Price Stability through Price-Level Targeting or Inflation Targeting? A Tale of Two Experiments

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Abstract: Price stability can be attained through price-level or inflation targeting. This paper compares the two monetary policy strategies from both a historical and a theoretical perspective. The Swedish experiment with price-level targeting in the 1930 occurred within a framework that lacked the accountability characteristic of New Zealand's current policy framework for inflation-targeting. Using a simple forward-looking rational expectations framework, we show that price-level targeting offers a better output-inflation variability tradeoff than inflation targeting in the forward-looking New Keynesian framework.

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Broadly defined, inflation targeting is a monetary policy strategy whose chief objective is to maintain inflation at a constant level or within a band. The era of formal inflation targeting began in 1989 when legislation in New Zealand declared price stability to be the overriding goal of monetary policy. There has been widespread support in academic circles for inflation targeting as a monetary policy regime over the past decade (Leiderman and Svensson (1995), Bernanke et al (1999)). It has won acclaim as the best-practice strategy for monetary policy in a large number of countries around the globe. Every country that followed New Zealand's example and adopted formal inflation targets in the early 1990s - Australia, Canada, New Zealand, Sweden, and the United Kingdom - has since then enjoyed price stability and satisfactory real growth records. As a result, none of the inflation-targeting countries has seen fit to abandon its current monetary policy strategy for any other.

A conceivable alternative to inflation targeting is price-level targeting. Historical evidence on the performance of price level targeting is scant. Indeed the Swedish experiment of targeting the CPI during the 1930s remains the only attempt at targeting the price level over a prolonged period of time. From an academic perspective, support for price-level targeting was particularly strong at the beginning and early part of the 20th century. Wicksell (1898) was an early proponent of price-level targeting. Yet in practice, monetary policy in the industrialized world was geared towards maintaining some semblance of a pegged exchange rate system that gave way only with the collapse of the Bretton Woods agreement in the spring of 1973. Skepticism about the effectiveness of pegged exchange rate arrangements had led to calls for basing the conduct of monetary policy on an alternative nominal anchor long before the abandonment of the Bretton Woods agreement. Most analysts would probably concur with the view that the post-World War II literature on monetary policy recommended targeting monetary aggregates over alternative strategies such as price-level targeting. A forceful statement of this policy prescription can be found in Friedman (1968): "Attempting to control directly the price level is therefore likely to make monetary policy itself a source of economic disturbances because of false stops and starts."[1] More than 25 years later, Fischer (1995) is equally critical of price-level targeting. He goes as far as claiming that conventional wisdom

[1] p.108.

cast aside price-level targeting because of its potential for causing unnecessary variability in the output gap.

A few recent papers challenge the notion that price-level targeting delivers poor stabilization results. Svensson (1999) and Vestin (2000) argue that price-level targeting delivers better results for price stability than inflation targeting. Indeed, price level targeting dominates inflation targeting as the former yields a better output-inflation variability trade-off. Svensson's comparison of the two alternative strategies is based on a Lucas-type Phillips curve that allows for substantial persistence in output. In contrast, Vestin analyzes the merits of price-level versus inflation targeting in the context of the New Keynesian framework.[2]

In this paper, we follow Vestin's example and carry out the exercise by employing the forward-looking model. However, we use a somewhat different approach, one that dispenses with an intertemporal optimization framework. Our analysis of price-level and inflation targeting is grounded in a standard rational expectations framework where the policymaker follows a simple linear policy rule and minimizes an expected loss function that consists of the unconditional variances of the target variables. The examination of price-level targeting in this simple set-up yields the same powerful insight as the more complex intertemporal approach. Three different approaches to modeling discretionary price-level targeting are compared in the appendix, each generating a better output-inflation variability tradeoff than inflation targeting.

We believe that our approach yields more intuitive results to show why price-level targeting in the forward-looking model is such an attractive monetary policy strategy compared to inflation targeting. In particular, we show how the process of forming rational expectations depends critically on the current price level under price-level targeting. As economic agents are forward-looking, they base their *current* expectations of future endogenous variables on current information. As a consequence, these expectations depend on the current price level which in turn

[2] Dittmar and Gavin (2000) compare and contrast the output-inflation variability trade-off in models featuring variants of the expectations-augmented and the New Keynesian Phillips Curves. According to their findings, the degree of persistence of real output in the Phillips Curve does not matter in the assessment of the output-inflation variability tradeoff under price level targeting as opposed to inflation targeting in the New Keynesian model. They concur with Svensson (1999) that persistence matters if an expectations-augmented Phillips Curve forms the basis for the comparison of the two targeting strategies.

responds to contemporaneous policy action. Thus, current policy action in response to a cost-push shock affects not only the current price level but also the current expectation of next period's price level. The mechanism through which expectations are affected is absent under inflation targeting and explains why in the simple forward-looking model price-level targeting is arguably the superior monetary policy strategy.

The remainder of the paper is as follows. Section 2 analyzes the historical context which led to the adoption of price level-targeting in Sweden and inflation targeting in New Zealand. Section 3 compares and contrasts the monetary policy frameworks in the two countries. Section 4 introduces the forward-looking model and illustrates the conduct of optimal monetary policy under price-level targeting and inflation targeting. Section 5 illustrates the output-inflation variability tradeoff. The final section offers a conclusion.

2. Price Stability through Price-Level Targeting or Inflation Targeting? A Historical Perspective

2.1. Price-Level Targeting in Practice[3]

The Swedish experiment with price-level targeting began in September 1931 and lasted until the outbreak of World War II. Two factors led to the adoption of a price-level target. The economic factor - the sharp deflation that began in the late 1920s, the onset of the Depression in 1930, and the eventual abandonment of the gold standard necessitated the mapping out of a new, coherent strategy for monetary policy. Over the 1928-1931 period wholesale prices had fallen by more than 25 percent while consumer prices had fallen by about 9 percent. From 1929 to 1931 industrial production had fallen by 21 percent and real income by 9 percent. The rate of unemployment had risen from about 10 percent in 1930 to about 25 percent in 1933. The Swedish Krona had come under speculative attack on September 19th, 1931 upon the Bank of England's decision to suspend the convertibility of the pound into gold. Confronted with a steadily deteriorating economy and international monetary

[3] A detailed analysis of the Swedish experiment with price-level targeting is provided by Berg and Jonung (1999). A concise yet insightful analysis is found in Black and Gavin (1990).

arrangements that had fallen into a state of disrepair, the Swedish government felt obliged to take action.

The other factor instrumental in the decision to adopt price-level targeting was the influence of the economics profession on policymakers in Sweden in the 1930s. Around the turn of the 19th century, Wicksell had made a case in his economic writings for price-level stabilization to be the sole objective of monetary policy. His recommendation was taken up by Cassell and Heckscher, two promiment Swedish economists of the time. When Sweden went off the gold standard on September 27, 1931, both economists urged the Minister of Finance to adopt a price-level target as the nominal anchor for monetary policy. No extended policy deliberations preceded the switch from to the gold standard to the price-level stabilization scheme. It took less than 48 hours to make the switch which, incidentally, was accompanied by a mere one-sentence declaration.

