Price-level targeting as a monetary policy strategy

Safeguarding price stability has increasingly become a primary objective of monetary policy worldwide in recent decades. Price stability is generally taken in this context to mean a low inflation rate. In recent times, however, an ever-growing number of academics, in particular, have been asking whether it would not be better to base monetary policy on a target path for the price level. Theory does suggest that price-level targeting could wield an advantage over targeting the inflation rate, the main reason being that, under a monetary policy geared towards the price level, undesirable movements in the inflation rate trigger changes in inflation rate expectations, which facilitate monetary policy.

This article illustrates this argument. It also shows, however, that price-level targeting is only optimal under very specific circumstances. In many extensions of the prototypical theoretical model, for example, it makes more sense to allow a shift in the price level in the event of unexpected price shocks. Because of this qualification, the lack of practical experience and the potential cost of a change in the monetary policy regime, price-level targeting cannot be regarded as a viable strategy at present.

Introduction

Quantitative inflation rate target ...

The negative experience amassed from surges in inflation in the 1970s and early 1980s prompted many countries to make long-term price stability the primary objective of monetary policy. In order to effectively implement this goal and monitor its level of attainment, a growing number of central banks have defined price stability as a quantitative target for the rate of inflation. Given that the current inflation path is also influenced by short-term developments, the effects of which cannot be controlled directly by monetary policy measures owing to the time-lag in their implementation, central banks have also routinely implemented the goal of a low inflation rate as a medium-term strategy. In this respect, the Eurosystem's definition of price stability is no different to the inflation-rate targets formulated by central banks in other countries.

... promotes macroeconomic stability

Making price stability the primary objective of monetary policy, together with the institutionalisation of central bank independence and the increasing transparency of monetary policy, has made a significant contribution to sustained low inflation rates on a global scale in many countries while, at the same time, promoting macroeconomic stability.

Further improvement through price-level targeting?

The question of whether it would be possible to further enhance monetary policy efficiency by switching to a target for the price level instead of inflation has been raised repeatedly in academic circles in recent years. This question has gained in importance in the current period of extremely low policy rates since, from the perspective of its advocates, a target path for the price level has the added advantage of being less likely to be affected by the zero interest rate bound.

This article explores these considerations and provides an overview of the arguments for and against price-level targeting. The absence of any practical experience of a policy of price-level targeting, with the exception of Swedish monetary policy in the 1930s, is problematic for evaluating the pros and cons of such a policy.[1] The arguments made are therefore based solely on model-based theory.

Characteristics of a price-level targeting policy

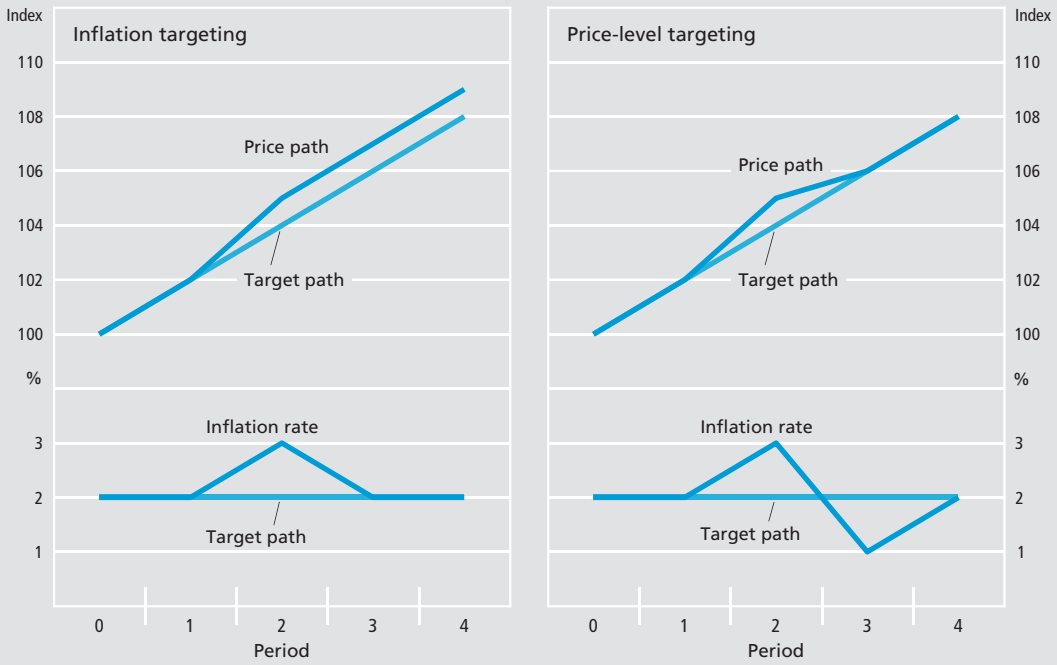
Price-level target path versus inflation-rate target

In the case of monetary policy based on price-level targeting, the central bank defines a target path for the development of the aggregate price level (measured against a suitable index) and commits itself to correcting deviations from this path within a given period. By contrast, when targeting the rate of change in the price level, ie the inflation rate, central banks' goal is merely to correct inflation-rate deviations from the given target rate (or target corridor).

The crucial difference between both strategies becomes clear in the monetary policy response to unexpected price shocks (see

1 The degree of success of the introduction of price-level targeting in Sweden is still subject to debate. See B Cournède and D Moccero (2009), Is there a case for price level targeting?, Economics Department Working Paper 721, OECD.

Inflation-rate targeting and price-level targeting in response to a price shock



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above chart).[2] In the scenario depicted, it is assumed for simplicity that the central bank is aiming for a 2% medium-term rise in the price level for both strategies. Following a price shock, the price level in period 2 overshoots the target rate: the overall price index climbs from 102 to 105.

