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The future of inflation targeting

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Abstract

By the end of the Great Moderation, over two dozen central banks were formal inflation targeters, and others, such as the Federal Reserve, the European Central Bank, and the Swiss National Bank behaved essentially as inflation targeters even though they were resistant to identifying themselves as such. However, the past three years have seen central banks faced with new challenges, and these have raised questions about the future of inflation targeting as a framework for the conduct of monetary policy. I consider three suggested modifications to this policy framework: incorporating additional goals among a central bank's objectives; raising the average target for inflation; and switching to price level targeting.

1 Introduction

Twenty years ago, the Reserve Bank of New Zealand Act of 1989 came into effect, restructuring the relationship between New Zealand's central bank and its elected government. This change heralded the emergence of inflation targeting as a means of achieving low and stable inflation. Australia was one of the earlier adopters of inflation targeting, announcing its first inflation target in 1993. From these early adopters, inflation targeting spread so that, at the onset of the recent financial crisis, over two dozen central banks

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were formal inflation targeters, and others, such as the Federal Reserve, the European Central Bank, and the Swiss National Bank behaved essentially as inflation targeters even though they were resistant to identifying themselves as such.

In the years immediately leading up to the crisis in financial markets and the most severe global recession since the 1930s, policy makers and academic economists shared a broad consensus about monetary policy (Svensson 2002, Goodfriend 2007).[1] As part of this consensus, the notion that inflation targeting represented best practice among central banks was wide-spread, but most discussions of monetary policy emphasized the dual objectives of stabilizing inflation around a low level and stabilizing some measure of real economic activity. Financial stability was also mentioned as desirable, but by and large, discussions of monetary policy took financial stability for granted, and models used for policy analysis almost always assumed financial frictions were irrelevant for policy design.

During the past three years, key aspects of this consensus have been called into question. And while countries like Australia which were relatively immune from the global crisis may see little reason to alter their monetary strategy, inflation targeting elsewhere has come under attack. Early in the crisis, for example, Joe Stiglitz wrote that "Today, inflation targeting is being put to the test – and it will almost certainly fail" (Stiglitz 2008). And Samuel Brittan recently wrote in the *Financial Times* that "....these regimes broke down in a spectacular fashion." (Brittan FT, Mar. 19, 2010) Even if it has not failed, recent developments have lead to a re-examination of inflation targeting. After briefly reviewing the pre-crisis consensus and the performance of inflation targeting, I consider three suggested modifications to this policy framework. The first modification calls for incorporating additional objectives into the mandates of central banks. The second two, raising the average target for inflation and, more radically, switching to price level targeting, have gained adherents as ways of overcoming the constraint the zero lower bound on nominal interest rates poses for monetary policy. Conclusions are summarized in the final section.

[1] Bean, Paustian, Penalver, and Taylor (2010) provide a summary of this consensus.

2 Inflation targeting as a policy framework

When the Reserve Bank of New Zealand became the first formal targeter, the existing theory, based on Rogoff (1985), implied that giving more emphasis to controlling inflation would lower average inflation but would come with a cost – greater volatility in the real economy. This prediction has not been born out, and in fact among developing economies inflation targeting has been associated with declines in average inflation and both inflation and output volatility (see section 3).

The average inflation-output volatility trade-off predicted by Rogoff only arises if the incentives of the central bank are distorted. Correctly designed incentives can produce lower average inflation without an increase in output volatility (Walsh 1995). Svensson (1997) showed how an optimal incentive structure could be implemented by assigning an inflation target to an operationally independent central bank.

With the problem of excess average inflation solved through adoption of an appropriate target, the academic literature reached a consensus that optimal monetary policy involved stabilizing fluctuations of inflation around a low, possibly zero, rate while also stabilizing real economic activity, as measured by the output gap.[2] The resulting framework was generally described as flexible inflation targeting. The inflation targeting in the name reflected the primacy of inflation as the ultimate objective of monetary policy; the flexibility reflected the short-run trade off between inflation control and real economic stability that would make strict inflation targeting – an exclusive focus on stabilizing inflation – too costly to be socially desirable.

Formally, flexible inflation targeting is modeled by assuming the central bank implements policy to minimize a quadratic loss function of the form

$$\mathrm{E}_t \sum_{i=0}^{\infty} \beta^i \left[(\pi_{t+i} - \pi^*)^2 + \lambda x_{t+i}^2 \right] \tag{1}$$

where π_t is inflation, π^* is the inflation target, and x_t is the output gap. Equation (1) can represent the objectives of formal inflation targeters as well has those of central banks such as the Federal Reserve that emphasize the role of real objectives in addition to inflation.

If flexible inflation targeting has come to mean policies designed to minimize fluctua-

[2] How the output gap is measured, both in theory and practice raises a well known set of issues.

tions of inflation around target and the output gap as in (1), how has it fared? The next section very briefly considers some of the evidence on macroeconomic performance under inflation targeting.

3 The performance of inflation targeters

Prior to the crisis, inflation targeting (IT) was widely accepted as a successful policy framework, and recent favorable reviews of IT include Rose (2007) and Walsh (2009a). IT was successful in supporting low and stable inflation without generating the greater output volatility its critics had predicted.

The primary concern with inflation targeting, even of the flexible variety, was that other legitimate goals of macroeconomic policy would be neglected. Initially, this concern focused on the possibility that inflation targeting central banks would ignore real objectives such as stabilizing the output gap (for example, see B. Friedman 2004). As surveyed in Walsh (2009a), the empirical evidence does not support this view, at least with respect to output volatility. Prior to the crisis, IT countries had not experienced any cost in terms of greater real economic instability. And while the consensus view that monetary policy should only be concerned with inflation and output gap stability may have contributed to the financial crisis by ignoring financial distortions, this failure was not limited to IT central banks.

For emerging market economies, in fact, the adoption of inflation targeting has been associated with improved real and inflation macroeconomic performance. For high income economies, the benefits have been perhaps less apparent as both inflation targeters and non-targeters benefited from the Great Moderation. However, inflation targeting definitely did not contributed to an increase in real economic volatility.

While it is easy to forget, the chief policy concern in 2006-2007 was the potential inflationary effects of the dramatic increase in commodity prices. Rogers (2010, p. 48) concludes that "Inflation-targeting economics appear to have done better than others in minimizing the inflationary impact of the 2007 surge in commodity prices...Among low-income economics, however, non-inflation-targeting countries experienced bigger increases in inflation than inflation-targeting economics, although their GDP growth rates fell by similar amounts. Among high-income economies, inflation-targeting countries had a smaller growth rate decline than non-inflation-targeting countries and slightly less of an increase in inflation."

Furthermore, a financial crisis that acts primarily as a negative aggregate demand shock clearly calls for expansionary monetary policy, whether the central bank is targeting inflation or not. Such a shock would reduce the forecast for inflation, requiring cuts in the policy interest rate. Attempts to insulate the effects on inflation of such a shock would also act to insulate real output from the shock. Thus, if one views the financial crisis as a negative aggregate demand shock causing both output and inflation to decline, then even a strict inflation targeter would respond with expansionary policies as it attempted to prevent the collapse of aggregate spending.

Tables 1-3 document the recent experiences of 33 high income counties, of whom 10 were inflation targeters. Table 1 reports the average growth rate of real GDP for the 1995-2007 period, for 2008-2009, and, using the IMF forecasts, 2008-2010. While both inflation targeters and non-targeters have seen sharp falls in real growth, the inflation targeters have, as a group, done somewhat better.

Table 2 reports average CPI inflation rates. Perhaps somewhat surprising, average inflation has been higher among the targeters. And while average inflation is expected to be higher during 2008-2010 for the IT countries than it was during 1995-2007, it is projected to be lower for the non-IT countries. At a minimum, the evidence does not seem to be that IT countries suffer greater output declines because their central banks are too focused on controlling inflation.

Thus, inflation targeting countries have certainly not performed worst than non-inflation targeters. It isn't clear that they have done better either. Such a weak conclusion is actually consistent with much of the research that has tried to assess the effects of inflation targeting, including a recent skeptical survey by Ball (2010).

Of course, real GDP growth and inflation are just two measures of macroeconomic performance. Rose and Spiegel (2010) employ a cross-section of 107 countries and 6 different measures of the severity of the crisis in a search for variables that can account for international differences in the impact of the crisis. In general, they find "...few reliable indicators in the pre-crisis data of the incidence of the Great Recession." (Rose and Spiegel 2010, abstract). One of the few indicators seems to be the level of real GDP in 2006 – high income countries were more severely affected by the crisis. Two more indicators were the growth rate of bank credit between 2000 and 2006 and a measure of credit market regulation.

Figure 1 shows the six measures of the crisis used by Rose and Spiegel plotted against 2006 real GDP per capita. The circles denote inflation targeters. Figures 2 and 3 replace

real GDP per capita with bank credit growth and credit market regulation, respectively. Again, it is less clear that there was any association with being an inflation targeter, though Iceland is a clear outlier.[3]

4 Should inflation targeting become more flexible?

Inflation targeting has performed well as a monetary policy framework. Still, it has frequently been criticized as focusing too much on inflation stability, or it has been argued that central banks should focus on more objectives than just inflation and output gap stability. So should central banks add to their list of policy objectives? That is, should they become more flexible in pursuing their inflation goals?

