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Inflation Targeting under Imperfect Credibility Based on the Aggregate Rational Inflation-Targeting Model for Bank Indonesia (ARIMBI): Lessons from the Indonesian Experience

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Abstract

Credibility is one of the central issues in conducting monetary policy. It is necessary in order to anchor the economic agents’ expectation on the central bank’s inflation target. A central bank which is capable of managing the public’s expectation of inflation in a proper manner would able to implement monetary policy more effectively and efficiently. This paper attempts to assess the role of credibility in the implementation of the inflation targeting framework in Indonesia. It illustrates how credibility may play an important role in the evolution of the Indonesian monetary policy. Knowing the degree of credibility would be beneficial for Bank Indonesia (BI) in understanding how policy instruments can be adjusted to achieve a long-term inflation target.

A small open-economy model originally based on Global Projection Model (GPM) of the IMF (Carabenciov et.al, 2008), namely the Aggregate Rational Inflation-Targeting Model for Bank Indonesia (ARIMBI) is developed to analyse how monetary policy affects the economy and how an optimal policy should be designed. The model employs a New-Keynesian Phillips Curve (NKPC), an expectation IS curve, an uncovered interest parity (UIP) equation and a monetary policy rule which are basically derived from the microfoundation of economic agents’ behaviours. Hence, the model is able to generate key economic variables (inflation, output, interest rate and exchange rate). In addition, we also study how credibility affects these dynamic variables by incorporating an ad-hoc credibility variable in two alternatives ways: exogen and endogen.

For the initial value in the model, we need to measure the current value of the credibility index of Indonesian monetary policy. We follow Valentin & Rozalia (2008) and Cecchetti & Krause (2002) for the approaches. Summing up the previous measurement results (such as Harmanta (2009)), we conclude that monetary credibility in Indonesia is not yet perfectly credible or, in other words, there is imperfect credibility. On a scale ranging from zero (purely not credible) to one (perfect credibility), our quantitative measurements found that the credibility index for Indonesian monetary policy seems converge at around 0.5.

Referring to the projection and simulation results in this paper, the study shows that the expectation inflation of economic agents is strongly influenced by monetary policy credibility. The more credible the monetary policy, the faster inflation expectation would anchor to its target. Consequently, it is also more likely that actual inflation would anchor to the target. In turn, the operation of the disinflation process towards the long-term target of low-and-stable inflation
would accelerate. In addition to this effectiveness factor, high credibility is also beneficial in terms of the efficiency of the monetary policy transmission as disinflation cost (proxied by the sacrifice ratio) would also decrease. In terms of the two alternative ways of incorporating credibility, the result shows that the endogenous way is more realistic than the exogenous one. In addition, we found that under imperfect credibility, the central bank prefers to attain its inflation target gradually. Another interesting finding is that if the authority has twice the credibility stock, then achieving its long-term inflation target requires only much shorter time periods (approximately 0.4 periods than the baseline).

JEL Classification: E31, E52, E58, E61.
Keywords: Disinflation, Monetary Policy, Imperfect Credibility, Sacrifice Ratio.
1. Introduction

1.1 Background

The Law No.23 of 1999 mandates Bank Indonesia (BI) to achieve and maintain the stability of the Rupiah (single objective). Although it is not formally stated explicitly in the Act, the Inflation Targeting Framework (ITF) is currently BI’s monetary policy framework. The ITF is characterised by the setting of an inflation target, announced to the public, and pursuance of this target as the primary goal of monetary policy. Implementation of the ITF in Indonesia emphasises the importance of controlling inflation anchored to the target as it is a necessary condition for improving overall social welfare. Numerically, low and stable long-term inflation of 3% is the common figure to represent competitiveness with other countries.

The ITF could be taken as a framework for a forward-looking monetary policy, focusing on inflation, and inflation expectations of economic agents. According to Mishkin (2000), the important features of the ITF are commitment to pursuing inflation as a primary goal of monetary policy, announcement of the inflation target (including monetary policy measures), and accountability. Some advantages of the ITF are that there is a clear inflation target, it is easily observable and the monetary policy measures easily understood. The framework would provide a nominal anchor of economic agents in forming inflation expectations and predict monetary policy actions. However, formulating an inflation target as a nominal anchor requires credible monetary policy.

