EUROPEAN CENTRAL BANK

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NO. 564 / DECEMBER 2005

EUROSYSTEM INFLATION PERSISTENCE NETWORK

FORECASTING THE CENTRAL BANK'S INFLATION OBJECTIVE IS A GOOD RULE OF THUMB

by Marie Diron
and Benoît Mojon

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In 2005 all ECB publications will feature a motif taken from the €50 banknote.

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The Eurosystem Inflation Persistence Network

This paper reflects research conducted within the Inflation Persistence Network (IPN), a team of Eurosystem economists undertaking joint research on inflation persistence in the euro area and in its member countries. The research of the IPN combines theoretical and empirical analyses using three data sources: individual consumer and producer prices; surveys on firms' price-setting practices; aggregated sectoral, national and area-wide price indices. Patterns, causes and policy implications of inflation persistence are addressed.

Since June 2005 the IPN is chaired by Frank Smets; Stephen Cecchetti (Brandeis University), Jordi Galí (CREI, Universitat Pompeu Fabra) and Andrew Levin (Board of Governors of the Federal Reserve System) act as external consultants and Gonzalo Camba-Méndez as Secretary.

The refereeing process is co-ordinated by a team composed of Günter Coenen (Chairman), Stephen Cecchetti, Silvia Fabiani, Jordi Galí, Andrew Levin, and Gonzalo Camba-Méndez. The paper is released in order to make the results of IPN research generally available, in preliminary form, to encourage comments and suggestions prior to final publication. The views expressed in the paper are the author's own and do not necessarily reflect those of the Eurosystem.

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CONTENTS

Abstract 4

Non-technical summary 5

1 Introduction 7

2 Rule of thumb expectations and inflation targets 8

2.1 Rule of thumb expectations can be micro-founded 8

2.2 Inflation targets can gear rule of thumb expectations 10

3 How well do you forecast inflation if you believe in the central bank's target? 10

3.1 Choice of the quantified inflation objectives 11

3.2 Econometric forecast benchmarks and estimation 11

3.3 The published forecasts benchmark 14

4 The benefits of having agents believing in the inflation objective 15

5 Conclusion 17

References 17

Tables and figures 19

European Central Bank working paper series 25

Abstract: This paper first shows that the forecast error incurred when assuming that future inflation will be equal to the inflation target announced by the central bank is typically at least as small and often smaller than forecast errors of model-based and published inflation forecasts. It then shows that there are substantial benefits in having rule-of-thumb agents who simply trust that the central bank will deliver its pre-announced inflation objective.

Keywords: monetary policy, credibility, inflation targeting, inflation forecast

JEL codes: E5

Non technical summary

The spreading of inflation targeting and other forms of quantified inflation objectives has marked monetary policy history since 1990. Indeed, a majority of industrialised countries have either adopted some form of inflation targeting or, most notably for the 12 countries that form the euro area, defined a quantified inflation objective.

In theory, a major virtue of quantified inflation objectives is to anchor inflation expectations. This in turn should help central banks to stabilise inflation at the pre-announced target level. One reason why inflation expectations are important is that economic agents who adjust prices and wages do so infrequently. Agents form expectations on the general level of prices over the horizon of their "nominal contracts". The credibility of the central bank's target implies that economic agents "trust" the central bank and expect that the general price level will grow at the rate of the inflation target. This expectation mechanism itself helps deliver realised inflation close to the target.

While this argument is convincing and well accepted, there has been so far little research on the reasons why economic agents should trust the central bank target or whether there could be some incentives to do so.

This paper therefore proposes a simple evaluation of the benefits of trusting the central bank target. The evaluation consists of comparing the forecasting performance of benchmark forecasts of inflation (model-based and published forecasts) to the forecasting performance of forecasts which are set equal to the inflation target.

The results provide unconditional support for trusting the inflation targeting (IT) central banks, in particular when forming inflation expectations over long horizons. In all seven IT developed countries and in the euro area, forecasting that inflation will be at the inflation "target" implies a smaller forecasting error than either a random walk or AR(2) model of inflation – which we take as representative of econometric model based forecasts of inflation - for both the 4 and 8 quarters horizon forecasts. Forecasting inflation to be at the target also beats the Consensus forecast for the euro area, Canada, Sweden and Switzerland, while it does as well as the Consensus forecast for the UK.

To our knowledge, our paper is the first one to show that, while inflation is never exactly at the target, "trusting" the central bank's target has provided an ex ante reliable and, to a large extent, unbeatable inflation forecasting device for countries that have adopted a quantified inflation objective.