The actual implementation of the price-level scheme in 1931 did not go without a hitch. Despite the clear evidence of deflationary pressure, the Riksbank raised the discount rate almost immediately after the abandonment of the gold standard for fear of inflationary pressure! Evidently the concern about rising prices that were expected to follow the decoupling of the Krona from the Pound outweighed the then existing deflationary pressure on prices. The increase of the discount rate from 4 to 8 percent in September 1931 proved unnecessary as it was quickly undone. In hindsight it is difficult to judge whether the tightening of the stance of monetary policy – a domestic factor – was costly in terms of loss of domestic production. There appears to be a consensus, however, that the importance of the monetary policy tightening pales in comparison to the importance of external factors in causing the economic depression in Sweden. The beginning of the Swedish experiment with price-level targeting also witnessed rather large fluctuations in the Pound/Krona exchange rate despite substantial interventions in the foreign exchange market in the fall of 1931. By 1933, however, these fluctuations had subsided and the Riksbank returned to a *de facto* pegging of the domestic currency to the British Pound.

The quick decision to abandon the gold standard and the subsequent adoption of a price-level targeting scheme in Sweden contributed to the sustained recovery of the

economy that began in 1933/34.[4] Fluctuations in the CPI were kept within a 3 percentage point band around the target value (the CPI of September 1931) through 1936. Despite a 5 percentage point rise in 1937, the CPI remained fairly stable until the outbreak of WWII.[5] Indeed, over the mid-1933 to early 1937 period the Riksbank achieved the dual objective of price and exchange rate stability. From 1933 onwards the level of industrial production began to rise again; the rate of unemployment peaked in the same year before declining in 1937 to approximately the same rate that prevailed in 1928.

Despite the apparent success of the price-level stabilization program during the 1930s, the strategy was eventually abandoned in April 1937 by a vote of the Board of Directors. A number of reasons were responsible for the end of the experiment. By early 1937 the CPI was consistently above the upper bound of the target range as a result of the increase in the British price level and the successful operation of a fixed exchange regime by the Swedish Riksbank. There was a clear reluctance on the part of the Riksbank to allow the Krona to appreciate vis-à-vis the Pound in 1937.[6] The clear emphasis on keeping the exchange rate fixed reflected a growing belief that price-level targeting was not *the* best-practice strategy to lift Sweden out of the depression. The slow rise of the Keynesian paradigm with its emphasis on discretionary demand-side management coupled with its sanguine view about increased government involvement in the macroeconomic policy framework was the final reason for the abandonment of price-level targeting.

2.2. The Genesis of Formal Inflation Targeting

The first country to introduce inflation targeting formally was New Zealand in 1989.[7,8] The New Zealand experiment with inflation targeting evolved slowly over the

[4] Bernanke (1995) documents that Sweden and the United Kingdom avoided the prolonged economic depression experienced by other countries by leaving the gold standard in the early stage of the Great Depression.

[5] Import and export prices were allowed to rise. The emphasis of the price-level targeting scheme was on stabilizing the average level of domestic consumer goods prices.

[6] On this point see Jonung (1979), pp. 476-77. He goes as far as arguing that the Riksbank's first and foremost goal was to keep a fixed exchange rate. "It was probably the Bank's traditional inclination towards fixed rates which took precedence over *other considerations*. Under the prevailing circumstances, however, the management could not state this *openly* (Italics added for emphasis).

[7] The evolution of inflation targeting in New Zealand is described in greater detail by Reddell (1999) and Sherwyn (1999).

[8] Without a doubt, a few central banks, notably the Bundesbank of Germany (prior to surrendering control over monetary policy to the ECB) and the Swiss National Bank, were and have always been committed to some form of inflation targeting. Most students of monetary policy would probably shy

mid-1980s and culminated with the passage of the Reserve Bank Act of 1989. The legislation redefining the mandate and responsibilities of New Zealand's central bank was part of a general reform process that sought to restructure the New Zealand economy. This process began as early as 1984 with the election of the Labour government which set about instantly to remove interest rate and foreign exchange controls and freed financial institutions from holding government securities as reserve assets. In March 1985 the New Zealand Dollar was allowed to float freely.

The early attempts at deregulation came in response to a steadily deteriorating economy. Table *1* provides some background information about the performance of the New Zealand economy over the 1975 to 1986 period.

Table 1

	Public Overseas Debt (% of GDP)	Nominal Exchange Rate[a] (Index)	CPI Index	CPI Rate of Inflation (%)	Nominal Interest Rate (%)	Real GDP Growth (%)
1975	8.8	148.1	163	13.2	8.9	4.2
1979	17.2	122.9	274	10.5	12.1	0.2
1986	32.2	75.2	647	13.1	19.9	0.7

Note: [a] A decrease in the index signifies a devaluation (or depreciation after March 1985). Source: RB of New Zealand, Dalziel and Lattimore (1996).

Low real growth prospects, a high and variable rate of inflation, a rapidly depreciating exchange rate, steadily increasing nominal interest rates, and increasing overseas indebtedness were the order of the day.

In 1986 the then Minister of Finance Roger Douglas took the initiative to revamp the governing structure and mandate of the Reserve Bank of New Zealand (RBNZ). In the following year, he began his crusade to control inflation. Two characteristics about Douglas's reform process are noteworthy. First, as far as the

away from classifying both institutions as *formal* inflation-targeters because they were or are not subject to formal, explicit quantitative inflation targets. This is not to deny the importance of explicit numerical objectives for the long-term inflation rate ("unavoidable inflation") in the implementation of monetary policy by the Bundesbank. These numerical targets for long-term inflation, which were first announced in December 1974 and amended in December 1984 when the target rate for inflation was set at 2 percent, were self-imposed, however.

restructuring of the Reserve Bank is concerned, there is no evidence that academics had any material input in the transformation of the Reserve Bank from a tightly controlled central bank that functioned largely as the extended arm of the Minister of Finance to an autonomous central bank. Indeed, the restructuring of the Reserve Bank was largely accomplished by reconciling the recommendations expressed by the Reserve Bank, which pushed for *autonomy* in the operation of monetary policy, with the recommendation expressed by the Treasury, which argued for greater *accountability* in the operation of monetary policy. The latter recommendation was embedded in the Reserve Bank Act of 1989 in the form of an employment contract for the Governor of the Reserve Bank and the requirement to issue six-monthly Monetary Policy Statements. *Autonomy* was achieved through operational independence from the fiscal authority.

Second, the reorganization of New Zealand's central bank and the formalizing of inflation targeting as the official monetary policy strategy of the Reserve Bank were two separate processes. That is to say, as the revamp of the Reserve Bank went underway there was no clear-cut indication that price stability would be defined in terms of an inflation target range of 0 to 2 percent. The first time price stability was defined in terms of an inflation target range was during a television interview in April 1988 when Roger Douglas suggested a 0 to 1 percent interval. Douglas used the concept of an inflation target in an attempt to bring down the public's rather high inflationary expectations well below the 5 percent mark. He mentioned 1990 as the date by which low inflation was to be achieved. Shortly after Douglas's announcement, in June 1988, the Reserve Bank fell in line and described price stability in terms of a rate of inflation between 0 and 2 percent which it hoped to achieve by the early 1990s.