The most critical point where monetary policy could affect inflation is when the leading inflation expectations of economic agents are able to be anchored to the central bank’s inflation target. There is general agreement that inflation expectations of economic agents is an important variable in implementing monetary policy. If economic agents' expectations remain high, the disinflation process would last longer and require greater cost (loss of output) (Clarida, Gali and Gertler, 1999). A central bank which is able to manage inflation expectations would be able to conduct effective monetary policy and, thus, monetary policy could be said to be credible (Blinder, 1999).

Some studies indicated that the monetary policy credibility problem may arise due to the uncertainties of economic agents about the preferences of monetary authorities. Although the monetary authorities announce an inflation target, it may not be fully credible if the inclinations of central banks toward inflation reduction is not too convincing (Geraats, 2001; Kozicki and Tinsley, 2003). Economic agents try to interpret preferences based on the monetary policy actions of monetary authorities and performance of inflation which then further feedback on their expectations. King (1996) stressed that transparency would encourage the learning process so that the inflation expectations of economic agents would be anchored to the inflation target more quickly.

There has been significant attention associated with the disinflation strategy in achieving low and stable inflation, namely: (i) the cost of disinflation, in relation to the trade-off of output - inflation (output loss), and (ii) the length of disinflation. Numerous studies show that the disinflation strategy is highly influenced by the credibility of monetary policy. Within the
framework of the ITF, if monetary policy is not fully credible (imperfect credibility), the learning process of economic agents will be very slow as the economic agents do not fully believe that monetary policy can attain the inflation target. This, in turn, would affect the formation of inflation expectations and the actual inflation would subsequently converge slowly to the inflation target, putting a damper on policy rates and other macro variables (GDP, exchange rate, etc).

1.2 Objective and Benefit

In order to answer several questions related to the impact of monetary policy credibility on the dynamics of the main macroeconomic variables, particularly in the achievement of the inflation target, the study aims to develop a model, namely the Aggregate Rational Inflation-Targeting Model for Bank Indonesia (ARIMBI), which is endowed with credibility features. Specifically, the research objectives include:

- measuring the degree of monetary policy credibility in Indonesia;
- studying the dynamics of the credibility of monetary policy in Indonesia and its impact on the dynamics of the key macroeconomic variables (inflation, GDP, exchange rates, interest policy rates); and,
- conducting simulations to gauge the size of the cost of disinflation and the speed of the process of disinflation that is translated to the inflation target over the medium term and long term according to varying degrees of monetary policy credibility knowledge in Indonesia.

By adding the credibility feature into the model, the ARIMBI is expected to generate an optimal trajectory of the main macroeconomic variables, namely GDP, inflation, interest rates and exchange rates. Furthermore, the ARIMBI with Imperfect Credibility could be utilised for simulation and forecasting of monetary policy to support achieving low and stable inflation with minimum output loss based on knowledge about its credibility.

1.3 Scope of Research

The ARIMBI with Imperfect Credibility is used to conduct simulations and projections of economic policy by adding features of monetary policy credibility. There are two ways to add such features, mainly the exogenous and endogenous methods. The degree of credibility is measured by considering the extent to which the inflation targeting monetary authority is trusted by economic agents in forming inflation expectations. The smaller the deviation between the inflation expectations of economic agents and its target inflation, the higher is the policy credibility. The ARIMBI model is developed using the IRIS toolbox in Matlab environment for programming, parameter estimation, managing data and conducting simulations and forecasting.

1.4 Paper Organisation

Section 1 introduces and outlines the background of development models, objective and benefit, and research limitation. The theoretical review in Section 2 discusses the macroeconomic models, stylised facts of the Indonesian economy in recent years, and the
credibility of monetary policy. Section 3 explains the methodology and model, describing the model structure and transmission mechanism with imperfect credibility and equations in the model. Section 4 presents the results and analysis, specifically the results of simulations and projections using this model, particularly related to the costs and periods of disinflation process. Lastly, Section 5 presents the conclusions and policy implications. In addition, some potential improvements in model development are also discussed.

