Open-Economy Inflation-Forecast Targeting*

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Abstract

We study simple inflation-forecast targeting in an open-economy setting. Simple inflation-forecast targeting implies setting an interest rate which, if kept unchanged throughout the forecast-targeting horizon, produces a conditional inflation forecast equal to the inflation target at the end of the horizon. We find that the optimal forecast-targeting horizon is relatively short (one year). A longer horizon does not consistently contribute to improved output stability, indeed it increases exchange rate variability and traded sector variability. The targeting procedure is substantially inferior to the optimal pre-commitment policy. Moreover, the targeting procedure does not necessarily determine the rational expectations equilibrium and is subject to time inconsistency.

Keywords: Inflation targeting, forecast targeting, monetary policy, small open economy.

JEL codes: E52, E47, E43.

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1. Introduction

A large number of countries have either formally or more informally adopted inflation targeting as a framework for monetary policy throughout the 1990s. Following the idea that inflation targeting implies using all available information efficiently in minimizing the variance of inflation around a target level\(^1\) (possibly by stabilizing other variables as well), the implementation is left to the discretion of the analysts and policymakers in the respective central banks. Due to the traditional arguments of lags in the monetary policy transmission mechanism, e.g. as modeled in the influential article by Svensson (1997), the inflation forecast plays an important role in the conduct of monetary policy. The argument is that since the monetary policymaker’s instrument has its strongest impact on its goal variables several quarters ahead, optimal monetary policy is forward-looking and the instrument should respond to the determinants of future inflation (i.e., the forecast) and possibly other target variables. Since in most models, nominal inertia induces a trade-off between nominal and real variability, the inflation-targeting central bank should aim to bring inflation in line with the target over time. Short-sightedness should be avoided, since such a policy could produce high output and interest rate volatility. In the open economy, the exchange rate channel opens the possibility of stabilizing inflation at a very short horizon, leading to high real variability (Svensson, 2000).\(^2\)

This paper extends previous research on the implications of a simple inflation-forecast targeting strategy where the central bank sets an interest rate which, if kept unchanged throughout the forecast-targeting horizon, produces a conditional inflation forecast equal to the inflation target at the end of the horizon. If the constant-interest-rate forecast shows that inflation will miss the target, the interest rate is changed appropriately so as to bring the inflation forecast on target. This rule has seemingly strong intuitive appeal: the monetary policy stance is set in such a way that if the economy evolves as expected, the inflation target will be achieved at the given horizon.

The simplicity of this procedure for implementing inflation targeting makes it attractive as an operational guideline for practical inflation-targeting policymaking. Several researchers and policymakers claim that the inflation-forecast targeting procedure constitutes such a guideline for inflation-targeting central banks. Charles Goodhart, former member of the UK Monetary Policy Committee states:

\(^{\text{a}}\)When I was a member of the MPC I thought that I was trying, at each

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\(^1\)Lars Svensson suggests this definition of inflation targeting in several papers, for instance (Svensson, 1999b, 2000).

\(^2\)See also Leitemo and Røisland (2002).
forecast round, to set the level of interest rates so that, without the need for future rate changes, prospective (forecast) inflation would on average equal that target at the policy horizon. This was, I thought, what the exercise was supposed to be.” (Goodhart, 2001, p.175)

Lars Svensson asks whether it is possible to provide more optimal, but still operational, targeting rules than the Bank of England’s and the Riksbank’s “the constant-interest-rate inflation forecast about two years ahead should equal the inflation target?” (Svensson, 2003, p.57)

Some of the inflation-targeting central banks have expressed that their policy is consistent with inflation-forecast targeting. Svein Gjedrem, the Governor of the Central Bank of Norway, states that

“The key rate is set on the basis of an overall assessment of the inflation outlook two years ahead. If it appears that inflation will be higher than 2 per cent with unchanged interest rates, the interest rate will be increased. If it appears that inflation will be lower than 2 per cent with unchanged interest rates, the interest rate will be reduced.” (Gjedrem, 2002)

Claes Berg, chief economist at Bank of Sweden, states:

“The principles for monetary policy decisions can be formulated as a simple rule of thumb: if the inflation forecast, based on an unchanged repo rate, is in line with the target at the suitable horizon, then the monetary stance is appropriate; if the forecast is above (below) the inflation target, then the monetary stance is too expansionary (restrictive) and the repo rate should be raised (lowered) immediately or in the near future. As this rule of thumb refers to an inflation forecast with the instrument rate unchanged, it is natural for the Riksbank to present its forecasts accordingly.” (Berg, 2000)

In this regard, inflation-forecast targeting seems empirically relevant. It is discussed in Rudebusch and Svensson (1999) and Leitemo (2003) within a closed-economy framework. In this paper, a particular emphasis is put on describing how the forecast-targeting horizon effects the traded and non-traded sectors through implied exchange-rate and interest-rate dynamics and what role the choice of horizon plays in determining the rational expectations equilibrium. Moreover, the paper also discusses what role the inflation...
target plays in pinning down long-run inflation expectations under inflation-forecast targeting.

In the first part of this paper, we analytically show within a large class of models that inflation-forecast targeting requires stronger movements in the interest rate if the forecast-targeting horizon is relatively short. If a shock hits the economy, the policymaker needs to stabilise the inflationary impulses quickly which requires strong interest rate responses to the factors determining future inflation. There are two reasons for this argument. First, with a longer forecast-targeting horizon, there is less need for strong interest rate responses since the policy multiplier increases with the forecast-targeting horizon: a given monetary policy stance has a stronger effect the longer its remains in effect. Second, in models that respect the long-run superneutrality of monetary policy, the equilibrium rate of inflation is achieved without monetary policy following a state-contingent rule, but rather satisfies the equilibrium conditions for having long-run inflation rate equal to target. Extending the forecast-targeting horizon brings it closer to the time it takes for the nominal inertia to have worked itself out and the equilibrium rate of inflation achieved. Hence, a longer forecast-targeting horizon implies a greater degree of interest-rate stabilization around its equilibrium rate.

In the second part of the paper, we address the properties of inflation-forecast targeting in a small open economy. We present an open-economy macroeconomic model similar to the one-sector model developed by Batini and Haldane (1999). We extend their model by including a competitive traded sector in order to refine the view on the effect of monetary policy on the real economy. Our main findings from the analysis are the following. First, we find that the optimal horizon for a policymaker that cares equally about inflation and output variability is relatively short, about four quarters. The optimal horizon is extended to six quarters if the policymaker is also concerned about interest-rate smoothing. Extending the forecast-targeting horizon increases inflation variability, but, more surprisingly, does not consistently reduce output stability. Second, as the forecast-targeting horizon increases, real exchange rate variability increases while real interest rate variability falls. As inflation is brought back to target more slowly, there is more persistence in the real interest rate which has a strong impact on the forward-looking exchange rate. Since the real exchange rate affects the traded sector relatively more than it does the non-traded sector, extending the forecast-targeting horizon tends to increase traded-sector variability. Third, the rational expectations equilibrium may or may not be determined under fore-

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3 Ball (2000) argues that monetary policy analysis should be carried out within multi-sector models in order to shed light on the role and sectoral influence of the exchange rate in monetary policymaking.
cast targeting, but indeterminacy may be more prevailing at longer forecast-targeting horizons where interest rate responses are weaker. If the nominal interest rate does not react sufficiently to shocks that increase inflationary expectations, the real interest rate may fall and the so-called Taylor principle will not be satisfied.

