

ANALYSIS OF THE POSSIBILITY OF PRICE LEVEL TARGETING IN INDONESIA TO ACHIEVE PRICE STABILITY: AN ALTERNATIVE TO INFLATION TARGETING

Oleh:

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Abstract

Price stability is one of the important macroeconomic policy goals. In recent years, price stability has become an important issue for society, especially since oil and global food prices increase continually. This phenomenon motivates this study to know, whether Inflation Targeting (IT) or Price Level Targeting that more appropriate to apply in Indonesia's monetary framework.

IT is ignoring the deviation from past target. The average inflation rate will be convergent to the long term target. Other alternative that has been studied scientifically is price level targeting (PLT). PLT is a policy that has the effect of systematically responding to deviations of the price level from the price level target to preclude long term price level drift.

This study will discuss possibility to apply PLT over IT in Indonesia from welfare gain side. The result from theoretical modeling, generally indicate that PLT is better to apply than IT. But empirical result using Dittmar, Gavin, and Kydland model (1999) shows that IT is better than PLT for Indonesia. It can be seen from rejection of the persistence of the output gap hypothesis in Indonesia during period of study (1983-2008). The result with secondary data also shows that IT has been quite successfully applied consistently. It can be seen by stationary inflation during period of study.

Keywords : Inflation Targeting, Price Level Targeting, Price Stability

1. Introduction

More inflation target used by countries to define the monetary policy framework. With the enactment of Law's new Central Bank No. 23 of 1993

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concerning Bank Indonesia on May 17, 1999, Bank Indonesia got its independence as the Central Bank in setting targets to be achieved (goal independence) and the use of instruments of monetary policy (instrument independence). Under article 10 of that law, Bank Indonesia set an inflation target to be achieved as the basis for planning and control of monetary targets.

The application for the single objective of price stability is based on the relevance of goals and objectives of monetary policy. In the long run, the policy conducted by the Central Bank through the demand side can only affect the nominal value, while real economic activity is determined in the real sector. But according to Phillips curve analysis, suggested the existence of a trade-off between inflation with economic growth. But it only happens in the short term. In the long term, the objective of price stability supports the achievement of sustainable economic growth. Within the framework of aggregate supply and demand, macroeconomic policies can increase the short-term aggregate demand. With certain potential output, achievement of targets of high economic growth will be financed by the high rate of inflation, which is usually controlled by a tight monetary policy or stabilization program.

Based on this, the idea to make inflation targeting monetary policy becomes very relevant. Currently countries using low inflation rate and stable (inflation targeting). With the appropriate inflation target, monetary policy can be directed to influence aggregate demand in line with the economic capacity of the supply side. Therefore has encouraged the Central Bank to select a single target of inflation as the target of monetary policy.

But the conditions that occurred in the past year started to show that the inflation target does not guarantee a stable price level. With energy prices pressure conditions and global food prices are more issues about the effectiveness of price stability and inflation targets has become more prominent and becomes increasingly important to discuss both in academic and also in the policy making level.

There is agreement that the primary goal of monetary policy should be price stability. There is debate about the form of price stability itself, whether it's better to target inflation (IT), namely the stability of price changes or the price level (PLT), which is stabilizing the price level. The problems that arise in this study is whether target policy is better implemented in current condition of Indonesia : inflation targeting or price-level targeting.

Topic of debate between the PLT and IT was put forward due to several reasons identified occurred on the inflation targeting regime. First, inflation target is set based on the inflation forecast in the future. Monetary policy is determined based on future inflation expectations and inflation expectations which also influenced by monetary policy. So monetary policy which oriented to the future, it will cause potential problems due to the extra uncertainty and volatility in the economy. Second, there is a new view among scientists that by incorporating elements of inflation expectations as a automatic stabilizer, a trade-off between the certainty of the price level with the volatility of inflation and output gap does not occur. Targeting the price level causes small fluctuations in the price, both in the short or long term. Because the price-level targeting, the perpetrator always

hoping the price will return to the original level so reluctant to change the price they set as a result of shock. PLT is believed to achieve both, namely the certainty of the price level and also reduced the volatility of inflation and output. By borrowing the term from Svensson (1996), "there is free lunch with the implementation of PLT".

According to the conventional view, the target price level led to many fluctuations in output and prices in the short term, because it requires that the target price back to the original level after the shock. Meanwhile, the inflation target is considered cause some movement in the short term, because the price shifting accommodate unanticipated and only expects that the inflation rate back to the initial level. But the price is uncertain in the long term. In the past, the choice between price-level targeting and inflation targeting is a choice between the price predictable in the long term or short-term stability" (Gabriel Srouf, 2001:1-2).

Based on the above descriptions, the research problem that the main focus in this study are : which policy targets are better implemented in Indonesia : inflation targeting or price-level targeting which appropriate with current conditions in Indonesia; whether inflation targeting that already implemented by the Central Bank has been effective to achieve price stability and well-being of society; evaluate the possibility of applying price-level targeting in Indonesia; and resistance or loss if the price-level targeting is applied in Indonesia.

2. Literature Review

2.1. Introduction of Price Level Targeting

The main difference between inflation targeting and price level targeting is in inflation targeting, effect that has passed will be allowed to pass, while the price-level targeting efforts to improve the failures of the past. This means that long-term price levels (and therefore long-term inflation rate) is more certain with the price-level targeting than inflation targeting. Because the price-level target effectively is always updated each year, while the inflation targeting, price level varies randomly and after a few years the difference becomes significant. Next, what is the different between the price-level targeting and inflation targeting in terms of short-term inflation shocks and output shocks?

2.1.1. Short Run Inflation Shocks

In the price-level targeting, the inflation rate from year to year may be more distinct than with inflation targeting (in the short-term price fluctuations may be higher) because of the increased prices are not expected to be followed by efforts to reduce the price level. Thus, when inflation-targeting authority to reduce inflation back to target, this will change the rate of inflation as the output gap.

Price-level authorities are also targeting the price level will decrease as the proportion of the output gap. But because inflation changes the price level, then the price-level targeting the inflation rate will move proportional to the change in the output gap, rather than the size of the

output gap. Thus, if there is a nominal rigidity, then the output shock will remain moderately, the turmoil short-term inflation rate will be lower with the price level targeting than with inflation targeting.

2.1.2. Output Shocks

Output may be more volatile with the price-level targeting. For example, an earthquake happens, before you can import it will happen goods increase due to a scarcity of goods. Price-level targeting monetary authorities would push to restore prices to the starting position, although the higher prices represent a new equilibrium, so the real charge in the economy. Of course, with the inflation targeting monetary authority tried to block the transfer of the new balance and lead to real cost. The difference is that once a new equilibrium is reached, authorities will stop the inflation targeting resistance (because prices are no longer up), while the authority of price-level targeting would try to lower the price again.

2.2. Benefit from Apply Price Level Targeting

2.2.1. Long Run Price Stability

Higher inflation causes investment projects can not walk, although expected to benefit if we are certain of inflation. This makes the decline in economic growth, and making people poorer. Price-level targeting offers the confidence of long-term rates greater than inflation targeting so that the price-level targeting offers greater prospects for economic growth and prosperity.

2.2.2. Price-level Targeting is Self Regulating

What is interesting from the price-level targeting is to be self-regulating. By giving him credibility, price-level targeting will tend to stabilize itself without much intervention.

2.2.3. Price Level Targeting creates It's Own Credibility

Classic problem in monetary policy is time-inconsistency. Because in the short run, unemployment can be reduced and output increased by creating surprise inflation, monetary authorities are seeking the maximum welfare of the community will have a permanent incentive to create inflation surprises. So in this case increased inflationary expectations. Even if the monetary authority does not intend to create inflation, expected inflation will be higher because the risk may occur. This causes an inflationary bias into the system.

To be noted, the price-level targeting is reduce or even remove the incentive to create inflation surprises. Reduction/ increase in the price trend will lead to lower costs that can hamper development, means that today's inflation surprise loss of output will be followed the next day. So

the price-level targeting, monetary authorities will have greater credibility if the claim does not want to create inflation surprises. Another case with which to form the inflation targeting inflation surprises to enhance credibility, but this will lead to real cost so that it gains credibility not for price-level targeting.

2.2.4. Price-level Targeting Provide a Way Out from Low Employment

Assume there is depression due to the economic shock. Since the beginning inflation targeting will try to deal with preventing falling prices. But this failed and the price drops. If the economy is characterized by nominal rigidity, the output will not improve quickly and unemployment will not fall again. The economy was trapped for a long time (low equilibrium trap).

If this occurs, then inflation targeting will not help. Fiscal action may be taken, but it may encourage increased prices. So, fiscal and monetary authorities will face tradeoffs. Now what might happen is to change the inflation targeting monetary authority to price-level targeting. So that would be a target inflation rate but not the price level. If the price level are explicitly targeted the initial actions can be taken to help improve the price and work with than to deal with fiscal measures/contradictory.

2.3. Welfare Benefits from Reduced Uncertainty of Long Run Price Volatility

By theory, PLT will benefit in terms of:

2.3.1. Inter-temporal Decision Making

Konieczny (1994, 2001): "Constant price level which makes the nominal value becomes real value that reduces the cost of calculation (menu cost), reducing the risk of miscalculation estimated expenses, and improve the role of prices in the allocation of resources".

2.3.2. Long-run Nominal Contracts (Nominal Long-run Contract)

The absence of nominal debt contracts are indexed perfectly (with a change in price), the risk premium of long-term debt contracts will be higher than short-term debt contracts. With the PLT, risk premium of long-term debt contracts will decrease and make it more attractive for borrowers. On the other hand, inflation will also cause a decrease in the real value of nominal assets and liabilities, which would redistribute wealth. Although in theory the level of policy regimes that reduce the uncertainty level of prices in the long run is welfare enhancing, very little research that evaluates the amount of potential profit.