2. Theoretical Review

2.1 Model Review

In general, the structure of macroeconomic models are built with the aim of capturing the reality of the workings of an economy as reflected from the interactive relationships of various economic variables. Basically there are two main objectives of macroeconomic modeling, namely: (i) preparing economic projections (economic projection), and (ii) policy impact analysis (policy simulation). With reference to the various central banks which employ the ITF, a reliable macroeconomic model must fulfill several characteristics: (i) it reflects the characteristics of the economic structure and is able to produce a comprehensive analysis of the main determinants of inflation; (ii) represents the workings of monetary policy transmission mechanism; (iii) equipped with a policy rule, inference of the interest rate, Taylor’s rule, and sets the inflation target and an explicit expectation formation mechanism therein; (iv) consistent with its underlying theory (theoretically consistent); and (v) has a well-defined steady state which could produce projections/analysis that are consistent with theory.

Macroeconomic modeling that is directed is generally characterised by short-term projections and utilises a lot of historical data (time series) incorporating the use of econometric methods. It is plausible for econometric models to produce short-term forecasting of economic variables, but the estimated relationship between the variables is usually less well defined when used as a benchmark to evaluate a policy (policy simulation). While policy simulation is usually more of medium and long term, its high theoretical orientation and ability to explain real world phenomena can be validated by historical data. One economic model used for policy simulation that is built on microeconomic foundations on the general principle of equilibrium, and operated by entering a stochastic shock is often known as the Dynamic Stochastic General Equilibrium (DSGE).

In practice, there is usually a trade-off between the accuracy of projection resulting from the econometric model and the medium- and long-term policy simulation obtained from the DSGE model. Projections generated from econometric models and their directions do not necessarily commensurate with the simulation results stemming from the DSGE model. Short-term projections based on acceptable goodness of fit in the econometric model, may not be necessarily aligned with the simulation results of the DSGE model. Based on the trade-offs since 2008, BI has started to develop a model that combines the advantages of econometric models (adopting Bayesian Econometric estimation method) and DSGE (New Keynesian macroeconomic model) for projections and policy simulations.
The ARIMBI with Imperfect Credibility can be classified as a semi-structural model which is derived from a simple DSGE model. The equation used in the model is on an ad-hoc basis, in the sense that it is not purely derived from standard equations as in the DSGE model. This provides flexibility in the development of the model as the emphasis of this study is policy-oriented.

2.2 Inflation Behavior and Expectation in Indonesia

In the last two decades, Indonesian inflation was in the high single-digit level. By removing the crisis period, the average inflation is around 8.5% with a relatively high level of volatility (standard deviation). After eliminating the effect of structural shocks (shocks), inflation in Indonesia still registers 7.9%. However, core inflation tends to decline relative to the average, by more than 7.4% after the implementation of the ITF (Table 2.1). If there are no surprises from the supply and demand sides, inflation would then trend towards the level of the core inflation. Indonesian inflation is relatively high compared to other ASEAN countries (Thailand, Malaysia, Singapore or the Philippines), see Chart 2.1.

<table>
<thead>
<tr>
<th>Period</th>
<th>CPI</th>
<th>Core CPI</th>
<th>VF</th>
<th>Adm</th>
<th>CPI Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Crisis (1992.01 - 1997.12)</td>
<td>8.08</td>
<td>8.5</td>
<td>9.13</td>
<td>6.91</td>
<td>1.92</td>
</tr>
<tr>
<td>Pre ITF (2000.01 - 2005.06)</td>
<td>7.94</td>
<td>7.69</td>
<td>4.47</td>
<td>14.96</td>
<td>4.34</td>
</tr>
<tr>
<td>Post ITF (2005.07 - 2009.08)</td>
<td>9.75</td>
<td>7.41</td>
<td>14.18</td>
<td>13.33</td>
<td>4.35</td>
</tr>
<tr>
<td>Total (excl. crisis)</td>
<td>8.47</td>
<td>7.93</td>
<td>8.84</td>
<td>11.44</td>
<td>3.40</td>
</tr>
</tbody>
</table>

Chart 2.1
Comparison of Inflation in ASEAN Region
The phenomenon of high inflation which remains despite eliminating the shocks, led to the hypothesis of inflation persistence. If persistence is defined as the time required to return to the original level after the occurrence of shocks, then the above facts have implications for the persistence of high inflation in Indonesia. Several studies have been done to confirm this (Alamsyah, 2008). The persistence of CPI inflation, disaggregated by groups of goods and services, is around 0.8 to 0.9, although there is a general decreasing trend between the periods before and after the Asian Crisis (1997). Decline in the degree of inflation persistence is also consistent with research by Yanuarti (2007).