Price level drift under inflation-rate targeting ...

If the central bank bases its monetary policy on inflation only, it then steers the inflation rate back down towards the target rate of 2% in the stylised example at hand. The price shock therefore affects the inflation rate only temporarily. Its effect on the price level, on the other hand, is permanent. There is a parallel shift in the price path: in other words, a price-level drift. Over the course of time, the price-level shifts caused by various price shocks accumulate. Consequently, the price level becomes more difficult to predict over longer forecast horizons.

... and return to trend under price-level targeting

By contrast, monetary policy based on price-level targeting subsequently corrects the effects of a price shock on the price level. In this stylised example, the monetary policy response already causes the price level to fall back towards the target path in period 3. This means, however, that the inflation rate must temporarily sink below the envisaged trend inflation rate. It returns to its target rate of 2% in period 4, however. This mean reversion – taking into account a given price-level growth path, where appropriate – is known as "stationarity" in the literature. Thus, while

2 Such price shocks can be triggered by different things, such as unexpected changes in the price of upstream products, profit margins or wages.

the inflation rate and the price level are both stationary under price-level targeting, only the inflation rate is stationary in an inflation-targeting regime.

Traditional arguments for and against price-level targeting

Price-level targeting facilitates forecasting of real payment flows ...

The return of the price level to its specified path limits uncertainty regarding the future price level and thus facilitates the forecasting of the real value of payment flows, as agreed, for instance, in long-term financial contracts.

The reduction in uncertainty regarding the long-term price level is traditionally considered a fundamental advantage of price-level targeting, which is reflected, for example, in the reduction in risk premiums and avoidance of undesired redistributive effects.

... and reduces risk premiums

Indeed, most payment flows agreed in financial contracts are not, or not entirely, indexed to the price level. This is why price shocks change the real value of nominally agreed payments: unexpected rises in the price level reduce the real value of nominal debt and vice versa.[3] In order to safeguard against this uncertainty, risk-averse creditors demand a risk premium for the provision of capital. Uncertainty regarding the price-level path is therefore reflected in a risk premium, which raises the cost of capital and thus negatively influences capital formation.[4]

Extent of welfare gains unclear, however

Opinions differ as to the actual cost of uncertainty regarding future price levels, however. While some authors believe that the reduction in risk premiums that could be achieved through price-level targeting would be associated with significant welfare gains, other studies are sceptical in this regard.[5]

These differences in opinion are unsurprising inasmuch as the degree of uncertainty regarding the future price level depends on the average level and volatility of the inflation rate. Accordingly, the extent of price-level uncertainty across relevant decision-making horizons may not be a major consideration in many countries, particularly in developed economies with low and relatively stable inflation rates.[6]

Price-level targeting mitigates redistributive effects, ...

Another perceived advantage of price-level targeting is that it tends to mitigate the redistributive effects of unexpected price-level movements. For example, an unexpected rise in the price level leads to a redistribution of real wealth in favour of borrowers. The quan-

3 In the case of expected inflation, the associated change in the real value is already factored into the contract.
4 At the same time, uncertainty regarding the real cost of debt also poses a risk for borrowers, which may result in less demand for credit, especially for longer-term project funding.
5 Crawford, Meh and Yaz (2009) emphasise possible welfare gains while Fischer (1994) and McCallum (1999) contest them. See A Crawford, C A Meh and T Yaz (2009), Price-Level Uncertainty, Price-Level Targeting, and Nominal Debt Contracts, Bank of Canada Review, pp 31-41; S Fischer (1994), Modern Central Banking, pp 262-308, in: F Capie, C Goodhart, S Fischer and N Schnadt (eds), The Future of Central Banking: The Tercentenary Symposium of the Bank of England, Cambridge University Press; B T McCallum (1999), Issues in the design of monetary policy rules, pp 1483-1530, in: J B Taylor and M Woodford (eds), Handbook of Macroeconomics, Volume 1c, North-Holland, Elsevier.
6 In the calculations of Tödter and Manzke (2007), the transition from inflation-rate targeting to price-level targeting leads to a welfare gain of just 0.066% of long-term consumption. See K-H Tödter and B Manzke (2007), The welfare effects of inflation: a cost-benefit perspective, Deutsche Bundesbank Research Centre, Discussion Paper, Series 1, No 33/2007.

titative effect established in various empirical studies is not insignificant in this regard.[7] The correction of the unexpected price-level rise under price-level targeting would diminish the degree of redistribution. Whether and to what extent this form of redistribution affects overall economic welfare, however, cannot be assessed without knowing how redistribution gains are used.

... but may increase inflation-rate volatility

The potential benefits of the reduction in uncertainty regarding the future price level must be weighed against the potential cost of correcting shock-induced price-level shifts. From a traditional perspective, these costs arise, in particular, due to increased inflation-rate volatility resulting from previous deviations from the target path having to be corrected by countervailing inflation-rate movements. If prices and wages are not completely flexible, the desired change in the inflation rate can only be effected by increasing or decreasing output and employment where appropriate. This is why, under price-level targeting, both the inflation rate and real economic activity may fluctuate more than under inflation-rate targeting. Taking the traditional view of price-level targeting, a trade-off therefore arises between the long-term benefits of lower price-level uncertainty and the short-term costs, ie greater fluctuation of the inflation rate and overall economic activity.[8]

Advantages of price-level targeting in more recent academic studies: mitigating the trade-off between inflation and output variability

Forward-looking expectations alleviate trade-off ...