The result could be and perhaps should be used by central banks in their communication as it may induce more agents to choose the inflation target as a rule of thumb inflation forecast. This would in turn make it more likely that the target is actually hit or at least that low and stable inflation is maintained. We further illustrate this point by using a stylised 3- equation new Keynesian type of model where a proportion of agents trust the central bank's target. We then describe the dynamics of standard shocks depending on the proportion of such agents in the overall population. The larger this proportion the lower the effects of cost-push shocks and demand shocks on inflation and on the interest rate and the more stable inflation and interest rates are.

"*For a successful and credible central bank like the Federal Reserve, the immediate benefits of adopting a more explicit communication strategy may be modest. Nevertheless, making the investment now in greater transparency about the central bank's objectives, plans, and assessments of the economy could pay increasing dividends in the future.*"[1]

Governor Ben S. Bernanke (2003)

1. Introduction

The growing use of inflation targeting and other forms of quantified inflation objectives has marked the history of monetary policy since 1990. Indeed, a majority of industrialised countries have either adopted some form of inflation targeting or, most notably for the 12 countries that form the euro area, defined a quantified inflation objective.

In theory, a major virtue of quantified inflation objectives is to anchor expectations of inflation. This in turn should help central banks to stabilise inflation at the pre-announced target level[2]. One reason why inflation expectations are important is that economic agents who adjust prices and wages do so infrequently (for most up-to-date evidence, see Dhyne et al., 2005; Fabiani et al, 2005, Vermulen et al. 2005 and references therein). Agents form their expectations of the general level of prices over the horizon of their "nominal contracts". The credibility of the central bank's target implies that economic agents "trust" the central bank and expect that the general price level will grow at the rate of the inflation target. This expectation mechanism itself helps deliver realised inflation close to the target.

While this argument is convincing and well accepted, there has so far been little research into the reasons why economic agents should trust the central bank target, or whether there might be incentives to do so.

This paper therefore proposes a simple evaluation of the benefits of trusting the central bank target. The evaluation consists of comparing the forecasting performance of benchmark forecasts of inflation (model-based and published forecasts) with the forecasting performance of forecasts which are set equal to central bank inflation targets.

[1] Extract from "A Perspective on Inflation Targeting", remarks by Governor Ben S. Bernanke. At the Annual Washington Policy Conference of the National Association of Business Economists, Washington, D.C. March 25, 2003.

[2] See the discussion in Castelnuovo et al. (2004), Levin et al. (2004) and Svensson (1999) and the above quote by Governor Bernanke.

The results provide unconditional support for trusting inflation targeting (IT) central banks, in particular when forming inflation expectations over long horizons. In all seven IT developed countries and in the euro area, forecasting that inflation will be at the inflation "target" produces a smaller forecasting error than either a random walk or AR(2) model of inflation – which we take as representative of econometric model-based inflation forcasting - for both the 4- and 8-quarter horizon forecasts. Forecasting inflation to be at the target also beats the Consensus forecast for the euro area, Canada, Sweden and Switzerland, while it does as well as the Consensus forecast for the UK.

To our knowledge, our paper is the first to show that, while inflation is never exactly at the target, "trusting" the central bank's target has provided an *ex ante* reliable and, to a large extent, unbeatable inflation forecasting device for countries that have adopted a quantified inflation objective.

The result could be - and perhaps should be - used by central banks in their communications as it could induce more agents to choose central bank inflation targets as their rule-of-thumb inflation forecast. This would in turn make it more likely that the central bank target is actually hit, or at least that low and stable inflation is maintained. We further illustrate this point by using a stylised 3-equation new Keynesian type of model, where a proportion of agents trust the central bank's target. We then describe the dynamics of standard shocks depending on the proportion of such agents in the overall population. The larger this proportion the lower the effects of cost-push shocks and demand shocks on inflation and on the interest rate, and the more stable inflation and interest rates.

The rest of the paper is organised as follows. Section 2 discusses the role of inflation targets in the formation of inflation expectations. Section 3 reports the results of a horse race of inflation forecasting between believers in the central bank's target and believers in other forecasts. Section 4 illustrates, by way of a simple extended New Keynesian Hybrid Philips Curve, how the proportion of believers in central bank targets affects the response of inflation to standard shocks and the variance of inflation, the output gap and the central bank interest rate. Section 5 concludes.

2. Rule of thumb expectations and inflation targets

2.1 Rule of thumb expectations can be micro-founded

The formation of inflation expectations plays a large role in the success of monetary policy. Since all prices and wages cannot be readjusted constantly, anchoring inflation expectations at a low level is essential to ensure price stability.

The academic debate on inflation expectations has centred on the operational mode of expectation formation. However, inflation expectations are not observable. As a result, several views on expectations formation which are mutually exclusive cannot easily be proven to be inconsistent with the data (Linde, 2001).

