Price-Level Targeting and Stabilization Policy: A Review

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- *The Bank of Canada is leading a research program to address whether and how the monetary policy framework in Canada might be improved.*

- *Part of this research relates to the potential costs and benefits of replacing the Bank's inflation-targeting regime with a price-level targeting regime.*

- *This article reviews arguments for and against price-level targeting put forward by researchers at the Bank of Canada, at other central banks, and in academia.*

- *It summarizes four main arguments in favour of price-level targeting and discusses some issues related to its optimality and implementation.*

In November 2006, the Bank of Canada and the Government of Canada announced the renewal of the Bank's inflation-control target for a period of five years, to the end of 2011. The agreement stipulated that the Bank would continue to aim to keep CPI inflation at two per cent, with a one to three per cent control range around the target. In a background document to the renewal (Bank of Canada 2006), the Bank announced its intention to lead a research program to address whether and how the monetary policy framework in Canada might be improved. The background document raised two broad sets of questions. The first related to the possibility of lowering the inflation target below two per cent. The second related to the potential costs and benefits of replacing the inflation-targeting (henceforth IT) regime with a price-level targeting (henceforth PT) regime. An IT regime is defined as a regime in which the central bank aims to keep some measure of inflation, such as CPI inflation, close to a target rate. By contrast, under a PT regime, the central bank's aim is to stabilize the price level around a known target path, leading it to target a lower (higher) inflation rate after a positive (negative) shock to inflation in order to bring the price level back to its target path.[1]

This article is concerned with the second set of questions. There is a substantial body of research that examines the costs and benefits of PT compared with IT. This article reviews four main arguments from the modern academic literature advanced in favour of PT.[2] In the next section, the traditional arguments for and against PT are summarized. This is followed by an

1 A PT regime does not necessarily mean that the long-run price level is constant, since the target path may have a positive slope (which determines the long-run rate of inflation). What a PT regime does mean is that the central bank acts to offset deviations of the price level from the target path.

2 An older literature on PT goes back to Keynes, Fisher, Wicksell, and others. See Duguay (1994) for a cogent survey.

assessment of three of the four main arguments for PT arising from recent research. First, committing to PT affects expectations of future inflation and leads to a better trade-off in the short run between inflation and output. Second, assigning a price-level target to a central bank that cannot commit to its future policies can, to some extent, substitute for that commitment and lead to improved economic performance. Third, it can lead to smaller forecast errors for firms that use these forecasts to set their prices. The following section discusses the fourth argument: PT can be beneficial if it reduces the degree to which wage contracts are indexed, since it improves the economy's ability to react to real shocks. Other issues related to PT are then discussed briefly before the article concludes.

> *Committing to PT affects expectations of future inflation and leads to a better trade-off between inflation and output.*

Price-Level Targeting: Arguments For and Against

The Bank of Canada's current target rate of inflation is two per cent. If the annualized rate of inflation is unexpectedly above that rate during the current period, then under the Bank's IT regime, the target remains at two per cent going forward. Under a PT regime, the inflation target would be reduced to below two per cent until the price level itself returned to its original targeted growth path.[3] The positive inflation surprise is offset. Under IT, there is no such offset. A temporary inflation shock leads to a permanent shift in the time path of the price level (this is referred to as "price-level drift"), and shocks to inflation have a cumulative impact on the price level. The future price level is increasingly hard to predict as the forecast horizon increases, and becomes virtually unpredictable at sufficiently long horizons.

The long-run predictability of the price level under PT is precisely the source of the intuitive appeal of this monetary policy regime. It means that the real value of future payments specified contractually in nominal terms is more predictable than it would be under an

IT regime.[4] Under a PT regime, current prices convey intertemporal information, since the relative price of future goods in terms of today's goods is predictable, as argued by Coulombe (1998a, 1998b).