The paper is organised as follows. Section 2 starts by formally defining inflation-forecast targeting and thereafter discusses some issues in forecast targeting that is fairly model independent. Section 3 considers the open-economy model with nominal inertia and transmission lags. Section 4 first discusses issues related to the determinacy of the rational expectations equilibrium under inflation-forecast targeting. The stabilizing properties of the model under inflation-forecast targeting are then considered. Section 5 concludes.

2. Inflation-forecast targeting

Simple inflation-forecast targeting is denoted by a policy that sets the interest rate in accordance with the following rule

\[ \pi_{t+h|t}(\bar{\pi}) = \pi^*. \]  

(2.1)

where \( \pi_{t+h|t}(\bar{\pi}) \) is the forecast of the four-quarter inflation rate given in period \( t \) for period \( t + h \), conditional on a unchanged interest rate in the forecast-targeting horizon. \( \pi^* \) is the inflation target. The targeting procedure implies that the interest rate in period \( t \) is set so as to have the constant-interest-rate inflation forecast equal to the target level. If the interest rate from then on is unchanged throughout the horizon and the economy evolves as expected, inflation will be on target in period \( t + h \). Our definition of (simple) inflation-forecast targeting is distinct from optimal inflation-forecast targeting, explored in Svensson and Woodford (1999) and Svensson (2003), where the forecasts of the target variables satisfy the first-order conditions for minimizing a quadratic loss function. Simple and optimal inflation-forecast targeting will, however, coincide when the forecast-targeting horizon is equal to the inflation control lag and inflation is the only argument in the loss function.\(^4\)

Our definition of inflation-forecast targeting is different from the inflation-forecast-based (IFB) instrument rules proposed by among others Batini and Haldane (1999), Batini and Nelson (2001) and Leitemo (2000). Using IFB rules, the central bank makes

\(^4\)Smets (2003) discusses another forecast-targeting procedure, where the central bank minimises a loss function subject to inflation being back on target within a specified time period.
the interest rate a direct function of the inflation forecast deviations\(^5\) from target at some given forecast-feedback horizon. The interest rate deviation from the equilibrium rate moves proportionally to any changes in deviation of the inflation forecast from target. The procedure deviates from the targeting procedure in this paper in several ways. First, using IFB rules, there is nothing that ensures that the resulting interest rate would bring expected inflation back to target by the end of the forecast-feedback horizon. Indeed, it is a requirement for the interest rate to deviate from its equilibrium value that it does not. Second, the factor of proportionality is not pinned down by the IFB procedure and must be derived by some other procedure, e.g., minimizing the welfare loss with respect to this factor. Third, IFB rules are instrument rules as opposed to targeting rules, i.e., they specify requirements for the interest rate as opposed to the target variables.

Several central banks provide constant-interest-rate projections of inflation in their inflation reports and discuss their policy stance in relation to these projections.\(^6\) These projections show the most likely outcome of inflation if the policy stance is kept unchanged, thereby providing a helpful benchmark to guide further policy assessment (See, e.g. Bank of England, 2001, p.58). Goodhart (2001, p.172) notes that “[T]he forecasts, conditioned on constant interest rates, is the more important for U.K. policymaking purposes.” He argues furthermore that the constant-interest-rate assumption “simplifies the decision-making process, making it easier to understand and to explain publicly;... and encourages the MPC to act in a robust, preemptive fashion.” (p.181) Providing constant-interest-rate forecasts is much simpler than providing fully policy-consistent forecast, as the policymakers do not have to take a stand on future interest-rate movements. From a practical point of view, constant-interest-rate forecasts are very convenient.

2.1. Time inconsistency

Inflation-forecast targeting does not necessarily imply that inflation will be back on target at the end of the \(h\)-period forecast-targeting horizon. Under inflation-forecast targeting, the chosen interest rate will attain the inflation target (in expectations) provided that the interest rate is kept unchanged within the forecast-targeting horizon. If the central bank, however, conducts inflation-forecast targeting also in subsequent periods, the condition of interest rate constancy will in general not be valid. The reason for this is that as time passes, the end of the forecast-targeting horizon moves forward and the relevant

\(^5\)Forecasts may either be policy-consistent as in Batini and Haldane (1999) and Batini and Nelson (2001), or based on an unchanged interest rate, as in Leitemo (2000).

\(^6\)In fact, the only central banks that currently provide internal forecasts of the short-term interest rate and hence fully policy-consistent inflation forecast, are the The Reserve Bank of New Zealand and the Czech National Bank.
forecast horizon changes and may necessitate a change in the interest rate. For these reason inflation-forecast targeting is time inconsistent (see also Leitemo, 2003). The time inconsistency implies that the expected time at which inflation would have returned to its target level, the policy targeting horizon, is longer than the forecast-targeting horizon. The policy will, however, be time consistent if the forecast-targeting horizon is equal to the inflation control lag. Future changes to the interest rate will then only affect inflation forecasts at horizons beyond the forecast-targeting horizon.

This form of time inconsistency may not be as harmless as it may seem at first sight. As a constant-interest-rate inflation forecast potentially deviates considerably from the rational expectations path, it may contain limited information for agents who strive to base their nominal contracts on the most likely future development of inflation. For agents who do not understand the time-inconsistency implications of inflation-forecast targeting, the updating of policy each period which creates the “postponement” of the time at which inflation should attain its target level, may be interpreted as the central bank not being fully committed to its stated inflation target. Such beliefs would possibly induce a loss of credibility for the central bank and be a problem for reasons outlined in Svensson (1999a). If private agents do not believe inflation will quickly stabilise around the announced inflation target, the informational content of the target is reduced and agents will undertake the costs of forming expectations based upon other indicators with larger informational content. This may reduce the central bank’s ability to stabilise inflation without causing large output movements, i.e., increase the sacrifice ratio.

2.2. Long-run inflation expectations

Does inflation-forecast targeting provide an anchor for long-run or unconditional inflation expectations? The answer is simple, yet important. Assuming that there is symmetric information between the monetary authorities and the private agents in the economy, any deviations of long-run inflation expectations from target makes the inflation-forecast targeter adjust the interest rate in an either contractionary or expansionary manner and brings the expectations in line with the target. Since private agents know this, there are no reasons for long-run inflation expectations to deviate from the target level in the first place. However, considering the time inconsistency matters, it is important to note that long run may mean the very long run, especially if the forecast-targeting horizon is relatively long.

If the economy features long-run superneutrality, the choice of the inflation target does not influence any unconditional moments of real variables, in particular, the real
interest rate. Using the relationship between the nominal and real interest rate, given by the Fisher equation,

\[ E[i_t] = E[r_t] + E[\pi_{t+1}], \]  

(2.2)
yields that the unconditional inflation expectations are determined by the unconditional expected value of the policy instrument. Then setting the nominal interest rate so that it hovers around a level given by

\[ i^*_t = E[r_t] + \pi^*, \]  

(2.3)
in such a way that \( E[i_t] = E[i^*_t] \) ensures that \( E[\pi_{t+1}] = \pi^* \), and the inflation target plays the role of pinning down inflation expectations. If the inflation-forecast targeter adjusts the interest rate around the equilibrium nominal interest rate, the targeting procedure ensures that long-run inflation expectations equals the inflation target.