The most popular view has long been to consider that inflation expectations are rational. Rational expectations take two complementary meanings. First, expectations need to fulfil certain criteria to be "rational'. Thus rational expectations cannot be systematically or persistently "wrong". As a result, a good approximation of rational expectations is the result of a regression of future realisations of inflation on past and present observable economic variables. By construction, this procedure yields expectation errors which are zero on average. In addition, if the set of economic variables taken into account is comprehensive enough, this procedure is consistent with the requirement that expectations take into account all available information. The second meaning of rational expectations formulates that in any given model of the economy, agents form their expectations in a way which is consistent with the functioning of the model. Although the assumption of rational expectations is largely used in micro-founded models, it is often rejected when these models are brought to the data (Rudd and Whelan, 2003).

As Sargent (1993) stresses, "model consistent" expectations are obviously not realistic since only very few highly technical economists would be able to solve dynamic macroeconomic models to formulate their expectations. The "learning" literature and the more recent discussion of rational inattention (Sims 2003, Mankiw and Reis (2002), Mackowiak and Wiederholt, 2005) model processes of expectation formation that deviate from rational expectations. In essence, the cost of information processing can justify that agents recourse to "rules of thumbs" to form expectations about future inflation.

In particular, inflation expectations seem to depend significantly on past and present values of inflation (e.g. Estrela and Fuhrer 1999). Note that such "rule of thumb" expectations are not necessarily irrational to the extent that rules deriving future inflation from its past values may be the most efficient use of current available information to derive the outlook for inflation. A good rationale for such rule of thumb is precisely that inflation proves extremely difficult to forecast with multivariate economic models (Stock and Watson, 1999a and 1999b; Banerjee et al., 2003 and Banerjee and Marcellino, 2003). Simple rules of thumb may therefore optimally solve the trade-off between accuracy of the expectations and effort spent to derive them. However, especially at times of persistent changes in inflation, such backward looking rules will lead to recurring forecast errors of persistent signs.

2.2 Inflation targets can gear rule of thumb expectations

Most analytical studies of inflation targeting assume that agents form rational expectations and accept that the central bank will aim at stabilising inflation at the pre-announced target (e.g. Svenson, 1999 and references therein). These papers do not however evaluate whether, when applied to inflation expectations, rational expectation is a good approximation of the way the real world form expectations, nor why adopting an inflation target would suffice to eliminate time inconsistency related inflation biases[3].

Ideally, one should derive an endogenous mechanism within which agents can estimate with some recursive update the likelihood that the central will pursue its inflation target. To some extent, Orphanides and Williams (2003) undertake this difficult challenge. However, their model does not allow the central bank to be fully credible, at least for some agents, with respect to the achievement of a quantified inflation objective. It is only through establishing a track record of being hawkish that the central bank manages to anchor expectations. This contrasts somewhat with the experience of central banks that manage to stabilise inflation from the inception of inflation targeting regimes.

In addition, any modelling exercise of the type implemented by Orphanides and Williams (2003) requires many assumptions on the model underlying the economy, the information set available to the agents and the central bank, etc A much simpler alternative is to use the experience of inflation targeting countries to evaluate the benefits to agents of actually taking the inflation target seriously enough so as to use it as their inflation forecast.

The forecast error of this rule of thumb is given by the deviation of realised inflation from the pre-announced target. It is different from zero because the central bank cannot deliver that inflation is exactly on target at every period. However, whether this forecast error is big or small will depend on one's benchmarks.

The following section proposes to answer this question by comparing the forecast error of forecasting the pre-announced objective to two benchmarks: an econometric model based forecast and the economists' forecasts as published by Consensus Economics (henceforth "Consensus").

3. How well do you forecast inflation if you believe in the central bank's target?

We first check how accurate "forecasts" of agents taking the central bank's target for granted (henceforth "target forecast") would perform compared with forecasts based either on a Random Walk or on an AR(2)

[3] An exception is Clark, Goodhart and Huang (1999) who analyse a trade off between inflation and output variances even though the central bank is not trying to raise unemployment below the natural rate.

process for the quarterly change in inflation. These models, which are standard benchmarks in the forecast evaluation, have proved difficult to beat when trying to forecast inflation (Stock and Watson 2004; Banerjee et al., 2004).

3.1 Choice of the quantified inflation objectives

The paths of inflation targets or quantified inflation objectives are shown in Table 1. For the first seven countries of the sample, these paths are relatively straightforward. They correspond to the objectives stated by the central banks and take into account the medium-term nature of the central banks' objective, which we interpret as a two-year horizon.[4] Thus, a target announced at a given time should be reflected in inflation expectations for two years in the future. Inflation objectives are sometimes specified in terms of ranges. Following Castelnuovo et al (2004), we take the mid-point of the range in order to have a point estimate to which actual inflation can be compared.