Furthermore, the high persistence of inflation in Indonesia was influenced by inflation expectations. Some studies in Indonesia in recent years also demonstrated the importance of inflation expectations on inflation forming. Therefore, inflation expectations must be considered in formulating monetary policy in order to achieve the inflation target.

**Chart 2.2**

**Component of Inflation in Indonesia**

In the transition period and the implementation of ITF since 2000-2009, the actual inflation rate is more often out of the target range. This was mainly due to large shocks in the domestic economy, both in terms of food supply and distribution (volatile food) and pricing policies set by the government (administered prices). Unfortunately, core inflation is also often higher than the CPI inflation target.

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2 Estimation of the persistence was completed by employing an autoregressive univariate model. By adopting the formula of Gujarati (2003) contained in the Alamsyah (2008), the persistence of inflation from 0.8 to 0.9 means that if there is a surprise, then 50% of those surprises would be absorbed within a period of 4-9 months and the rest would be absorbed as inflation trip back to the normal average length of term. Long computation time required to absorb 50% shocks using a formula calculating the mean lag $\rho/(1-\rho)$, with $\rho$ is the degree of persistence.

3 Hutabarat (2005) also found that inflation expectations of economic agents in the period 1999-2004 was dominated by inflation formation rather than the output gap, administered prices, supply shocks, and exchange rates.

4 A study by Chatib Basri, Damayanti and Sutisna (2002) from LPEM - UI indicates that the major sources of Indonesian inflation are expected inflation, followed by exchange rate depreciation and money supply.
Besides the problems mentioned above, the high inflation in Indonesia is also impacted by external influences, including the exchange rate pass-through effect and world commodity prices. Additionally, the inevitable fact is that phenomenon shocks that spread through the follow-up expectations would in turn affect core inflation. Examples are inflationary pressures in 2005 and 2008, originating from external shocks coming from the increases in global commodity prices of both energy and food commodities. The increase in world oil prices has prompted the government to raise fuel prices by an average of 28.7%. In addition to having a direct impact on inflation, the influence of this second-round effect would also contribute to elevate the inflation rate. In general, for almost a decade, the deviation between actual inflation and the target has been due to good fundamentals as well as non-fundamental shocks closely associated with supply-side management. Given that monetary policy tools are more suited to solving the problems on the demand side, supply-side problems require coordination between institutions, including Bank Indonesia and the government and its related agencies.

With the above mentioned facts, the task of bringing about a decline in inflation (disinflation) is not an easy one. The characteristics of persistent inflation would naturally imply a slow process of disinflation. One study (Alamsyah, 2008) shows that persistence is caused primarily by the formation of inflation expectations which are mostly backward looking in manner. This occurrence is attributable to the fairly large proportion of producers who do not
adjust their prices and maintain prices on previous expectations\(^5\). The Survey of Price Formation Mechanism (in 2000 and 2003) confirms the relative reluctance of price changes at the producer level. The Survey indicates that prices are less flexible and companies rarely make changes in their price (only 1-2 times a year).

This backward-looking occurrence in forming inflation expectation is also indicated in other regular surveys, both in metric (stating level) and non-metric (only direction) terms. BI’s inflation expectation surveys cover a range of respondents: consumer level (Survey of Consumer-BI), traders (Retail Sales Survey-BI), enterprises (Business Survey-BI) and economists (Market Perception Survey-BI and Consensus Forecast (CF). In general, these surveys confirm a correlation between expectation and the lag actual inflation. For example, in CF, inflation expectations move in line with actual inflation. In addition, the backward-looking phenomenon is also demonstrated through empirical observations where the average of the last six months of actual inflation has a significant explanatory power on inflation expectations (Bank Indonesia, 2008).