This trade-off, upon which a great deal of emphasis is placed in older literature, is, however, modified by a series of new studies which suggest that, under certain assumptions, price-level targeting can promote macroeconomic stability in the short term, too. Expectations are the crucial factor in this regard. If firms' and consumers' expectations are forward-looking, price-level targeting can reduce price-level and inflation-rate fluctuations without simultaneously increasing output variability.[9] This result crucially depends on the assumption that economic agents are aware of the relevant macroeconomic relationships as well as the central bank's monetary policy strategy and take these into due account in their price expectations. If expectations are forward-looking (rational), price-level targeting causes inflation expectations to move in the opposite direction following a

7 See C Meh, J-V Ríos-Rull and Y Terajima (2008), Aggregate and Welfare Effects of Redistribution of Wealth under Inflation and Price-Level Targeting, Bank of Canada Working Paper 2008-31.
8 Older model-based studies, such as Lebow, Roberts and Stockton (1992), or Haldane and Salmon (1995), support this assumption. They refer to macroeconomic models based on backward-looking expectations in which a change in monetary policy strategy had no effect on expectations. See D E Lebow, J M Roberts and D J Stockton (1992), Economic performance under price stability, US Board of Governors of the Federal Reserve Board, Economic Activity Section Working Paper 125; A G Haldane and C K Salmon (1995), Three issues on inflation targets: some United Kingdom evidence, pp 170-201, in A G Haldane (ed), Targeting Inflation, Bank of England.
9 See, in particular, L E O Svensson (1999), Price-Level Targeting versus Inflation Targeting: A Free Lunch?, Journal of Money, Credit and Banking 31, pp 277-295 and D Vestin (2006), Price-Level versus Inflation Targeting, Journal of Monetary Economics 53, pp 1361-1376.

shock-induced price-level deviation from the target path. Under plausible assumptions regarding firms' price-setting behaviour – especially assuming that prices are set for an extended period in advance – the current inflation rate depends on inflation expectations. Consequently, under price-level targeting, the movement of inflation expectations mitigates the effect of the original shock on the inflation rate.

... by acting as automatic stabilisers

The fact that the expected return to the target path dampens the effects of shocks on current inflation means that monetary policy does not have to respond as aggressively with its interest rate instrument. This weaker monetary policy response also reduces the fluctuation in overall economic activity associated with a price shock. The target path for the price level thus acts as an automatic stabilisation mechanism which cushions the effects of disturbances to macroeconomic stability and thus mitigates the trade-off between inflation variability and output variability.

Price-level targeting leads to history dependence, ...

These advantages of price-level targeting can also be explained as follows. A policy of price-level targeting does not treat the past as having no relevance for the future under the motto "let bygones be bygones". Instead, it assumes that, for forward-looking economic agents, a correction of the effects of past shocks on the price level influences expectations and therefore already affects current actions. Thus, the measures associated with price-level targeting are anchored in the past; they are "history-dependent". This history dependence enhances welfare by eliminating inefficiencies resulting from monetary policy measures which are beneficial in the short term but detrimental from a longer-term perspective.[10] A policy which does not take into account this historical reference and bases its actions solely on the immediate future ("discretionary monetary policy") does not have this advantage.

... is therefore superior to discretionary monetary policy ...

This difference becomes clear using the example of a one-off rise in the price level: a discretionary policy which aims at keeping the future inflation rate close to a given target value in the medium term would not correct this price surge or the accompanying transitional upswing in inflation. This is suboptimal in terms of monetary policy, however. The central bank waives the option of correcting the effects of past shocks on the price level and thus of influencing expectations such that the inflation effects of price shocks are less pronounced overall both today and in the future.

... and even mimics the optimal commitment solution in some cases

Given the stabilising attributes of price-level targeting, it is hardly surprising that, in comparable model-based analyses, a policy of price-level targeting regularly performs well with regard to monetary policy efficiency. Price-level targeting even proves identical to optimal monetary policy under commitment in some cases: for example, when the relevant analyses are performed on the basis of the popular prototypical New Keynesian model.[11] This is a strong result as optimal

10 In technical terms, this inefficiency is known as the "stabilisation bias" of discretionary monetary policy. See R Clarida, J Galí and M Gertler (1999), The Science of Monetary Policy: A New Keynesian Perspective, Journal of Economic Literature 37, pp 1661-1707.
11 See D Vestin (2006), op cit.

monetary policy under commitment describes the best possible reaction of the central bank from a theoretical viewpoint.[12]

Price-level targeting lowers probability of hitting zero interest rate bound

The case for price-level targeting is strengthened further by the insight that this strategy reduces the risk of hitting the zero interest rate bound. The argument is based on the following reasoning: If the central bank's commitment to the price-level target is credible for the private sector, a drop in the price level to below the target path as a result of a negative goods demand shock, for example, leads to an automatic rise in inflation expectations. Consequently, for a given nominal interest rate, the real interest rate sinks, which stimulates aggregate demand and, in turn, keeps the required nominal interest reduction cut to a minimum. Hence, a credible price-level targeting regime lowers the risk of hitting the zero bound and falling into a deflationary trap following a negative goods demand shock.[13] In fact, theoretical studies which explicitly address the zero bound problem have shown that, under certain assumptions, price-level targeting still comes very close to optimal policy under commitment.[14]

Price-level targeting in more complex economic environments

Robustness of results crucial

The advantages of price-level targeting presented so far illustrate why the strategy is being given serious consideration as a monetary policy option in academic debate. From a monetary policy perspective, however, the robustness of the optimality of price-level targeting – ie how well it performs in the context of other models – among other considerations, is crucial. The key question in this context is whether the optimal monetary policy under commitment continues to lead to a stationary price level under more realistic assumptions. If this is not the case, price-level targeting would – compared with optimal monetary policy under commitment – inevitably stabilise prices too much and, inversely, lead to a higher volatility of other variables, especially inflation and/or output. It is therefore expedient to take a closer look at the properties of the price level under the optimal commitment policy in models which extend the framework of the prototypical New Keynesian model.