This begs the question of why individuals sign long-term contracts that stipulate the value of future payments in nominal terms. There is not a strong consensus among economists as to why this is the case, but the prevalence of contracts with fixed nominal payments is not in doubt. Fischer (1994) argued that the benefits of reduced uncertainty concerning the real value of payments could not be very high, given that individuals in the private sector could easily use other means, such as indexed bonds and contingent contracts, to mitigate the uncertainty without any change in the monetary policy regime. Others infer on the basis of the same evidence that the use of these measures by individuals must be economically costly. For example, Howitt (2001) judged that "long-term price-level uncertainty is one of the most serious consequences of inflation, because of its ruinous effects on long-term contracting."[5]

If reduced price-level uncertainty is the main argument traditionally invoked in favour of PT, the traditional argument against PT is that it must raise the short-run variability of both inflation and output. The logic of this argument seems straightforward. In response to a temporary, unexpected increase (decrease) in inflation in a PT regime, inflation would have to be reduced below (above) its long-run target rate in the short run in order to move the price level back to its target growth path. This increases the variability of inflation, taking the initially lower (higher) price level as a starting point. Since monetary policy operates by affecting aggregate demand, the way to move the price level back down towards the target path would be to raise interest rates in order to reduce aggregate demand. Since no such reduction would be necessary under an IT regime, the variability of output would also be lower under IT.

To summarize, the traditional view sees PT as a trade-off between the longer-run benefits of increased price-level predictability and the short-run costs of increased variability of both prices and output. Formal models from the early 1990s largely confirmed

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3   This obviously applies in reverse in response to a negative shock to inflation.

4   The existence of imperfectly indexed long-term nominal contracts has implications for the effects of price-level shocks on the distribution of wealth under PT and IT. This is an active area of research. See, for example, Doepke and Schneider (2006), Meh, Ríos-Rull, and Terajima (2008), and Meh and Terajima (2008).

5   Some recent work analyzes the welfare benefits from reduced uncertainty surrounding the real value of the payoffs of nominal contracts. These studies take the existence of long-term nominal contracts as given. See for example Doepke and Schneider (2006) or Meh and Terajima (2008).

the traditional view concerning increased short-run variability of prices and output under PT. Examples include Lebow, Roberts, and Stockton (1992), and Haldane and Salmon (1995). The contribution of the more recent literature on PT has been to show that, under some circumstances, PT can actually lead to an improved trade-off between inflation and output variability. Much of the focus of recent papers has been to investigate just how wide the range of these circumstances is.

> *The traditional view sees PT as a trade-off between increased price-level pre-dictability and increased variability of both prices and output.*

Optimal Monetary Policy with Forward-Looking Expectations

Much of the modern analysis of PT has been conducted in the context of so-called New Keynesian macroeconomic models.[6] These models have become workhorses for monetary policy analysis by both central banks and academic economists.[7] New Keynesian models have monopolistically competitive firms that set prices optimally but are unable, by assumption, to reset their prices every period. When they do have the opportunity to revise their prices, firms take into account the marginal cost of producing their output and, knowing that they will not be able to adjust their prices for several periods, they forecast the evolution of the overall price level over the period for which their price will remain fixed. The optimal behaviour of firms in such a setting, when aggregated across the different firms in the economy, yields the "New Keynesian Phillips curve." This equation states that current inflation depends directly both on firms' real marginal costs of production and on their current forecast of future inflation. Real marginal cost is in turn related, under certain assumptions (see Clarida, Galí, and Gertler 1999), to the output gap, the difference

between aggregate output with sticky prices, and what output would be with complete price flexibility.[8]

The New Keynesian model can be used to derive the optimal monetary policy for a central bank that sets short-term nominal interest rates in order to reduce the variability of both inflation and the output gap.[9] If the central bank can commit to a time path for future interest rates and if the public believes that it will stick to this announced path (so that its commitment is credible), its optimal policy has the feature that the price *level* itself is stable in the long run.[10] In response to a cost-push shock to the inflation rate, inflation initially moves less than the value of the shock itself as the central bank moves the short-term interest rate to affect aggregate demand to partially offset the effect on inflation. Starting with the first period after the shock dissipates, inflation changes sign, and the price level is gradually brought back to its initial pre-shock value. It appears as if the central bank is targeting the price level itself.