4.1 Performance measures, incentives, and accountability[4]

Prior to the advent of inflation targeting, most central bank charters included a list of desirable objectives, but attempting to pursue many of these objectives could conflict with achieving and maintaining low and stable inflation. For example, of the 35 countries evaluated by Cukierman, Webb, and Neyapti to construct their index of central bank independence, 24 were judged during the 1980s to have objectives that were potentially in conflict with price stability (Cukierman 1992, Appendix A). Central bank charters frequently listed goals that were controllable by the central bank (at least over an appropriate horizon) and others that the central bank could affect temporarily but not in a sustained manner. The goals were often not easily measured, even in principle, much less in practice. Ambiguous objectives lead to a lack of accountability. They also make a central bank more susceptible to political influence.

The design of a framework for monetary policy is a perfect example of the case in which goals are hard to define in theory and difficult to measure in practice. What is maximum sustainable employment? How would we know whether it was achieved? What is the output gap? How do we measure financial distortions? In this type of environment, any system designed to establish benchmarks for accountability will need to rely on easily observed performance measures. Inflation is therefore the prime candidate to serve as the

[3] If an IT dummy is added to a regression of the measures of severity on 2006 log real GDP, the coefficient on IT is never statistically significant. This remains the case if IT is also interacted with the real GDP measures. Results available from the author.

[4] This section borrows from Walsh (2009a).

measure of central bank performance. It can be observed directly, and it is related to the more fundamental but vaguely defined and difficult to measure objectives of monetary policy (e.g. contributing to social welfare). The theory of performance measures tell us, however, that if accountability is tied to a specific outcome such as inflation, the policy maker has an inherent bias towards ensuring the performance measure looks good, even if this comes at some sacrifice of the broader goals of policy. This, at least at the conceptual level, is a major potential disadvantage of inflation targeting and the basis of both some of the original opposition to inflation targeting and to some of the criticism that central banks ignored signs of financial imbalances (Friedman 2004).

Fortunately, the empirical evidence suggests that inflation targeting central banks have not neglected real economic stability.

4.2 Dealing with distortions

The theoretical rationale for flexible inflation targeting was based on models in which stabilizing the inflation gap and the output gap succeeded in minimizing economic distortions.[5] When additional distortions are present, then a policy aimed at minimizing the welfare costs of economic fluctuations will need to expand the list of objectives beyond the minimization of inflation and output gaps.[6] With more distortions than policy instruments, we are in the world of the second best and an exclusive focus on eliminating a single distortion, by stabilizing inflation for example, is unlikely to be optimal.

Much of the recent research has focused on improving our understanding of credit frictions and the distortions these frictions may generate. Unfortunately, I do not think we yet have a clear understanding of the nature of financial market distortions that might be addressed by monetary policy, how we would measure the financial market distortions to which monetary policy might respond, or even what that response should be. For example, Faia and Monacelli (2007) derive the optimal monetary policy in the context of a model with a financial accelerator and find that the central bank should actually cut interest rates in response to a rise in asset prices. In their model, financial frictions limit the response of investment to productivity shocks. Essentially, these frictions act

[5] This is not quite right. These models generally assume a fiscal subsidy is used to address the average distortion created by monopolistic competition. Consistent with that literature, I will continue to focus on the distortions that can be ameliorated by monetary policy.

[6] For example, when nominal wages are sticky, optimal policy needs to consider a wage inflation gap as well as an inflation gap.

as a procyclical tax on investment, and the central bank should offset this tax by cutting interest rates in a boom and raising them in a bust. As this example illustrates, the policy implications of financial market frictions are not always straightforward and depend heavily on the sources of economic fluctuations and the nature of the frictions.

Of course, the mere existence of distortions in financial markets does not necessarily call for a monetary policy response. Presumable, the first best policy involves establishing an adequate system of financial market regulation. As an analogy, consider a baseline new Keynesian model with monopolistic competition and sticky prices. The presence of imperfect competition implies that even with flexible prices, the equilibrium output level would be too low. But the solution is to use taxes and subsidies, not monetary policy, to deal with the distortion caused by imperfect competition. This leaves monetary policy free to address the distortions created by nominal rigidities.

But even with the best designed financial regulation, credit markets may be subject to frictions that interact with the nominal rigidities that give monetary policy leverage to affect the real economy. In this case, the central bank cannot ignore the effect it may have on financial markets. Thus, the key issues involve identifying what the distortions are, measuring them, deciding whether they present trade-offs in that achieving inflation, output, and financial market objectives conflict, and whether there are other policies better designed to deal with these other distortions.

Because much of my own recent research has focused on the policy implications of labor frictions and unemployment, let me illustrate these issues by drawing on examples from this work.[7]

4.2.1 Labor market frictions

A large literature has studied the implications of two types of frictions that characterize labor markets. First, since the original work of Erceg, Henderson, and Levin (2000), it has become common to incorporate nominal wage rigidities. The staggered adjustment of wages generates an inefficient dispersion of relative wages whenever nominal wage inflation deviates from zero. Optimal policy balances the resulting welfare cost against the welfare costs of relative price dispersion that is generated when price inflation deviates from zero. If, as a result of real shocks, real wages need to adjust, the goals of price stability and of wage stability clash.

[7] Walsh (2005), Ravenna and Walsh (2008, forthcoming).

Second, an alternative literature has worked to embed unemployment into DSGE models, and much of this literature has explored the consequences of labor market frictions within the Mortensen-Pissarides seach and matching model (e.g., Walsh 2005, Blanchard and Galí 2009, Ravenna and Walsh forthcoming). In this class of search models, the initial employment level (the number of matches) is a critical state variable that affects the dynamics of economic adjustment, and the evolution of employment depends on both the incentives firms have to create jobs and the frictions that prevent unmatched vacancies and unemployment workers from quickly matching.

Ravenna and Walsh (forthcoming) show that in a basic model with labor search frictions the welfare-consistent loss function takes the form

$$\left(\frac{1}{2}\right) \mathrm{E}_t \sum_{i=0}^{\infty} \beta^i \left[\pi_{t+i}^2 + \lambda_x x_{t+i}^2 + \lambda_\theta \theta_{t+i}^2\right],$$

where the new term, θ_t^2, is the squared deviation of labor market tightness (vacancies relative to unemployment) around its efficient level. That is, it is appropriate to stabilize inflation, the output gap, and a labor market gap.[8] The intuition behind the appearance of labor market objectives is instructive. Price inflation is costly because it generates an inefficient dispersion of relative prices. This reduces welfare because, conditional on total consumption, it leads the economy to produce an inefficient bundle of goods. Similarly, when market production is subject to frictions in matching workers and firms, deviations of labor market tightness from its efficient level lead, for a given level of utility, to an inefficient combination of market production (which incurs search costs) and non-market activities (which do not incur search costs).

Thus, frictions in the labor market can made labor market conditions and variables such as the unemployment rate appropriate objectives for monetary policy, though as with the output gap, it is not the level of labor market variables that should be stabilized but only their volatility around a correctly defined but difficult to measure efficient level.

Of course, in many macroeconomic models, an appeal is often made to Okun's Law to relate an unemployment rate gap to the output gap. If Okun's Law held exactly, then any distortions associated with fluctuations in an unemployment rate gap could be equally as well represented by the output gap. Labor market frictions might alter the weight placed on the output gap in a standard loss function but would not call for adding any new policy

[8] As Ravenna and Walsh show, θ_t can be equivalently expressed in terms of a measure of unemployment.

objectives. Figure 4 plots the unemployment rate gap for the United States (the civilian unemployment rate minus the Congressional Budget Office's estimate of the natural rate (NAIRU)) against the output gap (HP-filtered real GDP). While both the output gap and the appropriate gap that captures the welfare costs of labor market fluctuations are difficult to measure, it is clear from the figure that there are frequent deviations from Okun's Law that leave room for fluctuations of unemployment and fluctuations of the output gap to provide different signals on macroeconomic distortions.

4.3 Summary on policy objectives

Most of the recent research has focused on how labor market and financial frictions affect the transmission process of monetary policy. Fluctuations in labor market tightness, credit spreads and borrowing constraints matter for macro dynamics and aggregate spending, and monetary policy may be able to affect them directly. Distortions originating in either labor or financial markets that generate real effects of monetary policy may require making trade-offs with the goals of inflation stability and stability of real economic activity. However, measuring these distortions is a difficult task. While measures such as credit spreads may provide one measure of the type of inefficient fluctuations that would call for a policy response, we still do not fully understand the factors that generate movements in spreads, or the degree to which these movements reflect inefficient fluctuations that call for policy responses. Similarly, just as measuring the output gap raises significant issues, the same applies to measuring the labor market tightness gap.

In models with multiple distortions, eliminating any one distortion, such as by focusing solely on price stability, may lead to suboptimal outcomes by worsening other economic distortions. Despite this, a common result in much of the literature to date has been that price stability is often a close approximation to the optimal policy even in the face of other distortions.[9]

5 The ZLB and raising the inflation target

Over the past two years, many central banks have had to cut their policy rate to zero as they strove to counteract the massive contraction associated with the financial crises.

[9] For example, this is the finding of Faia and Monacelli (2007) in a model with credit frictions and Ravenna and Walsh (2010) in a model with labor market frictions.

Figure 7 shows the behavior of the policy rates for Australia, Canada, the Euro system, Japan, New Zealand, the U.K. and the United States. Using a simple Taylor rule to represent policy, Rudebusch (2009) has concluded that the federal funds rate in the U.S. needed to be cut to -5 percent in 2009.