Nevertheless, the Reserve Bank appeared to be rather lukewarm to the idea of being bound by a formal inflation target. In a memorandum to the Minister of Finance the bank argued that "...the gains likely to accrue from the use of inflation targets are limited and the costs, although unknown, of a continued tight monetary policy stance over the next year or two are potentially high."[9] Thus, the drive to include explicit quantitative targets for inflation in the legislation that gave rise to the Reserve Bank Act stemmed from the ruling government of the day in 1989, and not

[9] *Price Stability and Inflation Targets*, RBNZ Memorandum to the Minister of Finance (Nos. 2536 & 2537), July 1988.

the Reserve Bank or Treasury. Academic economists seemed to have no input in working out the specifics of the inflation-targeting strategy either.[10]

The formal inflation target band of 0 to 2 percent was specified in the first Policy Target Agreement signed in March 1990. In this contract between the Minister of Finance and the Governor of the Reserve Bank it was agreed that control over inflation in this range was to be accomplished by December 1993. This goal was indeed achieved. December 1993 did not, however, mark the end of the evolution of the inflation targeting strategy of the Reserve Bank. The strategy turns out to be an ongoing process that adjusts to changes in conditions and circumstances. This is most evident in the rewording of the Policy Agreements over time.

The complete overhaul of the monetary policy framework in New Zealand preceded the solid growth performance of the New Zealand economy during the 1990s and the early years of the new millennium. Over the March 1994 to June 2004 period, the economy grew at an average real rate of 4 percent; CPI inflation was kept to an average of 2 percent, and the 90 bank bill rate was 6.8 percent on average.[11] At the very least one can argue that the successful operation of the new monetary policy framework has resulted in lower and more stable inflation in the post-Reserve Bank Act period than in the 1970-1985 period. Other positive effects such as improved predictability of policy action by the Bank may have boosted the general public's confidence in the policy-making process and therefore contributed to the respectable growth performance of the New Zealand economy in the recent past.

3. The Two Frameworks Compared: A Historical Perspective.

Transparency in the conduct of monetary policy, accountability and the legal independence of the central bank are the hallmarks of the monetary policy framework in New Zealand, the country that pioneered inflation-targeting. At the time of its conception, New Zealand's design of its monetary policy arrangements was hailed as path-breaking. But with the Swedish Riksbank pursing a price level objective in the

[10] Lars Svensson, then affiliated with the University of Stockholm, was however, asked to conduct an independent review of the performance of the Reserve Bank of New Zealand in 2001.
[11] The annualized average for CPI inflation was calculated for the March 1995-June 2004 period. All averages reported are based on quarterly data. The data were taken from the website operated by the Reserve Bank of New Zealand.

1930, one might inquire about the characteristic features of the Swedish monetary policy framework of the 1930s. After all, given the same ultimate objective – price stability – there is reason to believe that the institutional framework governing the conduct of monetary policy in the two countries to be alike in certain respects. Comparing the two monetary policy frameworks should throw some light on the extent to which the overhaul of New Zealand's monetary arrangements in the 1980s can be considered as truly unprecedented and trail-blazing.

Table *2* compares and contrasts the key characteristics of the monetary policy framework within which the Swedish Riksbank engaged in price-level targeting in the 1930s with the inflation-targeting framework adopted officially by the Reserve Bank of New Zealand in 1990. There are a few noteworthy similarities between the two policy frameworks. At the same time, there are also a few critical differences.

One distinct difference concerns the speed with which the two targeting strategies were implemented. The price-level targeting strategy was introduced in Sweden with a one-sentence declaration on September 27, 1931. The inflation-targeting strategy in New Zealand, in contrast, developed over a span of three years. In addition, the introduction of price-level targeting in Sweden was not accompanied by major changes to the structure of the Riksbank while the Reserve Bank Act of 1989 made for a complete overhaul of the monetary policy framework within which the Reserve Bank of New Zealand conducts monetary policy. Accountability is an integral part of the NZ policy framework while it was virtually absent from the Swedish policy framework. Moreover, the price-level targeting strategy in Sweden was looked upon as a *temporary* monetary policy strategy. An eventual return to the gold standard was expected. The Reserve Bank Act of 1989 lays down price stability to be the overriding goal of monetary policy in New Zealand. As such inflation-targeting can be considered to be a *permanent* strategy for monetary policy in New Zealand.

Other notable differences pertain to the policy instrument and the role of forecasts. The Swedish Riksbank relied on the discount rate and foreign currency operations as its policy instruments. [12] In contrast, the Reserve Bank of New Zealand initially targeted a reserves aggregate called Settlement Cash Balances and has maintained a clean float of the New Zealand Dollar since March 1985. Forecasts of inflation, the

[12] According to Black and Gavin (1990), of the two instruments, transactions in the foreign exchange market were far more important than adjustments in the discount rate. Indeed, from December 1933 to 1940 the discount rate on long-term bonds remained fixed at 3 percent.

output gap, the exchange rate and other macroeconomic factors play an important role in the operational framework that guides monetary policy decisions in New Zealand. Forecasts of macroeconomic variables were not central to the Swedish monetary policy framework of the 1930s. The Swedish experience with price-level targeting also yields a unique result as regards the exchange rate. Apart from a few short episodes, the Swedish Riksbank continued to peg the Krona to the British pound from 1933 onwards until the outbreak of World War II. In sharp contrast, the Reserve Bank of New Zealand has steadfastly refrained from intervening in the foreign exchange market to steer the course of the NZ Dollar ever since the switch to a flexible exchange rate regime in March 1985.[13]

Despite a number of distinct and critical differences, the Swedish and New Zealand monetary policy frameworks also share commonalities. First, the Swedish Riksbank had and the Reserve Bank currently has instrument independence in the conduct of monetary policy. At the same time, neither central bank had (has) goal independence as the goals of monetary policy were (have been) specified by the legislative branch of government. Caveats play(ed) an important role in both operational frameworks. Breaches of the operational target were (are) admissible in certain circumstances such as an increase in excise taxes or crop failures. Also noteworthy is the fact that the consumer price index was the operational target of the price level stabilization scheme in Sweden and serves as the operational target of the RBNZ monetary policy strategy today. Notice though that in both countries price stability was (has been) defined to imply or encompasses stability in the general level of prices, i.e. stability in other price indices as well. Perhaps not surprisingly, the objectives of monetary policy were or have been broadened over time. In both frameworks price stability was initially the sole goal of monetary policy. As time progressed other important variables such as stable output levels became or have become additional objectives. This is particularly evident in New Zealand where more recent policy target agreements go even further and mention stability of interest rates and exchange rates as desirable complementary objectives.