The logic of how a commitment to reducing future inflation can be beneficial is simple. By committing to a reduction in future inflation (in response to a positive cost-push shock) even after the shock has passed, current expectations of future inflation are reduced. According to the New Keynesian Phillips curve, current inflation depends directly on expected future inflation as well as on the output gap. This improves the trade-off between inflation and output in the current period, reducing the output loss associated with fighting inflation in the face of a positive cost-push shock. This in turn reduces inflation persistence, thereby reducing inflation variability. The New Keynesian Phillips curve assigns a crucial role to forward-looking expectations of inflation as a determinant of current inflation, and these forward-looking expectations are crucial for the result that is optimal for the central bank to offset shocks to the price level.

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8   The equation can be written as follows:

$$\pi_t = \beta E_t \pi_{t+1} + \psi x_t + \mu_t$$

where π_t is the deviation of inflation from its target or trend at time t, $E_t \pi_{t+1}$ denotes expected future deviation of the inflation rate, x_t is the output gap, μ_t is a "cost-push" error term, and $0 < \beta < 1$ and $\psi > 0$ are parameters.

9   Since the central bank cannot completely eliminate fluctuations in two variables using only one instrument, it minimizes a loss function that depends on a weighted average of squared deviations of inflation from its target rate and of the squared output gap. This form of loss function can be derived under certain assumptions as an approximation to the utility function of a representative household. See Woodford (2003) for details. Inflation has a direct impact on economic welfare because it influences the dispersion of prices across different firms and thereby decreases the efficiency of production.

10   This result was first demonstrated by Woodford (1999) and by Clarida, Galí, and Gertler (1999).

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6   See Clarida, Galí, and Gertler (1999) for a detailed summary of the standard New Keynesian model and an application to optimal monetary policy.

7   The main model currently in use for internal forecasting purposes at the Bank of Canada, ToTEM, is an elaborate version of a New Keynesian model. See Murchison and Rennison (2006) for a detailed description.

Committing to fighting future inflation improves the trade-off between inflation and output.

Optimal monetary policy under commitment generally has the property that it is *time inconsistent*.[11] That is, it is in the interest of the central bank (and in the interest of society as a whole if the central bank maximizes social welfare) to renege on its announced path for the interest rate. It can achieve a higher level of welfare by choosing a new optimal policy. In turn, if individuals recognize the central bank's incentive to do this, then unless the bank can credibly commit to its announced path for interest rates, its policy will not be believed by the public. An inability to commit to its announced policies reduces the level of economic welfare that the central bank can achieve.

What is the central bank's optimal policy if it is unable to commit to its future policies? (It is standard to refer to optimal policy in this case as "optimal *discretionary* policy.") It can be shown that the optimal policy rule has the property that the rate of inflation—and therefore the short-term interest rate set by the central bank—should vary with the level of the output gap. In this case, the central bank allows a temporary cost-push shock to have a permanent effect on the price level, unlike the case of optimal monetary policy with commitment.

It is also possible to direct the bank to set a goal of reducing fluctuations in output and the price *level*, even if society's true economic welfare depends on reducing fluctuations in output and inflation. Howitt (2001) calls this instructing the central bank to act like a "Zen archer" by aiming at a target that is not society's true target.[12]

In this context, Vestin (2006) demonstrated a remarkable result. In a standard New Keynesian model, as long as cost-push shocks are not persistent, the central bank can attain the same level of economic welfare under discretion as it can under commitment if it uses a loss function that depends on price-level deviations and provided that the relative weight on price-level deviations in the loss function is chosen

appropriately. Giving such a loss function to the central bank is a perfect substitute for commitment. It has the effect of affecting expectations of future inflation in the same way as the optimal monetary policy under commitment. In response to a positive cost-push shock to inflation, expectations of future inflation fall, improving the current trade-off between output variability and inflation variability.

