Stone (2003), "How Should Monetary Policy Respond to Asset-Price Bubbles?" Reserve Bank of Australia, Research Discussion Paper, 2003-11.

Issing, O. (2003), "Monetary and Financial Stability: Is There a Trade-Off?", in *Monetary Stability, Financial Stability and the Business Cycle: Five Views*, BIS Paper, No. 18.

Kent, C. and P. Lowe (1997), "Asset-Price Bubbles and Monetary Policy," Reserve Bank of Australia, Research Discussion Paper, 1997-09.

Mishkin, F. (2004), "Can Central Bank Transparency Go Too Far?", paper presented at the Reserve Bank of Australia's conference on *The Future of Inflation Targeting*, Sydney, August 9-10, 2004.

Mussa, M. (2003), "Remarks on Achieving Monetary and Financial Stability," in *Monetary Stability, Financial Stability and the Business Cycle: Five Views*, BIS Paper, No. 18.

Rudebusch, G. and L. Svensson (1999), "Policy Rules for Inflation Targeting," in Taylor J. (ed.), *Monetary Policy Rules*, Chicago University Press, Chicago, pp. 203-246.

Svensson, L. (2003a), "What Is Wrong with Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules," *Journal of Economic Literature* 41, pp. 426-477.

______, (2003b), "Monetary Policy and Real Stabilization," NBER Working Paper 9486.

______, (1997), "Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets," *European Economic Review* 41, pp. 1111-1146.

Svensson, L. and M. Woodford (2003), "Implementing Optimal Policy through Inflation-Forecast Targeting," NBER Working Paper 9747.

Woodford, M. (2004), "Inflation Targeting and Optimal Monetary Policy," Federal Reserve Bank of St. Louis *Review*, pp. 15-41.

______, (2003), *Interest and Prices*, Princeton University Press, Princeton.

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