2.4. Characteristic of Short Run Stability with Standard Loss Function

In this section, it will discuss the latest results from the literature obtained under the assumption of no price variability incorporation into the social loss function.

2.4.1. Conventional Wisdom

As stated by Svensson (1999:278), "year on year inflation will be more volatile than in PLT in IT (short-term price variability will be greater in comparison to PLT in IT) due to an increase in the price level will suddenly be followed up with the price reduction efforts by central banks". Thus, after the rise of a sudden, inflation does not return to normal levels, but will change in the opposite direction from the direction of the previous inflation. With nominal rigidities (price is sticky in the short run), a more volatile inflation will lead to a more volatile output too.

Conventional wisdom does not take into account the possibility that the inflation formation process will change because of changes in monetary policy. When people have to understand the regime PLT, their behavior will change. With the PLT, the response of inflation expectations price shock would be smaller, which in turn will reduce inflation shocks. However, the turmoil will continue to increase output because of the policy response to supply shocks. In relative terms, compared with PLT performance, IT depends on several assumptions, such as whether the formation of expectations are forward looking and whether the central bank is credible. Performance of IT and PLT also differ depending on whether the central bank is assumed to be committed to a policy or operate with discretion.

2.4.2. Free Lunch under Discretion

Svensson shows that if the chosen endogenous rules without commitment, PLT can produce price levels and variability of inflation lower than in IT and provide the same output variability with IT. Therefore, there is free lunch. Svensson, MSG (2006), Nessen and MSG (2005), Yetman (2005) show that PLT can outperform the discretion if the IT expectations oriented enough to the front (forward looking), or if it has been determined expectations first but there are endogenous output persistence.

2.4.3. Results Under Commitment

Ranking of alternative policy regime also depends on the commitment expectations behavior. Based on the writings Barnett and Engineer (2001); Ball, Mankiw, and Reis (2005); and Cover and Pecorino (2005), by providing a strong nominal anchor for expectation, PLT can

surpass IT in the forward looking models under commitment. If the price expectations not clear, pure PLT is optimal.

2.4.4. Hybrid Regimes

The literature reviewed in the previous section shows that although the society's loss function does not include the stabilization of the price level, is still optimal to choose PLT than IT in a particular model specification. Of course, the PLT will be much stronger argument if the people put weight on the price level uncertainty. Several recent studies concluded that if the social loss function includes the variance of the price level in addition to inflation and output, the optimal policy is a hybrid targeting regime. Hybrid targeting is a policy where part of the price shock will be reversed, but not completely as in a strict PLT. How large a proportion of the price shock will be reversed depending of some basic parameters of the model, such as the persistence of output level or how much expectations oriented forward (forward looking). Hybrid targeting could also be a statement about optimal period to bring the price level back to the desired lane. If the price level variability included in the loss function and no clear expectations (mixed), then the optimal policy is located between IT and PLT.

2.4.5. Deflation Risk and Zero-Bound Problem

One of the strong argument against PLT articulated by Fischer (1994) is, "if there is a significant overshoot in the price level, to return to the target will require a period of deflation that will lead to financial instability and would harm the economy". Ragan (2006) argued that "prolonged deflation that would threaten the financial system will not occur in a credible PLT". Duguay (1994) argued that "the excess of PLT is that it can cause a stabilizing effect on aggregate demand, by raising real interest rates when the rates move above the target price and lowered it when the price level fell below the target". Thus, real interest rates can fall below zero when the economy has reached the zero lower bound.

However, in recent years, the argument which states that PLT can avoid the zero-bound problem and brought the economy to move away from deflation has been reaping a lot of approval. Coulombe (1998) stated that "a credible PLT can help overcome the problem of the zero bound for PLT reduce the need to alter the nominal interest rate". Berg and Jonung (1999:548) states that "an important lesson from the experience of Sweden in the past was the target of price stability can be used to improve expectations fears of inflation when there is a widespread deflation". Miskhin (2006:211) states that "the target price level, which motivates expansionary monetary policy, should be viewed as a complement to restructure rather than obstacles". Recent evidence suggests that PLT can help avoid the zero bound problem.

2.5. Theoretical Model of Price Level Targeting for Closed Economy

Opinion that the price-level targeting has a comparative advantage becomes evident when the economy is divided into two periods. The price is subject to a shock in period 1 and influenced price expectations in the period 2, so here is used horizontal model of closed economy for two periods. We will lower the first best policies and compare them with price-level targeting and inflation targeting. Because of the expectations, price-level targeting could not only affect the price but also other variables.

2.5.1 Basic Model : Two Period Model

Suppose the prices in the economy regulated by standard Phillips curve:

$$\pi_t = \beta \pi_{t+1|t} + BZ_{t|t-1} + \varepsilon_t \quad (1)$$

where β is discount rate, π_t inflation rate, Z_t vector variable, and ε_t white-noise shock which observed after monetary action at time t implemented. Z_t is anticipated term and ε_t is unanticipated term. The value of $BZ_{t|t-1}$ controlled by central bank and assumed determined by expected value of $i_{t|t-1}$, which is a monetary instrument at time t . Those variables have lag in response to an unanticipated shock. The crucial element in this model is forward looking expectations, $\pi_{t+1|t}$. This shows the fact that change in expectation affect current pricing.

For simplicity, in this model is assumed there are only two periods. At $t=0$, assumed in steady state condition, where $BZ_{t|t-1}$ and it's expectation value equal to zero. At $t=3$, is assumed economy back to steady state condition. Consistent with the specifications of the horizon of two periods, social welfare function of economy is :

$$-L_t = -E_t \left[\pi_t^2 + \lambda y_t^2 + \beta \pi_{t+1}^2 + \lambda y_{t+1}^2 \right] \quad (2)$$

where y_t is output gap, and λ is weight for output variability $0 \leq \lambda \leq 1$. Base on this function, only inflation and output variability which determines the economy, while the price variability is not. In this model, is assumed inflation target equal to zero.

2.5.2. Terminology

Policies that maximize the welfare function at time 1, when the central bank could make early commitments about future actions is called first-best policy. In general, this policy is not consistent with the time.

Time-consistent policy is called the inflation targeting policy. Inflation targeting is a policy that applies when policy makers try to maximize the welfare function (2) each period.

Time-consistent policy in every period maximize :

$$-E_t \left[p_t^2 + \lambda y_t^2 + \beta p_{t+1}^2 + \lambda y_{t+1}^2 \right] \quad (3)$$

where p_t is price level, which called as price level targeting.

Part (c) will show that the first-best policy close to the price-level targeting, and central banks can apply price-level targeting as a proxy for the first-best policy. The question is could the central bank implement first-best policy?. The problem is the monetary authorities are not able to make early commitments needed to achieve first-best policy, because they have an incentive to maximize the welfare function of each commitment period, it ignored past commitment. So price-level targeting is implemented. These reap two criticisms. First, whether the central bank will not commit to the long commitment, because it will decrease the welfare of (McCallum 1997). Second, if the central bank can not make a credible commitment, then he could not commit to price-level targeting.

Alternative answer lies in the importance of communication and transparency in public policy should also be time-consistency in public policy, meaning that the implementation of policies and targets can be explained clearly and simply to the public every time. Time-inconsistency can make an unworkable policy that monetary authorities need to explain what will be done in the future based on their past habits. Thus, price-level targeting, the time-consistent (relative to the objective function (3)), can be a practical way to implement first-best policy, the time-inconsistent.

2.5.3. Basic Argument

Social welfare function in equation (2) show that the smaller the inflation and output deviations from equilibrium during the period 1 and 2, the greater the social welfare. Base on Philips Curve in equation 1, π_1 as resulted from a combination of contemporaneous shock ε_t and inflation expectation in period 2, π_{2t} . Inflation in period 1 will react less to shock ε_t , and welfare will increase if price is expected return to initial level in coming period.

The argument that price level targeting is the first best policy would be more convincing if price stability is the only consideration (it means $\lambda = 0$). We consider the case where the output variability doesn't affect the economic welfare (it means $\lambda = 0$) and social loss function form:

$$L_t = E_t \left[\pi_t^2 + \beta \pi_{t+1}^2 \right] \quad (4)$$

Discount rate β is eliminated each other in two period model. Here β assumed equal to unity. Because the economy in steady state conditions in the period 0 and 3, so BZ_{10} and $\pi_{21} = 0$ and ε_2 equal to zero, because shock only in the period 1. Base on Philips curve in equation (1), so :

$$\pi_1 = \pi_{2|1} + \varepsilon_1 \quad (5)$$

$$\pi_2 = BZ_{2|1} \quad (6)$$

The first-best policy

Because it depends one for one, so social cost in period 1, $L_1 = E_1 \left[\pi_1^2 + \beta \pi_2^2 \right]$ is minimize when inflation have same smooth in the two periods:

$$\pi_{2|1}^2 = \pi_1^2 \quad (7)$$

Which can be expressed as :

$$\pi_{2|1} = -\pi_1 \quad (8)$$

Then we will obtain :

$$\pi_1 = \frac{1}{2} \varepsilon_1 \quad (9)$$

By first-best policy, only a half of shocks assimilated into the price in period 1, although at the cost due to price changes of the same magnitude, but marked contrast in period 2. So overall loss in period 1 is:

$$L_1 = \frac{1}{2} \sigma_\varepsilon^2 \quad (10)$$

Where σ_ε is standard deviation of random shock ε

Inflation Targeting

Conversely, with inflation targeting, price is not expected to fall in period 2, because the public is rational to expect the authority to target the inflation rate was zero. In this case, the full shock assimilated into the price in period 1 and the total losses at time 1 are two times greater than in the first-best policy:

$$\pi_{2|1} = 0 \quad (11)$$

$$\pi_1 = \varepsilon_1 \quad (12)$$

So the overall loss in period 1 is two times greater than the first-best policy.

$$L_1 = \sigma_\varepsilon^2 \quad (13)$$

Price-level Targeting

The first-best outcome also applies if the authorities believed to target the price level than the inflation rate that is if they believe it to maximize equation (3) than (2) (where $\lambda = 0$). With this policy, the goal at period 2 appropriately inhibiting the shock of inflation at period 1, to bring the price level back to the initial level.
Conclusion :

In the model of two periods, if the variability of output is not a consideration in the welfare, the first-best policy is in accordance with the price-level targeting. In this case, the magnitude of welfare loss is smaller for price-level targeting than with inflation targeting :

$$\text{Inflation targeting} : L_1 = \sigma_\varepsilon^2 \quad (13)$$

$$\text{Price-Level targeting} : L_1 = \frac{1}{2} \sigma_\varepsilon^2 \quad (10)$$

2.5.4. Output Variability

Certainly the return of prices to the starting position after the shock requires a larger deviation in real interest rates and thus to the output. Supposes that:

$$BZ = by_t + CX_t \quad (15)$$

Under plausible specifications, price-level targeting is likely to generate higher variability in output than inflation targeting, with the assumption of equal weights assigned to the two regimes.