Nonetheless, forward-looking occurrence is also indicated, albeit for only a very short term. This is partly visible from inflation expectations on Survey of Consumer for a three month period which has a high correlation with actual inflation at t +1 and t +2. Regression testing with the inclusion of other macroeconomic variables also shows that inflation expectations for three months in the Survey of Consumer has explanatory power of “ahead” core inflation projection in the very short term of 2-3 months. This indicates that inflation expectations from surveys have been able to act as an indicator of inflationary pressure albeit for the very short term.

In general, though backward-looking behaviour is quite dominant in inflation formation in Indonesia, this tended to decline in the aftermath of the Asian Crisis (1997). Conversely, Alamsyah (2008) found that forward-looking behaviour tends to increase in the period after the crisis. As backward-looking behavior is declining, the degree of inflation persistence seems to be also declining. From the perspective of commodity groups, the decline in inflation persistence is occurring mainly in clothing goods and imported goods due to the increasingly competitive market structure. Hence, decreasing the degree of inflation persistence would bolster the growing role of monetary policy to control inflation.

2.3 Inflation Persistence, Credibility Issue, and Disinflation Process

2.3.1 Inflation Persistence and Policy Credibility

The persistence of inflation in the midst of current economic conditions with pressures from external and domestic sources makes disinflation efforts towards low and stable inflation in the medium to long term very challenging. It should be noted also that the central banks’ ability

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\(^5\) In the formation of inflation within the framework of the NKPC equation (the New Keynesian Phillips Curve), it is assumed that the firm faces a monopolistic competition market structure so that there are companies that could determine the price (price setting) because it has little monopoly power. However, most companies still keep its price by indexation to a price before (backward looking). With this assumption, we would get the hybrid NKPC, in which inflation expectations would be influenced by backward looking and forward looking and the output gap (as a proxy of marginal cost).
to control inflation is only limited to core inflation and not overall CPI inflation. Core inflation is influenced by fundamental factors such as the output gap, exchange rates, particularly prices of imported goods (imported inflation), and inflation expectations. Other components, such as volatile food and administered prices which are part of the CPI inflation rate, are not in the central bank’s domain of influence. Thus, a low and stable inflation rate cannot be achieved solely through the monetary policy of Bank Indonesia, but is also determined by fiscal and other economic policies pursued by the government. In addition to reducing the exchange rate pass-through effect into inflation, it is necessary to also support policies to prevent exchange rate from being too volatile.

As noted earlier, the influence of core inflation on CPI inflation is more dominant than volatile food and administered prices. Meanwhile, core inflation is more affected by inflation expectations of the community compared to the output gap and exchange rates. To this end, the inflation target and monetary policy measures and monetary instruments used to achieve it should be communicated effectively to the public in order to influence and shape inflation expectations.

Hence, the credibility of monetary policy is essential for achieving a central bank’s goal of low and stable inflation. If economic agents are convinced that monetary policy would be capable or credible in achieving the inflation target, the inflation expectations of economic agents would be anchored to the inflation target leading to the actual inflation being anchored to the inflation target as well. This would further reduce inflation persistence. With a more credible monetary policy, the adjustment process of economic agents of anchoring inflation expectations to the target would be quick, and vice versa. As a common indicator, the deviation between inflation expectations and actual inflation to the inflation target is employed to indicate the credibility.

Due to the high persistence of inflation, a rapid process of disinflation would be very expensive as it requires tight interest rates which could cause a huge output loss. Consequently, to achieve the objectives of monetary policy and minimise the loss of social welfare, monetary authorities tend to implement gradual disinflation. If the decline in actual inflation is not significant, then inflation expectations of economic agents would adjust only marginally to the inflation target. Moreover, economic agents would rely on backward-looking behavior which increases the persistence of inflation.