Vestin's result holds under quite restrictive assumptions: If the cost-push shock has any persistence, it is no longer possible to attain the same level of welfare as under commitment. However, under a much wider range of circumstances, it is possible to do better than the optimal discretionary monetary policy by assigning a price-level target to the central bank.

Svensson's (1999) seminal paper was the first to construct a model in which an improved short-run trade-off between output and inflation variability is possible under discretion. His model was built around a New Classical Phillips curve, in which current inflation depends on the previous period's expectation of current inflation as well as the output gap. His main result was that, when the output gap is persistent, assigning a price-level target to the central bank improves the trade-off between inflation variability and output variability. Inflation expectations in Svensson's model are indirectly forward-looking. With a persistent endogenous output gap, the central bank can affect the future trade-off between inflation and output variability by affecting the current output gap. As the output gap becomes more persistent, the central bank's ability to affect the future trade-off is enhanced.[13]

Forward-looking inflation expectations, either direct or indirect, are key here. Dittmar and Gavin (2000) showed that replacing the New Classical Phillips curve with the New Keynesian Phillips curve in Svensson's (1999) model leads to an improved trade-off even without endogenous persistence in the output gap. In a recent article, Cover and Pecorino (2005) used the same basic model as Svensson (1999) but changed the assumption of the timing of the central bank's decisions. They supposed that the central bank must choose its optimal policy before knowing the current value of aggregate disturbances. In such a context, the aggregate demand side of the economy plays an active role in the determination of macroeconomic equilibrium, rather than just recursively determining the nominal interest rate necessary to attain the

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11   The classic reference on the time inconsistency of optimal government policies is Kydland and Prescott (1979).

12   Assigning an objective different from the true social welfare function to the central bank has a long tradition in macroeconomics. One of the best known examples is Rogoff (1985), who constructed a model in which appointing a "conservative" central banker who is more concerned than society as a whole with fighting inflation could lead to an unambiguously better outcome, with lower inflation and the same average level of output.

13   It can be shown that if the output persistence is purely exogenous (arising from, for example, a persistent error term in the Phillips curve equation), there are no advantages to be had by assigning a price-level target to the central bank.

central bank's chosen rate of inflation. In their model, aggregate demand depends on the real interest rate, equal to the nominal interest rate minus expected inflation based on current information. Their main result is that PT gives an improved trade-off even with no persistence of the output gap. When there is a positive inflation shock under PT, expected future inflation declines, which yields a higher real interest rate for any given level of the nominal interest rate. This reduces aggregate demand, which reduces the equilibrium inflation rate in the current period.

Ball, Mankiw, and Reis (2005) analyzed a model with a Phillips curve derived in a setting where price-setters pay costs to update their information concerning macroeconomic conditions. Like the New Classical Phillips curve, it depends on past expectations of current inflation as well as the output gap. Like Cover and Pecorino (2005), they suppose that the central bank sets its policy before observing current shocks. They show that optimal policy under commitment gives a stationary price level, a result similar to that of Clarida, Galí, and Gertler (1999) and Woodford (1999) for New Keynesian models.[14] Ball, Mankiw, and Reis (2005) stress that the beneficial effects of PT in their model come from reducing the prediction errors of price-setters.

Contracting, Indexation, and Price-Level Targeting

Most of the literature comparing PT and IT takes as given the type and degree of nominal rigidity across the two types of monetary policy regimes. It is important to note that the details of how prices are set in New Keynesian models are imposed by assumption. Any comparison between the two types of regime that holds the type of nominal rigidity constant is potentially vulnerable to the Lucas (1976) critique. Barnett and Engineer (2001, 132) note that:

> The literature has yet to examine how policy endogenously affects contracting and expectations. For example, the Calvo (1983) staggered-price-setting model is used in the New-Keynesian analysis. Yet it is not clear that this model of price setting is optimal in both IT and PT worlds. Similarly, wage and financial contracts may display quite different forms under different policy regimes.