In the case of the euro area, the choice of a specific number for the inflation quantified objective is somewhat more delicate. In 1998, the ECB had defined that its inflation objective was a positive inflation rate inferior to 2 %, over the medium run. In May 2003, the ECB clarified that its inflation objective is below but close to 2%.[5] Consistent with this, we set the inflation objective for the euro area at 1.9 %. While this choice is somewhat arbitrary and not necessarily in line with the perception of the ECB objective between 1999 and 2003, we chose this level of inflation objective because it is consistent with the ECB strategy both before and after its evaluation of May 2003.

3.2 Econometric forecast benchmarks and estimation

We start by comparing the target forecasts with model-based forecasts from two types of benchmarks, AR(2) processes and random walks of the first difference of inflation, which have been shown to perform relatively well in inflation forecasting competitions. Thus, if the target forecasts prove more accurate than these benchmarks, we can be confident that they would be more accurate than most inflation forecasts based on macroeconomic models. We first estimate the models on the first differences of the quarter-on-quarter inflation rate because this specification is robust with respect to occurrences of breaks in the mean of inflation. The simplest form of the AR(2) model and the Random Walk models that we estimate are described as follows.

[4] See for instance, Castelnuevo et al.(2003).
[5] See the Background studies for the ECB evaluation of its strategy; European Central Bank (2003).

(1a) $\Delta\pi_t = C + \alpha\Delta\pi_{t-1} + \beta\Delta\pi_{t-2} + \varepsilon_t$

(2a) $\Delta\pi_t = \pi_{t-1} - \pi_{t-2} + \eta_t$,

where $\pi_t = Log(P_t) - Log(P_{t-1})$, with P the level of the price index, Δ is the first difference operator and ε_t, η_t are error terms.

Second, in line with Labhard, Kapetanios and Price (2005), we take into account potential breaks in the dynamics of inflation due by announcements of changes in the inflation objective by the central banks.[6] Hence, we enrich the AR(2) and the RW models by allowing for changes in the intercept 8 quarters after a change in the inflation target. For a given country, we have as many changes in the intercept as changes in the quantitative inflation objective. In the case of Australia, for instance, the central bank announced its objective in 1993, and has not changed it since. We therefore include one step dummy taking a zero value before 1995 (1993 plus two years) and 1 thereafter. We refer to this second set of models, which are reported in (1b) and (2b), as 'AR(2) with breaks' and 'random walks with breaks':

(1b) $\Delta\pi_t = C_o + \sum_i C_i Ind_i + \alpha\Delta\pi_{t-1} + \beta\Delta\pi_{t-2} + \varepsilon_t$

(2b) $\Delta\pi_t = \sum_i C_i Ind_i + \pi_{t-1} - \pi_{t-2} + \eta_t$

where Ind_i is a dummy variable that takes a value one from 8 quarters after the announced change in the target.

Finally, for completeness, we also run forecasts for models specified in *levels*:

(1c) $\pi_t = C + \sum C_i Ind_i + \alpha\pi_{t-1} + \beta\pi_{t-2} + \varepsilon_t$

(2c) $\pi_t = \sum_i C_i Ind_i + \pi_{t-1} + \eta_t$

We estimate the models from the first quarter of 1985 onwards on annualised quarter-on-quarter inflation rates. The out of sample forecast evaluation is then carried out in real time. For example, the model (1a) is estimated from the first quarter of 1985 up to the fourth quarter of 1994. Based on this testimation, we calculate forecasts $\tilde{\pi}$ of the models at horizons 1 quarter, 4 quarters (actually the average of the next 4 quarters) and 8 quarters (actually the average of quarters 5 to 8) ahead.

[6] However, an obvious weakness of this model is that it assumes that the econometrician himself is convinced that the central bank announcement of a new target will immediately have an effect on the inflation process.

Then we store the associated forecast errors and the one of taking the inflation forecast equal to the central bank quantified objective π^*, defined as follows:

$$
\begin{array}{ll}
\left[\widetilde{\pi}_{1995:Q1} - \pi_{1995:Q1}\right] & \text{and} \quad \left[\pi^* - \pi_{1995:Q1}\right] \\
\left[0.25 * \left(\widetilde{\pi}_{1995:Q1} + \widetilde{\pi}_{1995:Q2} + \widetilde{\pi}_{1995:Q3} + \widetilde{\pi}_{1995:Q4}\right) - \pi_{1995}\right] & \text{and} \quad \left[\pi^* - \pi_{1995}\right] \\
\left[0.25 * \left(\widetilde{\pi}_{1996:Q1} + \widetilde{\pi}_{1996:Q2} + \widetilde{\pi}_{1996:Q3} + \widetilde{\pi}_{1996:Q4}\right) - \pi_{1996}\right] & \text{and} \quad \left[\pi^* - \pi_{1996}\right]
\end{array} \tag{3}
$$

The set-up is brought forward sequentially by one quarter until the end of the evaluation sample.