From observation, it can be garnered that the credibility of monetary policy in Indonesia is relatively low, contributing to the persistence of high inflation (Harmanta, 2009). However, with the implementation of the ITF, the credibility of monetary policy has improved. This is reflected

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6 Erceg and Levin (2003) show that the low credibility of monetary policy of the US in 1980-1985 led to the persistence of high inflation and high cost (sacrifice ratio). An important implication of these findings is that the persistence of inflation is not an inherent characteristic of an economy but diversity associated with the credibility of monetary policy. It is shown that the persistence of inflation would be lower if monetary policy is credible, and otherwise create a high persistence of inflation when monetary policy is not fully credible (imperfect credibility) because economic agents have not fully believe in the inflation target in the future (forward looking).
by the increase of the Kalman Gain\textsuperscript{7} parameter from around 0.2 during the period before implementation of the ITF (July 2005) to approximately 0.4 in the period after ITF implementation. It may be argued that with increased credibility of monetary policy after the ITF, inflation tends to be more influenced by the behavior of forward-looking economic agents. As a consequence, declining inflation persistence would guide inflationary expectations towards the target due to deliberate policies of the monetary authority\textsuperscript{8}.

This is consistent with the observation of Orphanides and Williams (2007). Their study indicates that the formation of inflation expectations by focusing on the target inflation as the main goal of monetary policy in the era of ITF would facilitate the learning process of economic agents better than the non-ITF era with multiple objectives. This process would cause the inflation expectations of economic agents to be more forward looking and be anchored to the inflation target. The results are also consistent with Siregar and Goo (2008) who show that inflation inertia in Indonesia has decreased for both non-tradable goods and tradable goods in the period of implementation of the ITF, as compared to the period before implementation of the ITF.

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual Inflation (1)</th>
<th>Inflation Expectation (2)</th>
<th>Inflation Target (3)</th>
<th>Mistake (1) − (3)</th>
<th>Surprise (2) − (1)</th>
<th>Anchoring (2) − (3)</th>
<th>Credibility *)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>9.35</td>
<td>10.61</td>
<td>6.00</td>
<td>3.35</td>
<td>1.26</td>
<td>4.61</td>
<td>24</td>
</tr>
<tr>
<td>2001</td>
<td>12.55</td>
<td>14.29</td>
<td>7.25</td>
<td>5.30</td>
<td>1.74</td>
<td>7.04</td>
<td>21</td>
</tr>
<tr>
<td>2002</td>
<td>10.03</td>
<td>12.12</td>
<td>9.50</td>
<td>0.53</td>
<td>2.09</td>
<td>2.62</td>
<td>26</td>
</tr>
<tr>
<td>2003</td>
<td>5.06</td>
<td>8.04</td>
<td>9.00</td>
<td>-3.94</td>
<td>2.98</td>
<td>-0.96</td>
<td>46</td>
</tr>
<tr>
<td>2004</td>
<td>6.40</td>
<td>7.38</td>
<td>5.50</td>
<td>0.90</td>
<td>0.98</td>
<td>1.88</td>
<td>42</td>
</tr>
<tr>
<td>2005</td>
<td>17.10</td>
<td>9.75</td>
<td>6.00</td>
<td>11.10</td>
<td>-7.35</td>
<td>3.75</td>
<td>32</td>
</tr>
<tr>
<td>2006</td>
<td>6.60</td>
<td>9.20</td>
<td>8.00</td>
<td>-1.40</td>
<td>2.60</td>
<td>1.20</td>
<td>23</td>
</tr>
<tr>
<td>2007</td>
<td>6.60</td>
<td>7.47</td>
<td>6.00</td>
<td>0.60</td>
<td>0.87</td>
<td>1.47</td>
<td>47</td>
</tr>
<tr>
<td>2008</td>
<td>11.06</td>
<td>7.75</td>
<td>5.00</td>
<td>6.06</td>
<td>-3.31</td>
<td>2.75</td>
<td>37</td>
</tr>
<tr>
<td>2009</td>
<td>2.78</td>
<td>4.90</td>
<td>4.50</td>
<td>-1.72</td>
<td>2.12</td>
<td>0.40</td>
<td>51</td>
</tr>
</tbody>
</table>

*) Credibility: the number of respondents that have a range of inflation expectations in inflation targeting monetary authority (Business Survey - BI, processed).