Variability of output when considered in the well-being (welfare) (which means $\lambda \neq 0$), then there must be a comparison of marginal benefits from the movement of prices returning to the starting position of the marginal cost of output variation is greater.

Rule: Comparing the Marginal Benefit from Price's return to the first position with the Marginal Cost of Output Variation

2.6. Swedia's Experience in Applying Price Level Targeting

The only country in the world has ever applied regime Price Level Targeting (PLT) is Sweden in September 1931 when the country finally decided to not adopt the gold standard and therefore requires a policy framework until the period of instability as a result of the collapse of the gold standard regime elapsed. Below it will be presented briefly the international monetary system as the gold standard at the time operated until the fall of the system. Then, an explanation will go to Sweden to implement the policy PLT in the transition from the gold standard.

2.6.1. International Macroeconomic Policy in Gold Standard Regime and Gold Exchange Standard

In the gold standard, each state determines the gold content of its currency and passively always ready to buy and sell gold at predetermined prices. The main task of the central bank is to maintain the exchange rate between its currency with gold. Gold prices in domestic currency are determined and then the price is kept. With a commitment to keep the gold price, the central bank ready to meet any market demand and supply will be gold at a predetermined price. The gold standard regime is a system that goes well with the possibility of rapid adjustment in the event an imbalance in the balance of payments through the price-specie-flow mechanism. Adjustment mechanism so that the gold standard goes well, the central bank is expected to coordinate policies that follow 'rules of The Game'. Thus the rules of The Game will strengthen the price-specie-flow mechanism to encourage all countries in balance of payments equilibrium.

Unfortunately, the rules of The Game is broken in about the year 1914. Incentive to follow the rules of the game strong on the state deficit and weak at the state surplus that the deficit countries is bear the burden to restore the balance of payments balance of all countries. State deficits are also sometimes reluctant to lower prices by increasing domestic interest rates because it is an impact on unemployment and declining output. On the other hand, countries that experienced a surplus is also not always make an effort to reduce the inflow of gold. In addition, countries are also common sterilization policy. Countries that perform sterilization policies decided the direct influence of the balance of payments condition for the circulation of domestic currency by selling/buying domestic assets.

In 1922, at a meeting in Genoa, Italy reached an agreement to return to the gold standard and improve coordination among central banks to achieve internal and external balance. Realizing that the availability of gold are not sufficient to meet the demand for central banks around the world for foreign exchange reserves, the conference agreed Genoa Gold Exchange Standard system to save the gold which the major nations save the entire foreign exchange reserves in gold and the small countries of reserves major foreign currencies and gold itself. Country at that time used Britain pound sterling as common currency in their international reserves.

In 1925, Britain adopted a policy to link the pound to gold at the price level before the war the world. To achieve this goal, deflation should be done by way of exporting (reduce) the gold owned by Britain (to implement a tight monetary policy), which became one of the reasons increasing the number of unemployed in Britain. Stagnation in Britain have raised doubts about Britain's ability to always be ready to defend the fixed conversion rates between the pound to gold because of Britain's gold reserves are limited.

On the other hand, France was in a state of balance of payments surplus and then adopted a policy to convert entirely to reserves in gold (no foreign reserves in other currencies whose value is fixed to the gold). This policy is due to France's ambition to make Paris as a centre of international monetary compete with London. Since France also convert all his property into gold pounds, then the pressure forced Britain to prohibit September 1931 pounds conversion into gold, devalued the pound (to overcome stagnation), and the gold standard regime was over. Pound conversion into gold, too, carried out by other countries besides France.

Besides that, there are several causes why the gold standard regime collapses. First, there is a lack of adequate adjustment mechanisms to achieve internal and external balance given the scope for central banks to not comply with the rules of The Game (eg, by performing sterilization). Second, the amount of flow of gold from London to Paris and New York that resulted in destabilization (in 1932, the U.S. and France has 70% of world gold reserves). Monetary contraction around the world contributed to the Great Depression. And the third is the occurrence of the great depression.

2.6.2. Price Level Targeting : Swedia's Experience 1931 – 1937¹

Sweden is the only country in the world has ever applied PLT. There are two main reasons why Sweden adopted the PLT :

- 1) Strong influence of economists on policy making at that time.
In Sweden, economists enjoy a respected social status and influence in society and in government. PLT idea was first coined by Knut Wicksell in the year 1898 and later by Gustav Cassel in the 1920s. Special position of economists will eventually pave the way of the adoption of monetary program in 1931.
- 2) Monetary experiences in the period after World War I.
Attacked the Great Depression swept Sweden in the year 1931 through a decline in exports and foreign exchange reserves depletion. The number of bankrupt banks in Europe helped trigger capital outflows from Sweden. When the Bank of England decided that the pound can not be exchanged for gold in 1931, speculators

¹ Summarized from Berg & Jonung, "Pioneering Price Level Targeting: The Swedish Experience 1931 – 1937". SSE/EFI Working Paper Series in Economics and Finance No 290, December 1998.

then attacked krona (pounds exchange speculators and the krona exchange gold for Sweden at that time still the gold standard), and put Sweden in international reserves prone position .

Monetary program in 1931 were monetary policy to stabilize prices, the domestic purchasing power of the krona should be maintained by using all means available. In May 1932, Rijsdag (Swedish parliament) issued a comprehensive package of monetary policy that can be summarized in 5 (five) points as follows :

- 1) The possibility to return to the gold exchange standard (Gold Exchange Standard) or business associate (PEG) krona to the pound does not need to be reconsidered. Sweden should float its exchange rate for the time being. Attempt to control the value of the krona could begin to control the domestic price level and from seeing the needs of the national economy.
- 2) Persistent deflation must be resisted just as strongly against inflation.
- 3) Price control is desired, provided that no refund price too far from current prices. Domestic prices, in addition to the price of exports and imports of goods, are allowed to increase, provided the increase does not increase significantly the cost of living. The increase in prices because import duties are considered consistent with the monetary program.
- 4) Monetary policy does not systematically tied to a particular index. Implementation of monetary policy is a national interest consideration many factors not just follow the formal rules and simple.
- 5) Choice of instruments in order to achieve monetary policy objectives fully submitted to the Riksbank (central bank), and the Riksbank is allowed to achieve freedom of action for monetary purposes.

Shift in the monetary system to control prices initially a temporary decision taken by Swedish authorities for the international monetary system is still experiencing turbulence. Immediately after the international monetary system stabilized, then Sweden will again follow the international monetary standards. Price stabilization is intended to keep the domestic purchasing power (purchasing power) of the krone. Price stabilization adopted price level targeting (Price Level Targeting) of the domestic production of goods. Then, the question that arises is that the price level which needs to be targeted by Riskbank? The central bank needs to monitor the price level as an indicator to measure the effects of monetary policy and to predict future price movements to.

Riskbank then calculate the consumer price index each week after the price stabilization policy norms published in 1931. However, not only see Riskbank this index alone, a large trade price index and raw materials price index were also monitored. Temporary movement of prices as

seasonal effects, import duties, prices of imports and exports of goods that influence inflation also considered in view the price index movements. Seen that Riskbank focus on underlying inflation. PLT does not mean the price level constant. PLT allowed prices to increase as long as the cost of living does not improve significantly.

Instruments that used by Riskbank at the time was a discount rate and the intervention in the foreign exchange market. The announcement about the purpose of the central bank to control prices was also considered as an important instrument in influencing society's expectations, to maintain credibility, and maintain confidence in the value of krona. According to Dag Hammarskjold (1935), the central bank does not have the expertise to do the forecasting inflation, because at that time, econometric techniques and statistical data are available are not sufficient to do the forecast. Therefore, more Riskbank dealing with actual price movements although economists have a deep understanding of the importance of forecasting inflation.

Because the price stabilization policy is the policy while in the chaos of the international monetary system, Sweden saw the return to fixed exchange rate system, as happened in the gold standard is the next step is to be implemented. Swedish realize that to return to the system of fixed exchange rate requires a large foreign exchange reserves. Having accumulated reserves considered, Sweden associate (PEG) krona against the pound in July 1933 until the end of World War II. This policy raises the question whether the Swedish consistent in implementing price stabilization purposes. Fixed exchange rate policy consistent with the assessed price stabilization policy if the price level in countries which are also linked its currency against the pound (sterling bloc) coincides with the price level in Sweden. This is what happened during the period 1933 - 1939, so the price stabilization policy and system of fixed exchange rates can go hand in hand.

Although the purpose of price control is a priority for central banks in 1930, then made adjustments aim at the request of parliament and minister of finance associated with worsening depression. Riskbank asked to also keep interest rates as low as possible without sacrificing the price control objectives. In 1933, prompted the central bank to intervene more actively and coordinate monetary policy with fiscal policy to combat unemployment. In 1937, besides having the main purpose of maintaining price stability, central banks provided additional objective to achieve full employment.