However, before being able to consider the issue of long-run inflation expectations, the price level must be determinate. Price-level determinacy was initially discussed in Sargent and Wallace (1975). They note that using the interest rate as the monetary-policy instrument is not likely to produce a determinate price level, because one interest rate level may support an infinitum of price levels. McCallum (1981) shows, however, that this result only hold when the interest rate does not respond sufficiently to a nominal variable (e.g., inflation). Accordingly, forecast-targeting may not provide determinacy of the price level if the implied interest-rate movements do not fulfill this requirement. Determinacy-issues are however related to the particular model in question; forecast-targeting does not a priori ensure that the determinacy requirements are fulfilled.

2.3. Some interest rate implications

In this section we derive some implications for the setting of the interest rate under inflation-forecast targeting for a large class of models. We allow the central bank to target the conditional forecast of output in addition to the forecast of inflation. A policy that targets the forecast of other variables as well as inflation, can be denoted by flexible inflation-forecast targeting.

The inflation-forecast targeting central bank is concerned with choosing an interest rate in each period that minimises its loss function given by

\[ L_t = \frac{1}{2} \left[ \theta (\bar{\pi}_{t+h|t} (i) - \pi^*)^2 + (1 - \theta) (y_{t+h|t}(i) - y^*)^2 \right], \]  

(2.4)
where $\tilde{\pi}_{t+h|t}(\tilde{i})$ and $y_{t+h|t}(\tilde{i})$ are the constant-interest-rate forecasts of four-quarter inflation and output respectively, and $y^*$ is the output target, assumed to be equal to the equilibrium output. For the remainder of the paper, the inflation target ($\pi^*$) and equilibrium output ($y^*$) are both normalised to zero. According to (2.4), the central bank is concerned with having both the forecast of inflation and output gap close to their target or equilibrium values. $\theta \in [0.5, 1]$ reflects the central bank preference for inflation forecast stabilization relative to output forecast stabilization.\(^7\) A lower value reflects a central bank that is relatively more concerned about stabilizing the output forecast. The first order condition of (2.4) is

$$
\theta \frac{\partial \tilde{\pi}_{t+h|t}(\tilde{i})}{\partial i} \tilde{\pi}_{t+h|t}(\tilde{i}) + (1 - \theta) \frac{\partial y_{t+h|t}(\tilde{i})}{\partial i} y_{t+h|t}(\tilde{i}) = 0. \quad (2.5)
$$

According to (2.5), the central bank targets a weighted average of the inflation and output forecasts. The weights are partly determined by the preferences of the central bank, but also by the policy multipliers, i.e. the effect a change in the interest rate has on the respective forecasts. An inflation-forecast targeting central bank with preferences for output forecast targeting, i.e. $\theta < 1$, accepts over- or undershooting of the target in accordance with the distance of the forecast of output from the natural rate. This can easily be seen by rearranging (2.5) as

$$
\tilde{\pi}_{t+h|t}(\tilde{i}) = -\frac{(1 - \theta)}{\theta} \frac{\partial y_{t+h|t}(\tilde{i})}{\partial i} y_{t+h|t}(\tilde{i}), \quad (2.6)
$$

which implies that the central bank accepts deviations of forecasted inflation from the target, conditional on the output gap. If the output forecast is well below the natural rate, the inflation target rises above its normal rate, e.g. to the upper level of a target band. Equation (2.1) is equivalent to equation (2.6) when $\theta = 1$, that is, under strict inflation-forecast targeting.

In order to derive the policy implications, i.e. the interest rate reaction function, under this procedure, consider a general backward-looking model in state space form\(^8\)

$$
X_{t+1} = AX_t + Bi_t + \epsilon_{t+1}, \quad (2.7)
$$

\(^7\)It seems appropriate to restrict $\theta$ downwards to a value of 0.5, as a smaller number would be more in line with output-forecast targeting than inflation-forecast targeting.

\(^8\)See Leitemo (2003) for the derivation of policy in the context of models with forward-looking behaviour.
where $X$ is a vector of state variables; $i$ is the policy instrument, i.e. the short nominal interest rate within our framework, and $\epsilon$ is a vector of disturbance terms with zero expectations and finite variance. $A$ is the transition matrix of the model and $B$ is the vector of parameters describing the direct effects of the interest rate. By subsequent substitutions, the $h$-period-ahead forecast is written as

$$X_{t+h|t} = A^h X_t + \sum_{j=0}^{h-1} A^j B i_{t+h-j|t},$$

(2.8)

where the forecast of the state variables is a function of the state of the economy at the time of the forecast, the policy assumptions in the forecast period and the economic model being analyzed. Under the assumption that the interest rate is kept unchanged in the forecast period, $i_{t+j|t}(\bar{i}) = i_t$ for $h > j \geq 0$, we can write the constant-interest-rate forecast of the state variables as

$$X_{t+h|t}(\bar{i}) = A^h X_t + \sum_{j=0}^{h-1} A^j B i_t.$$

(2.9)

We may also write the target variables as functions of the state variables

$$\bar{\pi}_t = K_\pi X_t,$$
$$y_t = K_y X_t,$$

where $K_\pi$ and $K_y$ are vectors that relate inflation and output to the state vector.

Correspondingly, the constant-interest-rate forecasts of the target variables are then given by $\bar{\pi}_{t+h|t}(\bar{i}) = K_\pi X_{t+h|t}(\bar{i})$ and $y_{t+h|t}(\bar{i}) = K_y X_{t+h|t}(\bar{i})$. Using (2.9), we can write these forecasts as functions of the interest rate and the current state,

$$\bar{\pi}_{t+h|t}(\bar{i}) = K_\pi A^h X_t + K_\pi \sum_{j=0}^{h-1} A^j B i_t,$$
$$y_{t+h|t}(\bar{i}) = K_y A^h X_t + K_y \sum_{j=0}^{h-1} A^j B i_t,$$

(2.9)
where the policy multipliers associated with the inflation and output forecasts are
\[
\frac{\partial \pi_{t+h|t}}{\partial i} = K_\pi \sum_{j=0}^{h-1} A^j B,
\]
\[
\frac{\partial y_{t+h|t}}{\partial i} = K_y \sum_{j=0}^{h-1} A^j B.
\]

Substituting the expressions for the forecasts and the policy multipliers into (2.5) gives
\[
\theta K_\pi \sum_{j=0}^{h-1} A^j B \left[ K_\pi A^h X_t + K_\pi \sum_{j=0}^{h-1} A^j B i_t \right] + (1-\theta) K_y \sum_{j=0}^{h-1} A^j B \left[ K_y A^h X_t + K_y \sum_{j=0}^{h-1} A^j B i_t \right] = 0,
\]
which may be expressed in terms of the interest rate as
\[
i_t = -\frac{\Omega}{\Omega \sum_{j=0}^{h-1} A^j} A^h X_t,
\]
where \(\Omega = \left( \theta K_\pi \sum_{j=0}^{h-1} A^j B K_\pi + (1-\theta) K_y \sum_{j=0}^{h-1} A^j B K_y \right)\). Equation (2.10) denotes

**Proposition 1**

*Given that \(A\) is positive semi-definite and has eigenvalues within the unit circle, extending the length of the forecast-targeting horizon reduces the absolute value of the coefficients in the reaction function (2.10).*

There are two independent effects that produce this outcome. The first, which refers to \(\sum_{j=0}^{h-1} A^j B\) in the denominator of (2.10), is the effect of the interest rate level on the forecast when extending the inflation-forecast targeting horizon. A given unchanged interest rate level is more effective in influencing the determinants of the forecasts if it remains in place for a longer period of time. Thus, the reaction to the underlying determinants does not have to be as strong as under a shorter forecast-targeting horizon. The second effect refers to the inherent properties of the forecasting model and its transition matrix, \(A\). If \(A\) is ‘stable’, that is, has all eigenvalues within the unit circle, the state variables in the model will approach their equilibrium values even without any response from policy since \(A^h \to 0\) as \(h \to \infty\). For an important class of models, however, the latter condition will fail to hold. For example, if the pricing schedule gives rise to an
expectations-augmented Phillips curve, there will be a unit root in the $A$ matrix, and the model is not self-stabilizing with respect to the inflation rate. The first effect will still ensure that a longer forecast-targeting horizon will imply a less aggressive interest-rate setting. In the limit, the central bank only satisfies the conditions for having the unconditional expected inflation on target.