The zero interest rate bound

Price drift at the zero interest rate bound

The desirable attributes of a policy based on price-level targeting are modified in more recent studies on the zero interest rate bound.[15] In particular, it has been shown

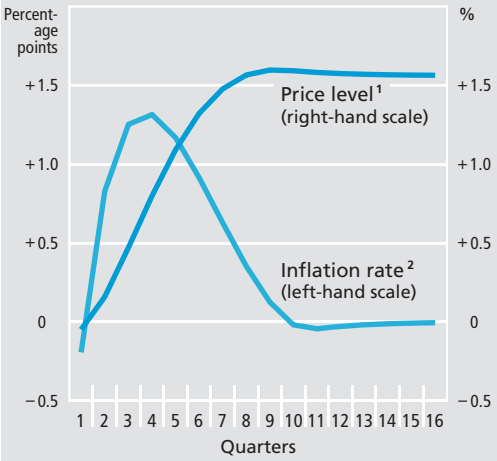
12 Under commitment, the central bank defines in advance how it will react in future to deviations of its targets from the relevant target paths and commits to act in accordance with its original intentions in the subsequent periods. The measures implemented in the subsequent periods thus depend on the state of the economy in the preceding periods; in this sense, monetary policy is history-dependent.

13 In practice, the zero interest rate bound is a reason to choose a positive value for the inflation rate target. On the other hand, there are welfare losses associated with inflation. By allowing the central bank to target a lower trend inflation rate at the same probability of hitting the zero interest rate bound, price-level targeting renders it possible to reach a higher overall welfare level. See C Lavoie and S Murchison (2008), The Zero Bound on Nominal Interest Rates: Implications for Monetary Policy, Bank of Canada Review, Winter 2007-2008, pp 27-34.

14 See G B Eggertsson and M Woodford (2003), The zero bound on interest rates and optimal monetary policy, Brookings Papers on Economic Activity 1, pp 139-211.

15 See A Levin, D López-Salido, E Nelson and T Yun (2009), Limitations on the Effectiveness of Forward Guidance at the Zero Lower Bound, CEPR Discussion Paper 7581.

Price drift at the zero interest rate bound *



Source: A Levin, D López-Salido, E Nelson, and T Yun (2009), Limitations on the Effectiveness of Forward Guidance at the Zero Lower Bound, CEPR Discussion Paper 7581. — * Optimal monetary policy under commitment: reaction to a negative goods demand shock. — 1 Relative deviation from the steady state. — 2 Absolute deviation from the steady state.

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that, in a New Keynesian model which explicitly takes into account the zero interest rate bound, optimal monetary policy under commitment may involve considerable price-level drift following a more substantial contractionary demand shock (see chart above).[16] Consequently, compared with the optimal monetary policy under commitment, returning the price level to its target path, as required under price-level targeting, is associated with welfare losses. These costs are particularly high if the negative shock to macroeconomic activity is larger than was generally assumed in pre-financial crisis studies. If such a shock were to occur, the overall economy would sink into a much deeper recession under price-level targeting than it would under the optimal commitment policy.

Price-level stationarity not necessarily optimal

As this example shows, it cannot necessarily be assumed that bringing the price level back to the target path is always the best response to macroeconomic disequilibrium. Instead, it illustrates that price-level stationarity is optimal only under specific assumptions. This caveat applies not only with respect to the zero interest rate bound, but also to other extensions of the prototypical New Keynesian model, such as alternative models for price-setting behaviour.

More complex price-setting

Price-setting and inflation in the prototypical New Keynesian model

A central element of New Keynesian models is the assumption that prices are not fully flexible. The prototypical version of the model works on the simplifying assumption that, in each period, only a proportion of firms are allowed to reset the price of their product. This means that, when setting prices, firms take into account not only the marginal costs of production, but also the expected price path, thus ensuring that their sales price does not stray too far from the general price level in the coming periods.[17] Since firms set their

16 This consideration is based on the following insight: Since aggregate demand at the zero interest rate bound can only be revived by steering expectations, the optimal monetary policy under commitment aims to lower the real interest rate by increasing inflation expectations. At the zero interest rate bound, inflation expectations can be increased further if the central bank gradually raises the implicit price-level target. The real interest rate is therefore reduced more than would be the case if monetary policy "merely" attempts to return to the target path for the price level. Price-level targeting is therefore suboptimal as expectations cannot be steered as effectively as under optimal monetary policy under commitment.

17 Most of the literature comparing inflation-rate targeting and price-level targeting implicitly assumes that the type of price-setting (and thus the underlying nominal rigidity) does not depend on the monetary policy the central bank pursues. The extent to which this assumption is justified is not normally called into question. Any comparison of inflation-rate targeting and price-level targeting which takes firms' price-setting behaviour as given is therefore vulnerable to the Lucas critique.

prices on the basis of the expected price path, the inflation process is forward-looking: the higher the expected future inflation rate, the higher the current inflation rate (see the box on pages 40-41). Conversely, the inflation rate in the preceding period has no impact on the current inflation rate in this model.