PLT considered successful implemented. In 1937, the price index of trading value approaches the levels in 1928. Consumer price index was relatively stable since 1931. This indicates that the target price level contributed to the low variability of the price of consumer goods during the period of recovery from depression mainly through its impact on inflation expectations of society. In terms of unemployment and production, during the regime PLT, unemployment remained high

although decreasing during the 1930s while the production sector, especially in exports fell sharply during the depression. When compared with other countries are still at the gold standard, the economic performance of Sweden, including quite. However, this can not be claimed as a result of the PLT only, because all the countries that decided not to adopt the gold standard of better economic performance than countries that still clung to the gold standard.

PLT later judged to be sufficient to bring Sweden out of the depression is becoming more and more deeply. Assessed monetary program capable of controlling the price, but not sufficient to increase production and reduce unemployment. Monetary policy should be coordinated with fiscal policy to stabilize macroeconomic. This view is a common view at that time (popularized by Keynes) that put fiscal policy as a powerful tool to overcome depression. This view became the state's decision to put monetary policy in the second position under the fiscal policy. PLT and no longer followed by Sweden in 1937 (after World War II).

Inflation Targeting dan Stasionarity of Inflation

Svenson (1997) argues that IT implies the existence of "base drift" in the price level (CPI), which means that the CPI has a unit root (not stationary) and on the other hand implies a stationary inflation. Empirical research on this test is usually done with a linear unit root test with the Augmented Dickey Fuller (ADF) or using correlogram. Gregouriou, Andros and Kontonikas, Alexandros develop unit root tests using ESTAR unit root test (Exponential Smooth Transition Autoregressive Model).

3. Design and Research Methodology

Research methodology that used in this research can be divided into three, namely :

3.1. Using Theoretical Modelling and Simulation

Since no country in the world who apply PLT implicitly or explicitly, the empirical evidence that can be used to study the relative advantages of IT PLT are very limited. Sweden in the 1930s is the only country in the world to embrace explicitly PLT). Therefore, PLT research methodologies are on theoretical approaches and simulation modelling. The central bank is assumed to choose policies that minimize the loss function is assumed to be derived from the satisfaction function of economic agents. With this framework, the researchers hoped to determine the optimal policy rule and evaluate various alternatives to other policy proposals. We will use research methods using theoretical models that will compare the implementation of inflation targeting and price level targeting in the monetary policy rule or operated based discretion.

3.2. Econometrics Methods to Find Empirical Evidences

In this study expected to be an empirical test using econometrics to test which one is better applied in Indonesia. Is inflation targeting or price level targeting. This is an important scientific contribution that will be donated by a researcher who is not only a scientific contribution but also contribute to recommendations for the improvement of economic conditions in Indonesia. E. The results of this empirical method would then be used in theoretical models that have been developed to determine the possible scenarios in terms of welfare of economic agents when the monetary policy regime change from IT to PLT.

One of Econometrics models are used to test the model output Persistence. Ditmarr (1999) stated that if the output gap is relatively persistent, price level targeting is a better choice for the Central Bank. To test the persistence of output, we used Hodrick Prescott filter (HP Filter)².

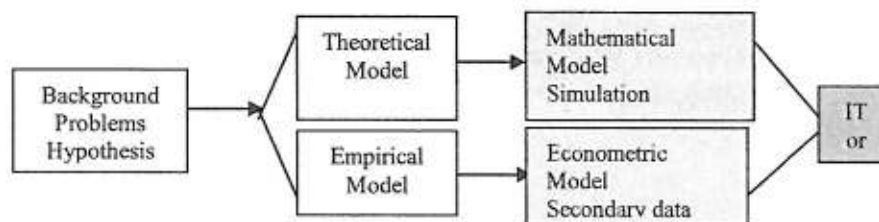
HP Filter is minimize :

$$\sum_{t=1}^T y_t - s_t^2 + \lambda \sum_{t=1}^T [s_{t+1} - s_t - s_t - s_{t-1}]^2 \quad (15)$$

where λ is a parameter which express penalty/constraints. λ control smoothness of s_t series. The more greater λ value, the more smooth is λ value will approach infinity if s_t close to linier trend. If HP filter output gap in Indonesia is persistent then it is better to use tprice level targeting as the anchor of monetary policy.

In this table, it seems that the research methods including theoretical models and empirical models laden with quantitative methods. Summary of the methodology in this research can be seen in Figure 1.

Figure 1.
Summary of Research Methodology



² HP Filter is a smoothing method which widely used by macroeconomics specialist to get estimation of smooth long term trend component from a macro data series. This method was first used by Hodrick and Prescott in early 1980's to analyze business cycle in US after world war II. HP Filter is a linear filter which calculate series S that has been have smoothing process from a series y . This process minimize variance y around S , with constraint second difference of S .

Econometric model that used in Dittmar, Gavin, and Kydland (1999) study is :

$$Output\ gap = \beta_0 + \rho \text{ Output gap }_{-1} + \beta_1 \Delta [Output\ gap]_{-1} + \varepsilon \quad (16)$$

If $\rho > \frac{1}{2}$ and getting closer to 1, the output gap is relatively persistent (to be random walk) then the target price level (price level targeting) to be a better choice for the Central Bank than inflation targeting. This will be tested empirically in this study. The derivation of mathematical model of Dittmar, Gavin, and Kydland (1999) is attached in this study.

4. Results and Analysis

4.1. Theoretical Model : PLT vs ITF in Forward Looking Model

The purpose of this theoretical model is to show that price-level targeting gives variance inflation-output trade-off is better than inflation targeting in the forward looking model of New Keynesian. New Keynesian model consist of two equations:

a) Forward looking IS

$$y_t = -\alpha r_t + E_t y_{t+1} + v_t \quad (17)$$

where y_t : output gap ; r_t : real interest rate ; v_t : white noise disturbance

b) Forward Looking Phillips Curve

$$\pi_t = \beta E_t \pi_{t+1} + \alpha y_t + u_t \quad (18)$$

where π_t : inflation ; u_t : cost push shock ; β : discount factor (henceforth assumed to be equal to 1)

4.1.1. Flexible Price-Level Targeting

In this case the purpose of the policymaker is to minimize the variance of the price level and variance of the output gap. Assume the target of constant price level at any time and is a potential target output of output. Policymaker minimize the expected loss function:

$$E L_t = V y_t + \hat{\mu} V p_t \quad (19)$$

where L_t : loss function ; V : variance ; $\hat{\mu}$: variance price level relative to variance output gap

At the discretion policy, set policy policymaker different rule each period (every policymaker optimizing return period). Policy rule based on the flexible price level targeting:

$$\hat{\theta} y_t + p_t - p^* = 0 \quad (20)$$

where $\hat{\theta}$: output gap relative to deviation of price level from it's target level ; p^* : constant target level

If $\pi_t = p_t - p_{t-1}$ and $E_t \pi_{t+1} = E_t p_{t+1} - p_t$, substitute that both equation into equation (18) turn out :

$$p_t = \frac{1}{2} E_t p_{t+1} + p_{t-1} + a y_t + u_t \quad (18')$$

Then determine reaction function by substitute equation (17) and (18') into policy rule :

$$r_t = \frac{1}{a_1} E_t y_{t+1} + v_t + \frac{1}{2a_1 \left(\hat{\theta} + \frac{a}{2} \right)} E_t p_{t+1} + p_{t-1} + u_t - \frac{1}{a_1 \left(\hat{\theta} + \frac{a}{2} \right)} p^* \quad (21)$$

Policymaker react to the demand shock by increase the interest rate $\frac{1}{a_1}$.

And if there is cost-push shock, policymaker response will depend on addition of parameter $\hat{\theta}$ and a .

Substitute eq.(21) into (17) will turn out :

$$y_t = \frac{2p^*}{2\hat{\theta} + a} - \frac{E_t p_{t+1} + p_{t-1} + u_t}{2\hat{\theta} + a} \quad (22)$$

and then substitute above equation into eq. (18') :

$$p_t = \frac{ap^*}{2\hat{\theta} + a} + \frac{\hat{\theta} E_t p_{t+1} + p_{t-1} + u_t}{2\hat{\theta} + a} \quad (23)$$

In discrete policy, the policymaker set $E_t p_{t+1}$ to be fixed in eq.(22) and (23). So variance of price level and output riil are:

$$V p_t^{PLT} = \frac{\hat{\theta}^2}{2\hat{\theta} + a^2 - \hat{\theta}^2} \sigma_u^2 \quad (24)$$

$$V y_t^{PLT} = \frac{1}{2\hat{\theta} + a^2 - \hat{\theta}^2} \sigma_u^2 \quad (25)$$

So that optimization problem in eq. (19) become:

$$\underset{\hat{\theta}}{\text{Min}} E L_t = V y_t^{PLT} + \hat{\mu} V p_t^{PLT} = \frac{1 + \hat{\mu}\hat{\theta}^2}{2\hat{\theta} + a^2 - \hat{\theta}^2} \sigma_u^2 \quad (26)$$

FOC :

$$\hat{\theta}^* = \frac{-\hat{\mu}a^2 - 3 \pm \sqrt{\hat{\mu}a^2 - 3^2 + 4a^2\hat{\mu}}}{4a\hat{\mu}} \quad (27)$$

The optimal value $\hat{\theta}$ depend on $\hat{\mu}$ (preference policymaker parameter) and a (structural parameter in Phillips Curve equation). In addition, there is a negative relationship between $\hat{\theta}$ and $\hat{\mu}$ for given value of a .