Most properties of forecast-targeting are dependent upon the model. In particular, the effect for forward-looking expectation formation may influence its properties. We now turn to addressing some of the issues inflation-forecast targeting give rise to in an open economy setting. The next section considers the an open-economy model with rational expectation formation and moreover includes numerous transmission lags that gives a rational for targeting the forecast of inflation.

3. An open-economy policy model

We use an open-economy model with a traded and a non-traded sector, which is an extended version of the model in Blake and Westaway (1996) and Batini and Haldane (1999). The model is in the New Keynesian tradition and features price inertia. There is monopolistic competition in the non-traded sector. Output in this sector is hence restricted by demand. Monetary policy influences demand through the short-term real interest rate and expectations about its future development. The traded sector operates in a perfectly competitive market and takes prices as given.

All variables, except the interest rate, are measured as log deviations from their (possibly time-varying) long-run equilibrium values which are assumed to be independent of monetary policy. To make notation easier to read, we generally write $x_{t+s}$.

The supply function of the traded sector is given by

$$y_{t+1} = \rho_T y_t + \beta \sum_{s=0}^{\infty} \delta^s (p_{t+1+s} - p_{t+1+s}) + u_{t+1},$$

(3.1)

where $y_T$ denotes traded sector output, $p_T$ is the price of the traded good and $p$ is the domestic price level. $u^T$ is a white-noise traded sector output (productivity) shock. The representative traded sector firm is a price taker in the international, competitive market,
and the traded sector good price is given by

\[ p^T_t = s_t + p^f_t, \]  

(3.2)

where \( s \) is the nominal exchange rate and \( p^f \) is the foreign price level. The producer real price \( p^T_t - p_t \) is therefore equal to the real exchange rate, i.e., \( q_t \equiv p^T_t - p_t \).

The supply of traded sector goods increase in the producer real price. Owing to adjustment costs, the firms set production in a smoothed manner by not deviating too strongly from the production level in the previous period. Adjustment costs introduce a role for forward-looking behaviour, as production adjustment today may limit the magnitude of such costs tomorrow. Firms are assumed to exploit this and employ resources to produce rational forecasts of producer real prices and react to these forecasts. There is a one-period planning and implementation horizon which implies that firms make production decisions with a one-period lead and are hence based upon a one-period lagged information set. \( 0 < 1 - \delta < 1 \) captures the rate at which traded sector firms “discount” information about expected future producer real prices. This parameter is treated exogenously in our model. However, higher adjustment costs, higher start-up or closure costs pertaining to production facilities may make information about the future more important to the firm and are expected to raise the value of \( \delta \). Higher costs of producing rational forecasts may reduce the extent to which firms exhibit forward-looking behaviour, and hence be reflected in a lower value of \( \delta \). By taking expectations in (3.1) and using the lead operator,\(^{10}\) expected production may be expressed as

\[ y_{t+1}^T = \rho_T y_t^T + \frac{\beta (p^T_{t+1} - p_{t+1})}{(1 - \delta F)}. \]

This expression can be rearranged to the form \((1 - \rho_T L)(1 - \delta F)y_{t+1}[t] = \beta(p^T_{t+1}[t] - p_{t+1}[t]).\) Combined with the fact that production is predetermined one period in advance, traded sector output can be expressed conveniently as

\[ y_{t+1}^T = \frac{\rho_T}{1 + \delta \rho_T} y_t^T + \frac{\delta}{1 + \delta \rho_T} y_{t+2}^T + \frac{\beta}{1 + \delta \rho_T} (p^T_{t+1}[t] - p_{t+1}[t]) + u_{t+1}. \]

(3.3)

Whereas production in the traded sector is assumed to be determined by producer real wages, we assume that the non-traded sector operates in a market of monopolistic competition and that aggregate sector output is restricted by demand. Demand for the

\(^{10}\)The lead operator, \( F \), is defined as \( F x_{s}[t] \equiv x_{s+1}[t]. \)
non-traded good is assumed to be given by

\[ y_{t+1}^N = \rho y_t^N - \alpha(\omega R_t + (1 - \omega) r_t) + \kappa(p_T^t - p_t) + u_{t+1}^N, \quad (3.4) \]

where \( y^N \) is non-traded sector output, \( r \) is the short-term real interest rate, given by the Fisher equation

\[ r_t \equiv i_t - 4(p_{t+1|t} - p_t), \quad (3.5) \]

\( R \) is the long-term real interest rate given by the expectations hypothesis as

\[ R_t = \frac{1}{\tau} \sum_{s=t}^{t+\tau} r_{s|t}, \quad (3.6) \]

and \( u^N \) is a white-noise demand shock.

Due to intertemporal substitution effects in consumption, non-traded output may deviate from its equilibrium level. Demand is affected by the whole expected future path of the short real interest rate as consumers exploit the intertemporal substitution possibilities. In this paper, however, we assume that demand directed towards the non-traded sector is affected in particular by the short-term real interest rate due to the prevalence of floating-rate debt instruments in many countries. We also assume that consumers may to some extent substitute non-traded goods for traded goods in consumption depending on the relative price. Furthermore, in order for the model to replicate the smoothed movements in output, persistence in demand has been included. Persistence can be justified by the consumers being subject to habit-formation (see Fuhrer, 2000).

Aggregate output is given by

\[ y_t = \eta y_t^T + (1 - \eta) y_t^N, \quad (3.7) \]

where \( \eta \) is the equilibrium traded sector share of aggregate output.

We assume that domestic prices (the price on the non-traded sector good) are given by a simple New Keynesian Phillips curve (see Clarida et al. (2002)) that allows for inflation persistence

\[ \pi_t = \phi \pi_{t+1|t} + (1 - \phi) \pi_{t-1} + \gamma y_t + \mu q_t + \epsilon_t, \quad (3.8) \]

where we assume that marginal costs are affected both by the domestic degree of resource utilization and the real exchange rate, representing the effect of imported goods prices on the costs of inputs in production. The New Keynesian Phillips curve seems to describe inflation well in many countries and is therefore convenient for studying the effects of
inflation-forecast targeting.\textsuperscript{11}

The consumer price inflation is given by a weighted average of non-traded and traded goods prices

\[
\pi_C^t = (1 - \psi)\pi_t + \psi\pi^T_t \\
= (1 - \psi)\pi_t + \psi(\Delta s_t + \Delta p_f^t) \\
= \pi_t + \psi(\Delta s_t + \pi^f_t - \pi_t) \\
= \pi_t + \psi \Delta q_t.
\]

The exchange rate is determined by the uncovered interest rate parity condition,

\[
q_t = q_{t+1}\left(1 - \frac{1}{4}(r_t - r_f^t)\right),
\]
where $q$ is the real exchange rate and $r_f^t$ is the foreign “risk-premium corrected” real interest rate, assumed to follow an exogenous autoregressive process of order one, $r_{t+1}^f = \rho r_t^f + u_{t+1}^f$.