Price drift given inflation persistence

This model is not, however, consistent with the inflation persistence which can be observed in many countries.[18] For this reason, various model variants were developed in which the inflation rate depends not only on expected future inflation, but also on its own past values. Whether a policy of price-level targeting is optimal in these model variants depends on the specific assumptions made regarding firms' price-setting behaviour. If a fraction of firms are simple, backward-looking "rule-of-thumb" price-setters, ie they set their prices in direct relation to past inflation rates, then it is no longer optimal to fully correct the effects of price shocks on the price level (see the chart on p 42).[19] The higher the percentage of rule-of-thumb firms, the less advisable it is to correct price level shifts.[20]

Taking into account money balances

Price drift in a model with money

Another simplifying assumption of the prototypical New Keynesian model is the abstraction of those transaction costs associated with a direct exchange of goods in an economy when no generally accepted means of payment is available.[21] Pursuant to this assumption, "money" need not exist in this model. If, acknowledging reality, one deviates from this assumption, the utility derived from holding money balances gives rise to a demand for money which depends on the nominal interest rate. Taking into account the fact that unexpected price shocks cause fluctuations in both the nominal interest rate and money demand, it follows that, as well containing the deviations of inflation and macroeconomic activity from their target paths, the central bank has to keep fluctuations in interest rates as small as possible. In other words, if demand for money is explicitly included in the New Keynesian model, the central bank's target catalogue then includes an additional interest rate stabilisation term.[22] In this case, as in the examples above, the price level again does not return to its original equilibrium following a price shock under the optimal commitment policy; rather, it remains

18 Inflation persistence measures the influence of past price shocks on the current inflation path. For more information on the topic, see J Fuhrer and G Moore (1995), Inflation Persistence, Quarterly Journal of Economics 110, pp 200-223.
19 This has the following underlying logic: those firms applying simple rule-of-thumb price-setting are not forward-looking. Thus, their expectations cannot be steered as is usual under price-level targeting. Any price-level correction for monetary policy reasons therefore merely gives rise to costs for this category of firms. Returning to the original target path is not optimal.
20 See J Steinsson (2003), Optimal monetary policy in an economy with inflation persistence, Journal of Monetary Economics 50, pp 1425-1456.
21 Barter trade presupposes mutual agreement between trading partners about what they want to trade in each transaction. This is likely to be the exception rather than the rule. Complex chains of transactions are therefore necessary in an economic environment with no generally accepted means of payment. See the example coined by C Menger (1909) in P Bofinger, J Reischle and A Schächter (1996), Geldpolitik, Vahlen, p 460.
22 If the nominal interest rate increases following a price shock and deviates from its equilibrium rate, private agents demand correspondingly low and therefore suboptimal money balances. As a result, in a model that specifically includes money demand, shock-induced fluctuations of nominal interest rates are associated with welfare costs. See M Woodford (2003), Interest and Prices, Princeton University Press, p 422.

Inflation-rate targeting and price-level targeting in a New Keynesian model

The basic New Keynesian model is a simple variant of a dynamic stochastic general equilibrium (DSGE) model.[1] The model equations are derived from the decisions of a representative household and a representative firm. The representative household supplies labour and demands goods and bonds while the representative firm demands labour and produces goods. From the model's assumptions it follows that the decision-making rules derived at the individual level apply at the aggregate level as well. The model is log-linearised around an equilibrium and then solved numerically. All variables are therefore deviations from their steady states. This simple model is based on a closed economy and does not take into account the existence of a capital stock. The model can be summarised in three equations.

The IS equation describes the household's saving and investment decisions. The household maximises its lifetime utility taking into account its resource constraint. Output of the current period x_t depends on expected output and the real interest rate. The real interest rate is calculated using the difference between the nominal interest rate i_t and expected inflation $E_t \pi_{t+1}$ where E_t is the expectations operator. The parameter σ represents the intertemporal elasticity of household consumption; therefore,

$$x_t = E_t x_{t+1} - \frac{1}{\sigma}(i_t - E_t \pi_{t+1}) .$$

The Phillips curve describes the path of inflation resulting from the price-setting behaviour of firms. The representative firm maximises its profit within the constraints for production and sales. In particular, in each period prices can only be adjusted with a probability of $1-\theta$ (Calvo price-setting). If there is an opportunity to adjust prices, the respective firm acknowledges that the selected price will remain fixed for several periods. The firm must therefore take into account the future path of marginal costs of production as well as the path of the general price level. On aggregate, the optimal behaviour of firms means that inflation in the current period is a function of the real marginal costs and the inflation of the subsequent period discounted with β. Real marginal costs can be expressed as a function of the output gap. In the model presented here, shocks to potential output are not taken into account, implying that the difference between output and its steady state equals the output gap. The elasticity of inflation with respect to changes in the output gap, κ, depends in part on the degree of price stickiness. In order to analyse deviations from the equilibrium, a cost-push shock u_t is added to the equation

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t + u_t .$$

According to the IS equation and the Phillips curve, both current output and inflation depend on future expected variables. Thus, the two key variables in this model economy are forward-looking.

Monetary policy makers set the (short-term) nominal interest rate with the aim of minimising welfare losses resulting from frictions and shocks. The measure for overall economic welfare is derived from the lifetime utility function of the representative individual. Welfare can be approximated using the weighted total of the squared deviations of the inflation rate and the output gap from their respective steady state levels

$$L_t = E_t \sum_{\tau=t}^{\infty} \beta^{\tau} (\pi_\tau^2 + \lambda_x x_\tau^2) .$$

The weight λ_x is determined by the structural parameters of the model, such as the Calvo parameter θ in particular.

The attainable welfare level depends on whether interest rates are set under commitment or according to the discretionary policy approach. In the case of monetary policy under commitment, the welfare function is minimised under the assumption that binding statements regarding future policy are possible. Additionally, the constraints resulting from the IS equation and the Phillips curve must be taken into account. The consolidated optimality condition expresses inflation as dependent on output in the current and preceding periods

$$\pi_t = -\frac{\lambda_x}{\kappa}(x_t - x_{t-1}) .$$

From this it is apparent that optimal monetary policy under commitment depends on its history as the output of period t-1 is factored into the decisions.