4.1.2. Flexible Inflation Targeting

In flexible inflation targeting, policymaker focus to inflation variance and variance of output gap. Policymaker is minimize expected loss function :

$$E L_t = V y_t + \mu V \pi_t \quad (28)$$

where μ : ratio between variance of price level relative to output gap variances

Policy rule base on flexible inflation targeting is :

$$\theta y_t + \pi_t = 0 \quad (29)$$

The policymaker goal is determining optimal value θ which minimizes the loss function.

Substitute eq.(17) and (18) into eq.(29) generate policymaker reaction function :

$$r_t = \frac{1}{\alpha_1} E_t y_{t+1} + v_t + \frac{1}{\alpha_1 \theta + a} E_t \pi_{t+1} + u_t \quad (30)$$

The policymaker reaction to demand shock in inflation targeting same as policymaker reaction to demand shock in price-level targeting, it is $\frac{1}{\alpha_1}$.

Substitute eq.(30) into (17) :

$$y_t = -\frac{1}{\theta + a} E_t \pi_{t+1} + u_t \quad (31)$$

And then substitute again into eq.(29) :

$$\pi_t = \frac{\theta}{\theta + a} E_t \pi_{t+1} + u_t \quad (32)$$

Because the policymaker discretion policy will be considered constant inflation expectations (Note: inflation expectations equal to zero based on the assumption of white noise disturbance). Therefore, the variance of inflation and output gap are :

$$V y_t^{IT} = \left(\frac{1}{\theta + a} \right)^2 \sigma_u^2 \quad (33)$$

$$V \pi_t^{IT} = \left(\frac{\theta}{\theta + a} \right)^2 \sigma_u^2 \quad (34)$$

Finally policymaker problem become :

$$\text{Min}_\theta E L_t = V y_t + \mu V \pi_t = \frac{1}{\theta + a} \sqrt{1 + \theta^2 \mu} \sigma_u^2 \quad (35)$$

FOC to θ turn out:

$$\theta^* = \frac{1}{\mu a} \quad (36)$$

Similarly, the price-level targeting, the inflation targeting policy parameters of the optimal value is inversely proportional to the policymaker preferences parameters and structural parameters Phillips Curve.

4.2. Result to Persistence Output Test (Result of Study with Indonesia's Secondary During First Quarter 1983 until Fourth Quarter 2008.

Econometrics model that used to test the persistence of output in Indonesia is using the model in Dittmar, Gavin, and Kydland (1999).

$$\text{Output gap} = \beta_0 + \rho \text{Output gap}^{-1} + \beta_1 \Delta \text{Output gap}^{-1} + \varepsilon \quad (37)$$

By using the HP filter method to get the output gap is obtained results of OLS regressions with the following methods :

$$\Delta Output\ gap = -0.000502 - 0.478\ Output\ gap_{-1} - 0.039\ \Delta\ Output\ gap_{-1} - 0.139649 - 4.867511 * - 0.414568 \quad (38)$$

Note : t statistic in parentheses

* Significant at $\alpha = 1\%$

So from the results of this research, note that the coefficient value $\rho = -0.478$. These results indicate that the output gap is not a random walk or not persistent. Since the output gap is not persistent then the Inflation Targeting (IT) is better applied in Indonesia compared to Price Level Targeting (PLT).

4.3. Evaluation Results with Inflation Targeting Using Secondary Data

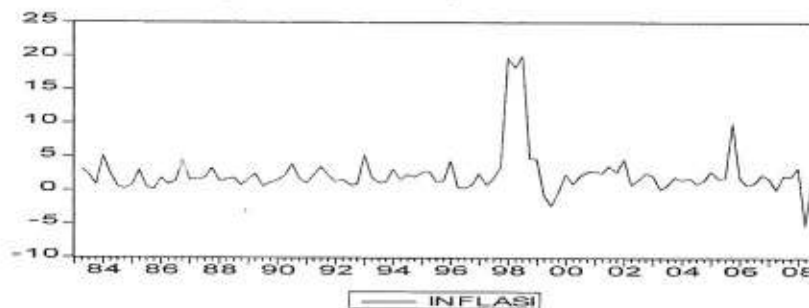
Table 1.
Unit Root Test of Variables

Variabel	ADF T-Stat
IHK	1.728902
Inflasi	-5.336801*

* Significant at $\alpha = 1\%$

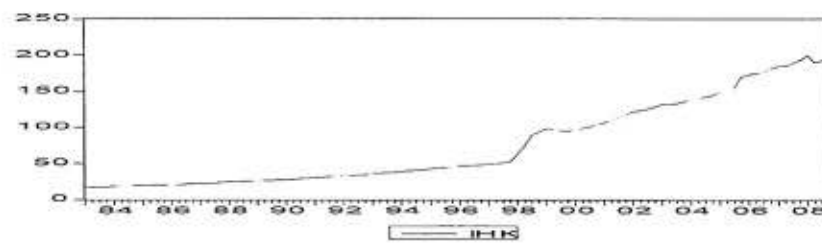
Based on these results it appears that variable Consumer Price Index (CPI) is not stationary (random walk), while inflation stationary variables (not random walk). This shows that inflation targeting has been fairly consistently applied in Indonesia. Stationarity of inflation data can also be seen in the following graph.

Figure 2. Stationarity of Inflation Data



While non-stationarity of CPI can be seen in this graph.

Figure 3. Non-Stationarity of CPI



5. Conclusions and Recommendations

5.1. Conclusions

The conclusions of this study are as follows :

1. The results of theoretical modelling shows that the Price Level Targeting (PLT) is better implemented than the Inflation Targeting (IT).
2. Empirical studies show that the output gap is not a random walk or not persistent in Indonesia during the study period. Since the output gap is not persistent then the Inflation Targeting (IT) is better applied in Indonesia compared to Price Level Targeting (PLT). This conclusion must be based on certain assumptions based on the reduction model in Dittmar, Gavin, and Kydland (1999). Sensitivity analysis of model conclusions can be made in future studies using other models or by modifying the model.
3. The difference between the results of theoretical conclusions modelling and empirical studies is due to theoretical modelling that has a set of assumptions and restrictions that may not appropriate empirically for the case of Indonesia.
4. Stationarity of the inflation variable during the study period can be interpreted as the success of the implementation of inflation targeting and consistency of application of inflation targeting in Indonesia.

5.2. Recommendations

The recommendations of this study are as follows :

1. PLT framework can still be further investigated, although it till now IT framework is still the optimal choice for Indonesia. Deepening the discussion about PLT is very interesting for the academic side of research in the field of macroeconomic and monetary economics.
2. Suggestion for future research is to develop further models to test the robustness to the conclusion that IT is better applied in Indonesia compared to PLT.

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Attachment 1

Mathematical Analysis of Paper : "The Inflation-Output Variability Tradeoff and Price Level Targets" from Model Dittmar, Gavin, dan Kydland (1999)

Trade off between inflation and output qualitatively differentiated into two, there is inflation targeting and price level targeting.

Inflation Targeting

- (1) Central Bank minimize quadratic loss function :

$$L = \sum_{t=0}^{\infty} \beta^t \left[\lambda y_t^2 + \pi_t - \pi^* \right]^2$$

where

β : discount future variability in output gap and inflation

λ : Central bank preference or relative weight on output gap

y_t : Deviation output from target level

$\pi_t - \pi^*$: Deviation of inflation from target inflation of central bank

- (2) The economy illustrated by short run AS curve with persistence output gap (short run Phillips curve)

$$y_t = \rho y_{t-1} + \alpha (\pi_t - \pi_t^e) + \varepsilon_t$$

Where

α : slope of short run Phillips curve

- (3) Rational expectation assumption: $\pi_t^e = E_{t-1} \pi_t$

This is cause trade off between output and inflation

- (4) Lagrange function:

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\lambda y_t^2 + \pi_t - \pi^* \right]^2 - \mu_t \left[y_t - \rho y_{t-1} - \alpha (\pi_t - \pi_t^e) - \varepsilon_t \right] \right\}$$

- (5) FOC to y_t :

$$\beta^0 \left[2\lambda y_t - \mu_t \right] + \beta^1 \left[\rho E_t \mu_{t+1} \right] = 0$$

$$2\lambda y_t - \mu_t + \beta \rho \left[E_t \mu_{t+1} \right] = 0$$

(6) FOC to π_t :

$$\beta^0 [2 \pi_t - \pi^* + \alpha \mu_t] = 0$$

$$2 \pi_t - \pi^* + \alpha \mu_t = 0 \quad \rightarrow \quad \mu_t = -\frac{2}{\alpha} \pi_t - \pi^*$$

(7) Substitute that equation into eq. (5) :

$$2\lambda y_t - \mu_t + \beta\rho [E_t \mu_{t+1}] = 0$$

$$2\lambda y_t - \left(-\frac{2}{\alpha} \pi_t - \pi^*\right) + \beta\rho [E_t \mu_{t+1}] = 0$$

$$2\lambda y_t + \frac{2}{\alpha} \pi_t - \pi^* + \beta\rho \left[E_t \left(-\frac{2}{\alpha} \pi_{t+1} - \pi^* \right) \right] = 0$$

$$\lambda y_t + \frac{1}{\alpha} \pi_t - \pi^* - \frac{\beta\rho}{\alpha} [E_t \pi_{t+1} - \pi^*] = 0$$