Taken altogether, the novel aspect of the monetary policy framework that was put in place in New Zealand in the late 1980s is not the emphasis on price stability. The

[13] This is not to say that the Reserve Bank of New Zealand has remained silent on issues concerning the exchange rate. The bank has on occasion used "open-mouth" operations to inform market participants about its views concerning the exchange rate.

emphasis on price stability was an integral part of the Swedish monetary arrangements of the 1930s. The unique and arguably most important characteristic of the new monetary policy framework in New Zealand is that it provides for accountability. The responsibility for the conduct of monetary policy rests with an individual, the Governor, who can be dismissed in case of unsatisfactory performance. This unprecedented feature sets the current New Zealand monetary policy framework apart from the monetary arrangements that existed in Sweden in the 1930s.

It is true that other countries where the accountability feature is not embedded in the monetary policy framework reduced inflation during the 1990s and have maintained low inflation since then. Thus, it is possible to bring inflation down without threatening the chief executive of the central bank with dismissal in case of non-performance. However, it is impossible to say whether New Zealand would have been as successful in keeping inflation at bay without the accountability feature in the policy framework. The fact remains that the overall design of the monetary policy framework of New Zealand, which rests on autonomy, accountability, and transparency, has served New Zealand well.

4. Price-Level Targeting Versus Inflation Targeting in the Forward-Looking Model

In practice inflation targeting is clearly preferred to price-level targeting. As mentioned in the introduction, inflation targeting is considered to be a best-practice strategy for monetary policy. Price-level targeting is not really thought of as a viable option in central-banking circles for two reasons. First, there is the deeply entrenched conventional view that price-level targeting is associated with increased output variability. According to this view, price-level targeting makes monetary policy more volatile as the central bank must undo misses of the price-level target. With sticky prices, greater volatility in the conduct of monetary policy leads to higher output variability.[14] Second, central bankers fear instability in financial markets. Price-level targeting has the potential to create financial instability because of the increased possibility of prolonged spells of deflation. A forceful proponent of this view is

[14] Fischer (1995) gives a detailed account of this view. The earlier literature (Friedman (1968)) stresses the existence of long and variable lags in the conduct of monetary policy. The existence of these lags is bound to lead to undesirable output fluctuations.

Mishkin (2001) who argues that deflation hurts the balance sheet of firms, thereby exacerbating moral hazard and adverse selection problems, which in turn promote financial instability.

Yet from a theoretical perspective, price-level targeting has some appeal.[15] The purpose of this section is to show that from the standpoint of the output-inflation variability tradeoff the dominance of price-level targeting over inflation targeting in the forward-looking New Keynesian model can be determined in a simple rational expectations framework that does not depend on intertemporal optimization subject to a constraint. The trade-off between the variability of the output gap and the rate of inflation is established in the context of flexible price-level and flexible inflation targeting. The flexible approach describes situations in which the policymaker cares about both the variance of the price level or inflation and the variance of the output gap.

The simple New Keynesian model consists of two equations:[16]

$$y_t = -a_1 r_t + E_t y_{t+1} + v_t \qquad (1)$$

$$\pi_t = \beta E_t \pi_{t+1} + a y_t + u_t \qquad (2)$$

Equation (1) is the forward-looking IS relation where y_t represents the output gap. r_t is the real rate of interest over which the policymaker is assumed to have full control. v_t is a white noise disturbance.

Equation (2) is the forward-looking Phillips Curve. The current rate of inflation π_t depends on the current expectation of the rate of inflation in the next

[15]Several recent papers address various aspects of inflation and price-level targeting in a general equilibrium framework or forward-looking framework. Benhabib, Schmitt-Grohe, and Uribe (2001) point out undesirable consequences of implementing a monetary policy rule that responds to deviations of the rate of inflation from target. They find that following a Taylor Rule may expose the economy to two equilibria, one intended the other unintended. The latter involves a liquidity trap where both the rate of inflation and the nominal interest rate are below their target values. Using a flexible-price general equilibrium model, Dittmar and Gavin (2004) show that price-level targeting avoids the indeterminacy problem. Examining policymaking under discretion, Nessén and Vestin (2005) find that average inflation targeting dominates single-period inflation targeting but is inferior to price-level targeting in the simple forward-looking model. The reason for the dominance of price-level targeting over average inflation targeting is that the policy rule associated with price-level targeting is consistent with optimal policy from the timeless perspective (commitment) while the policy rule under average inflation is not. Similar to price-level targeting, average inflation targeting leads to expected deflation if in the current period the rate of inflation exceeds its target level (of zero).

[16] Both the IS relation and the Phillips Curve are derived from an explicit intertemporal optimization framework. The two parameters of the simple forward-looking model (a_1, a) depend on deep parameters such as the degree of relative risk aversion and the degree of price stickiness. See Rotemberg and Woodford (1997) or McCallum and Nelson (1999) for further details.

period, $E_t\pi_{t+1}$, the current output gap y_t, and the cost-push shock, u_t. The discount factor β is assumed to equal *1* henceforth.

4.1. Flexible Price-Level Targeting

Under flexible price-level targeting, the policymaker seeks to minimize the variance of the price level and the variance of the output gap. The target for the price level is assumed to be constant over time and the target for the level of real output is its potential level. The expected loss function that the policymaker seeks to minimize takes the following form:

$$E[L_t] = V(y_t) + \hat{\mu}V(p_t) \qquad (3)$$

where $\hat{\mu}$ = the weight that the policymaker places on the variability of the price level relative to the variability of the real output gap.

Optimal Policy under Discretion

Under discretion, the policymaker sets the policy rule anew in every period, i.e. he re-optimizes every period, and he takes the expectations of the future values of endogenous variables as given.[17]

The policy rule under flexible price-level targeting is given by:

$$\hat{\theta}y_t + p_t - p^* = 0 \qquad (4)$$

The policy rule is a linear relationship between y_t and the difference between, p_t, the actual price level at time *t*, and the constant target level, p^*. The policy parameter $\hat{\theta}$ is a choice variable and represents the weight the policymaker puts on the output gap relative to the deviation of the price level from its target level in setting policy.[18]

The next step consists of rewriting the Phillips Curve equation in terms of the price level because the price level rather than the rate of inflation serves as one of the

[17] Thus the policymaker takes the expectations proper as given and not the process by which expectations are formed. The former is a more stringent condition than the latter and is preferred mainly because it allows for tractable analytical solutions for the optimal policy parameter and the endogenous variables. For the purpose at hand, the treatment of expectations under discretionary optimization is immaterial as both approaches yield a more favorable output-inflation variability tradeoff under price-level targeting compared to inflation targeting. The treatment of expectations matters, however, in the delegation process. For further details, see Guender (2005).