Given the constraint posed by the zero lower bound (ZLB) on nominal interest rates, Blanchard, et al (2010) have recently proposed raising average inflation targets, arguing that a 4 percent average rate would constitute a safer target by providing more room for interest rate cuts when the economy faces an adverse shock. And when Japan was confronted with the ZLB, Krugman (1998), McCallum (2000), Svensson (2001, 2003), and Auerbach and Obstfeld (2005) all proposed that the Bank of Japan commit to policies that promised future inflation.

These proposals for higher inflation are relevant for two separate questions. First, how can the chances of hitting the ZLB be reduced? And second, how can a central bank expand the economy when its policy rate is already at zero?

5.1 Reducing the chances of hitting the ZLB

Prior to the crisis, a consensus existed among high income inflation targeters that a target within the range of $1-3$ percent represented an appropriate goal for average inflation. Central banks that have not formally adopted inflation targeting also seem to have implicit targets that fall in the $1-3$ percent range. For example, it is reasonable to interpret the long-term inflation forecast of members of the Federal Reserve's Federal Open Market Committee (FOMC) as equivalent to an implicit inflation target. This central tendency forecast for inflation in the longer term, measured by the price index for personal consumption expenditures, ranges between 1.5 and 2 percent. The ECB has stated publicly that inflation should remain at or below 2 percent.

Raising the average inflation target would lead to a higher average level of nominal interest rates. This would give the central bank more room to cut rates in the face of a contractionary shock to the economy before hitting the zero lower bound. This point was first made by Summers (1991).

Using the FRB/US model and a Taylor rule to represent monetary policy, Williams (2009) shows that in simulation exercises using shocks drawn from the 1968-2002 period the nominal rate falls below 0.01 percent in 13 percent of the periods when the equilibrium real interest rate plus the inflation target equal 3 percent. Raising the inflation target by

2 percentage points (so the the mean nominal rate is 5 percent), reduces this probability of the ZLB to 4 percent. What matters for determining the frequency with which the ZLB is encountered are the distribution of the shocks affecting the real interest rate and the target inflation rate. Given the real rate process, a higher inflation target reduces the chances the ZLB will become a constraint on policy. Williams (2009) finds that the ZLB has proven to be a hindrance to economic recovery in the aftermath of the recent financial crisis and concludes that "The analysis in this paper argues that an inflation target of between 2 and 4 percent will, on average, be sufficient to avoid the ZLB causing sizable costs in terms of macroeconomic stabilization even in a much more adverse macroeconomic climate." (p. 26)

Not all authors have found low inflation to lead to frequent encounters with the ZLB. For example, Schmitt-Grohe and Uribe (2010) argue that even with a quite low average inflation rate, the ZLB binds infrequently. In fact, in many of the variants of the model they analyze, the optimal rate of inflation is negative and still the ZLB occurs infrequently. Of course, this result is dependent on the level of the average real return and variances of the underlying exogenous shocks, with the ZLB encountered more frequently if the economy is subject to larger shocks.

Blanchard, et al (2010) are perhaps the most prominent proponents of raising the inflation target, and they have argued that a 4% average inflation rate would constitute a safer target by providing more room for interest rate cuts when the economy faces an adverse shock. While accepting that higher inflation is distortionary, they suggest that many of these distortions could be eliminated if tax systems were corrected to allow for higher average inflation. Higher inflation might also induce more widespread wage indexation which would then hinder the ability of the economy to adjust to shocks requiring adjustment of real wages. Blanchard, et. al also recognize that we do not really know whether inflation expectations would be more difficult to anchor if average inflation rates were to rise.

Determining whether average inflation targets should be raised requires an analysis of the costs and benefits of higher inflation. Of course, a long literature has addressed the issue of the optimal rate of inflation. Much of this literature focused on the steady state and so ignored the role of monetary policy as a tool for stabilizing the economy in the face of shocks, but it provides a useful starting point for a discussion of inflation targets.

5.1.1 The optimal rate of inflation: the traditional analysis

Bailey (1956) and Friedman (1969) identified an inefficiency that arises when nominal interest rates are positive. Since money is costless to produce, efficiency requires that the private opportunity cost of holding money also equal zero. If nominal interest rates are positive, private agents will inefficiently economize on their money holdings. An increase in the average rate of inflation would increase this efficiency cost. However, the size of this welfare cost if average inflation rose from 2 to 4 percent is likely to be small. Ireland (2009) finds that, using a measure of the money stock that accounts for some of the changes due to financial market deregulation, the traditional welfare cost of 2 percent inflation is less than 0.04 percent of income.

Even that small cost can be avoided, as higher inflation need not raise the opportunity cost of holding money if money pays an own return that also rises with inflation. While there may be technical difficulties in paying interest on cash, many countries, including now the United States, pay interest on bank reserves. With interest paid only on reserves, the demand for currency remains distorted by a positive nominal interest rate, but if it becomes feasible to pay explicit interest on money, then the Friedman welfare costs of moving from an average inflation rate of 2 percent to one of 4 percent are likely to be tiny.

Paying interest on money does have fiscal implications. The interest paid on money or bank reserves cannot be financed by printing additional money – attempting to do so rises nominal interest rates as inflation rises but fails to close the gap between the nominal rate and the nominal return on money. Other sources of fiscal revenue must be used to finance interest on money, and this will require increases in other potentially distorting taxes. If the welfare costs of the Friedman distortion are small, however, the fiscal implications of eliminating them is also likely to be small.

5.1.2 Other costs of inflation

The more recent literature on wage and price stickiness has emphasized a second distortion that would be worsened by a rise in inflation. When the adjustment of wages and prices is staggered across firms, and is not fully indexed, higher inflation generates an increase in relative wage and price dispersion. Because this dispersion is not generated by fundamental shifts in the demand or supply of individual products or labor types, economic efficiency is reduced. Essentially with sticky wages and prices, inflation reduces the

ability of the price system to signal shifts in demand and supply that call for a reallocate of resources.

In calibrated models, this efficiency loss arising from relative price dispersion is significantly larger than the costs Friedman identified. Thus, even if the Friedman distortion is eliminated by paying interest on money, higher inflation could generate significant welfare costs by reducing the ability of the price system to direct resource allocation efficiently.

If firms indexed prices to the average rate of inflation, as is commonly assumed in many of the empirically estimated models employed for policy analysis, then a move from say 2 percent to 4 percent average inflation would not affect the dispersion of relative prices. However, since micro data provide no evidence of this type of indexation, an increase in the average rate of inflation is likely to reduce the ability of the price system to efficiently guide the allocation of resources.

In fact, Coibion, Gorodichenko, and Wieland (2010) and Lago Alves (2010) show that the effect of trend inflation on welfare can be quite significant, and standard approximations to welfare that are correct for a zero-trend inflation rate can be quite misleading if used to estimate the welfare costs when average inflation is positive. In particular, the standard approximation suggests that welfare is little affected by an increase of average inflation from 1 percent to 6 percent. Yet when the correct approximation is employed, welfare falls sharply as inflation rises past around 2 percent. With their calibration, Coibion, Gorodichenko, and Wieland find the optimal inflation rate is equal to about 1 percent per year. Coibion, Gorodichenko, and Wieland also account explicitly for the ZLB in their analysis of the optimal rate of inflation and examine the robustness of their estimate of the optimal inflation rate to various changes in the model parameters. In general, they find that the optimal rate is positive but quite low, usually on the order of 1 to 2 percent per year, a figure actually on the low side of most target ranges employed by central banks. The traditional Friedman distortion is ignored in the analysis of Coibion, Gorodichenko, and Wieland, so if that were incorporated (as in Schmitt-Grohe and Uribe 2010), the optimal inflation rate would be even lower.

5.1.3 Benefits of higher inflation

Three benefits of inflation are relevant in considering whether to raise inflation targets.

First, positive nominal interest rates provide revenue for the government – seigniorage. The temptation governments face in using inflation to finance expenditures is well known

and is one reason most central banks today have a fair amount of independence from their country's fiscal authority.

Second, some have argued that a bit of inflation increases the flexibility of real wages if nominal wages display downward rigidity. Akerlof, Dickens, and Perry (1996) suggested that, due to the resistance to nominal wage cuts, the long-run (unemployment) Phillips curve is not vertical but has a negative slope at low rates of inflation. Thus, higher average inflation would lower the average rate of unemployment. This issues has recently been revisited by Benigno and Ricci (2010) who show how the Phillips curve flattens at low rates of inflation and shifts with changes in macro volatility.

The evidence on downward nominal wage stickiness is mixed. Haefke, Sonntag, and van Rens (2007) and Pissarides (2009) conclude that wage stickiness does not explain the observed volatility of unemployment, and Kudlyak (2009) finds that the real user cost of labor is fairly cyclically sensitive. The evidence suggests that wages for new hirers display much greater flexibility than wages for existing workers. Thus, at the margin relevant for hiring decisions, wage stickiness may be less important. However, whenever a contraction leads firms to reduce their workforce by more than can be achieved through normal turnover, the inflexibility of nominal wages of existing workers can prevent the adjustment of real wages.

5.1.4 Summary on raising the inflation target

In considering whether average inflation targets should raised, it is relevant to consider whether other policies might reduce macro volatility and thereby reduce the chances of hitting the ZLB. Better financial sector regulation, for example, might insulate the economy from large shocks without necessitating a rise in the average inflation rate. And it is important to recall that central banks have spent the past twenty-five years striving to reduce inflation and to gain the credibility necessary to maintain inflation at low and stable rates. The stability of inflation expectations has been a characteristic of the recent crisis, a stability that might have been less likely during earlier periods in which the commitment of central banks to low and stable inflation was less clear. This credibility may be put at risk if inflation targets are increased.