This point was developed in a series of papers by Patrick Minford with various co-authors (Minford 2004; Minford, Nowell, and Webb 2003; Minford and Peel 2003). They build models with households that cannot insure against fluctuations in their real wage and that have a strong interest in smoothing fluctuations in their real wage. The equilibrium degree of indexation of nominal wages to the price level is also endogenous and can depend on the monetary policy regime that is in place. They find that the optimal degree of wage indexation is lower under a PT regime, and that this can lead to substantial welfare benefits. The superiority of PT results from reducing fluctuations in the real wage in response to monetary shocks.

The optimal degree of wage indexation is lower under a PT regime, and this can lead to substantial welfare benefits.

Amano, Ambler, and Ireland (2007) develop a model with nominal wage rigidities and an endogenous degree of indexation to unexpected changes in the price level. They show, as in Minford's work with his co-authors, that the optimal degree of wage indexation is lower under a PT regime. Improved welfare under PT in their model comes from a different mechanism: It helps the economy respond better to real shocks, moving the labour market closer to Walrasian equilibrium.[15]

Other Issues

Price-level targeting and the zero bound

The research program announced by the Bank of Canada in November 2006 proposed looking at both a lower inflation target and the potential advantages of PT. The two sets of questions are actually closely related. A commonly stated objection to a lower inflation target is that it raises the possibility that nominal short-term interest rates will hit the so-called zero bound: The central bank cannot lower its policy rate below zero, given the availability of an alternative asset, namely money balances, that always pays a zero nominal rate of interest. In response to large

14   I conjecture that, as in New Keynesian models, assigning a price-level target to a central bank that is unable to commit to its policies would also be welfare improving in their framework.

15   Walrasian equilibrium refers to a situation where all markets are perfectly competitive and all prices and wages adjust simultaneously to equate supply and demand in all markets.

negative inflation shocks that call for an expansionary monetary policy, the zero lower bound may become a binding constraint on monetary policy.

The possible advantages of PT close to the zero bound are of more than merely theoretical interest. Currently (March 2009), several major central banks have moved their policy rates close to zero and are actively seeking ways to make their monetary policies even more expansionary. One possibility that has received some attention is PT.[16] Under IT, if inflation is expected to remain at or close to zero for an extended period of time, followed by a return to a low targeted inflation rate, the average expected inflation rate over this period would be close to zero. Under a credible commitment to a price-level path, average expected inflation would be equal to the slope of the price-level path (the long-run inflation rate). For the same time path of short-term nominal interest rates, the long-term real interest rate would be lower by the difference in average expected inflation, resulting in stronger aggregate demand.

Monetary policy has more leverage at or near the zero bound under PT than under IT.

Some authors have suggested that, for a given target inflation rate, adopting a PT regime with a price-level path that gives the same rate of inflation in the long run can help to avoid hitting the zero lower bound. The argument for why this would be the case is straightforward. A negative inflation shock under PT is, if the regime is credible, expected to be followed by inflation that is higher than average in order to bring the price level back to its predetermined path. The channel through which monetary policy has real effects operates through the real interest rate. With expected inflation increasing in response to a negative inflation shock, the bank's policy rate has to be reduced by less to achieve the same decrease in the real interest rate compared with a situation in which inflation

expectations remain approximately constant. For this reason, monetary policy has more leverage at or near the zero bound under PT than under IT. The effects of PT on the zero bound have been analyzed rigorously by Eggertsson and Woodford (2003) and Wolman (2005). Both papers find that PT is advantageous in helping economies avoid the zero bound problem.

Price-level drift with rule-of-thumb expectations

One shortcoming of the standard New Keynesian Phillips curve, first pointed out by Fuhrer and Moore (1995), is that it is unable to generate persistent inflation. The typical response to this empirical shortcoming has been to add lagged inflation to the New Keynesian Phillips curve equation. The usual justification for the presence of lagged inflation is that a fraction of firms are rule-of-thumb price-setters, setting their price based on past inflation rather than their rational expectation of future inflation (see, for example, Galí and Gertler 1999).