In the case of monetary policy under discretion, the central bank cannot influence the expectations of households and firms as the policy is optimised in each period. In contrast to monetary policy under commitment, the optimality condition for discretionary inflation-rate targeting is a purely contemporaneous relationship

$$\pi_t = -\frac{\lambda_x}{\kappa} x_t .$$

The table on page 41 shows the variances and welfare losses for optimal monetary policy under commitment and under discretion.[2] As a result of the absence of history dependence, there are significant welfare losses in the case of discretionary inflation-rate targeting when compared to monetary policy under commitment. As a rule, in the case of discretionary monetary policy there is, therefore, the possibility of welfare improvements if the central bank follows a modified loss function which results in monetary policy being history dependent.

When pursuing a strategy of price-level targeting, the central bank does not optimise the actual welfare function but instead optimises a modified loss function in which the inflation rate is replaced by the deviation of the price level p_t from the steady state

$$L_t^{DP} = E_t \sum_{\tau=t}^{\infty} \beta^{\tau} (p_\tau^2 + \lambda_{DP} x_\tau^2) .$$

1 DSGE models have become an important instrument in the analysis of monetary policy issues. See, for example, Deutsche Bundesbank, Development and application of DSGE models for the German economy, Deutsche Bundesbank Monthly Report, July 2008, pp 31-46. — **2** The parameterisation of the model is similar to the work by J Galí (2008), Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian

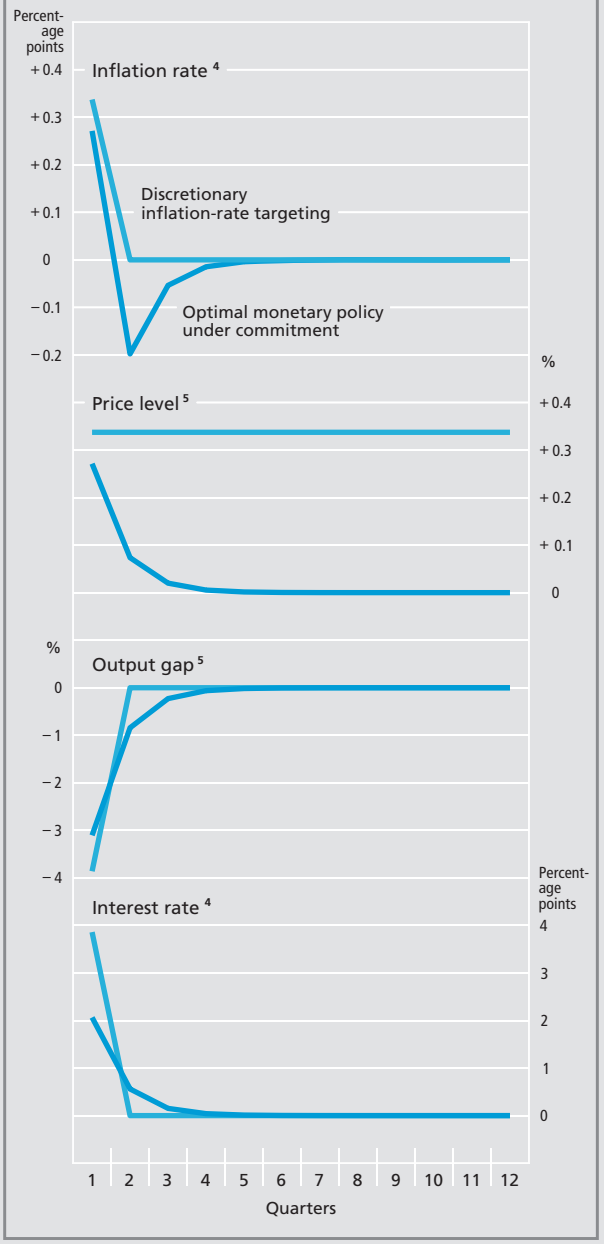
Welfare losses associated with the different strategies

Strategy	Variance				Welfare loss
	Inflation	Output gap	Price level	Interest rate	
Optimal monetary policy under commitment	0.59	52.68	–	23.30	1.38
Discretionary inflation-rate targeting	1.11	37.51	603.62	25.94	1.68
Discretionary price level targeting	0.62	50.61	0.43	21.66	1.38

In the modified loss function, the weight λ_{DP} on the output gap can also be freely and therefore optimally chosen.[3] The solution under the discretionary regime is again calculated from the minimisation of the loss function, taking the IS equation and the Phillips curve into account. The variances in the table show that a target path for the price level results in lower variances for both inflation and output gap than when using discretionary inflation-rate targeting. Also, it can be observed that in this simple model – and only in this model – price-level targeting leads to welfare losses identical to those obtained when applying monetary policy under commitment.