(8) Suppose linier decision rule form for inflation:

$$\pi_t = A_1 + A_2 y_{t-1} + A_3 \varepsilon_t$$

(9) Expectation at time $t-1$ rational, so:

$$\pi_t^e = E_{t-1} \pi_t$$

$$= E_{t-1} [A_1 + A_2 y_{t-1} + A_3 \varepsilon_t]$$

$$= A_1 + A_2 y_{t-1}$$

(10) Substitute eq. (9) into (8) :

$$\pi_t = A_1 + A_2 y_{t-1} + A_3 \varepsilon_t$$

$$\pi_t = \pi_t^e + A_3 \varepsilon_t$$

$$\pi_t - \pi_t^e = A_3 \varepsilon_t$$

(11) Substitute eq. (10) into (2) :

$$y_t = \rho y_{t-1} + \alpha \pi_t - \pi_t^e + \varepsilon_t$$

$$= \rho y_{t-1} + \alpha A_3 \varepsilon_t + \varepsilon_t$$

$$= \rho y_{t-1} + \alpha A_3 + 1 \varepsilon_t$$

(12) From eq. (8) for time $t+1$:

$$\pi_{t+1} = A_1 + A_2 y_t + A_3 \varepsilon_{t+1}$$

(13) Substitute eq. (11) into (12) :

$$\pi_{t+1} = A_1 + A_2 y_t + A_3 \varepsilon_{t+1} = A_1 + A_2 \rho y_{t-1} + \alpha A_3 + 1 \varepsilon_t + A_3 \varepsilon_{t+1}$$

(14) Substitute eq. (A5), (A7), and (A8) into (A4) :

$$\lambda y_t + \frac{1}{\alpha} \pi_t - \pi^* - \frac{\beta\rho}{\alpha} [E_t \pi_{t+1} - \pi^*] = 0$$

$$\lambda \rho y_{t-1} + \alpha A_3 + 1 \varepsilon_t + \frac{1}{\alpha} A_1 + A_2 y_{t-1} + A_3 \varepsilon_t - \pi^* - \frac{\beta\rho}{\alpha} [E_t A_1 + A_2 \rho y_{t-1} + \alpha A_3 + 1 \varepsilon_t + A_3 \varepsilon_{t+1} - \pi^*] = 0$$

(15) Expectation equation above at time $t-1$:

$$E_{t-1} \left\{ \lambda \rho y_{t-1} + \alpha A_3 + 1 \varepsilon_t + \frac{1}{\alpha} A_1 + A_2 y_{t-1} + A_3 \varepsilon_t - \pi^* - \frac{\beta\rho}{\alpha} [E_t A_1 + A_2 \rho y_{t-1} + \alpha A_3 + 1 \varepsilon_t + A_3 \varepsilon_{t+1} - \pi^*] \right\} = 0$$

$$\lambda \rho y_{t-1} + \frac{1}{\alpha} A_1 + A_2 y_{t-1} - \pi^* - \frac{\beta\rho}{\alpha} A_1 + A_2 \rho y_{t-1} - \pi^* + \left[\lambda \alpha A_3 + 1 + \frac{1}{\alpha} A_3 - \frac{\beta\rho}{\alpha} A_2 \alpha A_3 + 1 \right] \varepsilon_t = 0$$

$$\left(\lambda \rho + \frac{1}{\alpha} A_2 - \frac{\beta\rho^2}{\alpha} A_2 \right) y_{t-1} + \left(\frac{1}{\alpha} - \frac{\beta\rho}{\alpha} \right) A_1 - \pi^* + \left[\lambda - \frac{\beta\rho}{\alpha} A_2 + \left(\alpha \lambda + \frac{1}{\alpha} - \beta\rho A_2 \right) A_3 \right] \varepsilon_t = 0$$

From equation above we derive 3 sections as follow:

(16) **First Section :**

$$\left(\lambda \rho + \frac{1}{\alpha} A_2 - \frac{\beta\rho^2}{\alpha} A_2 \right) y_{t-1} = 0$$

$$\lambda \rho + \frac{1}{\alpha} A_2 - \frac{\beta\rho^2}{\alpha} A_2 = 0$$

$$\alpha \lambda \rho + A_2 - \beta\rho^2 A_2 = 0$$

$$\alpha \lambda \rho + 1 - \beta\rho^2 A_2 = 0$$

$$A_2 = -\frac{\alpha \lambda \rho}{1 - \beta\rho^2}$$

(17) **Second Section :**

$$\left(\frac{1}{\alpha} - \frac{\beta\rho}{\alpha} \right) A_1 - \pi^* = 0$$

$$A_1 - \pi^* = 0$$

$$A_1 = \pi^*$$

(18) **Third Section :**

$$\left[\lambda - \frac{\beta\rho}{\alpha} A_2 + \left(\alpha\lambda + \frac{1}{\alpha} - \beta\rho A_2 \right) A_3 \right] \varepsilon_t = 0$$

Substitute solution of A_2 into above equation:

$$\left[\lambda - \frac{\beta\rho}{\alpha} \left(-\frac{\alpha\lambda\rho}{1-\beta\rho^2} \right) + \left(\alpha\lambda + \frac{1}{\alpha} - \beta\rho \left(-\frac{\alpha\lambda\rho}{1-\beta\rho^2} \right) \right) A_3 \right] \varepsilon_t = 0$$

$$\lambda 1 - \beta\rho^2 + \beta\rho^2\lambda + \left[1 - \beta\rho^2 \quad \lambda\alpha + \frac{1-\beta\rho^2}{\alpha} + \alpha\lambda\beta\rho^2 \right] A_3 = 0$$

$$\alpha\lambda 1 - \beta\rho^2 + \alpha\beta\rho^2\lambda + \left[1 - \beta\rho^2 \quad \lambda\alpha^2 + 1 - \beta\rho^2 + \alpha^2\lambda\beta\rho^2 \right] A_3 = 0$$

$$\lambda\alpha + \left[\lambda\alpha^2 + 1 - \beta\rho^2 \right] A_3 = 0$$

$$A_3 = -\frac{\lambda\alpha}{1-\beta\rho^2 + \lambda\alpha^2}$$

(19) From that three solutions above, so linier decision rule solution for inflation (eq.(8)) is :

$$\pi_t = A_1 + A_2 y_{t-1} + A_3 \varepsilon_t$$

$$\pi_t = \pi^* - \frac{\alpha\lambda\rho}{1-\beta\rho^2} y_{t-1} - \left(\frac{\lambda\alpha}{1-\beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t$$

$$\text{or } \pi_t^A = p_t^A - p_{t-1} = \pi^* - \frac{\alpha\lambda\rho}{1-\beta\rho^2} y_{t-1} - \left(\frac{\lambda\alpha}{1-\beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t$$

where

 A : show that inflation depend on inflation targeting rule p : logarithm of price level

(20) To get output solution, substitute eq. (19) into (2) :

$$y_t = \rho y_{t-1} + \alpha (\pi_t - \pi_t^e) + \varepsilon_t$$

$$= \rho y_{t-1} + \alpha \left(\pi^* - \frac{\alpha\lambda\rho}{1-\beta\rho^2} y_{t-1} - \left(\frac{\lambda\alpha}{1-\beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t - E_{t-1} \left(\pi^* - \frac{\alpha\lambda\rho}{1-\beta\rho^2} y_{t-1} - \left(\frac{\lambda\alpha}{1-\beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t \right) \right) + \varepsilon_t$$

$$= \rho y_{t-1} + \alpha \left(\pi^* - \frac{\alpha\lambda\rho}{1-\beta\rho^2} y_{t-1} - \left(\frac{\lambda\alpha}{1-\beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t - \left(\pi^* - \frac{\alpha\lambda\rho}{1-\beta\rho^2} y_{t-1} \right) \right) + \varepsilon_t$$

$$= \rho y_{t-1} - \left(\frac{\lambda\alpha^2}{1-\beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t + \varepsilon_t$$

$$y_t = \rho y_{t-1} + \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t$$

The more greater λ (relative weight on output), coefficient of error term will close to zero.

(21) If variance ε_t is σ_ε^2 , so unconditional variance dari output gap (eq (20)) :

$$y_t - \rho y_{t-1} = \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t$$

$$\text{Var } y_t - \rho y_{t-1} = \text{Var} \left(\left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t \right)$$

$$\text{Var } y_t - \text{Var } \rho y_{t-1} = \text{Var} \left(\left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t \right)$$

$$\sigma_y^2 - \rho^2 \sigma_y^2 = \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right)^2 \sigma_\varepsilon^2$$

$$1 - \rho^2 \sigma_y^2 = \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right)^2 \sigma_\varepsilon^2$$

$$\sigma_y^2 = \frac{1 - \beta\rho^2^2}{1 - \rho^2 \quad 1 - \beta\rho^2 + \lambda\alpha^2^2} \sigma_\varepsilon^2$$

(22) Unconditional variance of inflation (eq (19)) :

$$\pi_t = \pi^* - \frac{\alpha\lambda\rho}{1 - \beta\rho^2} y_{t-1} - \left(\frac{\lambda\alpha}{1 - \beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t$$

$$\text{Var } \pi_t = \text{Var } \pi^* + \left(\frac{\alpha\lambda\rho}{1 - \beta\rho^2} \right)^2 \text{Var } y_{t-1} + \left(\frac{\lambda\alpha}{1 - \beta\rho^2 + \lambda\alpha^2} \right)^2 \text{Var } \varepsilon_t$$

$$\sigma_\pi^2 = \left(\frac{\alpha\lambda\rho}{1 - \beta\rho^2} \right)^2 \sigma_y^2 + \left(\frac{\lambda\alpha}{1 - \beta\rho^2 + \lambda\alpha^2} \right)^2 \sigma_\varepsilon^2$$

(23) Substitute eq (21) into (22) :

$$\sigma_\pi^2 = \left(\frac{\alpha\lambda\rho}{1 - \beta\rho^2} \right)^2 \frac{1 - \beta\rho^2^2}{1 - \rho^2 \quad 1 - \beta\rho^2 + \lambda\alpha^2^2} \sigma_\varepsilon^2 + \left(\frac{\lambda\alpha}{1 - \beta\rho^2 + \lambda\alpha^2} \right)^2 \sigma_\varepsilon^2$$

$$\begin{aligned}
&= \frac{\alpha \lambda \rho^2}{1 - \rho^2} \frac{\sigma_\varepsilon^2}{1 - \beta \rho^2 + \lambda \alpha^2} + \left(\frac{\lambda \alpha}{1 - \beta \rho^2 + \lambda \alpha^2} \right)^2 \sigma_\varepsilon^2 \\
&= \frac{\alpha \lambda \rho^2 + 1 - \rho^2}{1 - \rho^2} \frac{\lambda \alpha^2}{1 - \beta \rho^2 + \lambda \alpha^2} \sigma_\varepsilon^2 \\
\sigma_\pi^2 &= \frac{\lambda^2 \alpha^2}{1 - \rho^2} \frac{\sigma_\varepsilon^2}{1 - \beta \rho^2 + \lambda \alpha^2}
\end{aligned}$$