A general result of models with lagged inflation is that some degree of price-level drift is optimal, even if the central bank can commit to its future policies. Steinsson (2003) demonstrates this result in a model in which a fraction of firms follow a particular rule of thumb: They set prices equal to the mean level of prices in the previous period, adjusted for lagged inflation and also adjusted to vary directly with the lagged output gap. He shows that as the fraction of firms that are rule-of-thumb price-setters increases, the amount by which the central bank should optimally offset unexpected changes in inflation becomes smaller.

Why is it not optimal to eliminate price-level drift when expectations are not forward-looking? A change in the price level in New Keynesian models arises because those firms that are able to modify their output price choose to do so. This creates a distortion in relative prices that reduces the efficiency of production.[17] If the central bank tries to bring the price level back to its initial level or path, firms whose relative prices are out of equilibrium may not be able to change their prices, and firms whose prices are on the equilibrium path may be pushed out of equilibrium. Minford (2004) puts it this way:

> The best thing to do strictly depends on the chances of being allowed to change your price. If it is low (the usual assumption),

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16 For example, Mankiw (2008) writes, " Suppose the Fed cuts the federal funds rate once again to, say, 25 basis points. More important, at the same time, the Fed announces a target path for the price level as measured by the core CPI. The price path might be, say, an increase of 2 or 3 per cent per year. The Fed promises not to raise the fed funds rate over the next 12 months and, after that, will keep the funds rate at that low level as long as the price level is significantly below its target path. The credibility of the promise is paramount. To get long-term real interest rates down, the Fed needs to convince markets that it will vigorously combat deflation, and that if deflation happens in the short run, the Fed will reverse it by subsequently producing extra inflation. . . . Monetary economists will recognize that this policy is price-level targeting rather than inflation targeting."

17 See Ambler (2007–2008) for a detailed explanation.

then it is best to keep the new price level as there is a low chance of those who already changed their price being allowed to change it back. If it is high (over 50%), then reversal could be worthwhile as there is a good chance that those who already changed could change back. The break-even chance is 50%; below this it is optimal to keep the new price level.

Reversing unexpected price-level changes may merely exacerbate relative price distortions. To the extent that expectations are backward-looking, the benefits in the short run from an improved trade-off between output and inflation are smaller, and it becomes optimal to not completely offset the initial shock to the price level, since fewer additional distortions are created.

Average-inflation targeting

A straightforward way to vary the amount of price-level drift under discretionary monetary policy is by targeting a moving average of current and past inflation rates rather than the current inflation rate. By increasing the size of the window used to calculate the moving average, the amount of price-level drift in the long run in response to an unanticipated change in the price level is reduced. As the size of the window tends towards infinity, price-level drift is eliminated completely, and the price level becomes stationary.

Recent studies show that targeting average inflation can dominate both IT and PT under certain circumstances.

Nessén and Vestin (2005) show that, under discretion, targeting average inflation can yield a superior outcome to IT in a forward-looking model. PT still dominates in a completely forward-looking model. This is not surprising, since Vestin (2006) showed that PT with an appropriately chosen weight on price-level fluctuations can reproduce the optimum under commitment. More interestingly, they show that targeting average inflation can dominate both IT and PT under certain circumstances, as long as the fraction of rule-of-thumb price-setters is positive, but not too large. The size of the window for calculating average inflation that provides the best performance depends directly on the fraction of rule-of-thumb price-setters. In some cases, the performance of average-inflation

targeting is very close to the optimal monetary policy under commitment. If the fraction of rule-of-thumb price-setters becomes too large, however, IT is better for economic welfare than PT.