5.2 The ZLB as a constraint on monetary policy

The primary reason for possibly raising the average inflation target is to reduce the chances of hitting the zero lower bound. But how big would the benefits be of avoiding the ZLB? Expressed alternatively, how much does the ZLB actually restrict the ability of central banks to ensure macroeconomics stability? And how can a central bank expand the economy when its policy rate is already at zero? To address these questions, it is useful to start with a conventional model.

5.2.1 Conventional policy at the ZLB

In recent years, monetary policy analysis has been dominated by the new Keynesian framework (Yun 1996, Goodfriend and King 1997, Rotemberg and Woodford 1997, Clarida, Galí, and Gertler 1999, Woodford 2003). This framework consists of an expectational IS relationship given by

$$x_t = \mathrm{E}_t x_{t+1} - \left(\frac{1}{\sigma}\right)(i_t - \mathrm{E}_t \pi_{t+1} - r_t^n), \tag{2}$$

and an inflation adjustment equation given by

$$\pi_t = \beta \mathrm{E}_t \pi_{t+1} + \kappa x_t + e_t, \tag{3}$$

where x_t is the output gap, π_t is inflation, r_t^n is the equilibrium real interest rate when the output gap is zero, e_t is a cost shock, and i_t is the nominal interest rate. These equations can be derived by log-linearizing a general equilibrium model consisting of a representative household and firms operating in goods markets characterized by monopolistic competition and using time-dependent price-adjustment strategies.[10]

The conventional policy instrument is taken to be the current policy interest rate. However, the expectational IS curve given in (2) can be solved forward to obtain

$$x_t = -\left(\frac{1}{\sigma}\right)\left[(i_t - \mathrm{E}_t \pi_{t+1}) + \mathrm{E}_t \sum_{i=1}^{\infty}(i_{t+i} - \pi_{t+1+i}) - \mathrm{E}_t \sum_{i=0}^{\infty} r_{t+i}^n\right], \tag{4}$$

Equation (4) makes clear that both the current policy rate and expectations about its

[10] For a textbook derivation, see Walsh (2010, ch. 8). The discussion in this section and the following one borrows from Walsh (2009b).

future path are important.

The idea that it is both current policy and expectations of the future policy path that matter has played an important role in discussions of monetary policy at the ZLB, a point emphasized by Eggertsson and Woodford (2003). Even when the current policy rate is at zero, the central bank still has the potential to influence real spending if it can affect expectations of future real interest rates. If $i_t = 0$ and is expected to remain at zero until $t + T$, then (4) becomes

$$x_t = \left(\frac{1}{\sigma}\right)\left[\sum_{i=0}^{T} \mathrm{E}_t \pi_{t+1+i} - \mathrm{E}_t \sum_{i=T+1}^{\infty} (i_{t+i} - \pi_{t+1+i}) + \mathrm{E}_t \sum_{i=0}^{\infty} r^n_{t+i}\right].$$

Thus, output can be stimulated by raising expected inflation, by lowering expected future real interest rates, or by raising the natural real rate, either now or in the future. If the central bank is able to commit to future policies, it can stimulate current output by committing to a lower future path for i_{t+j}, that is, by promising to keep rates low for an "extended period of time." In particular, this would involve keeping the policy rate at zero even when the natural rate has risen to levels that would normally call for the policy rate to move back into positive territory. That is, the central bank commits to maintaining a zero-rate policy even when the ZLB is no longer a binding constraint (Eggertsson and Woodford 2003). If the central bank is able to do this, most research suggests that the costs of the ZLB are quite small (e.g., Eggertsson and Woodford 2003, Adams and Billi 2006, Nakov 2008).

The finding that optimal policy involves committing to lower interest rates in the future is consistent with the strategies to generate higher inflation expectations that were proposed for Japan when it faced the ZLB (Krugman 1998, McCallum 2000, Svensson 2001, 2003, and Auerbach and Obstfeld 2005). Raising inflation expectations and committing to keeping the policy interest rate low in the future are not really separate policy options. It is by committing to lower future policy rates that the central bank affects future inflation at the ZLB. But commitment policies require that any promise to inflate in the future must be carried out; failing to do so would remove the possibility of influencing expectations if the ZLB were encountered again in the future.

To further expand on the point that the commitment to keep interest rates low is a commitment to higher future inflation, consider the following very simple four-period example. This example will serve to illustrate how an optimal commitment policy promises

low interest rates and high inflation even when the ZLB no longer binds. Following Bodenstein, Hebden, and Nunes (2010), it can also illustrate the effect of imperfect credibility, meaning that the central bank's promises to keep rates low are not fully believed.

The economy is characterized by (2) and (3); policy objectives are given by

$$\mathrm{E}_0 \sum_{i=0}^{\infty} \beta^i \left(\pi_i^2 + \lambda x_i^2\right).$$

Assume r_t^n is the only disturbance (i.e., $e_t \equiv 0$ for all t). This means that the central bank can achieve $\pi_t = x_t = 0$ as long as the ZLB is not encountered. Now suppose that in period 1, r_1^n takes a large enough negative value that the economy is pushed to the zero lower bound, so $i_1 = 0$. After one period, the natural real interest rate returns to its steady-state level r^n (assumed to be 4% in the numerical example) so that $x_i = \pi_i = 0$ for $i \geq 2$ is a feasible outcome. I assume (and this is the simplification) that $\pi_4 = x_4 = 0$ and $i_4 = r^n$.[11] The issue is what happens in periods 2 and 3 and how does this affect the output gap and inflation in period 1. The details of the model are provided in the appendix.

Suppose the public assigns a probability μ to the likelihood the central bank will fulfill its promises. Full credibility corresponds to $\mu = 1$; discretion corresponds to $\mu = 0$. Figure 5 shows the paths of the interest rate relative to the equilibrium real rate under the optimal policy with full credibility (solid line) and discretion (dashed line).[12] Under discretion, the central bank sets $i_2 = r_2^n > 0$ to ensure $x_2 = \pi_2 = 0$ (and similarly in periods 3 and 4). Under commitment, $i_2 < r_2^n$. As shown in figure 6, this causes inflation to rise about zero in period 2 and leads expected inflation in period 1 to be positive. This lowers the actual real interest rate in period 1: $r_1 = i_t - \mathrm{E}_1\pi_2 = -\mathrm{E}_1\pi_2 < 0$. For the calibrated parameters of the example, the fully credible policy is actually able to prevent any deflation and limit the decline in the output gap in period 1. With full credibility, the interest rate gap $i - r^n$, inflation, and the output gap return to zero in periods 3 and 4.[13]

Outcomes under imperfect credibility are also shown in the figures by the dashed line

[11] While this is feasible, and $x_{t+j} = \pi_{t+j} = 0$ is optimal for some $j \geq 2$, the fully optimal policy will delay the return to a zero output gap and inflation rate more than the two periods assumed in this example.

[12] Parameter values used for this example are $\beta = 0.99$, $\lambda = 0.25$, and $\kappa = 0.25$.

[13] The return to zero output gap and period 4 is by assumption; the return in period 3 depends on the choice of parameters employed in the example.

with circles for the case $\mu = 0.25$. Consistent with the results obtained by Bodenstein, Hebden, and Nunes (2010), a central bank that lacks credibility must promise to keep interest rates even lower and for longer than a credible central bank would find optimal (see figure 5). What is interesting is that, rather than falling between the cases of pure discretion and full credibility, partial credibility leads to more extreme promises. By weakening the central bank's ability to affect future expectations, the central bank is forced to promise to keep interest rates low for an extended period of time relative to the policy under full commitment. As a consequence, if the central bank actually carries out its announced policies, inflation and the output gap are much higher in period 2.

Of course, the high inflation under the promised path increases the temptation to revert to the discretionary policy in period 2. A central bank that lacks credibility has to make more extreme promises. This increases the cost of actually carrying out those promises and can further erode credibility.[14]

In fact, rather than promising future inflation, policy makers seem to be concerned that expectations of future inflation remain firmly anchored. For example, Federal Reserve Chairman Bernanke stressed that the Fed would prevent a rise in inflation as the economy recovers from the current recession, stating "....that it is important to assure the public and the markets that the extraordinary policy measures we have taken in response to the financial crisis and the recession can be withdrawn in a smooth and timely manner as needed, thereby avoiding the risk that policy stimulus could lead to a future rise in inflation."[15]

5.2.2 Old-school conventional policy at the ZLB

So far, the discussion has focused on using the conventional interest rate instrument. In addition to conventional tools, central banks have employed unconventional policy instruments as well. For example, at the ZLB, central banks can still expand the supply of bank reserves, a policy commonly referred to as *quantitative easing*. Quantitative easing plays no role in the standard new Keynesian model for the simple reason that the

[14] Most of the research on the ZLB has relied on models based on linear approximations to the structural equations. Levin, et. al. (2009) show that non-linearities can become very important when simulating a large "Great Recession" shock as opposed to a typical "Great Moderation" shock. They find that even a credible central bank that can affect expectations about the future path of policy rates may have limited ability to stabilize the economy when a large negative shock occurs.