Price Level Targeting

- (1) Central Bank minimize quadratic loss function :

$$L = \sum_{t=0}^{\infty} \beta^t \left[\lambda y_t^2 + p_t - p_t^* \right]^2$$

where p_t^* is price level target that change over time

- (2) Rational expectation assumption : $p_t^e = E_{t-1} p_t$
- (3) The economy illustrated by short run AS curve with persistence output gap (short run Phillips curve)

$$y_t = \rho y_{t-1} + \alpha p_t - p_t^e + \varepsilon_t$$

where

α : slope of short run Phillips curve

- (4) Lagrange function :

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\lambda y_t^2 + p_t - p_t^* \right]^2 - \mu_t \left[y_t - \rho y_{t-1} - \alpha p_t + p_t^e - \varepsilon_t \right] \right\}$$

- (5) FOC to y_t :

$$\beta^0 \left[2\lambda y_t - \mu_t + \beta^1 \left[\rho E_t \mu_{t+1} \right] \right] = 0$$

$$2\lambda y_t - \mu_t + \beta \rho \left[E_t \mu_{t+1} \right] = 0$$

(6) FOC to π_t :

$$\beta^0 \left[2 p_t - p_t^* + \alpha \mu_t \right] = 0$$

$$2 p_t - p_t^* + \alpha \mu_t = 0 \quad \rightarrow \quad \mu_t = -\frac{2}{\alpha} p_t - p_t^*$$

(7) Substitute eq (6) into (5) :

$$2\lambda y_t - \mu_t + \beta \rho \left[E_t \mu_{t+1} \right] = 0$$

$$2\lambda y_t - \left(-\frac{2}{\alpha} p_t - p_t^* \right) + \beta \rho \left[E_t \mu_{t+1} \right] = 0$$

$$2\lambda y_t + \frac{2}{\alpha} p_t - p_t^* + \beta \rho \left[E_t \left(-\frac{2}{\alpha} p_{t+1} - p_t^* \right) \right] = 0$$

$$\lambda y_t + \frac{1}{\alpha} p_t - p_t^* - \frac{\beta \rho}{\alpha} \left[E_t p_{t+1} - p_t^* \right] = 0$$

(8) Suppose linier decision rule form for inflation is :

$$p_t = A_1 + A_2 p_t^* + A_3 y_{t-1} + A_4 \varepsilon_t$$

(9) Expectation at time $t-1$ rational so :

$$p_t^e = E_{t-1} p_t$$

$$= E_{t-1} \left[A_1 + A_2 p_t^* + A_3 y_{t-1} + A_4 \varepsilon_t \right]$$

$$= A_1 + A_2 p_t^* + A_3 y_{t-1}$$

(10) Substitute eq(9) into(8) :

$$p_t = A_1 + A_2 p_t^* + A_3 y_{t-1} + A_4 \varepsilon_t$$

$$p_t = p_t^e + A_4 \varepsilon_t$$

$$p_t - p_t^e = A_4 \varepsilon_t$$

(11) Substitute eq(10) into (2) :

$$y_t = \rho y_{t-1} + \alpha p_t - p_t^e + \varepsilon_t$$

$$= \rho y_{t-1} + \alpha A_4 \varepsilon_t + \varepsilon_t$$

$$= \rho y_{t-1} + 1 + \alpha A_4 \varepsilon_t$$

(12) From linier decision rule form of inflation, for period $t+1$ is :

$$p_{t+1} = A_1 + A_2 p_{t+1}^* + A_3 y_t + A_4 \varepsilon_{t+1}$$

(13) Substitute eq(11) into (12) :

$$p_{t+1} = A_1 + A_2 p_{t+1}^* + A_3 \rho y_{t-1} + 1 + \alpha A_4 \varepsilon_t + A_4 \varepsilon_{t+1}$$

(14) Substitute eq(8), (11), and (13) into (7) :

$$\lambda y_t + \frac{1}{\alpha} p_t - p_t^* - \frac{\beta\rho}{\alpha} \left[E_t p_{t+1} - p_t^* \right] = 0$$

$$\lambda \rho y_{t-1} + 1 + \alpha A_4 \varepsilon_t + \frac{1}{\alpha} A_1 + A_2 p_t^* + A_3 y_{t-1} + A_4 \varepsilon_t - p_t^* - \frac{\beta\rho}{\alpha} \left[E_t A_1 + A_2 p_{t+1}^* + A_3 \rho y_{t-1} + 1 + \alpha A_4 \varepsilon_t + A_4 \varepsilon_{t+1} - p_t^* \right] = 0$$

(15) Expectation equation above at time $t-1$:

$$E_{t-1} \left\{ \lambda \rho y_{t-1} + 1 + \alpha A_4 \varepsilon_t + \frac{1}{\alpha} A_1 + A_2 p_t^* + A_3 y_{t-1} + A_4 \varepsilon_t - p_t^* \right. \\ \left. - \frac{\beta\rho}{\alpha} \left[E_t A_1 + A_2 p_{t+1}^* + A_3 \rho y_{t-1} + 1 + \alpha A_4 \varepsilon_t + A_4 \varepsilon_{t+1} - p_t^* \right] \right\} = 0$$

$$\lambda \rho y_{t-1} + \frac{1}{\alpha} A_1 + A_3 y_{t-1} - \frac{\beta\rho}{\alpha} A_1 + A_3 \rho y_{t-1} + \left(\frac{1}{\alpha} A_2 - \frac{1}{\alpha} \frac{\beta\rho}{\alpha} A_2 + \frac{\beta\rho}{\alpha} \right) p_t^* + \left[\lambda \alpha A_4 + 1 + \frac{1}{\alpha} A_4 - \frac{\beta\rho}{\alpha} A_4 \alpha A_4 + 1 \right] \varepsilon_t = 0$$

$$\left(\lambda \rho + \frac{1}{\alpha} A_3 - \frac{\beta\rho^2}{\alpha} A_3 \right) y_{t-1} + \left(\frac{1}{\alpha} - \frac{\beta\rho}{\alpha} \right) A_1 + \left(\left(\frac{1}{\alpha} - \frac{\beta\rho}{\alpha} \right) A_2 - \frac{1}{\alpha} + \frac{\beta\rho}{\alpha} \right) p_t^* + \left[\lambda - \frac{\beta\rho}{\alpha} A_3 + \left(\alpha \lambda + \frac{1}{\alpha} - \beta \rho A_3 \right) A_4 \right] \varepsilon_t = 0$$

From above equation there are four sections explained below:

(16) **First Section :**

$$\left(\lambda \rho + \frac{1}{\alpha} A_3 - \frac{\beta\rho^2}{\alpha} A_3 \right) y_{t-1} = 0$$

$$\lambda \rho + \frac{1}{\alpha} A_3 - \frac{\beta\rho^2}{\alpha} A_3 = 0$$

$$\alpha \lambda \rho + A_3 - \beta \rho^2 A_3 = 0$$

$$\alpha \lambda \rho + 1 - \beta \rho^2 A_3 = 0$$

$$A_3 = - \frac{\alpha \lambda \rho}{1 - \beta \rho^2}$$

(17) **Second Section :**

$$\left(\frac{1}{\alpha} - \frac{\beta\rho}{\alpha}\right) A_1 = 0$$

$$A_1 = 0$$

(18) **Third Section :**

$$\left(\left(\frac{1}{\alpha} - \frac{\beta\rho}{\alpha}\right) A_2 - \frac{1}{\alpha} + \frac{\beta\rho}{\alpha}\right) p_t^* = 0$$

$$\left(\frac{1}{\alpha} - \frac{\beta\rho}{\alpha}\right) A_2 - \frac{1}{\alpha} + \frac{\beta\rho}{\alpha} = 0$$

$$1 - \beta\rho A_2 = 1 - \beta\rho \rightarrow A_2 = 1$$

(19) **Fourth Section :**

$$\left[\lambda - \frac{\beta\rho}{\alpha} A_3 + \left(\alpha\lambda + \frac{1}{\alpha} - \beta\rho A_3\right) A_4\right] \varepsilon_t = 0$$

Substitute solution A_3 into above equation:

$$\left[\lambda - \frac{\beta\rho}{\alpha} \left(-\frac{\alpha\lambda\rho}{1-\beta\rho^2}\right) + \left(\alpha\lambda + \frac{1}{\alpha} - \beta\rho \left(-\frac{\alpha\lambda\rho}{1-\beta\rho^2}\right)\right) A_4\right] \varepsilon_t = 0$$

$$\lambda 1 - \beta\rho^2 + \beta\rho^2 \lambda + \left[1 - \beta\rho^2 \lambda\alpha + \frac{1 - \beta\rho^2}{\alpha} + \alpha\lambda\beta\rho^2\right] A_4 = 0$$

$$\alpha\lambda 1 - \beta\rho^2 + \alpha\beta\rho^2 \lambda + \left[1 - \beta\rho^2 \lambda\alpha^2 + 1 - \beta\rho^2 + \alpha^2 \lambda\beta\rho^2\right] A_4 = 0$$

$$\lambda\alpha + \left[\lambda\alpha^2 + 1 - \beta\rho^2\right] A_4 = 0$$

$$A_4 = -\frac{\lambda\alpha}{1 - \beta\rho^2 + \lambda\alpha^2}$$

(20) From three solutions above, linear decision rule solution for inflation is :

$$p_t = A_1 + A_2 p_t^* + A_3 y_{t-1} + A_4 \varepsilon_t$$

$$p_t^B = p_t^* - \frac{\alpha\lambda\rho}{1 - \beta\rho^2} y_{t-1} - \left(\frac{\lambda\alpha}{1 - \beta\rho^2 + \lambda\alpha^2}\right) \varepsilon_t$$

where

B : show inflasi depend on price level targeting rule

(21) Assume : $p_t^* = \pi^* + p_{t-1}^*$

(22) So linier decision rule solution for inflation :

$$\pi_t^b = p_t^b - p_{t-1} = \pi^* - \frac{\alpha\lambda\rho}{1-\beta\rho^2} (y_{t-1} - y_{t-2}) - \left(\frac{\lambda\alpha}{1-\beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t - \varepsilon_{t-1}$$

Eq (22) has three section in right side. The first section show steady state inflation. Second section show adjustment of output gap changes from period $t-2$ until $t-1$. And last section show adjustment of shock changes from periode $t-1$ until t .