Nessén and Vestin's results on average-inflation targeting are closely related to papers on the practice of hybrid targeting.[18] In these papers, the central bank's loss function is made to depend on a weighted average of price-level deviations and inflation. A positive weight on price-level deviations means no price-level drift in the very long run, but varying the relative weights on price-level deviations and inflation deviations changes the speed at which the price level is brought back to its target path. The behaviour of inflation and prices in the short and medium runs can be made to be very similar to their behaviour under average-inflation targeting. The relative weights that yield the highest welfare depend in a complicated way on the parameters of the model. For some parameter values, hybrid targeting can dominate both IT and PT. As in the case of average-inflation targeting, this tends to occur in cases where price setting is dominated neither by forward-looking nor by rule-of-thumb price-setters.

Prolonged movements in relative prices: Which price level?

Most of the models that have been used to study the costs and benefits of PT have contained either one or a small number of goods sectors. The models feature relative price changes across differentiated goods within a particular sector, which are always inefficient. Prolonged relative price swings across broad classes of goods such as commodities and manufactured goods are absent from these models. Volatile swings in subcomponents of the consumer price index (CPI) have led central banks such as the Bank of Canada to construct measures of "core" inflation that leave out these components. While the official target of the Bank of Canada remains the CPI, core inflation is tracked closely and is used as one of many measures of the pressure on inflation over the short to medium term.

Ortega and Rebei (2006) address this issue in a multi-sector framework. They also analyze the relative advantages of PT and IT and of a weighted average of the two. They construct a small open economy model of the Canadian economy with traded and non-traded sectors, and with nominal price rigidities in both sectors (and differential pricing of traded

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18   See Batini and Yates (2003) and Cecchetti and Kim (2005).

goods between domestic and export markets) as well as nominal wage rigidities. No clear advantages of PT over IT emerge, and it is difficult to discern the key assumptions in their model that are responsible for their results. Aoki (2001) builds a somewhat simpler two-sector model. One of the sectors is a competitive, flexible-price sector, and one is a sticky-price sector with monopolistically competitive firms. He finds that the optimal monetary policy in this framework entails the complete stabilization of inflation in the sticky-price sector alone. Insofar as relative prices must fluctuate in order to reduce fluctuations in the output gap, this allows prices in the flexible-price sector to do all of the adjusting.

While Erceg, Henderson, and Levin (2000) do not focus on the choice of the price index, their results are suggestive. They build a forward-looking model with both nominal wage and nominal price rigidities. They show that it is optimal to target a weighted average of wage inflation and price inflation. The relative weight on wage inflation versus price inflation is directly related to the average length of nominal wage rigidity compared with the average length of nominal price rigidity. Their results are compatible with those of Aoki and can be interpreted as a generalization of his results, since the relative degree of rigidity of prices and wages is variable in their model.

Monetary policy should stabilize stickier prices, allowing more flexible prices to adjust on their own.

This suggests that monetary policy should focus primarily (but not exclusively) on reducing fluctuations in prices that are relatively more sticky, allowing more flexible prices to adjust relative to these rigid prices. This solution represents a compromise. It facilitates relative price adjustment across different broad categories of goods while at the same time dampening inefficient relative price fluctuations across different monopolistic producers of the same category of good. Even though the Bank of Canada does not directly target core inflation, looking closely at a less volatile component of the overall price index is in keeping with the spirit of this result.

The result indicating that past inflation surprises should not be offset is related to the discussion of this section. Even though most New Keynesian models have one homogeneous final good, price setting is

introduced via differentiated intermediate goods produced by monopolistically competitive firms. These firms have identical production functions, they are all affected in the same way by aggregate technology shocks, and their goods enter the aggregate production function for final output symmetrically. However, since they choose prices at different times (price setting is staggered), they do so based on different information and therefore do not all set the same price.[19] It is not generally optimal to induce firms that are currently setting their prices to lower them in order to compensate for unexpectedly high prices set by firms in previous periods.