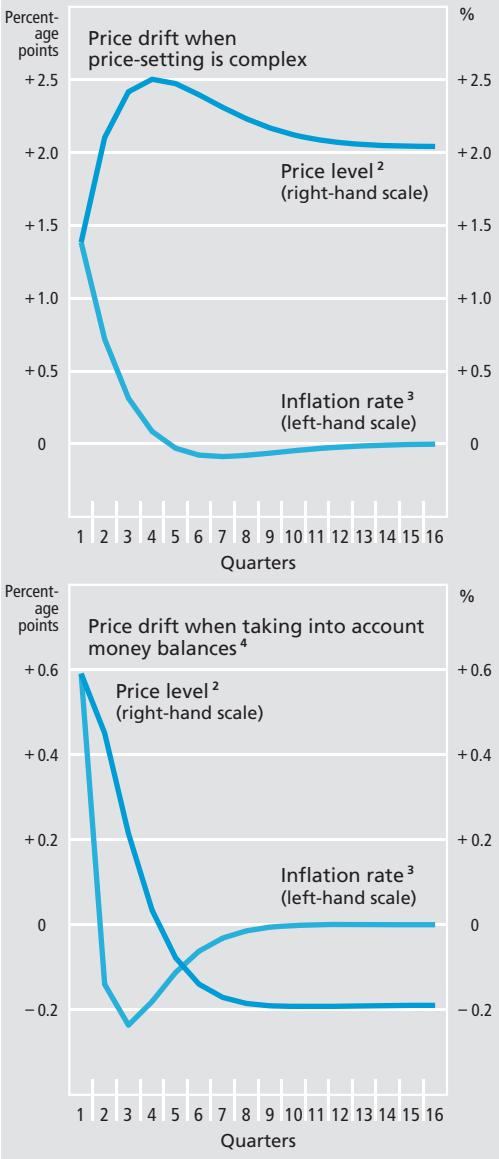
The chart shows the corresponding impulse responses for the uncorrelated cost-push shock u_t which results in a one-off increase in the inflation rate. Under a discretionary policy regime, monetary policy makers aim solely to minimise the shock-related increase in the inflation rate in period 1 by reducing the output gap, ie the percentage difference between output and potential output, to below zero through the implementation of a restrictive monetary policy. By period 2, the impulse responses of inflation and the output gap have already returned to their long-term equilibrium while the price level has increased permanently. The response of monetary policy makers under the commitment regime is different. In order to lower inflation expectations, the output gap is consciously pushed below its long-term equilibrium value for several periods despite the fact that the shock (not shown) has already faded after one period. Consequently, the inflation rate also drops below its long-term equilibrium value. The resulting difference between the commitment and the discretionary regime can be seen in the response of the price level: under the commitment regime, the price level is stationary whereas under the discretionary regime the shock brings about a drift in the price level.

Optimal monetary policy under commitment and discretionary inflation-rate targeting: reaction to a one-off cost-push shock



Framework, Princeton University Press. Here it is assumed that the cost-push shock u_t is uncorrelated. The value of 1 is used as the standard deviation of the cost-push shock. — **3** The optimal weight is 0.011 and was calculated using an interval between 0 and 1 in increments of 0.001. — **4** Absolute deviation from the steady state. — **5** Relative deviation from the steady state.

Price drift in extensions of the prototypical New Keynesian model *



* Optimal monetary policy under commitment: reaction to a positive cost-push shock — **1** Source: J Steinsson (2003), Optimal monetary policy in an economy with inflation persistance, Journal of Monetary Economics 50, pp 1425–1456 and Bundesbank calculations. — **2** Relative deviation from the steady state. — **3** Absolute deviation from the steady state. — **4** Source: M P Giannoni (2000), Optimal interest-rate rules in a forward-looking model, and inflation stabilization versus price-level stabilization, Columbia University, manuscript and Bundesbank calculations.

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below its original path (see opposite chart).[23] The price level therefore drifts; the return of prices to their original path, as associated with price-level targeting, is not a sign of optimal monetary policy under commitment in this model variant, either.[24]

Relative price shocks

Price drift following relative price shocks

Until now, the discussion of the advantages and disadvantages of price-level targeting has focused on the effects of a shock to the aggregated price index. Shock-induced changes in relative prices between sectors were not taken into account as the prototypical New Keynesian model assumed price stickiness in only one sector of production. This is too shortsighted an assessment of price-level targeting, however, as, even in the prototypical model, (shock-induced) changes in relative prices within a sector are associated with in-

23 A similar result can be reached in a New Keynesian model with a banking sector where it is optimal to stabilise not only inflation and output, but also the rate of change of average lending rates. See C Gerberding, R Gerke and F Hammermann (2010), On Price Level Targeting and Optimal Monetary Policy, manuscript.
24 However, this does not necessarily mean that a strategy of discretionary inflation-rate targeting is superior to price-level targeting for this model since the expected error correction continues to dull the effect of shocks on inflation and thus mitigates the trade-off between inflation and output variability. By comparing simple rules, Giannoni (2000) shows that a Wicksell rule in which the central bank adjusts its policy rate in response to price-level deviations from target generally produces better results than a prototypical Taylor rule in which the policy rate is adjusted in response to inflation-rate deviations from the inflation target. See M P Giannoni (2000), Optimal interest-rate rules in a forward-looking model, and inflation stabilization versus price-level stabilization, Columbia University, manuscript.

efficiencies.[25] If the New Keynesian model is extended to include additional sectors so that there are price rigidities in more than one sector, complete stabilisation of the aggregated price index, again, does not prove optimal.[26] Under optimal monetary policy under commitment, the consumer price index does not return to its original equilibrium following, for example, a negative technology shock[27] in a specific sector; it remains above its original path in the long term. In turn, the level of consumer prices therefore drifts (see chart on page 44).