We assume that the policymaker targeting the four-quarter CPI inflation forecast. The loss function that is minimized in each period subject to the model is thus given by

\[
L_t = \frac{1}{2} \left[ \theta (\bar{\pi}_{t+h\mid t}^C (\bar{\pi}) - \pi^*)^2 + (1 - \theta) (\bar{y}_{t+h\mid t} (\bar{\pi}) - y^*)^2 \right].
\]

3.1. A brief account of the transmission mechanism

The transmission mechanism of monetary policy works through several channels that influence both aggregate demand and supply. First, interest rate movements affects demand for non-traded goods due to intertemporal substitution effects, both directly through the short-term interest rate channel and indirectly, by affecting expectations about future interest-rate movements, through the long-term interest rate channel. The expectations about future interest rate movements also affects the exchange rate. The direct exchange-rate channel affects imported goods prices and the indirect exchange-rate or expenditure switching channel affects the price of non-traded sector goods relative to traded sector goods and thus demand non-traded goods demand. Domestic prices are affected by marginal costs, assumed to be a linear function of the aggregate output gap, representing the aggregate demand channel, and the real exchange rate, representing the foreign price influence on factors of production. Since expectations about future interest

\textsuperscript{11}See, among others, Batini and Nelson (2001), Batini and Haldane (1999) and Rudebusch (2002).
rate setting affect contemporaneous private-sector decision-making, the monetary policy expectations channels enhance the effectiveness of the other channels.

3.2. Parameterisation

A detailed account of the parameterisation of the model is given in Appendix A. As stated above, most of the parameter values were obtained from Batini and Haldane (1999) and Batini and Nelson (2001) who calibrate their model to the UK economy. Other parameters are set at values that do not seem a priori unreasonable for a small open economy. In any case, the qualitative properties of the model are robust to reasonable changes in the parameter values. The parameters used are given in Table 3.1.

In order to provide a simple evaluation of whether the model provides a plausible account of the degree of persistence, Figure 3.1 shows the impulse response functions for several variables under a simple Taylor (1993) rule of the conventional form $i_t = 1.5\pi_t + 0.5y_t$. The results do not seem unreasonable. The policymaker achieves full stabilization after 16-20 quarters for cost-push and risk-premium shocks, and after a slightly shorter period for the two remaining shocks.

In order to obtain estimates of the variance of shocks (except the foreign real interest rate shock) to the model, we use a particularly simple strategy. We estimate a quarterly, recursively-identified vector autoregressive model of order four with contemporaneous restrictions for the UK economy and use the variances of the residuals as proxies for the variances of the structural shocks in the model. The variables in the VAR model were OECD GDP, German three-month interest rate, hourly wages, manufacturing output,
Figure 3.1: Impulse responses to one percent shocks with a Taylor rule

non-manufacturing output, three-month interest rate, real effective exchange rate and imported goods prices. Constants and seasonal dummies were also included and the regressions were made over the period 1983(1)-1993(1). The ordering of the variables reflects the small country assumption as foreign variables are viewed as exogenous to the UK economy and put first.

In order to get an estimate of the shock to the foreign risk-premium corrected real interest rate, we use the uncovered real interest rate parity condition (3.13) to derive the risk-premium corrected real interest rate. The expected change in the real interest rate and expected inflation are obtained as the fitted values of reduced-form regressions of inflation and the change in the real exchange rate (see the appendix for details). The derived time series is then modelled as an AR(1) process and the variance of the shock obtained. The estimates are shown in Table 3.1 as standard deviations in per cent.

4. Policy evaluation and analysis

We now turn to evaluate inflation-forecast targeting within the above model. Under inflation-forecast targeting, the central bank will need to choose two important parameters: the forecast-targeting horizon \(h\) and how much weight should be put on stabilizing
conditional inflation forecast relative to the output forecasts ($\theta$). We start by discussing whether inflation-forecast targeting induces determinacy of the rational expectations equilibrium, and then go on to discuss the stabilizing properties of inflation-forecast targeting conditional on the choice of the two parameters.

4.1. Interest-rate stabilization and the Taylor principle

Table 4.1 shows the implicit reaction functions for forecast-targeting horizons of four, six and eight quarters. We are not able to solve the model for a shorter forecast-targeting horizon than four quarters. We suspect that this is due to instrument and model instability, i.e., a shorter forecast-targeting strategy cannot be pursued without the path of the variables becoming unbounded. If the central bank tries to stabilize inflation very quickly, it would have to use the interest rate excessively, in a way that would make it more and more difficult to reach the policy target in the future. Thus, present interest rate setting undermines future interest rate setting. In this case, the computation of the rational expectations solution of variables becomes infeasible and the procedure breaks down.

A longer inflation forecast-targeting horizon makes the responses to the state variables less aggressive, a feature that would be expected from the analysis of Section 2.3. Moreover, the rational expectations equilibrium is not determinate for a forecast-targeting horizon above six quarters. An inspection of the roots of the model shows that for long forecast-targeting horizons there are only one unstable root in the system, and since there are as many as three forward-looking variables ($e_t, y_t^T, \pi_t$), the Blanchard and Kahn (1980) condition for a determinate rational expectations equilibrium is not satisfied.

The Taylor principle says that in order to induce determinacy of the rational expectations equilibrium, the nominal interest rate should be moved in a sufficiently strong

---

Table 4.1

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Strict inflation-forecast targeting: $\theta = 1$</th>
<th>Flexible inflation-forecast targeting: $\theta = 0.5$</th>
</tr>
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<tr>
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<td>$h = 4$</td>
<td>$h = 6$</td>
</tr>
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<td>$y_t^T$</td>
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<td>$y_t^N$</td>
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<td>$\pi_{t-1}$</td>
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<td>$r_t^f$</td>
<td>0.56</td>
<td>0.21</td>
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</tbody>
</table>

---

12 The numerical procedures fail to solve the model for a forecast-targeting horizon of 12 quarters and above.

manner to shocks affecting future inflation, so that the real interest rate is moved in
the same direction. The weak response to the interest rate when the forecast-targeting
horizon is longer makes forecast-targeting subject to the criticism of not adhering to
the Taylor principle. The non-compliance with the Taylor principle and indeterminacy
may be a potential problem for inflation-forecast targeting for several reasons. Woodford
(2001) argues that compliance with the Taylor principle is important for determining the
price level under interest rate rules. Clarida et al. (2000) argue in a similar way that
the principle is important for ruling out sunspots solutions of the rational expectations
equilibrium, which, if not ruled out, may cause endogenous fluctuations in both inflation
and output. The violation of the Taylor principle is potentially an important objection
to long-run inflation-forecast targeting.

If we, however, are willing to invoke the minimal state variables (MSV) selection cri-
teron (see McCallum, 1983, 1999), which has been done here, inflation-forecast targeting
is determinate at all horizons considered. The MSV criterion picks the rational expec-
tations solution which is represented by the minimal use of state variables. McCallum
(2001) argues, however, that the Taylor principle may be important for agents to rule out
non-MSV solutions and moreover make the MSV solution E-stable and thus least squares
learnable (see Bullard and Mitra, 2002). The desirability of long-horizon inflation-forecast
targeting thus hinges upon whether one believes that the MSV selection criterion picks
the relevant rational expectations equilibrium.