Tables 2a, 2b and 2c (Tables 3a, 3b and 3c) show the ratio of Root Mean Square Errors (RMSE) of target forecasts to our three AR(2) forecasts (Random Walk), for inflation in first difference without and with breaks and for inflation in levels with breaks, calculated from 1995 to 2004 and from 2001 to 2004.[7] Numbers below 1 indicate that target forecasts are on average more accurate than the model-based benchmarks over the period of reference.

As shown in Table 2a, for forecast horizons of 4 and 8 quarters, taking the central bank's target as forecast yields significantly more accurate forecasts than an AR(2), and hence, given the evidence reported in Stock and Watson (2004) and Banerjee et al., (2004), than most inflation forecast models. Taking the example of Australia, forecast errors from target forecasts are around half as large as forecast errors from AR(2) processes over 1995 to 2004. This results also holds when we introduce breaks in the AR(2) process corresponding to the introduction of quantitative inflation objectives and changes thereof (Table 2b). Similar results are obtained for the comparison of the target forecasts with random walk forecasts as shown in Tables 3a, 3b and 3c.

Finally, our simple target forecast out performs the AR(2) model of the inflation level with breaks (Table 2c) in a majority of cases, however less systematically and by a smaller margin than for the RW models and the AR(2) of the first difference of inflation. It should be noted, however, that this model has in common with our simple target forecast to take for granted that the announcement of the target will indeed affect the inflation process.

[7] While somewhat arbitrary, the choice of these two evaluation periods has several advantages. First, most inflation targets were already in place in 1995. Second, the more recent post 2001evaluation sample allows us to check whether, while the inflation targeting regimes already had gain fully credibility, the rule of thumb of forecasting the "target" can still out perform the consensus forecast and the AR(2) which parameters will, by construction, mainly reflect inflation dynamics in the new "inflation targeting" regime. We keep the same evaluation samples also for the euro area, although EMU started in 1999, in order to simplify the exposition of the results.

3.3 The published forecasts benchmark

In addition, we compare target forecasts to Consensus forecasts. As mentioned before, we compare the target forecasts to several alternatives. One is the Consensus forecast which should represent informed forecasts produced on the basis of comprehensive information sets. Notably, respondents to the Consensus surveys should be aware of the central bank's inflation objective. Consensus forecasts depart from the central bank's stated objective depending on the degree of credibility that such an objective will be achieved, and, especially for shorter horizons, on various factors which economists estimate will make actual inflation deviate from the target.

Consensus data are available since 1990 for Canada, Norway, Sweden, Switzerland and the UK, providing forecasts for the current and following year. For the euro area, Consensus forecasts are available as of 2002. We calculate Consensus forecasts of the euro area pre-2002 based on forecasts for the countries (except Luxembourg), with fixed weights corresponding to the countries' share in euro area consumption[8]. This current and following year framework differs from the rolling forecast horizon of the previous horse race. In order to compare the performance of the Consensus with the degree of accuracy which target forecasts would have yielded had they been formed at the same time as the Consensus surveys, attention needs to be paid to the calendar of inflation data releases and the timetable of the Consensus surveys. Publication delays of inflation data differ between countries and, in some cases, have changed over the time period under consideration. However, inflation data are typically published around one month after the end of the reference period. Meanwhile, the Consensus survey results for a month M correspond to answers collected up to the middle of month M-1. The following comparisons can therefore be made:

- Consensus forecasts of inflation in the current year published in November can be made using inflation data available up to September. The only unknown inflation path included in these forecasts is for the last quarter of the year. These Consensus forecasts are therefore are compared with one-quarter ahead target forecasts (which are linked to actual data for the first three quarters of the year).

- Forecasts of inflation in the current year published in February rely on inflation data up to December of the previous year. The whole year therefore needs to be forecast. These forecasts are compared with four-quarter ahead target forecasts.

[8] Since respondents to the Consensus vary from country to country, these euro area constructs are not strictly-speaking forecasts for the euro area economy. However, unless respondents of a particular country have systematic biases in their inflation forecast, the average inflation forecast across countries should be close to a forecast by an "average" forecaster for the average of the countries, i.e. for the euro area as a whole.

- Similarly, forecasts of inflation in the following year published in February are compared with eight-quarter ahead target forecasts.

Table 4 shows the relative Root Mean Square Errors of target forecasts compared with the Consensus. For inflation two years ahead, using the central bank's target would yield at least as accurate forecasts as the Consensus. For the euro area and Switzerland, a target forecast is even significantly better than the Consensus for two-year ahead forecasts, especially in the period since 2001, as the latter has systematically underestimated actual inflation.