[15] Testimony before the House Committee on Financial Services in July 2009. Mishkin (2009) is also explicit in arguing that even in a financial crisis it is imperative to keep inflation expectations anchored.

real equilibrium in that model is independent of the quantity of money and the demand for money. To discuss quantitative easing requires a different theoretical framework.

Models common during the debates between monetarists and Keynesians in the 1960s and 1970s emphasized portfolio balance effects as the mechanism through which monetary policy affected interest rates, asset prices, and the real economy. The portfolio balance approach started with the assumption that assets, both real and financial, were imperfect substitutes. Therefore, changes in the relative supplies of the difference assets would set off a process of rebalancing that would affect asset prices and interest rates across a broad range of assets (Meltzer 1995, Tobin 1969). Disagreement focused on the set of assets that were potential substitutes for money in private portfolios. Monetarists emphasized that portfolio rebalancing could affect real asset holdings, not just financial holdings (see Meltzer 1995). Thus, the reduction in the liquidity yield of money that occurs when its quantity is increased causes a substitution into both financial and real assets. Since the private sector must, ultimately, hold the larger stock of money, this attempt at rebalancing portfolios raises the prices of both financial and real asset, creating incentives for capital goods producers to expand production. Recent papers employing this perspective include Andrés, López-Salido, and Nelson (2004) and Goodfriend (2000, 2011).

In this framework, open market operations in short-term Treasuries, in long-term Treasuries, or in private sector assets (credit easing) can be effective in moving long-term interest rates and asset prices to the extent that different assets are imperfect substitutes. If, at a zero short-term nominal rate, bank reserves and short-term government debt are essentially perfect substitutes, then open market operations involving purchases of long-term government debt can still succeed in raising the price of long-term debt and lowering long term yields. Such a purchase reduces the quantity of long-term government debt in the hands of the public, while raising the quantity of bank reserves. This induces an attempt by the public to readjust their portfolios, raising the prices of long-term assets and lowering their expected returns. In a similar manner, central bank purchases of private sector assets will generate portfolio adjustments that raise the price of these assets and lowers their yields and the yields of close substitutes.[16]

During the past two years, the size of the Fed's asset holdings and their composition have changed dramatically.[17] The initial expansion of the Fed's asset holdings occurred

[16] As with open market operations in standard short-term debt, changes in the composition of government debt will have fiscal implications; see Auerbach and Obstfeld (2005).

[17] Carlson, Haubrich, Cherny, and Wakefield (2009) provide a nice discussion of the asset side of the

through its programs to extend credit and liquidity to financial institutions. The growth in these two categories is shown in blue in figure 7. After averaging $30.5 billion from January 2007 until the end of July 2007, they rose to a peak of $1,988 billion in December 2008. Since then, this category of asset holdings has declined significantly, so that by the middle of September 2010, they totaled $223 billion. The pattern reflected in figure 7 is consistent with the behavior of a lender of last resort, providing temporary liquidity to markets during a crisis and then allowing this credit extension to shrink as markets return to more normal conditions.

However, while lending to financial institutions and the provision of liquidity have returned to something approaching pre-crisis levels, the size of the Fed's balance sheet has not. As lending and liquidity programs have shrunk, the Fed has purchased longer-term securities representing direct obligations of Fannie Mae, Feddie Mac and Federal Home Loan Banks as well as mortgage-backed securities. This expansion in long-term security holdings is shown in green in figure 7. As of the middle of September 2010, the Fed held $1,600 billion of these securities.

As noted by Clouse, et. al (2003), when short-term interest rates are at zero, an open market purchase of long-term government debt by the central bank is equivalent to a standard open market purchase of short-term debt for money plus a purchase of long-term debt financed by a sale of central bank holdings of short-term government debt, in effect, an operation that twists the maturity structure of privately held government debt.

Whether alterations in the private sector's portfolio of assets are effective is an empirical issue, and an issue that has, at least in the United States, long been debated. Modigliani and Sutch (1967) found little evidence that Operation Twist mattered in the 1960s, though this probably reflected the small scale of the operation relative to offsetting operations by the Treasury. Prior to the current crisis, many argued that it would require extremely large open market operation in non-standard assets to have a significant impact on yields (e.g., Clouse, et. al. 2003). Bernanke, Reinhart, and Sack (2004) offer one of the most extensive attempts to employ event studies and term structure models to determine if non-standard central bank open market operations have affected yields. Their general conclusion is that shifts in relative asset supplies, or the expectations of such shifts, do affect yields. However, it is not clear from their analysis whether these shifts lead to the sustained movements in relative yields that would be needed to successfully stabilize real

Fed's balance sheet.

economic activity. Gagnon et. al. (2010) discuss some of the more recent evidence and conclude that announcements of the Fed's asset purchases have lowered yields, though, as they note, using an announcement approach (as did Bernanke, Reinhart, and Sack 2004) to capture the effects relies on the assumption that financial markets are efficient in processing information. This assumption might be suspect as the rationale for credit easing policies is that financial markets are not operating efficiently.

Gagnon et. al. (2010) also provide some time series evidence on the impact on yields of the net supply of long-term debt held by the private sector. Using monthly data from 1985 until June 2008, just prior to the start of the Fed's purchases, they find that an increase in the debt stock held by the public lower prices and raised yields by a statistically significantly amount.[18] They conclude that the size of the Fed's purchases reduced yields by between roughly 40 and 80 basis points, depending on their empirical specification. However, because of the large Federal deficit, total debt (as a percent of GDP) held by the public has risen dramatically. While the Fed purchases may have reduced rates relative to the increase that might have been observed, it is less clear what the net impact of the debt stock on rates has been. Similarly, Joyce, Lasaosa, Stevens, and Tong (2010) find evidence that the unconventional policies of the Bank of England succeeded in lowering long-term interest rates.

5.3 Summary on the ZLB

Raising average inflation targets to avoid the zero lower bound is a form of insurance. The permanent distortionary costs of higher average inflation would need to be balanced against the low probability of another negative shock of the magnitude the global economy experienced in 2008. A more effective strategy for avoiding the ZLB would be reduce the risks of another major negative shock to aggregate demand. Better financial market regulation, as well as a more active response of monetary policy to emerging financial imbalances could lower the chances of returning to the ZLB. Clouse,. et. al. (2003) note that low inflation at the beginning of the 1953, 1956, and 1960 recessions in the U.S. did not pose a constraint on monetary policy. Interest rates were reduced, but the ZLB was not reached.

In principle, a central bank that enjoys high credibility should not find the ZLB a

[18] Their point estimates implied that an increase in longer-term debt supply equal to 1 percent of GDP (around $140 billion at 2008 GDP) would raise the 10-year term premium by between 4.4 and 6.4 basis points.

serious constraint. However, this requires promising higher future inflation when at the ZLB, and central bankers seem well aware of the dangers of sacrificing the gains that have been achieved by keeping inflation low and stable. As Ben Bernanke stated at the 2010 Jackson Hole Symposium, "...such a strategy is inappropriate for the United States in current circumstances. Inflation expectations appear reasonable well-anchored, and both inflation expectations and actual inflation remain within a range consistent with price stability. In this context, raising the inflation objective would likely entail much greater costs than benefits. Inflation would be higher and probably more volatile under such a policy, undermining confidence and the ability of firms and households to make longer-term plans, while squandering the Fed's hard-won inflation credibility."

Absent promises of future inflation, central banks still have the tools of quantitative and credit easing. The effectiveness of these tools depends on portfolio balance models that were, until recently, rejected by most of the profession. At a minimum, this means we lack the knowledge to accurately assess the likely effectiveness of these policies.

6 Price level targeting

If the constraint posed by the zero lower bound on the nominal policy interest rate is costly, and raising the average inflation target carries more costs than benefits, what other monetary policy strategies could help reduce the problems created by the zero lower bound? The search for new strategies has led to renewed interest in price-level targeting as an alternative to inflation targeting.[19] One argument for price-level targeting is that, by reducing errors in forecasting future prices, it may reduce long-term risk and facilitate economic planning by households and firms. However, the difference in forecast error variances for long-term price level forecasts under PLT and IT seem small. Kahn (2009) has recently updated estimates originally due to McCallum (1999) and finds that with a current price level set at 100 and a target inflation rate of 2 percent, the 95 percent confidence interval for the price level in twenty years for the U.S. would be [147 157]. This represents a range of ± 3.2 percent around the expected price path, a range that seems a relative small degree of uncertainty relative to other sources of both macro and individual uncertainty faced over a twenty year period. I will focus therefore on the second argument for price-level targeting which is that it leads inflation expectations to

[19] This discussion draws from Walsh (2009b, 2010b).

serve as an automatic stablizer.

6.0.1 Expectations as automatic stabilizers

Consider an environment in which a central bank can commit to objectives – an inflation target or a price level target – but that actual policy decisions are characterized by discretion. Than price-level targeting produces outcomes that mimic the optimal commitment policy (Svensson 1999, Vestin 2006). This improvement occurs even though welfare ultimately depends on inflation. When the public believes prices will return to a target level, their expectations about future inflation help to stabilize current inflation when price setting behavior is forward looking.[20]

This role for expectations can be particularly important in a deflationary situation at the zero lower bound. As the price level falls, the gap widens between the actual price level and the path for prices implied by the target path. The more severe the deflation, the greater must be the subsequent inflation to return prices to their intended path. Thus, a credible commitment to PLT would cause expected inflation to rise, lower the real interest rate, and help boost nominal interest rates above the ZLB. That is, under PLT, expectations serve as an automatic stabilizer.