4.2. The inflation-output trade-off and social loss

Table 4.2 considers the unconditional standard deviations\(^\text{14}\) (in per cent) of important
variables for different forecast-targeting horizons, ranging between four and eight quarters
under strict and flexible (\(\theta = .5\)) inflation-forecast targeting.

The length of the forecast-targeting horizon does affect inflation stability to a great
extent. A short forecast-targeting horizon provides tight control of inflation as the in-
terest rate changes are used intensively to have inflation return more quickly to target.
When the forecast-targeting horizon is extended, inflation becomes more variable, and so
does aggregate output. This is an important result. Stabilizing inflation at a longer hori-
zon does not necessarily contribute to more output stability.\(^\text{15}\) Since inflation-forecast

\(^{14}\)The unconditional standard deviations have been analytically calculated. See Leitemo and

\(^{15}\)As noted before, we are not able to solve the model for a shorter forecast-targeting horizon than four
quarters. We believe that this is due to model and instrument instability, a feature that would produce
excessive loss to the policymaker.
Table 4.2

Unconditional standard deviations in per cent and losses.

<table>
<thead>
<tr>
<th>Targeting horizon</th>
<th>(\pi^c)</th>
<th>(y^N)</th>
<th>(y^T)</th>
<th>(y)</th>
<th>(r)</th>
<th>(R)</th>
<th>(q)</th>
<th>(\Delta i)</th>
<th>(L(.25))</th>
<th>(L(.00))</th>
<th>(\rho_{TN})</th>
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</thead>
<tbody>
<tr>
<td>(\theta = 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>0.50</td>
<td>1.08</td>
<td>0.69</td>
<td>1.00</td>
<td>0.60</td>
<td>4.27</td>
<td>0.28</td>
<td>3.11</td>
<td>4.21</td>
<td>5.98</td>
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<td></td>
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<td>1.03</td>
<td>1.26</td>
<td>1.58</td>
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<td>2.97</td>
<td>15.94</td>
<td>65.05</td>
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<td>6</td>
<td>0.50</td>
<td>1.91</td>
<td>0.55</td>
<td>1.61</td>
<td>0.61</td>
<td>1.37</td>
<td>0.13</td>
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<td>4.01</td>
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<td>0.55</td>
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<td>40.38</td>
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<td>1.07</td>
<td>0.09</td>
<td>4.21</td>
<td>2.69</td>
<td>38.06</td>
<td>36.26</td>
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<tr>
<td>(L(.25)) under</td>
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<td>2.67</td>
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<tr>
<td>pre-commitment</td>
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<td>2.02</td>
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<td>0.28</td>
<td>3.48</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.36</td>
<td>1.18</td>
<td>2.10</td>
<td>0.62</td>
<td>12.91</td>
<td>0.44</td>
<td>1.67</td>
<td>14.76</td>
<td>54.96</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Flexible inflation-forecast targeting induces more output stability and less inflation stability at a very short forecast-targeting horizon. Flexibility does not decrease output variability at longer horizons, but does induce increased inflation variability.

It is useful to study the response of the model to an unanticipated reduction in the inflation target of one per cent. This experiment is depicted in Figure 4.1. The upper part of the figure shows the expected four-quarter CPI inflation evolvement and the corresponding constant-interest-rate forecasts made in each consecutive quarter. The middle part shows the expected evolvement of both nominal and real interest rates and the real exchange rate. The lower part shows the expected movement of aggregate and sectoral output. From the left, the inflation-forecast targeting horizon is four, six and eight quarters, respectively. Inflation-forecast targeting is assumed to be strict, i.e., \(\theta = 1\).

There are several interesting observations to be made. First, the time inconsistency of forecast-targeting is quite evident and severe for forecast-targeting horizons above four quarters. The constant-interest-rate forecasts deviate substantially from the rational expectations forecast of inflation. This implies that inflation is brought back to target much slower than suggested by the forecast-targeting horizon. In other words, the policy targeting horizon is much longer than the forecast-targeting horizon.

Second, there is an announcement effect on inflation. This is due to the forward-looking nature of the Phillips curve, in which lower expected future inflation has an
immediate effect on current pricing behaviour. The announcement effect is greater the faster inflation is brought back to target. Thus, with a short forecast-targeting horizon, the policymaker enjoys a greater initial effect on inflation.

Third, at all horizons, the policymaker raises the nominal interest rate relative to the equilibrium nominal interest rate level, which drops immediately by one percentage point due to the lowering of the inflation target. The immediate real interest rate response increases with a shorter forecast-targeting horizon to induce a sufficient tightening of monetary policy to bring inflation quicker back to target. The real interest rate response is more persistent at longer forecast-targeting horizons.

To summarise the aggregate performance of inflation-forecast targeting in the above model, it is appropriate to consider a measure of the social loss caused at different forecast-targeting horizons. We postulate a quadratic period loss function of the type

\[
L_t(\nu) = \left[ (\pi_t^c - \pi^*)^2 + y_t^2 + v(i_t - i_{t-1})^2 \right],
\]

(4.1)
that has become standard in the literature. Society is assumed to care equally about inflation and aggregate output stability, and also about smoothing of interest rate movements.\textsuperscript{16} The tenth and eleventh columns of Table 4.2 show the unconditionally expected loss (multiplied by $10^4$), $EL_t(\nu)$, with ($\nu = .25$) and without ($\nu = 0$) weight on the interest-rate smoothing argument. We see that interest rate smoothing is the prime reason for considering a forecast-targeting horizon beyond four quarters. In this case, the optimal horizon is six quarters.\textsuperscript{17}

The performance of inflation-forecast targeting is in general far from the optimal pre-commitment policy,\textsuperscript{18} reported in the two last rows of Table 4.2. In the case where the policymaker cares about instrument smoothing, the pre-commitment policy produces about half the expected loss of inflation-forecast targeting. In the case where the policymaker only cares about inflation and output variability, the forecast-targeting procedure produces three times the expected loss of the pre-commitment policy. The forecast-targeting procedure compares more favourably to a simple (non-optimized) Taylor (1993) rule. If the policymaker does not care about interest-rate smoothing, forecast-targeting dominates the Taylor rule. However, if interest-rate smoothing is not important, the conclusion is turned around.

4.3. Sectoral stability and the exchange rate

Policymakers may be concerned about other variables. In particular, the policymaker may care about sectoral variability. For example, if monetary policy achieves aggregate output stability by influencing the sectors in a way that expansion in one sector is offset by a contraction in the other sector, aggregate output variability will be an insufficient and misleading measure of the cost of adjustment in the economy.\textsuperscript{19} Then considering the sectoral adjustments may be a better indicator of the degree of adjustment.

From Table 4.2 we observe that the choice of the forecast-targeting horizon has important implications for sectoral stability. The non-traded sector is most exposed to

\textsuperscript{16}This is the targeting definition of interest-rate smoothing, i.e., when the change in the nominal interest rate is an argument in the loss function. The instrument rule definition of interest-rate smoothing, however, refers to a situation when the monetary policymaker gradually moves the instrument towards the optimal rate, e.g., $i_t = \zeta i_{t-1} + (1 - \zeta) i^*_t$.

\textsuperscript{17}We compared horizons between four and twelve quarters.

\textsuperscript{18}See Leitemo and Söderström (2004) for how to compute the standard deviations of variables resulting from the pre-commitment policy.