Altogether, we provided strikingly sharp evidence that forecasting the inflation target/objective has led, in a vast majority of cases to a forecast error smaller than the existing alternatives.

One caveat applying to these results is that they are based on relatively short samples, due to availability of Consensus forecasts for the past 15 years only and the even more recent switch to quantified inflation objectives by central banks. However, the paths of the forecasts obtained from the AR(2), the Consensus and central banks´ targets suggest that differences in relative average errors are significant.

4. The benefits of having agents believing in the inflation objective

This section uses a stylised dynamic model of the business cycle to illustrate the benefits of having convinced some (as many as possible) agents in the economy to expect that future inflation will be a the inflation target.

The model consists of three equations:

The IS curve and the Taylor rule are standard. In the former, the output gap y depends on its past and expected values, on a real *ex ante* interest rate and a demand shock η:

$$y_t = \varphi y_{t-1} + (1-\varphi)E_t[y_{t+1}] - \gamma(r_t - E_t[\pi_{t+1}]) + \eta_t$$

In the central bank interest rate rule, the difference between the nominal interest rate r inflation target π^* depends on its past value, on the deviation of inflation from the central bank inflation target $\pi^*$and the output gap y :

$$r_t - \pi^* = \rho(r_{t-1} - \pi^*) + (1-\rho)(\theta(\pi_t - \pi^*) + \lambda y_t)$$

The third equation is an extended Hybrid New Keynesian Philips Curve (H-NKPC):

$$\pi_t = \alpha_0(\alpha_1\pi^* + (1-\alpha_1)\pi_{t-1}) + (1-\alpha_0)E_t[\pi_{t+1}] + \beta y_t + \varepsilon_t$$

In particular, we assume that a fraction (1-α_0) of agents form model-consistent expectations and that among the α_0 fraction of agents that use rule of thumbs, (1-α_1) assume that inflation will be equal to the previous period's inflation and α_1 consider that inflation will be equal to the target of the central bank π*.

We calibrate the model's parameters at standard values. The lagged dependent variable has a coefficient of 0.5 in the three equations; the Taylor coefficients, which are defined for a rule on the real interest rate, are 0.5 for the deviation of inflation from its target and 0.5 for the output gap. The transmission mechanism coefficients β and γ are both equal to 0.1. The two shocks to the Philips curve and to the IS curve are assumed to be normal with a 1 % standard deviation and orthogonal to one another. Finally, we set the inflation target π* at 2 % and we assume that half the agents form model-consistent expectations, i.e. $\alpha_0 = 0.5$.

We first compare, in Table 5, the standard deviations of inflation, output and the interest rate for this three-equation economy, under different assumptions for α_1[9]. The higher α_1, the smaller the standard deviation of inflation and the interest rate. In contrast, the variance of the output gap is hardly affected by changes in α_1.

These results can be better understood by comparing the profile of the impulse responses of inflation and the output gap following a demand shock and a cost push shock for the same values of α_1 as reported in Figure 1. The larger the share of rule of thumb agents that expect inflation to be at the target, the faster inflation goes back to the target, and, in the case of cost push shocks, the smaller the recession induced by the central bank reaction to the shock.

However, following a demand shock, the output gap is slower to return to baseline with a higher α_1. This is because the central bank's reaction implies a sharper real interest rate increase. For our simulation scenario that combines both demand and cost push shocks, the improved output stabilisation following cost push shocks is compensated by the loss following demand shocks.

For a large class of welfare functions that depend on inflation stabilisation, output stabilisation, and possibly, financial stability (captured by the stabilisation of the interest rate), seeing more agents using the inflation target as "rule of thumb" inflation expectations is a clear improvement.

[9] The simulation program, which was run in Dynare, is available upon request.

5. Conclusion

We have shown that quantified inflation objectives can be used as rule of thumb forecasting devices. The experience of various countries that have adopted such objectives shows that, to a large extent, such a rule of thumb yields smaller forecast errors than forecasting models and the forecast of professional experts reported published by Consensus Economics. This result brings further support to the adoption of quantified inflation objectives. It should be used in the communication of central banks in order to convince more economic agents that that trusting the central banks' pre-announced objectives may be optimal.