Price-level targeting in complex model economies

Price drift in large macro models

The preceding examples show that price-level stationarity is not a general feature of optimal monetary policy under commitment but that its desirability depends instead on the details of the underlying model. This suggests that optimal monetary policy in (even) more complex economic environments is likewise not necessarily characterised by price-level stationarity.[28] In recent years, a number of central banks have endeavoured to develop large macro models which rest on rigorous microeconomic foundations and are able to better replicate the observed behaviour of macro variables within an economic area.[29] To do so, it has proved necessary to extend the prototypical New Keynesian model by adding a number of extra characteristics in addition to the modifications already discussed. However, currently little is known about the characteristics of optimal monetary policy under commitment in these complex models.[30] As a first step in this direction, two recent studies by the Bank of Canada show that the price level under optimal policy under commitment also drifts following a price shock in two models used by the ECB and the Bank of Canada for policy analysis.[31]

25 In the prototypical New Keynesian model, changes in relative prices between goods within a sector are a fundamental problem as firms cannot reset their price in each period. Conversely, households wish to consume a wide range of goods in such a way that they demand the same quantity of all goods. It is therefore efficient to offer the same quantities of all types of goods. This requires all goods to be offered at the same price at all times. Since firms' lagged price-setting behaviour leads to sticky prices, all prices must be constant over time to ensure the efficient provision of goods. Only then are the same quantities of all goods produced. If, by contrast, the aggregated price level changes over time, price adjustments differ at individual level owing to sticky prices, even in the case of constant rate of change, and this results in inefficiencies.

26 This is essentially due to the fact that, as with the preceding model variants, the target catalogue of the central bank is also extended in this variant. As well as the usual variables, the approximated welfare function derived on the basis of the utility function of households includes the stabilisation of a producer price index and producers' real marginal costs for upstream products. Complete stabilisation of the aggregated price index would make the variability of these parameters suboptimally high. See K Huang and Z Liu (2005), Inflation Targeting: What Inflation Rate to Target?, Journal of Monetary Economics 52, pp 1435-1462.

27 Technology shocks are unexpected changes in firms' productivity.

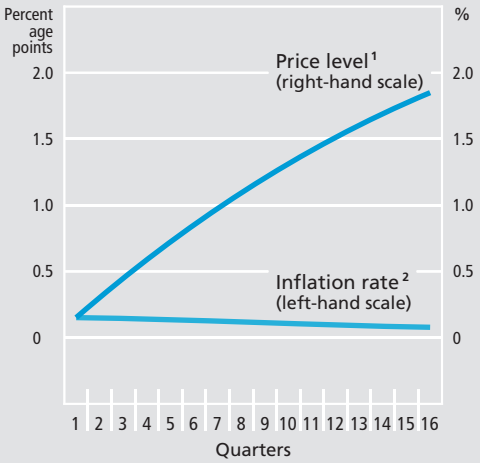
28 However, it does not automatically follow that a strategy of price-level targeting is superior to a strategy of inflation-rate targeting in more complex models. See also G Cateau (2008), Price Level versus Inflation Targeting under Model Uncertainty, Bank of Canada Working Paper 2008-15.

29 See Deutsche Bundesbank, Development and application of DSGE models for the German economy, Monthly Report, July 2008, pp 31-46.

30 Little is also known of how to assess the possible superiority of price-level targeting if uncertainty is explicitly included in the model. See C Gerberding, R Gerke and F Hammermann (2010), op cit.

31 See G Cateau (2008), op cit, and G Cateau (2009), Optimal Policy under Commitment and Price Level Stationarity, Bank of Canada Working Paper 2009-8.

Price drift given sticky prices in two sectors *



Source: K Huang and Z Liu (2005), Inflation Targeting: What Inflation Rate to Target?, Journal of Monetary Economics 52, pp 1435–1462 and Bundesbank calculations. — * Optimal monetary policy under commitment: reaction to a negative technology shock. — 1 Relative deviation from the steady state. — 2 Absolute deviation from the steady state.

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Conclusions and outlook

Congruence of price-level targeting and optimal monetary policy …

A conclusive assessment of price-level targeting requires as detailed a comparison as possible of the costs and benefits of this policy. In the older literature, the benefits allude mainly to lower uncertainty regarding the future price level. From a traditional perspective, costs arise, in particular, due to increased inflation-rate volatility resulting from previous deviations from the target rate having to be corrected by counteractive inflation-rate movements. By contrast, the more recent literature propounds that a strategy of price-level targeting in simple models with forward-looking expectations does not necessarily lead to higher inflation-rate volatility. Under these assumptions, a policy of price-level targeting is very close to or even replicates optimal policy under commitment.

… not evidenced in more complex models

Nonetheless, the evidence presented in this article confirms that price-level targeting in more complex and therefore more realistic models is not necessarily identical to optimal monetary policy under commitment.

Cost of a regime shift

In addition to the lack of robustness, which should be considered a fundamental drawback given the model uncertainty with which practical monetary policy is undeniably confronted, the costs associated with a regime shift are also ignored in most studies. These costs depend, among other things, on how long the central bank may need to establish credibility for the new strategy.[32] In this connection, the lack of experience of implementing a policy of price-level targeting is once again a disadvantage.

Problems associated with cost-benefit analyses

Two core problems are associated with a cost-benefit analysis: up to now, there is no uniform framework for assessment which encompasses all advantages and disadvantages, and it is not possible to simply summate the respective arguments. Although the debate regarding the pros and cons of price-level targeting does not provide any clear direction for practical monetary policy, it nonetheless remains that an optimal policy – and for actual monetary policy, this can only mean attempting to come close to this ideal – is

32 Such a cost-benefit analysis can also be carried out within the context of a simplified New Keynesian model if the assumption of rational expectations is replaced by the assumption of adaptive learning. See V Gaspar, F Smets and D Vestin (2007), "Is time ripe for price level path stability?", ECB Working Paper No 818.

more than the mechanistic pursuit of any objective, be it a price-level target or an inflation target. Good monetary policy strategy takes into account, above all, the fact that expectations cannot be managed in a stability-oriented manner without credibility, consistency and predictability.