\textsuperscript{19}The model considered in the previous section implicitly assumes that factors of production are traded in competitive markets and may move freely between sectors. There are no reason why the factor prices should be different between sectors. If, however, there are sector-specific factors, the price of the factors may move in such a way that there is improved stabilization of the traded sector, e.g., the price of factors may fall when the product prices fall.
adjustment at the very short forecast-targeting horizon. The policymaker is then using
the interest rate vigorously for controlling inflation. The short-term real interest rate is
therefore quite volatile and strongly influences the non-traded sector.

The traded sector is strongly influenced by expected future exchange rate movements.
At the very short forecast-targeting horizon, exchange rate movements are large, but short
lived. Since the traded sector responds to the expected one-period-ahead exchange rate,
these short-lived unexpected movements in the exchange rate has less of an influence on
the traded sector.

The real exchange rate becomes more volatile as the forecast-targeting horizon in-
creases. There are at least two reasons for this. As noted above, at longer forecast-
targeting horizons, there is greater persistence in the real interest rate. Thus, a rise in
the real interest rate is expected to be more prevailing. Real interest rate movements
have therefore a stronger impact on the expected future interest rate. According to the
uncovered interest rate parity condition, the exchange rate will therefore be more volatile.
Although the real interest rate becomes more stable as the horizon increases, the exchange
rate will fluctuate more.

A second reason is that with a long forecast-targeting horizon, a shock to prices has a
much stronger effect to the long-run price level as inflation stabilization is achieved more
slowly. Hence, a price shock has a greater impact on the equilibrium nominal exchange
rate. Since there the foreign exchange market is fully forward-looking, a movement in
the equilibrium exchange rate has an immediate impact on the current exchange rate.
This can be shown by stating the nominal uncovered interest rate parity condition, solv-
ing it forward and imposing the long-run equilibrium real exchange rate transversality
condition, i.e. \( \lim_{j \to \infty} q_j = \lim_{j \to \infty} (s_j - p_j) = 0 \).

\[
\begin{align*}
    s_t &= s_{t+1|t} - \dot{i}_t \\
    &= -\sum_{s=0}^{\infty} \dot{i}_{t+j|t} + \lim_{j \to \infty} s_{j|t} \\
    &= -\sum_{s=0}^{\infty} \dot{i}_{t+j|t} + \lim_{j \to \infty} p_{j|t}
\end{align*}
\]

where foreign variables have been disregarded. We see that the nominal exchange rate
is influenced by the future expected nominal interest rate (differentials), but also the
long-run equilibrium price level path. A long forecast-targeting horizon produces a more
stable nominal interest rate and is therefore less of a reason for exchange rate movements.
The nominal exchange rate is, however, driven by the failure to keep inflation close to
the target level, causing the expected long-run price level to drift and therefore affect the
equilibrium and the current nominal exchange rate accordingly.

Since exchange rate movements feed quickly through to inflation, the exchange rate process exacerbates the reason why the monetary policymaker should react quickly and sufficiently to shocks influencing inflation expectations, by choosing a relative short forecast-targeting horizon and therefore comply with the Taylor principle.

The last column of Table 4.2 shows the coefficient of correlation between the traded and non-traded sectors. A coefficient below unity indicates that at least some aggregate stability is achieved at the expense of traded and non-traded sector variability. This is in particular true at a short forecast-targeting horizon of four quarters where inflation targeting is strict. Aggregate output then conceals much of the adjustment in each sector. At longer targeting horizons, this effect is also present but to a much smaller degree.

4.4. Some sensitivity analysis

In this section we study how some of the implications of (strict) inflation forecast-targeting change as the economy deviates from the benchmark model of the previous section. We first study the implications of demand for non-traded goods being determined more or less by the short-term real interest rate, by considering changes in the coefficient $\omega$. Second, we study the changes to the model if the central bank ignores the effect of imported goods prices on CPI and targets domestic inflation.

4.4.1. The dependency on the long-term real interest rate

Modern macroeconomic theory stresses that intertemporal substitution effects in consumption should make aggregate demand dependent on the long-term real interest rate (see, e.g., Woodford (2003)), defined according to the expectations theory of the term structure of interest rates as the expected average future short-term real interest rates. It may be possible that consumption is mostly dependent on the very short-term real interest rate if consumers form expectations about the future interest rate in a simple adaptive way.\footnote{An anonymous referee made the point that $\omega$ may be endogenous to monetary policy. The share of variable-rate debt is higher in countries with a long history of high and volatile inflation, and lower in countries with stable and low inflation. Thus successful inflation targeting should increase $\omega$.} In this section we perform two experiments, letting $\omega$ take the values of 1.00 and 0.00. We thereby consider the two extreme cases where there is no separate influence of the short-term interest rate and only influence by the short-term interest rate on demand, respectively. The percentage standard deviations of the variables are considered in Table (4.3).
Interestingly, the optimal horizon is unaffected by a change in this parameter. The optimal horizons remain at four and six quarters, depending on the preferences for interest-rate smoothing. The conclusion with respect to the optimal horizon is therefore robust to this change in the model. Indeed, most of the qualitative conclusions from the previous section remain unchanged. There is somewhat more sectoral variability at the very short forecast-targeting horizon if the short-term real interest rate is the only influence on demand, as a result of a volatile short-term real interest rate. Although the exchange rate is relatively stable at this horizon, the traded sector is nevertheless strongly affected due to more persistent exchange rate movements.

Table 4.3
Unconditional standard deviations in per cent and losses.

<table>
<thead>
<tr>
<th>$\omega$</th>
<th>$\pi^c$</th>
<th>$y^N$</th>
<th>$y^F$</th>
<th>$y$</th>
<th>$r$</th>
<th>$R$</th>
<th>$q$</th>
<th>$\Delta i$</th>
<th>$L(.25)$</th>
<th>$L(.00)$</th>
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<tr>
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<td>1.12</td>
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</tr>
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<td>0.50</td>
<td>1.57</td>
<td>0.59</td>
<td>1.07</td>
<td>0.09</td>
<td>4.20</td>
<td>2.67</td>
<td>8.87</td>
<td>7.09</td>
</tr>
<tr>
<td><strong>Targeting horizon = 4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td>0.98</td>
<td>0.56</td>
<td>1.06</td>
<td>0.45</td>
<td>9.03</td>
<td>0.42</td>
<td>3.02</td>
<td>9.54</td>
<td>23.90</td>
<td>1.16</td>
</tr>
<tr>
<td><strong>Targeting horizon = 6</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td>1.94</td>
<td>0.62</td>
<td>1.74</td>
<td>0.63</td>
<td>1.40</td>
<td>0.14</td>
<td>3.90</td>
<td>2.72</td>
<td>6.00</td>
<td>4.15</td>
</tr>
<tr>
<td><strong>Targeting horizon = 7m</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td>3.58</td>
<td>0.66</td>
<td>1.50</td>
<td>0.67</td>
<td>1.16</td>
<td>0.11</td>
<td>4.11</td>
<td>2.69</td>
<td>15.09</td>
<td>13.28</td>
</tr>
</tbody>
</table>

*The numerical routines fail to solve the model for horizons above 7 quarters.