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Table 1: Inflation targets

	Target	Remarks
Euro area	1.9%	Positive inflation below 2% up to May 2003; below but close to 2% thereafter.
Australia	2.5%	Since 1993, the inflation target is set between 2% and 3%
Canada	Pre 1992Q4: 3% 1993Q1-1993Q4 : linear reduction to 2% 1994Q1 onwards: 2%	Range of 2-4%, focus on mid-point "Gradual reduction" to 2% Range of 1-3% with focus on mid-point announced at the end of 1993 and renewed since
New Zealand	Pre 1998Q4: 1% 1999Q1-2004Q3: 1.5% 2004Q4 onwards: 2%	Range of 0-2% announced in March 1990. Range renewed in subsequent Inflation Target Agreements Range of 0-3% announced in December 1996 Range of 1-3% announced in September 1992
Norway	2.5%	Defined in 2001
Sweden	2.0%	Quantitative objective announced in January 1995
Switzerland	1.0%	Official objective is below 2%
UK	Pre 2004Q4: 2.5%	Measured on the RPIX series

Table 2a: Relative RMSE of target forecasts to an AR(2) of the first difference of inflation

	As of 1995 Forecast horizon			As of 2001 Forecast horizon		
	1Q	4Q	8Q	1Q	4Q	8Q
Euro area	1.49	0.85	0.65	0.85	0.60	0.37
Australia	1.30	0.68	0.57	0.96	0.56	0.51
Canada	0.83	0.50	0.61	0.75	0.46	0.83
Norway	0.89	0.58	0.82	0.89	0.60	1.10
New Zealand	0.89	0.41	0.53	0.47	0.21	0.38
Sweden	1.07	0.73	0.75	0.60	0.42	0.43
Switzerland	1.55	0.94	0.84	1.97	1.04	1.04
UK	1.02	0.39	0.51	0.79	0.29	0.55

Values below 1 indicate that target forecasts are more accurate than AR(2) forecasts.

Table 2b: Relative RMSE of target forecasts to an AR(2) of the first difference of inflation with breaks in the mean inflation rate

	As of 1995 Forecast horizon			As of 2001 Forecast horizon		
	1Q	4Q	8Q	1Q	4Q	8Q
Euro area	1.35	0.61	0.65	1.17	0.31	0.31
Australia	1.40	0.75	0.56	1.29	0.72	0.57
Canada	0.83	0.53	0.27	0.75	0.61	0.48
Norway	0.90	0.59	0.52	0.89	0.61	0.52
New Zealand	1.30	0.66	0.71	1.06	0.52	0.58
Sweden	1.23	0.71	0.49	1.09	0.68	0.44
UK	0.78	0.32	0.25	1.07	0.51	0.37

Values below 1 indicate that target forecasts are more accurate than forecasts from an AR(2) with breaks model. There is no result for Switzerland since there has not been any announced changes in the central bank's strategy and objective for this country.

Table 2c: Relative RMSE of target forecasts to AR(2) of inflation levels with breaks in the mean inflation rate at dates when the target was changed

	As of 1995 Forecast horizon			As of 2001 Forecast horizon		
	1Q	4Q	8Q	1Q	4Q	8Q
Euro area	1.20	0.43	0.65	0.68	0.21	1.20
Australia	1.58	1.00	1.02	1.43	0.86	0.99
Canada	1.06	1.00	0.99	1.03	0.99	0.97
Norway	0.73	0.39	0.83	0.68	0.35	1.05
New Zealand	0.91	0.47	0.75	0.48	0.24	1.24
Sweden	1.32	0.90	1.30	0.76	0.48	0.88
Switzerland	0.49	0.23	0.54	0.32	0.15	0.69
UK	0.66	0.35	0.54	0.47	0.25	0.69

Values below 1 indicate that target forecasts are more accurate than forecasts from the AR(2).

Table 3a: Relative RMSE of target forecasts to random walk

	As of 1995 Forecast horizon			As of 2001 Forecast horizon		
	1Q	4Q	8Q	1Q	4Q	8Q
Euro area	1.49	0.85	0.65	0.85	0.60	0.37
Australia	1.30	0.68	0.57	0.96	0.56	0.51
Canada	0.83	0.50	0.61	0.75	0.46	0.83
Norway	0.89	0.58	0.82	0.89	0.60	1.10
New Zealand	0.89	0.41	0.53	0.47	0.21	0.38
Sweden	1.07	0.73	0.75	0.60	0.42	0.43
Switzerland	1.55	0.94	0.84	1.97	1.04	1.04
UK	1.02	0.39	0.51	0.79	0.29	0.55

Values below 1 indicate that target forecasts are more accurate than random walk forecasts.

Table 3b: Relative RMSE of target forecasts to random walk with breaks in the intercept at dates when the target was changed

	As of 1995 Forecast horizon			As of 2001 Forecast horizon		
	1Q	4Q	8Q	1Q	4Q	8Q
Euro area	1.35	0.61	0.65	1.17	0.31	0.31
Australia	1.40	0.75	0.56	1.29	0.72	0.57
Canada	0.83	0.53	0.27	0.75	0.61	0.48
Norway	0.90	0.59	0.52	0.89	0.61	0.52
New Zealand	1.30	0.66	0.71	1.06	0.52	0.58
Sweden	1.23	0.71	0.49	1.09	0.68	0.44
UK	0.78	0.32	0.25	1.07	0.51	0.37

Values below 1 indicate that target forecasts are more accurate than random walk forecasts. There is no result for Switzerland since there has not been any announced changes in the central bank's strategy and objective for this country.