[18] In the appendix we lay out the various ways in which the policy problem can be set up. We show that Equation (4) generates virtually the same output-inflation variability tradeoff as a rule that is based on explicit intertemporal optimization and constant expectations.

goal variables. Since $\pi_t = p_t - p_{t-1}$ and $E_t\pi_{t+1} = E_t p_{t+1} - p_t$, equation (2) can be rewritten as:

$$p_t - p_{t-1} = E_t p_{t+1} - p_t + ay_t + u_t \qquad (2')$$

$$\text{or, } p_t = \frac{1}{2}(E_t p_{t+1} + p_{t-1} + ay_t + u_t)$$

Our objective is to determine the optimal weight the policymaker attaches to the real output gap in the policy rule. Towards this end, we must first determine the reaction function by substituting the IS relation and the Phillips Curve Equation (2') into the policy rule. Solving for r_t yields:

$$r_t = \frac{1}{a_1}(E_t y_{t+1} + v_t) + \frac{1}{2a_1(\hat{\theta} + \frac{a}{2})}(E_t p_{t+1} + p_{t-1} + u_t) - \frac{1}{(\hat{\theta} + \frac{a}{2})a_1} p^* \qquad (5)$$

The policymaker reacts to the demand shock by raising the interest rate mechanically by $1/a_1$. In the face of a cost-push shock, his response depends in addition on both the value of the policy parameter $\hat{\theta}$ and a. Notice that policymaking becomes inertial as the setting of the interest rate responds to the price level of the previous period.

After substituting the reaction function into the IS relation, we obtain the reduced form for the real output gap:

$$y_t = \frac{2p^*}{(2\hat{\theta} + a)} - \frac{E_t p_{t+1} + p_{t-1} + u_t}{(2\hat{\theta} + a)} \qquad (6)$$

Inserting the above equation into equation (2') yields the reduced form for the price level:

$$p_t = \frac{ap^*}{(2\hat{\theta} + a)} + \frac{\hat{\theta}(E_t p_{t+1} + p_{t-1} + u_t)}{(2\hat{\theta} + a)} \qquad (7)$$

Under discretion, the policymaker treats $E_t p_{t+1}$ as fixed in Equations (6) and (7). As a result, the variance of the price level and real output are equal to:

$$V(p_t^{PLT}) = \frac{\hat{\theta}^2}{(2\hat{\theta} + a)^2 - \hat{\theta}^2}\sigma_u^2 \qquad (8)$$

$$V(y_t^{PLT}) = \frac{1}{(2\hat{\theta} + a)^2 - \hat{\theta}^2}\sigma_u^2 \qquad (9)$$

The policymaker's optimization problem reduces to the following exercise:

$$\min_{\hat{\theta}} E[L_t] = V(y_t^{PLT}) + \hat{\mu} V(p_t^{PLT})$$
$$= \frac{(1+\hat{\mu}\hat{\theta}^2)}{(2\hat{\theta}+a)^2 - \hat{\theta}^2}\sigma_u^2 \qquad (10)$$

Differentiating the policymaker's loss function with respect to $\hat{\theta}$ yields the optimal value of the policy parameter:

$$\hat{\theta}^* = \frac{-(\hat{\mu}a^2 - 3) \pm \sqrt{(\hat{\mu}a^2 - 3)^2 + (4a)^2\hat{\mu}}}{4a\hat{\mu}} \qquad (11)$$

The optimal choice of the policy parameter $\hat{\theta}$ depends on $\hat{\mu}$, the policymaker's preference parameter and *a*, the structural parameter in the Phillips Curve equation.[19] According to the above expression for the optimal value of the policy parameter, there is a negative relationship between $\hat{\theta}$ and $\hat{\mu}$ for a given value of a.

Although the policymaker treats the expectation of the price level as constant when setting policy, the actual behavior of p_t and y_t is very much influenced by the way private agents form this expectation. Hence it is necessary to show how this expectation is formed.

Let a putative solution for the price level be given by:

$$p_t = \phi_{20} + \phi_{21}u_t + \phi_{22}p_{t-1} \qquad (12)$$

To obtain the current expectation of next period's price level, update Equation (12) by one period and take the conditional expectation:

$$E_t p_{t+1} = \phi_{20}(1+\phi_{22}) + \phi_{21}\phi_{22}u_t + \phi_{22}^2 p_{t-1} \qquad (13)$$

Substituting Equations (12) and (13) into Equation (7) and matching coefficients yields the solution for the price level:

$$p^{PLT}{}_t = \frac{2ap^*}{a + \sqrt{a(4\hat{\theta}+a)}} + \frac{2\hat{\theta}u_t + 2\hat{\theta}p_{t-1}}{2\hat{\theta} + a + \sqrt{a(4\hat{\theta}+a)}} \qquad (14)$$

Combining Equation (14) with the policy rule allows us to solve for the output gap:

$$y_t^{PLT} = \frac{\left(\sqrt{a(4\hat{\theta}+a)} - a\right)p^*}{\hat{\theta}\left(a + \sqrt{a(4\hat{\theta}+a)}\right)} - \frac{2(u_t + p_{t-1})}{2\hat{\theta} + a + \sqrt{a(4\hat{\theta}+a)}} \qquad (15)$$

[19] The positive square root is appropriate as it implies $\hat{\theta} \to \infty$ *as* $\mu \to 0$ and $\hat{\theta} \to 0$ *as* $\mu \to \infty$.

Finally, we calculate the variances of the two variables that the policymaker cares about. The variances of the price level and the output gap appear in Equations (16) and (17).

$$V(p^{PLT}{}_t) = \frac{4\hat{\theta}^2}{\left(a+\sqrt{a(4\hat{\theta}+a)}\right)\left(a+4\hat{\theta}+\sqrt{a(4\hat{\theta}+a)}\right)}\sigma_u^2 \qquad (16)$$

$$V(y_t^{PLT}) = \frac{4}{\left(a+\sqrt{a(4\hat{\theta}+a)}\right)\left(a+4\hat{\theta}+\sqrt{a(4\hat{\theta}+a)}\right)}\sigma_u^2 \qquad (17)$$

As a final step, we determine the rate of inflation and calculate its variance under flexible price-level targeting. Subtracting the lagged price level, p_{t-1} from both sides of Equation (14) and defining the rate of inflation as $\pi_t = p_t - p_{t-1}$ yields:

$$\pi_t^{PLT} = \frac{2ap^*}{a+\sqrt{a(4\hat{\theta}+a)}} + \frac{2\hat{\theta}}{2\hat{\theta}+a+\sqrt{a(4\hat{\theta}+a)}}u_t - \frac{(a+\sqrt{a(4\hat{\theta}+a)})}{2\hat{\theta}+a+\sqrt{a(4\hat{\theta}+a)}}p_{t-1} \qquad (18)$$

Taking the variance of the above expression yields:

$$V(\pi_t^{PLT}) = \frac{2(2\hat{\theta})^2}{\left(2\hat{\theta}+a+\sqrt{a(4\hat{\theta}+a)}\right)\left(a+4\hat{\theta}+\sqrt{a(4\hat{\theta}+a)}\right)}\sigma_u^2 \qquad (19)$$

To sum up, we have obtained three variances under flexible price-level targeting: the variance of the price level, the variance of the output gap and the variance of rate of inflation. They all depend on the variance of the cost-push shock σ_u^2, the structural parameter a in the Phillips Curve, and on the policy parameter $\hat{\theta}$, which in turn depends on the policymaker's preference parameter $\hat{\mu}$ and the structural parameter a.