There is, however, an interesting change to the results. In the case where it is the short-term interest rate that influences demand, inflation forecast-targeting procedure produces a determinate rational expectations equilibrium at all horizons considered (between four and sixteen quarters). In the other case, with only long-term real interest rate effects, the forecast-targeting fails to produce determinacy at any horizon. This result seems to be linked to the time inconsistency argument of forecast-targeting procedure. If the long-term real interest rate determines demand, then expected future policy is important for demand management. However, policy is derived on the basis of constant-interest-rate forecasts that may be very different from the expect outcome. Hence, the policymaker may fail to fulfill the Taylor principle for this reason alone. If the short-term real interest rate is dominating demand, then future policy is less important and the time inconsistency result will have less of an impact.
4.4.2. Domestic inflation-forecast targeting

As a final experiment, consider domestic inflation forecast-targeting where the central bank targets the four-quarter domestic inflation rate, $\bar{\pi}$. It can be argued, as done in Woodford (2003), that the central bank should stabilize domestic inflation rate since it is this rate that is subject to stickiness and thus causes welfare losses. There are only small changes to the results, shown in Table 4.4.

<table>
<thead>
<tr>
<th>Targeting horizon = 3</th>
<th>$\pi^c$</th>
<th>$y^N$</th>
<th>$y^F$</th>
<th>$y$</th>
<th>$r$</th>
<th>$R$</th>
<th>$q$</th>
<th>$\Delta i$</th>
<th>$L(.25)$</th>
<th>$L(.00)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.76</td>
<td>1.24</td>
<td>1.65</td>
<td>0.71</td>
<td>11.23</td>
<td>0.44</td>
<td>2.53</td>
<td>12.31</td>
<td>38.97</td>
<td>1.09</td>
<td></td>
</tr>
<tr>
<td>Targeting horizon = 4</td>
<td>0.92</td>
<td>0.73</td>
<td>1.02</td>
<td>0.61</td>
<td>4.95</td>
<td>0.29</td>
<td>2.72</td>
<td>5.20</td>
<td>7.97</td>
<td>1.22</td>
</tr>
<tr>
<td>Targeting horizon = 6</td>
<td>1.98</td>
<td>0.56</td>
<td>1.62</td>
<td>0.62</td>
<td>1.33</td>
<td>0.13</td>
<td>3.96</td>
<td>2.72</td>
<td>6.17</td>
<td>4.32</td>
</tr>
<tr>
<td>Targeting horizon = 8</td>
<td>6.90</td>
<td>0.60</td>
<td>1.43</td>
<td>0.65</td>
<td>1.06</td>
<td>0.09</td>
<td>4.21</td>
<td>2.69</td>
<td>49.82</td>
<td>48.02</td>
</tr>
</tbody>
</table>

There are only marginal changes as a result of the change in the target variable. Without a concern for interest-rate smoothing, the optimal horizon is as low as three quarters. There is still indeterminacy for forecast-targeting horizons above six quarters.

5. Concluding remarks

Lags in the effect of monetary policy on inflation require a forward-looking monetary policy. Inflation forecast-targeting provides an intuitive way of implementing inflation targeting and accords well with how monetary policymakers say they implement their inflation-targeting policy. However, the intuition may be somewhat deceitful as inflation-forecast targeting is burdened with several problems such as rational expectations indeterminacy and time inconsistency.

A change in the length of the forecast-targeting horizon does not lead to a movement along the policy efficiency frontier, as increased inflation variability is not necessarily offset by decreased output variability as the forecast-targeting horizon increases. Indeed, exchange-rate variability increases due to more persistent interest rate movements and causes the traded sector to be more exposed to shocks.

The transmission mechanism of monetary policy includes several channels that work at different speeds to influence inflation and output, hence the optimal policy targeting
horizon depends on the specific shocks to the economy. Since forecast-targeting only offers one-horizon-fits-all situations and is not likely to be close to the optimal policy, except in particular choices of models.
Appendix

A. Parameterisation

The model presented above is calibrated in order to match some macroeconomic characteristics of the UK economy at a quarterly frequency. We obtain most of the parameter from Batini and Haldane (1999) (BH), who calibrate their model with parameter values that are set ‘in line with prior empirical estimates’ from the Bank of England forecasting model and in order ‘to ensure a plausible dynamic profile for impulse responses’. Other parameters were obtained from Batini and Nelson (2001), the remaining parameters are set at values that does not seems a priori unreasonable for a small open economy.

Persistence in output is considered to be high and the benchmark values are $\rho_T = \rho_N = 0.85$. Both are close to the persistence value of $\rho = 0.8$ in the one-sectoral model of BH. The real interest rate impact elasticity on the non-traded sector is set at $\alpha = 0.125$, equal to the value the corresponding value in BH. The coefficient for intratemporal substitution is set at $\kappa = 0.05$. The long-term interest rate weight in the interest rate index is set somewhat arbitrarily at $\omega = 0.7$, reflecting the strong theoretical arguments that long-term interest rates dominate the short rate in influencing aggregate demand. The impact elasticity of production in the traded sector with respect to an expected one-period change in the real exchange rate is set at $\beta = 0.4$. Together with a quarterly informational ‘discount’ factor of $\delta = 0.5$ in this sector, the impact elasticity of an expected permanent change in the producer real wage is $\frac{\beta}{1-\delta} = 0.8$. Traded sector share of output is set at $\eta = 0.25$ in accordance with the share of the manufacturing sector in the UK economy. The share of imported goods in the CPI index is set equal to $\psi = 0.25$. The degree of forward-lookingness in the Phillips curve is set at $\phi = 0.2$, in accordance with BH and Fuhrer (1997). Finally, we set $\gamma = 0.1$ as done in Batini and Nelson (2001) and $\mu = 0.05$.

A.1. The risk-premium corrected foreign real interest rate

The empirical study of Fisher et al. (1990) provides support for the uncovered interest parity condition for the UK economy. We impose this condition up to an autoregressive risk-premium component. As $r^f$ denotes the foreign risk-premium corrected real interest

\[ r^f = (1 + \phi) r_f + \phi r_{e^f} + \gamma + \mu - \delta. \]

In the BH model, the aggregate output impact elasticity of a change in the real exchange rate is $-2.2$. The long-run elasticity is $-1$. Our choice of coefficients would produce non-traded sector short-run and long-run elasticities of 0.05 and 0.33 respectively. For the traded sector we assume elasticities of $-0.4$ and $-2.66$ if the change is perceived to be transitory, and $-0.8$ and $-5.25$ if the change is perceived to be permanent. Given that the traded sector accounts for 25% of the economy, these responses seem reasonable.
rate, it can be calculated from (3.13) as

\[ r_t^f = r_t - 4\Delta\hat{e}_{t+1|t}. \]  

(A1)

In order to derive \( r_t^f \), we proxy \( e \) by the UK nominal effective exchange rate deflated by the respective relative CPI price levels. Moreover, \( r \) is proxied by the three-month nominal interest rate minus the expected quarterly change in the CPI inflation at an annual rate. Market expectations of the change in the real exchange rate and CPI price level were obtained from the fitted values of two regressions. The quarterly inflation rate was regressed on four lags of itself, and on five lags of the change in the log real exchange rate (as proxied) and the unemployment rate. The quarterly change in the log real exchange rate was regressed on four lags of itself and five lags of the CPI price level, UK and German three-month interest rates and the unemployment rate. A constant and seasonal dummies were added in both regressions and estimated from 1983:1 to 1999:2 and 1998:4 respectively.

The derived foreign risk-premium-corrected real interest rate was then assumed to follow an AR(1) error process. Thus, the following regression was made for the period 1983:2-1998:4,

\[ r_t^f = 0.37 r_{t-1}^f + \varepsilon_t^r. \]  

(A2)

A constant and seasonal dummies were included in the regression, but not reported. Additional lags were not statistically significant and hence our AR(1) seemed to be a good approximation.
References