(23) To get output solution, substitute eq (20) into (2) :

$$y_t = \rho y_{t-1} + \left(\frac{1-\beta\rho^2}{1-\beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t$$

Note: Equation above is same as output solution for inflation targeting rule (eq (20)). So unconditional variance for output gap will same as eq (21) in inflation targeting.

(24) Unconditional variance for output gap :

$$\sigma_y^2 = \frac{1-\beta\rho^2}{1-\rho^2} \frac{1-\beta\rho^2}{1-\beta\rho^2 + \lambda\alpha^2} \sigma_\varepsilon^2$$

(25) From eq (23) :

$$y_{t-1} = \rho y_{t-2} + \left(\frac{1-\beta\rho^2}{1-\beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_{t-1}$$

with variance :

$$\sigma_y^2 = \frac{1-\beta\rho^2}{1-\rho^2} \frac{1-\beta\rho^2}{1-\beta\rho^2 + \lambda\alpha^2} \sigma_\varepsilon^2$$

(26) Suppose $K_t = y_{t-1} - y_{t-2}$ so :

$$K_t = \rho y_{t-2} + \left(\frac{1-\beta\rho^2}{1-\beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_{t-1} - y_{t-2}$$

$$K_t = \rho^{-1} y_{t-2} + \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_{t-1}$$

(27) Variance of K_t :

$$\sigma_K^2 = \rho^{-1}{}^2 \sigma_y^2 + \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right)^2 \sigma_\varepsilon^2$$

Substitute variance (eq(25)) into above equation :

$$\begin{aligned} \sigma_K^2 &= \rho^{-1}{}^2 \frac{1 - \beta\rho^2{}^2}{1 - \rho^2} \frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \sigma_\varepsilon^2 + \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right)^2 \sigma_\varepsilon^2 \\ &= \frac{1 - \rho^2}{1 - \rho} \frac{1 - \beta\rho^2{}^2}{1 + \rho} \frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \sigma_\varepsilon^2 + \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right)^2 \sigma_\varepsilon^2 \\ &= \frac{1 - \rho}{1 + \rho} \frac{1 - \beta\rho^2{}^2}{1 - \beta\rho^2 + \lambda\alpha^2} \sigma_\varepsilon^2 + \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right)^2 \sigma_\varepsilon^2 \\ &= \frac{1 - \rho}{1 + \rho} \frac{1 - \beta\rho^2{}^2 + 1 + \rho}{1 - \beta\rho^2 + \lambda\alpha^2} \sigma_\varepsilon^2 \\ &= \frac{2}{1 + \rho} \frac{1 - \beta\rho^2{}^2}{1 - \beta\rho^2 + \lambda\alpha^2} \sigma_\varepsilon^2 \end{aligned}$$

(28) Suppose $L_t = y_t - y_{t-1}$ so :

$$L_t = y_t - y_{t-1} = \rho y_{t-1} + \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t - y_{t-1}$$

$$L_t = y_t - y_{t-1} = \rho^{-1} y_{t-1} + \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right) \varepsilon_t$$

$$\begin{aligned} \sigma_L^2 &= \rho^{-1}{}^2 \sigma_y^2 + \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right)^2 \sigma_\varepsilon^2 \\ &= \rho^{-1}{}^2 \left[\frac{1 - \beta\rho^2{}^2}{1 - \rho^2} \frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \sigma_\varepsilon^2 \right] + \left(\frac{1 - \beta\rho^2}{1 - \beta\rho^2 + \lambda\alpha^2} \right)^2 \sigma_\varepsilon^2 \end{aligned}$$

$$\begin{aligned}
&= \left[\frac{1-\rho^2}{1-\rho^2} \frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \sigma_\varepsilon^2 \right] + \left(\frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \right)^2 \sigma_\varepsilon^2 \\
&= \frac{1-\rho}{1+\rho} \frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} + \frac{1+\rho}{1+\rho} \frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \sigma_\varepsilon^2 \\
&= \frac{2}{1+\rho} \frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \sigma_\varepsilon^2
\end{aligned}$$

(29) Eliminate eq (23) and (25) :

$$\begin{aligned}
y_t - y_{t-1} &= \left[\rho y_{t-1} + \left(\frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \right) \varepsilon_t \right] - \left[\rho y_{t-2} + \left(\frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \right) \varepsilon_{t-1} \right] \\
y_t - y_{t-1} &= \rho y_{t-1} - \rho y_{t-2} + \left(\frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \right) \varepsilon_t - \varepsilon_{t-1} \\
\left(\frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \right) \varepsilon_t - \varepsilon_{t-1} &= \rho y_{t-1} - \rho y_{t-2} - y_t + y_{t-1} \\
\left(\frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \right)^2 \sigma_\varepsilon^2 &= \rho^2 \sigma_K^2 - \sigma_L^2 \\
\sigma_\varepsilon^2 &= \left(\frac{1-\beta\rho^2+\lambda\alpha^2}{1-\beta\rho^2} \right)^2 \rho^2 \sigma_K^2 - \sigma_L^2
\end{aligned}$$

(30) Unconditional variance for inflation (eq (22)) :

$$\begin{aligned}
\text{Var } \pi_t &= \text{Var } \pi^* + \left(\frac{\alpha\lambda\rho}{1-\beta\rho^2} \right)^2 \text{Var } y_{t-1} - y_{t-2} - \left(\frac{\lambda\alpha}{1-\beta\rho^2+\lambda\alpha^2} \right)^2 \text{Var } \varepsilon_t - \varepsilon_{t-1} \\
\sigma_\pi^2 &= \left(\frac{\alpha\lambda\rho}{1-\beta\rho^2} \right)^2 \left[\frac{2}{1+\rho} \frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \sigma_\varepsilon^2 \right] - \left(\frac{\lambda\alpha}{1-\beta\rho^2+\lambda\alpha^2} \right)^2 \left[\left(\frac{1-\beta\rho^2+\lambda\alpha^2}{1-\beta\rho^2} \right)^2 \rho^2 \sigma_K^2 - \sigma_L^2 \right] \\
&= \frac{2}{1+\rho} \frac{\alpha\lambda\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \sigma_\varepsilon^2 - \left(\frac{\lambda\alpha}{1-\beta\rho^2} \right)^2 \left(\rho^2 \left(\frac{2}{1+\rho} \frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \sigma_\varepsilon^2 \right) - \left(\frac{2}{1+\rho} \frac{1-\beta\rho^2}{1-\beta\rho^2+\lambda\alpha^2} \sigma_\varepsilon^2 \right) \right)
\end{aligned}$$

$$= \frac{2 \alpha \lambda \rho^2}{1 + \rho} \frac{\sigma_\varepsilon^2}{1 - \beta \rho^2 + \lambda \alpha^2} - \frac{2 \lambda \alpha^2 \rho^2 - 1}{1 + \rho} \frac{\sigma_\varepsilon^2}{1 - \beta \rho^2 + \lambda \alpha^2}$$

$$= \frac{2 \alpha \lambda \rho^2 - 2 \lambda \alpha^2 \rho^2 - 1}{1 + \rho} \frac{\sigma_\varepsilon^2}{1 - \beta \rho^2 + \lambda \alpha^2}$$

$$= \frac{2 \lambda \alpha^2}{1 + \rho} \frac{\sigma_\varepsilon^2}{1 - \beta \rho^2 + \lambda \alpha^2}$$

$$\sigma_\pi^2 = \frac{2 \lambda^2 \alpha^2}{1 + \rho} \frac{\sigma_\varepsilon^2}{1 - \beta \rho^2 + \lambda \alpha^2}$$

Attachment 2

Regression Output from EViews Program

ADF Test Statistic	-4.867511	1% Critical Value*	-3.4952	
		5% Critical Value	-2.8897	
		10% Critical Value	-2.5816	
*MacKinnon critical values for rejection of hypothesis of a unit root.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(GAP_3)				
Method: Least Squares				
Date: 09/02/09 Time: 10:10				
Sample(adjusted): 1983:3 2008:4				
Included observations: 102 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GAP_3(-1)	-0.478227	0.098249	-4.867511	0.0000
D(GAP_3(-1))	-0.038669	0.093276	-0.414568	0.6794
C	-0.000502	0.003592	-0.139649	0.8892
R-squared	0.261530	Mean dependent var	-0.001028	
Adjusted R-squared	0.246611	S.D. dependent var	0.041778	
S.E. of regression	0.036262	Akaike info criterion	-3.767114	
Sum squared resid	0.130179	Schwarz criterion	-3.689909	
Log likelihood	195.1228	F-statistic	17.53048	
Durbin-Watson stat	2.024266	Prob(F-statistic)	0.000000	