4.2. Flexible Inflation Targeting

Under flexible inflation targeting, the policymaker is concerned with the variability of the rate of inflation and the variability of the output gap. The expected loss function now takes the following form:

$$E_t[L_t] = V(y_t) + \mu V(\pi_t) \qquad (20)$$

μ is the weight that the policymaker puts on the variance of rate of inflation relative to the variance of the output gap.

Optimal Policy under Discretion

The policy rule under inflation targeting is given by a linear relationship between the output gap and the rate of inflation:

$$\theta y_t + \pi_t = 0 \qquad (21)$$

The policymaker's objective is to determine the optimal value of θ that minimizes his loss function. To obtain the optimal θ, we begin by substituting the two equations from the forward-looking model into the above policy rule. Doing so allows us to back out the policymaker's reaction function:

$$r_t = \frac{1}{a_1}(E_t y_{t+1} + v_t) + \frac{1}{a_1(\theta + a)}(E_t \pi_{t+1} + u_t) \qquad (22)$$

Under inflation targeting, the policy instrument reacts to the demand-side shock in the same manner as under price-level targeting. However, the response to the cost-push shock is specific to the targeting strategy being followed. Notice the absence of any inertia in conducting policy under inflation targeting.

Next, we derive the reduced forms of the output gap and the rate of inflation. Substituting the reaction function back into the IS equation yields the reduced form equation for the output gap:

$$y_t = -\frac{1}{\theta + a}(E_t \pi_{t+1} + u_t) \qquad (23)$$

Combining Equation (23) with the policy rule (Equation (21)) determines the reduced form for the rate of inflation:

$$\pi_t = \frac{\theta}{\theta + a}(E_t \pi_{t+1} + u_t) \qquad (24)$$

As the policymaker uses discretion in forming policy, he treats the expectation of the rate of inflation as a constant.[20] The variance of the output gap and the rate of inflation that enter his objective function are therefore:

[20] Notice that the expectation of inflation equals zero due to the assumption of white noise disturbances. The assumption of white noise disturbances simplifies the analysis. Serially correlated disturbances

$$V(y_t^{IT}) = \left(\frac{1}{\theta + a}\right)^2 \sigma_u^2 \tag{25}$$

$$V(\pi_t^{IT}) = \left(\frac{\theta}{\theta + a}\right)^2 \sigma_u^2 \tag{26}$$

Under inflation targeting the policymaker's problem then reduces to the following minimization exercise:

$$\begin{aligned} \min_{\theta} E[L_t] &= V(y_t^{IT}) + \mu V(\pi_t^{IT}) \\ &= \frac{1}{(\theta + a)^2}[1 + \theta^2 \mu]\sigma_u^2 \end{aligned} \tag{27}$$

Solving the minimization problem yields the optimal value of θ^*:

$$\theta^* = \frac{1}{\mu a} \tag{28}$$

Similar to price-level targeting, under inflation targeting the optimal value of the policy parameter depends inversely on the policymaker's preference parameter and the structural parameter in the Phillips Curve equation.

5. Price-Level vs Inflation Targeting: A Comparison of the Trade-off between the Variance of the Rate of Inflation and the Variance of the Output Gap

Figure *1* shows the trade-off between the variance of the rate of inflation and the variance of the output gap for both targeting strategies. It is apparent that the policymaker achieves a better tradeoff between the variance of inflation and the output gap if he stabilizes the price level instead of the rate of inflation. The superior performance of a price-level target is directly linked to the way it affects the current expectation of inflation next period. Consider a positive cost-push shock whose effect is felt only in the current period. Under inflation targeting, the current expectation of inflation next period remains unaffected. In sharp contrast under price-level targeting, the one-time shock causes the current price level to exceed its target level. Anticipating the central bank to tighten monetary policy to bring the current price level in line with the target, agents reduce their current expectation of next period's

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would cause the expectation to be non-zero but would not overturn the results reported in the next section.

price level, which is tantamount to a fall in inflationary expectations. The rise in the setting of the policy instrument affects the current price level which in turn affects the current expectation of next period's price level, thus creating the link between monetary policy and inflationary expectations under price-level targeting.

6. Conclusion

This paper has attempted to shed some light on the experiences of the two countries that pioneered price-level and inflation targeting. Our review of the circumstances and conditions that gave rise to price-level targeting in Sweden suggests that the deteriorating state of the economy was a catalyst for the adoption of price-level targeting in Sweden in 1931. Swedish academic economists were instrumental in the sudden move towards price-level targeting. The grim economic picture of the mid-1980s in New Zealand prompted policymakers to go beyond changing merely the strategy for monetary policy. A package of sweeping reforms was initiated to restructure the ailing economy. The inflation-targeting strategy of the Reserve Bank developed gradually alongside the transformation process that redefined the mandate of the central bank of New Zealand. Academic economists played no major part in the adoption of inflation targeting in New Zealand.

The paper also analyzes the monetary policy frameworks within which the two central banks sought to achieve price stability. The unique and novel characteristic of New Zealand's monetary policy framework is accountability in the form of a performance contract and the obligation to issue periodic monetary policy statements.

In the latter part of the paper we show that in the forward-looking model, price level targeting achieves a better output-inflation tradeoff than inflation targeting. The theoretical analysis reveals that price-level targeting introduces a dynamic element into the formation of expectations. The current price level affects the current expectation of the price level next period. Current policy action in response to a cost-push shock affects the current price level. Given the link between the current price level and the current expectation of next period's price level, a change in the policy setting affects the current expectation of the price level next period. The existence of this mechanism ensures that inflationary expectations can be reined in by current policy action in response to a cost-push shock. No such mechanism exists under inflation targeting.

Forward-looking behavior is central to the New Keynesian framework. It remains to be seen whether the hypothesized forward-looking behavior characterizes the actual behavior of consumers and price-setters in the real world. So far, the empirical evidence on this issue has been mixed (Fuhrer (1997), Gali and Gertler (1999), Roberts (2001), to name but a few). Further empirical work needs to be done to assess the extent to which people's decisions today are influenced by what they expect to happen in the future. In addition, it is necessary to establish whether forward-looking behavior is more important than backward-looking behavior.[21] If substantial evidence for forward-looking behavior is brought to light, then price-level targeting is a viable alternative to inflation targeting.

[21] Walsh (2003) reports that price-level targeting is less attractive if the lagged rate of inflation is more important than the forward-looking expectation in a more general specification of the Phillips Curve that allows for persistence.

Appendix:

This appendix provides a detailed discussion of the policy problem under discretionary price-level targeting. We can think of three ways in which the analytics of price-level targeting can be carried out. The three different approaches are labeled *Standard Approach*, *Intertemporal Approach A*, and *Intertemporal Approach B*, respectively.

Standard Approach: this approach employs a simple linear policy rule and treats the expectation proper as constant. The loss function consists of the unconditional variances of the target variables. Scaling the intertemporal loss function by $1-\beta$ and taking the limit as $\beta \to 1$ yields the loss function employed in the paper.

Intertemporal Approach A: optimization routine that treats the expectation proper as fixed.

Intertemporal Approach B: optimization routine that treats the process of expectations as given.