In practice, most discussions of PLT combine it with a positive trend or average rate of inflation so that the target path evolves according to

$$p_t^T = p_{t-1}^T + \pi^T$$

where π^T is the average rate of inflation and with the target path pinned down at some initial level $p_0^T = p_0$. In contrast, under inflation targeting, the implicit target for the price level evolves as

$$p_t^T = p_{t-1} + \pi^T.$$

Essentially inflation targeting allows for base drift in the target path of prices, while price-level targeting makes p_t^T a trend stationary variable. As a consequence, the subsequent inflation needed after a deviation of prices below the target path rises with π^T. A positive trend to the price path strengthens the way expectations act as an automatic stabilizer after deflationary shocks since with the target path rising over time, the gap between

[20] Not surprising, therefore, Walsh (2003) found that price level targeting performed less satisfactorily in a discretionary environment when the inflation process displays inertia.

it and the actual price level grows over time and amplifies the rise in expected inflation (if the path is credible). At the same time, a positive trend means that inflation shocks that push inflation above the target rate temporarily do not necessarily require actual deflation to return prices to the target path, only a period of below average inflation.

The credibility of price-level targeting is critical to its success, since expectations will not serve as automatic stabilizers if the public doubts the central bank's commitment to return prices to the target path. Kryvtsov, Shukayev, and Ueberfeldt (2008) show that the gains from imperfectly credible price-level targeting in a calibrated model are fairly small, and the gains may not be sufficient to dominant inflation targeting if credibility is obtained slowly.[21] However, repeating this exercise using the Bank of Canada's policy model ToTEM, Cateau, et. al. (2008) found the ultimate gains from price-level targeting to be more significant.[22]

The effect on inflation expectations of adopting PLT will depend on when it is adopted and how quickly the public expects deviations from target to be eliminated. Figure 8 shows the price level in the U.S., measured by the PCE chained index together with hypothetical 1.75 percent paths using different starting dates. One path begins in January 2007, one in January 2008 and one in January 2009. Also shown is the federal funds rate (right scale). If the Fed had adopted price level targeting with a 1.75 percent drift in January 2007, the movement of the PCE index above the target path during 2007 would have called for a tighter monetary policy throughout 2007 and 2008 and would have generated expectations of deflation over this period. Thus, it is not evident that adopting PLT prior to the crisis would have contributed a stabilizing influence, nor would it have generated increases in expected inflation that might have reduced real interest rates at the ZLB.[23]

The case for PLT is stronger if the target price path had been adopted in January 2008. While the actual level of prices rose above target in 2008, they subsequently fell below target just at the time the federal funds rate was cut to zero. A credible promise to return to the target price path might have contributed to a rise in expected inflation

[21] They ignore the ZLB in their analysis.

[22] Battini and Yates (2003) consider what they describe as hybrid inflation and price-level targeting. The central bank is assigned an objective that combines both inflation and the price level, and optimal trade-off frontiers are mapped. They argue that much of the benefit of price-level targeting is obtained when only a small weight is placed on the price level in the objective that guides the design of policy. See also Billi (2008).

[23] Of course, this analysis ignores the fact that the price level might have evolved differently during 2007 and 2008 if the Federal Reserve had adopted price-level targeting.

during the past two years.

While most of the literature on price-level targeting assumes complete credibility of the policy regime and so may overstate the advantages of PLT, there are two reasons its advantages may have been understate. First, the analysis based on model simulations often ignores the ZLB, yet it is just at the ZLB that price-level targeting has its primary advantages over inflation targeting. Second, models typically ignore an important financial frictions – nominal debt contracts. While nominal interest rates can adjust to compensate for average inflation expected over the duration of a contract, PLT, by increasing the predictability of the future price level, can reduce risk premiums associated with nominal contracts. In a DSGE model estimated using Canadian data and including agency costs and nominally denominated debt, Dib, Mendicino, and Zhang (2008) find that PLT reduces the volatility of the real interest rate. This helps reduce distortions associated with nominal contracts.[24]

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6.0.2 Should central banks adopt PLT at the ZLB?

There are several reasons for questioning the efficacy of adopting price-level targeting when an economy is at the ZLB. First, the stabilizing adjustment of expectations arises only if the public understands the implications of price-level targeting and believes the

[24] They also provide references to the related literature investigating price-level targeting with nominal contracts.

[25] They also provide references to the related literature investigating price-level targeting with nominal contracts.

central bank is committed to this new policy. The experience with inflation targeting was that credibility followed experience and the gain in anchoring expectations was not something that was achieved immediately. Gaining credibility for PLT in the midst of a liquidity trap may be particularly challenging. Adopting a new, untested targeting regime while in a crisis seems inadvisable.

Commitment to a price level target, to the extent to which it was successful in generating expectations of future inflation, would lead to a rise in long-term nominal interest rates. This rise in long-term rates may easily lead some to question the central bank's commitment to economic expansion.

The impact on expectations depends importantly on the speed with which the public expects the central bank to regain the target path. This may be hard for the public to forecast since there would be no past experience to draw upon. Similarly, it may be difficult for the central bank to assess the impact of the regime change on the public's expectations. If expectations are for an extended recession, the public may doubt whether the target path will be achieved very quickly. This would reduce the effect PLT would have in raising inflation expectations.

Finally, commitment to a price path that involves future inflation is time inconsistent. Recall that the price-level target is a means of implementing the optimal commitment policy, and this policy is itself time inconsistent. Once the economy recovers from the ZLB, the optimal policy is not to create the inflation required to restore the price level to the promised target path. Optimal commitment means doing what you had previously promised to do, even if it is not the optimal thing to do at the moment. Many central banks have committed to inflation targeting. They have developed credibility by delivering low and stable inflation. The optimal strategy at the ZLB is to change the policy regime to one of price level targeting, and of course to promise never to change the policy framework again. Changing the policy regime in a crisis is exactly what discretion would call for.

To summarize, PLT has advantages over inflation targeting by stabilizing the real interest rate, which can reduce financial frictions, and by ensuring inflation expectations act to help automatically stabilize inflation. This improves the trade-off between output and inflation stabilization. However, the advantages depend on its credibility. Particularly during a crisis, switching regimes is a sign of a discretionary policy maker and may make it more difficult to convince the public of the credibility of a new regime.

7 Conclusions

So where does this discussion leave us in assessing the future of inflation targeting? Flexible inflation target seems to have worked well during the crisis, or at least no worse than other policy frameworks. One consequence of the financial crisis should be to remind us that in the presence of multiple economic distortions, central banks face more complex trade offs than suggested by standard models of flexible inflation targeting. This is true because of financial frictions as well as labor market frictions. Understanding these trade offs and how to construct useful measures of the distortions that generate them must be high on the research agenda. But nothing suggests that inflation should not remain the primary objective of monetary policy.

The constraints associated with the zero lower bound on nominal interest rates have led to proposals to raise average inflation targets. When macro volatility is at the levels seen during the Great Moderation, occurrences of the ZLB may be sufficiently rare that raising average inflation is unnecessary. But if macroeconomic shocks are likely to be larger in the future, the benefits of higher average inflation increase, though these must be balanced against the costs of higher inflation. Better regulation of financial markets, rather than raising the inflation target, is clearly the place to focus in creating a more stable macro environment.

Central banks typically argue that interest rate policy is too blunt an instrument to deal with financial stability and asset price bubbles and that these problems are best dealt with through well designed and implemented regulatory policies. However, even in the presence of adequate financial sector regulation, imperfect information and the resulting moral hazard and adverse selection problems in financial markets remain a source of economic distortions that affect the appropriate objectives of monetary policy.

Price level targeting is a viable alternative to inflation targeting and may lead inflation expectations to move in a stabilizing fashion, particularly in helping to avoid the ZLB. However, the date PLT is adopted, its credibility, the public's understanding of it, and the speed with which price level deviations from the target path are expected to be reversed are all important for determining whether PLT would be a desirable policy regime.

Even at the ZLB, central banks are not without policy instruments, but the effectiveness of unconventional policies such as credit easing depend on the extent to which assets are imperfect substitutes or financial markets are segmented. These are both aspects of financial markets that we do not yet fully understand. Clearly the next-generation of

models will incorporate credit frictions, but in the models developed to date, these frictions often do not seem to generate big differences in the transmission mechanism. The sources of financial shocks and how best to respond to them is still an open issue on which no consensus has developed. The same is true of labor market frictions, whether arising from sticky nominal wages or from search and matching frictions. As Chari, Kehoe, and McGratten (2009) have noted with respect to the standard new Keynesian model, we need to know the sources of shocks if we are to determine whether they call for a policy response. None of these issues, though, suggests a need for major reform of flexible inflation targeting as a framework for monetary policy.

Appendix

This simple four period example illustrates some of the basic intuition behind the more general results of Bodenstein, M., J. Hebden, and R. Nunes, "Imperfect credibility and the zero lower bound on the nominal interest rate," Board of Governors of the Federal Reserve System, International Finance Discussion Paper No. 1001, June 2010.