Conclusions

Table 1 summarizes the main results from recent research on PT. The principal benefit from PT results from the improved trade-off between output and inflation when expectations are forward-looking, making it less costly for the central bank to reduce current inflation. Expectations can be directly forward-looking, as in the basic New Keynesian Phillips curve, or indirectly forward-looking, as in either Svensson's (1999) model with endogenous output persistence or when forward-looking expectations affect the equilibrium, as happens with both Cover and Pecorino (2005) and Ball, Mankiw, and Reis (2005). In these circumstances, the price level is optimally stationary when the central bank can commit to its future policies, and assigning a price-level target to a central bank can lead to superior outcomes under discretion. When information is costly, as in the Ball, Mankiw, and Reis model (2005), PT can be beneficial by reducing the average size of forecast errors. When price and wage setting depend on the monetary policy regime, PT can reduce the incentive for contingent wage indexation and can improve economic performance in the face of real shocks. Finally, when trend inflation is low, PT can help to alleviate zero bound problems. Only when price setting is based on rule-of-thumb behaviour that does not take into account the model's structure does some drift in the price level become optimal. Even then, pure PT can be superior to pure IT as long as the fraction of rule-of-thumb price-setters is not too high.

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19 Price dispersion across firms is one of the main costs of inflation in New Keynesian models. See Ambler (2007–2008) for a discussion.

Table 1: Arguments for and against Price-Level Targeting

Arguments in favour of PT	
Situation	**Advantages of PT**
• Forward-looking price setters	• Prices stable under commitment
• Commitment not possible	• PT can substitute for commitment
• Costly to update information	• Reduced forecast errors under PT
• Endogenous indexation	• Improved response to real shocks
• Low trend inflation	• Zero bound problem less severe
• Flexible prices in some sectors	• Stabilization of index of sticky prices
Arguments against PT	
Situation	**Disadvantages of PT**
• Rule-of-thumb behaviour	• Some price-level drift optimal
• Persistent relative price changes required	• Targeting overall price level not optimal

The rule-of-thumb price-setting rules in current models provide a convenient shortcut that helps to generate the degree of inflation persistence observed in the data; they are also the least theoretically satisfactory feature of New Keynesian models. It is unclear whether policy recommendations should be based on ad hoc modelling assumptions that are as vulnerable to the Lucas critique as previous generations of macroeconomic models. One characteristic of the rule-of-thumb price setting used in New Keynesian macroeconomic models is that it gives no weight whatsoever to monetary policy announcements. It should be possible to come up with price-setting rules that, while not fully compatible with rational expectations, take into account credible announcements of future monetary policy.

Insofar as backward-looking expectations remain an integral part of New Keynesian models (despite the lack of satisfactory microfoundations and despite their vulnerability to the Lucas critique), some amount of price-level drift in response to inflation surprises will be optimal. The section on average-inflation targeting showed that the amount of price-level drift in response to exogenous shocks can be varied by assigning to the central bank an objective function defined in terms of a moving average of past inflation rates as a target rather than the current inflation rate. An important benefit of targeting average inflation is that it could simplify a central bank's communication of its policy to the private sector and minimize the changes in communication strategy in switching from an IT regime to a PT regime.[20] Comparing the level of economic welfare with average-inflation targeting under discretion and that attainable under commitment should be one focus of future research.

The papers reviewed here are normative, having to do with characterizing optimal monetary policy, and depend critically on whether or not the central bank is assumed to be able to commit to its future policies. This begs the question as to which assumption, discretion or commitment, is more appropriate as a positive description of central bank behaviour. This has been a controversial subject in the literature. Price levels in economies with IT regimes appear to have been non-stationary. This could be interpreted as evidence either of discretionary behaviour or of rule-of-thumb price setting in the models used by the central banks to establish their policies.

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20 By tracking monthly fluctuations in year-on-year inflation, central banks that target inflation are already targeting a 12-month moving average of monthly inflation rates. Simply changing the number of terms used to calculate the moving average could greatly simplify the adjustment to a new regime.

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