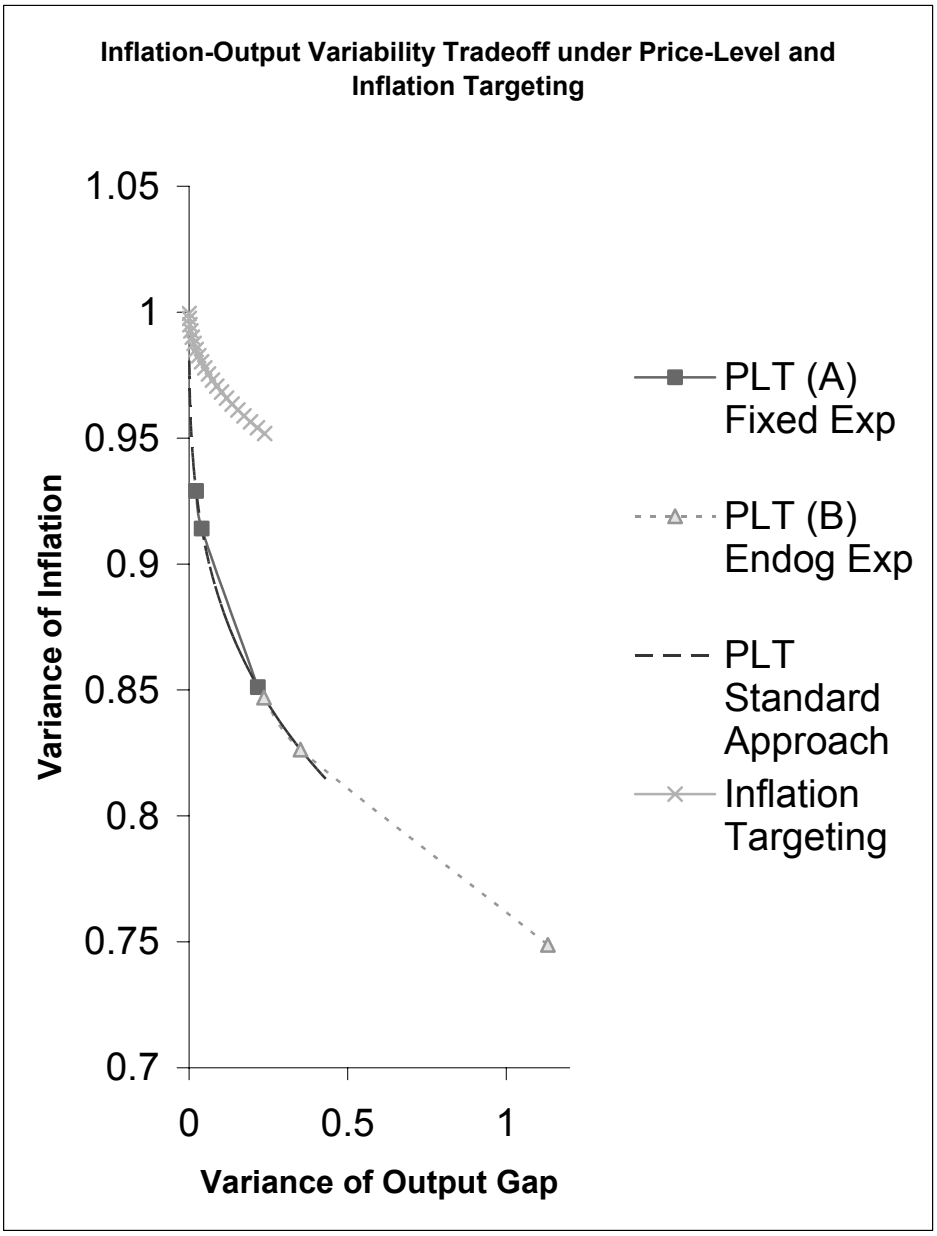
The results for the three different approaches appear in Table A1 and Figure A1. Table A1 specifies the optimization problem under discretionary price-level targeting, presents the policy rule for the standard case, and shows the first order conditions for the two intertemporal cases. It also reports the variances of the endogenous variables and the score of the loss function.

It is instructive to note that the output-inflation variability tradeoffs under the three different approaches to modeling price-level targeting are very similar, especially the ones characterizing the *Standard Approach* and the *Intertemporal Approach A* both of which treat expectations as constant. All three versions of modeling discretionary price-level targeting produce better output-inflation tradeoffs than inflation targeting. This is evident from Figure A1.

Table A1: Comparison of Approaches: $\sigma_u^2 = 0.00001$. All loss functions have been scaled by a factor of 100,000.

	Standard Approach(Paper)				*Intertemporal Approach A*				*Intertemporal Approach B*			
Treatment of Expectations When Policy is Being Set	$E_t p_{t+1} = \text{fixed}$				$E_t p_{t+1} = \text{fixed}$				$E_t p_{t+1} = \phi_{22} p_t$			
Policy Objective	$\underset{\theta}{Min}\, E[L_t] = V(y_t) + \hat{\mu} V(p_t)$				$\underset{y_t, p_t}{Min}\, E_t \sum_{j=0}^{\infty} \beta^j (y_{t+j}^2 + \hat{\mu}(p_{t+j} - p^*)^2)$ $s.t.\, p_t = \frac{1}{1+\beta}(E_t p_{t+1} + a y_t + u_t + p_{t-1})$				$\underset{y_t, p_t}{Min}\, E_t \sum_{j=0}^{\infty} \beta^j (y_{t+j}^2 + \hat{\mu}(p_{t+j} - p^*)^2)$ $s.t.\, p_t = \frac{1}{1+\beta}(E_t p_{t+1} + a y_t + u_t + p_{t-1})$			
Policy Rule (First-order conditions)	$\hat{\theta} y_t + p_t - p^* = 0$				*For* $\beta = 1$: $p_t - p^* + \frac{2y_t}{\hat{\mu}a} - \frac{E_t y_{t+1}}{\hat{\mu}a} = 0$				*For* $\beta = 1$: $p_t - p^* + \frac{(2 - \phi_{22}) y_t}{\hat{\mu}a} - \frac{E_t y_{t+1}}{\hat{\mu}a} = 0$			
	$V(p_t)$	$V(y_t)$	$V(\pi_t)$	$E[L_t]$	$V(p_t)$	$V(y_t)$	$V(\pi_t)$	$E[L_t]$	$V(p_t)$	$V(y_t)$	$V(\pi_t)$	$E[L_t]$
$a = 0.05, \hat{\mu} = 1$	11.7568	0.0130	0.9404	11.76	9.7446	0.0222	0.9290	9.76	4.0776	0.2362	0.8470	4.31
$a = 0.05, \hat{\mu} = 1.5$	9.5114	0.0237	0.9274	14.29	7.9087	0.0397	0.9141	11.90	3.4940	0.3513	0.8263	5.59
$a = 0.05, \hat{\mu} = 5$	4.998	0.1384	0.8712	25.12	4.2125	0.2171	0.8511	21.28	2.1653	1.1316	0.7488	11.95

Figure A1: Comparing the Output-Inflation Tradeoffs:



Note: $\sigma_u^2 = 0.00001$. All loss functions have been multiplied by 100,000.