The basic model is given by

$$x_t = \mathrm{E}_t x_{t+1} - \left(\frac{1}{\sigma}\right)(i_t - \mathrm{E}_t \pi_{t+1} - r_t^n)$$

$$\pi_t = \beta \mathrm{E}_t \pi_{t+1} + \kappa x_t$$

and the central bank's loss function is

$$\left(\frac{1}{2}\right) \mathrm{E}_1 \sum_{t=1}^{4} \beta^j \left(\pi_t^2 + \lambda x_t^2\right).$$

In period 1, r^n takes a large negative value and the nominal rate is pushed to zero. In periods $2-4$, $r^n = 0.04$ and the ZLB is no longer a binding constraint.

Pure discretion Under pure discretion, the equilibrium is $\pi_2 = \pi_3 = \pi_4 = x_2 = x_3 = x_4 = 0$ and

$$x_1 = \left(\frac{1}{\sigma}\right) r_1^n < 0,\ \pi_1 = \left(\frac{\kappa}{\sigma}\right) r_1^n < 0.$$

Imperfect credibility With imperfect credibility, the central bank announces a path for the nominal interest rate, inflation and the output gap in periods $2-4$ (in

period 1, $i_1 = 0$). Denoted these announced values as i_j^a, π_j^a and x_j^a. With probability $1-\mu$ each period it reverts to the discretionary policy. The case $\mu = 1$ corresponds to complete commitment.

In period 1, expected inflation is $\mu\pi_2^a$ while expected output is μx_2^a, where π_2^a (x_2^a) is the inflation rate (output gap) for period 2 announced in period 1. Hence,

$$\pi_1 = \beta \mathrm{E}_1 \pi_2 + \kappa x_1 = \beta\mu\pi_2^a + \kappa x_1$$

and

$$x_1 = \mathrm{E}_1 x_2 + \left(\frac{1}{\sigma}\right)(\mathrm{E}_1\pi_2 + r_1^n) = \mu x_2^a + \left(\frac{1}{\sigma}\right)(\mu\pi_2^a + r_1^n).$$

For periods 2 and 3,

$$\pi_2 = \beta\mu\pi_3^a + \kappa x_2$$

$$x_2 = \mu x_3^a - \left(\frac{1}{\sigma}\right)(i_2^a - \mu\pi_3^a - r_2^n)$$

$$\pi_3 = \kappa x_3$$

$$x_3 = -\left(\frac{1}{\sigma}\right)(i_3^a - r_3^n)$$

as $\pi_4 = x_4 = 0$.

Decision problem The decision problem of the central bank can be written as

$$\min \left(\frac{1}{2}\right)\sum_{j=0}^{4}\mu^j\beta^j\left(\pi_j^2 + \lambda x_j^2\right) + \psi_1\left[x_1 - \mu x_2^a - \left(\frac{1}{\sigma}\right)(\mu\pi_2^a + r_1^n)\right]$$
$$+\theta_1(\pi_1 - \mu\beta\pi_2^a - \kappa x_1) + \mu\beta\theta_2(\pi_2^a - \mu\beta\pi_3^a - \kappa x_2^a) + \mu^2\beta^2(\pi_3^a - \kappa x_3^a).$$

where ψ_1, θ_1, θ_2, and θ_3 are Lagrangian multipliers. Note that the IS relationship does not represent a constraint in periods 2-3 and further outcomes are relevant for decisions in period 1 only if the central bank has not reverted to the discretionary equilibrium, so the future is discounted at the rate $\mu\beta$.

First order conditions FOC for π_1, π_2^a, π_3^a, x_1, x_2^a, x_3^a:

$$\pi_1 + \theta_1 = 0$$

$$-\psi_1\left(\frac{\mu}{\sigma}\right) - \theta_1\mu\beta + \mu\beta\pi_2^a + \theta_2\mu\beta = 0$$

$$-\theta_2\mu^2\beta^2 + \mu^2\beta^2\pi a + \theta_3\mu^2\beta^2 = 0$$

$$\lambda x_1 + \psi_1 - \theta_1\kappa = 0$$

$$-\psi_1\mu + \mu\beta\lambda x_2^a - \theta_2\mu\beta\kappa = 0$$

$$\mu^2\beta^2\lambda x_3^a - \theta_3\mu^2\beta^2\kappa = 0$$

Simplifying:

$$\pi_1 + \theta_1 = 0$$

$$-\psi_1\left(\frac{1}{\sigma}\right) - \theta_1\beta + \beta\pi_2^a + \theta_2\beta = 0$$

$$-\theta_2 + \pi_3^a + \theta_3 = 0$$

$$\lambda x_1 + \psi_1 - \theta_1\kappa = 0$$

$$-\psi_1 + \beta\lambda x_2^a - \theta_2\beta\kappa = 0$$

$$\lambda x_3^a - \theta_3\kappa = 0$$

Note that these are independent of μ.

Equilibrium conditions The equilibrium conditions are given by the first order conditions and the structural equilibrium conditions of the model:

$$\pi_1 + \theta_1 = 0$$

$$-\psi_1\left(\frac{1}{\sigma}\right) - \theta_1\beta + \beta\pi_2^a + \theta_2\beta = 0$$

$$-\theta_2 + \pi_3^a + \theta_3 = 0$$

$$\lambda x_1 + \psi_1 - \theta_1\kappa = 0$$

$$-\psi_1 + \beta\lambda x_2^a - \theta_2\beta\kappa = 0$$

$$\lambda x_3^a - \theta_3\kappa = 0$$

$$x_1 = \mu x_2^a + \left(\frac{1}{\sigma}\right)(\mu\pi_2^a + r_1^n)$$

$$\pi_1 = \mu\beta\pi_2^a + \kappa x_1$$

$$\pi_2^C = \mu\beta\pi_3^a + \kappa x_2^a$$

$$\pi_3^a = \kappa x_3^a$$

This gives ten equations for π_1, π_2^a, π_3^a, x_1, x_2^a, x_3^a plus the four Lagrangian multipliers.

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Table 1: Real GDP: Growth Rate*

	All	IT	NIT
1995-2007	3.60	3.64	3.38
2008-2009	−1.08	−0.65	−1.27
2008-2010**	−0.35	0.06	−0.53

* Source: IMF World Economic Outlook, March 2010

** Projected

Table 2: Inflation: Average Consumer Prices*

	All	IT	NIT
1995-2007	2.54	2.82	2.42
2008-2009	2.56	3.90	1.97
2008-2010**	2.16	3.25	1.68

* Source: IMF World Economic Outlook, March 2010

** Projected

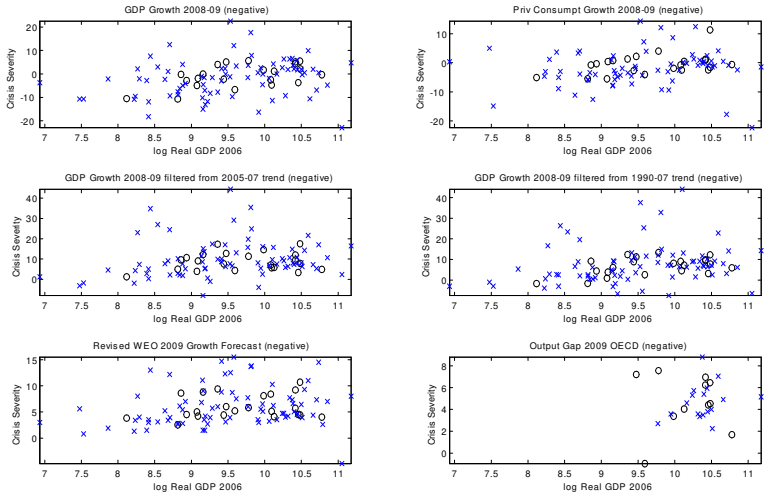


Figure 1: Crisis severity and 2006 log real GDp per capita. Inflation targeters denoted by circles.

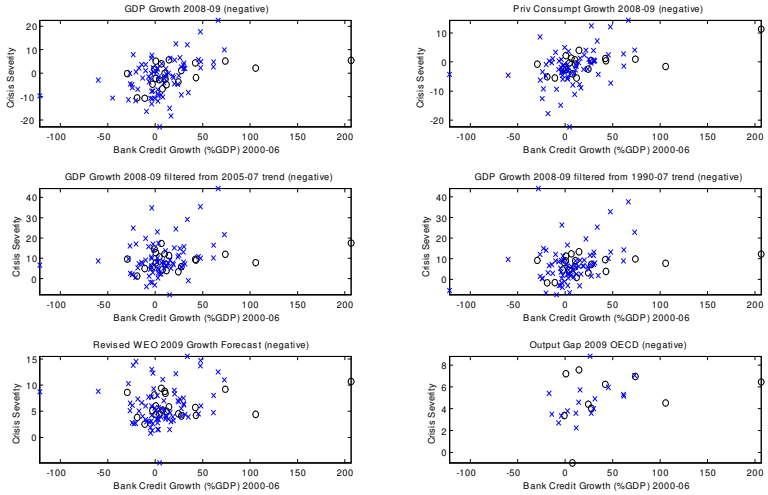


Figure 2: Crisis severity and bank credit growth 2000-2006. Inflation targeters denoted by circles.