Table 3c: Relative RMSE of target forecasts to random walk in inflation levels with breaks in the mean inflation rate at dates when the target was changed

	As of 1995 Forecast horizon			As of 2001 Forecast horizon		
	1Q	4Q	8Q	1Q	4Q	8Q
Euro area	2.28	0.87	0.63	1.39	0.61	0.45
Australia	1.84	0.76	0.63	1.36	0.64	0.57
Canada	1.20	0.63	0.70	1.14	0.64	0.76
Norway	1.49	0.76	0.79	1.64	0.86	0.74
New Zealand	2.16	0.71	0.71	1.55	0.43	0.43
Sweden	2.31	0.83	0.85	1.75	0.53	0.62
UK	1.47	0.91	0.80	1.27	0.80	0.81

Values below 1 indicate that target forecasts are more accurate than random walk forecasts.

Table 4: Relative RMSE of target forecasts to Consensus

	As of 1995 Forecast horizon			As of 2001 Forecast horizon		
	1Q	4Q	8Q	1Q	4Q	8Q
Euro area	5.90	1.55	0.84	2.34	0.96	0.69
Canada	2.20	1.10	0.87	1.49	0.74	0.93
Norway	4.44	1.42	1.06	4.00	2.17	1.35
Sweden	2.79	1.05	0.73	3.52	1.32	0.93
Switzerland	3.04	0.93	0.50	2.06	0.64	0.46
UK	1.12	1.02	0.65	7.37	1.49	1.01

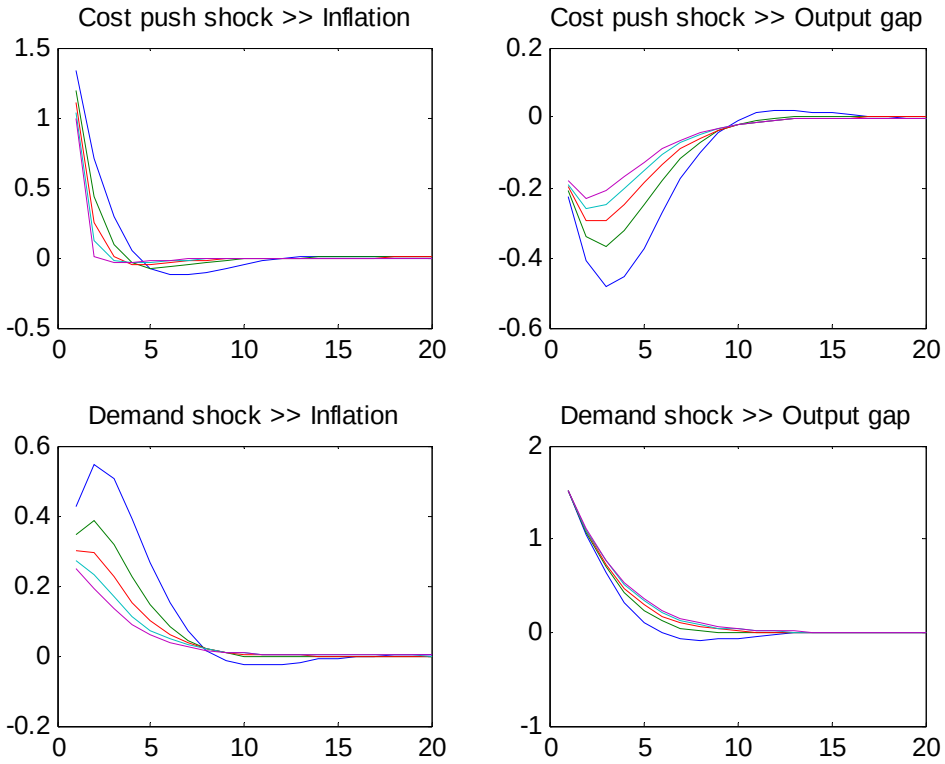
Values below 1 indicate that target forecasts are more accurate than Consensus forecasts.

Table 5: Standard deviation of inflation, output and the interest rate for different α_1

α_1	*Stdev*(π)	*Stdev(y)*	*Stdev(r)*
0,1	1,8	2,1	2,2
0,3	1,5	2,2	1,7
0,5	1,2	2,1	1,5
0,7	1,1	2,0	1,3
0,9	1,1	2,1	1,3

Based on 1000 periods simulation.

Figure 1: Impulse response of inflation and the output gap for different values of α_1



The blue line corresponds to $\alpha_1 = 0.1$ and the purple one to $\alpha_1 = 0.9$.

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