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Table 2:

	Sweden (Price Level Targeting)	**New Zealand (Inflation Targeting)**
Introduction/Adoption	Immediately following suspension of Gold Standard (September 27, 1931). One sentence declaration.	Reserve Bank (RB) Act passed by Parliament in 1989; took effect on February 1st, 1990.
Reason for Adoption	Deflation.	Inflation. Integral part of reform process.
Evolution of Policy Framework	5 point Monetary Programme passed by Riksdag(Parliament) in May 1932 Minor amendment in June 1933.	RB Act formalized conduct of monetary policy as practised since 1985.
Legal Framework	No change in Charter of Riksbank preceding or following switch of monetary regime.	RB Act marks comprehensive overhaul of Reserve Bank's modus operandi.
Relevant Price Index/Indices	Weekly Consumer Price Index *and* other price indices such as wholesale prices and prices of raw materials.	Consumer prices and other relevant price indices.
Most Important Operational Target at Time of Adoption	Average level of consumer goods prices as of September 1931.	0-2 % growth in adjusted quarterly CPI.
Caveats	Indirect taxes and seasonal factors.	Indirect taxes, terms of trade, natural disasters.
Temporary vs Permanent Strategy?	Clearly temporary as eventual return to gold standard was envisaged.	Clearly permanent.
Policy Instrument	Discount rate; operations in foreign exchange market; explicit announcements.	Settlement Cash Balances target; no foreign exchange market intervention; explicit announcements.[22]
Role of Exchange Rate	Successful peg of Krona to Pound	Free float; important indicator variable

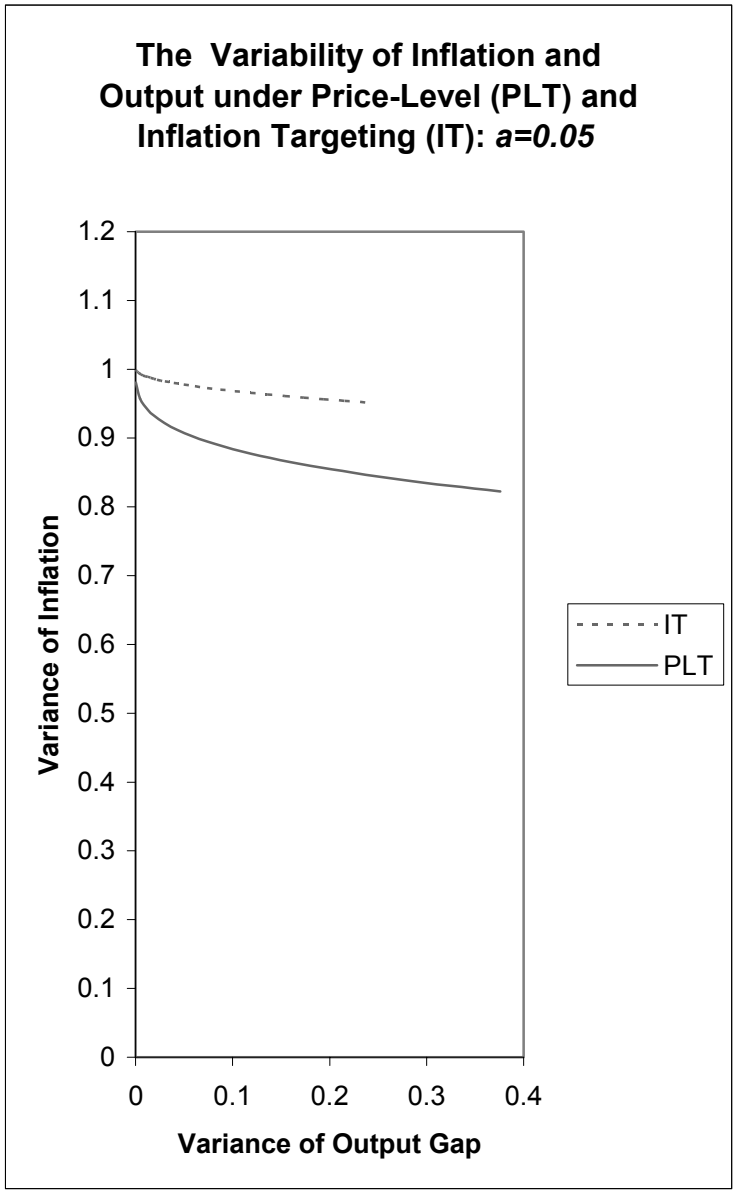
[22] In March 1999 the operating procedure of the Reserve Bank of New Zealand changed markedly. Since then the overnight cash rate has served as the instrument of monetary policy.

	from July 1933 to start of WWII.	
Role of Monetary Aggregates	No explicit mentioning in Monetary Programme.	No important role.[23]
Role of Forecasts	No mentioning at all, possibly due to lack of expertise.	Instrumental in setting current monetary policy stance.
Goal Independence	No; goals were set by Ridsdag.	No; goals have been defined by government and are mentioned in the Policy Target Agreement.
Instrument Independence	Yes.	Yes.
Accountability	No specific mentioning of sanctions in case policy goal was missed.	Yes. Governor subject to dismissal in case of unsatisfactory performance. Monetary Policy statements.
Review of Bank's Performance	Official evaluations in 1933 and 1937 by Minister of Finance. Ohlin Report of 1933.	Official review by Svensson (2001). Regular hearings before Parliamentary committee.
Slow Reinterpretation of Mandate over Time?	Yes. Initially Stable price level was the only policy objective (apart from keeping interest rates low). By 1937 price level stability was the primary goal of monetary policy with stable economy and full employment having become additional goals.	Yes. Most notable changes have occurred in the wording of the Policy Target Agreements (PTA) and the definition of the band width of the inflation target. PTA of 1989 mentions price stability as the sole goal monetary policy. PTA of 1999 defines goal of monetary policy as price stability without incurring unnecessary instability in output, interest rates, and exchange rates. PTA of 2002 mentions

[23] A very narrow monetary aggregate, Primary Liquidity, consisting of Cash Settlement Balances and discountable Reserve Bank bills, had a role to play in the initial stages of the new monetary policy framework. Over time its importance waned considerably as the Reserve Bank relied more on "Open-Mouth Operations" to announce policy changes to the financial market. Conventional aggregates such as M1 or M2 or credit aggregates were deemed all but irrelevant in the conduct of monetary policy.

		economic goals of government: full employment, higher and more equitable distribution of incomes. Since 1999 a target range for inflation of 1 to 3 percent has been in effect. The midpoint of the inflation band serves as the target for inflation over the business cycle.

Figure 1: The Tradeoffs under the Two Regimes.



Notes:

a. The values of the structural parameter, a and the variance of the cost-push shock, σ_u^2 are essentially the same as those reported by McCallum and Nelson (2004) and Walsh (2003): $a = 0.05$ and $\sigma_u^2 = 0.00001$. The loss functions are multiplied by 100,000.

b. In constructing the tradeoff between output gap and inflation variability, we allow both μ and $\hat{\mu}$ to vary from *0.1 to 10*.