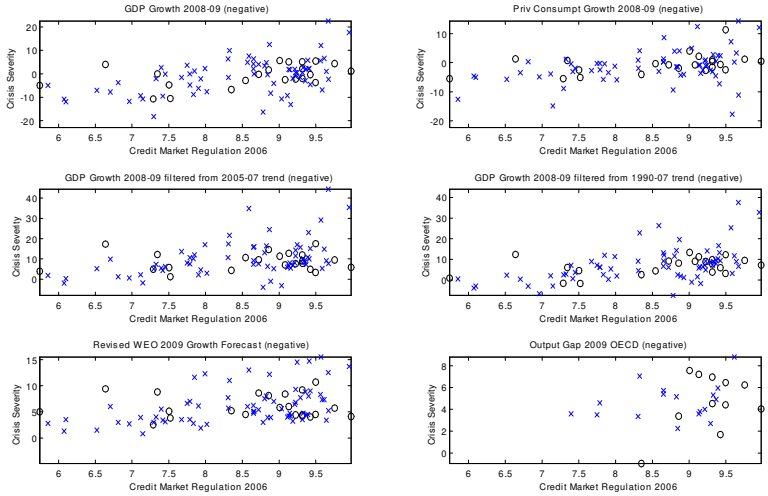


Figure 3: Crisis severity and credit market regulation. Inflation targeters denoted by circles.

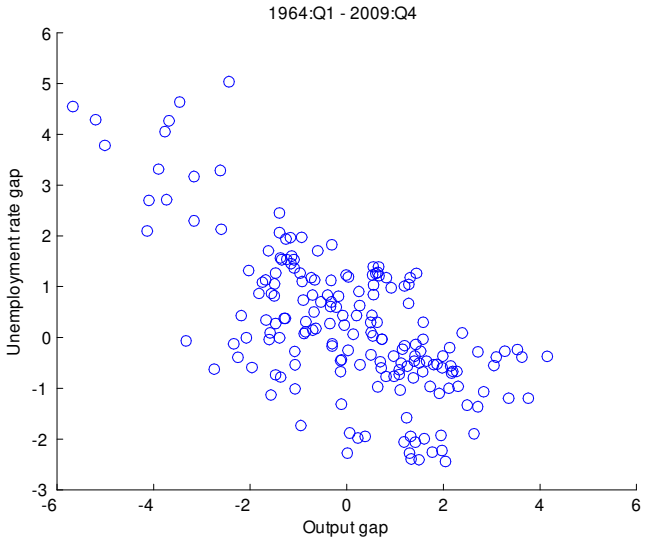
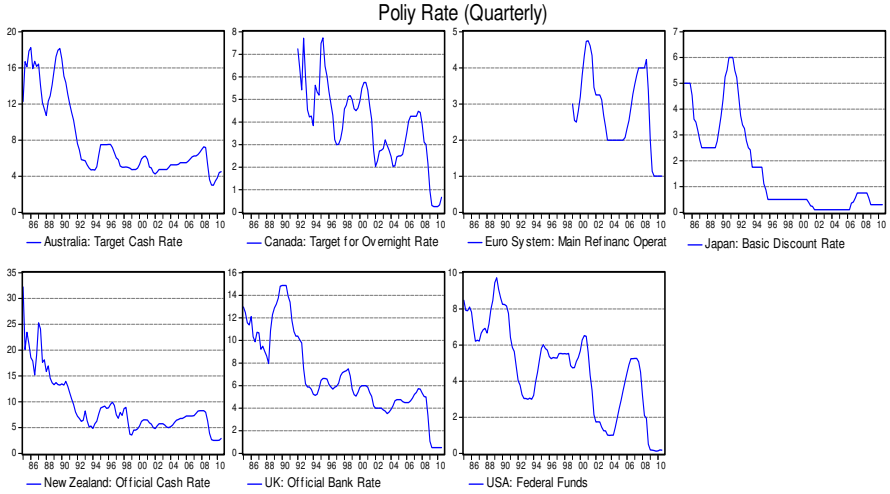


Figure 4: Okun's Law for the United States



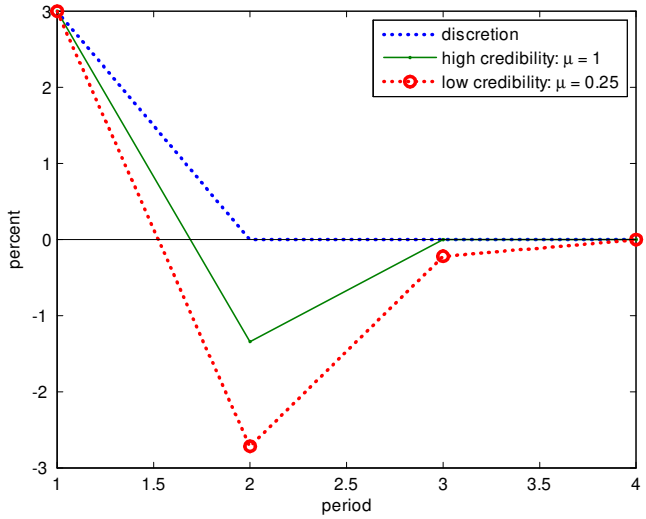


Figure 5: Nominal interest rate under discretion, full commitment, and imperfect credibility when the ZLB is binding only in period 1

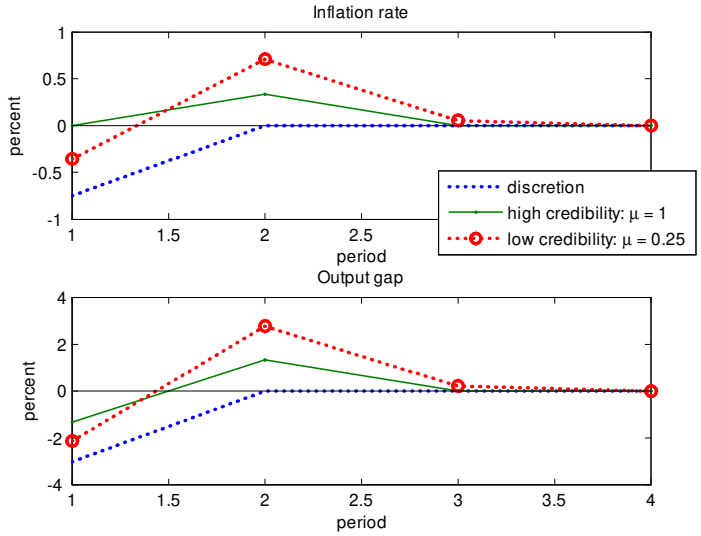


Figure 6: Inflation and the output gap under discretion, full commitment, and imperfect credibility when the ZLB is binding only in period 1

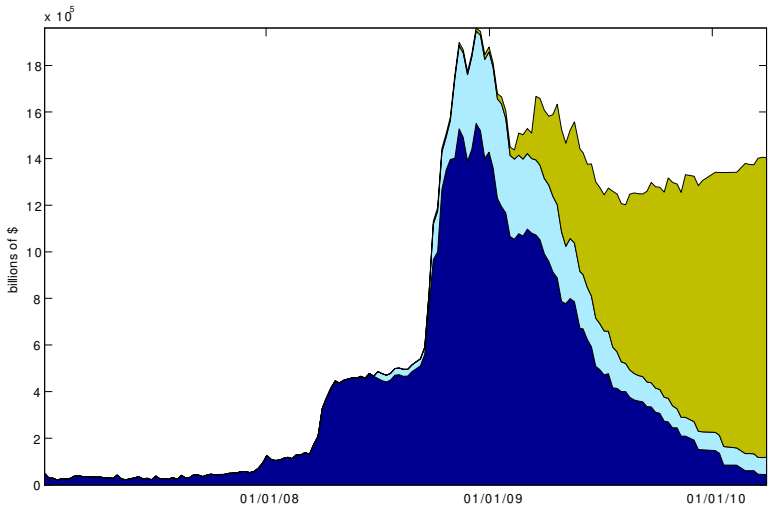


Figure 7: Unconventional policies: lending to financial institutions plus liquidity provision (blue), and purchases of long-term assets (green)

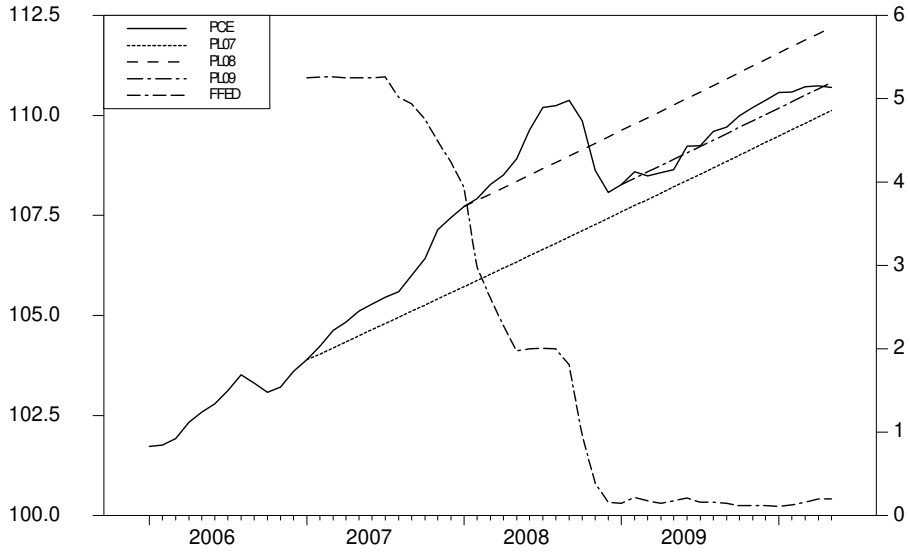


Figure 8: The PCE index and hypothetical price cones beginning January 2007 and January 2008. Lower paths correspond to 1.5% inflation, the upper paths to 2.0% inflation.