Meanwhile, the Business Survey – BI (SKDU) with 2,000 companies as respondents shows that 51% of the companies anchor their inflation expectations on the target at the end of 2009. This number has increased significantly as compared to around 24% in the early days of ITF implementation. If the results of the survey are used as a proxy for the degree of credibility

\textsuperscript{7} Technically, the Kalman Gain parameter captures a projection by economic agencies on an inflation target of monetary authorities in the Taylor rule equation through the derivation of Kalman filter. The Kalman gain parameter reflects the learning process of economic agents about the target inflation which the monetary authorities could use as a measure of the degree of credibility of monetary policy. The faster the learning process by the economic agents, about the inflation target of monetary authorities, the higher the degree of credibility of monetary policy. Kalman Gain value is between 0 and 1, where it is getting closer to a more credible monetary policy.

\textsuperscript{8} The behaviour of economic agents that are more forward looking in inflation formation during the period of ITF implementation is in line with the findings due to Solikin (2004), Yanuarti (2007), and Alamsyah (2008).
of monetary policy, then the credibility has increased from approximately 0.24 to 0.51 in line with the consistent implementation of the ITF, see Table 2.2.

2.3.2 Monetary Policy Credibility and Disinflation Process

Theoretically, the ITF aims to achieve a low and stable inflation. Although there is no agreement on how much the inflation target should actually be, the general long-term target level of inflation in developing and developed countries is around 2% - 3% (Roger and Stone, 2005). However, for developing countries, including Indonesia, inflation is quite far from this desired level of long-term inflation. The average inflation for developing countries implementing the ITF is above 13% (double digit), higher than the developed countries’ 4% (Fraga et al., 2004). Obviously, this would lead to different disinflation strategies in the ITF era. Most developing countries usually set their inflation targets in the short-term time horizon, usually very early on in the implementation of annual targets in order to build the ITF and increase the credibility of monetary policy.

Based on the empirical experience of many countries, there are several strategies to reduce inflation. In general, developed countries that have a low inflation level, (i.e. single digit) aggressively pursue a strategy of disinflation to reach a level-term inflation of about 2.0% - 3.0%. Meanwhile, developing countries that have a fairly high level of inflation (i.e. double digit) usually use a gradual disinflation strategy, targeting the short-term inflation with a rate of decrease of about 0.8% per year before converging to the long-term inflation level of around 2.0% - 3.0% (Roger and Stone, 2005).

The Indonesian case shows that the disinflation process conducted by the monetary authorities would bring about a “sacrifice cost” in the form of declines in economic growth, given that monetary policy is not fully credible (Harmanta, 2009). Therefore, as monetary policy is not fully credible in Indonesia, the process of convergence of perceptions or expectations of economic agents to the inflation target is slow and gradual. In light of this, the

---

9 Experience in several ITF countries shows that the inflation target set has the following characteristics: (i) quite low inflation, (ii) low inflation volatility, (iii) challenging efforts by the central bank, and (iv) could be achieved with a minimum loss of output.

10 Some researchers show that the strategy is strongly influenced by the credibility of disinflation policies of central banks/monetary authorities. Developed countries are considered to have more credible monetary policies and tend to implement an aggressive strategy of disinflation because their monetary policies are able to guide inflation expectations of economic agents and actual inflation towards its target quickly. Hence, interest rate response would be optimal and would not cause a large loss of output. While monetary policies of developing countries are considered less credible, the strategy of disinflation is likely to be applied gradually as monetary policy has not been able to fully guide inflation expectations. Response rates are therefore not optimal and may cause large loss of output.

11 As shown by Ball (1994, 1995) and Roberts (1997), disinflation could be implemented without a significant sacrificial fee (costless) if inflation expectations are purely rational and monetary policy is fully credible (perfect credibility).

12 In such a situation of a not fully credible monetary policy, inflation expectations on actual inflation and the slow economic convergence of the inflation target, rapid disinflation would require a response in interest rates so high that it could raise the cost in the form of high output loss. Consequently, to implement a monetary policy that minimises the loss of social welfare, the central bank pursues a strategy of gradual disinflation. Economic agents look at actual inflation rather than the inflation target. By observing a gradual decline in inflation, expectations of economic agents would adjust only marginally against the inflation target.
disinflation strategy in Indonesia during the period 2000 - 2008 tended to be gradual, at approximately -0.5% per year, slightly lower than average disinflation rate of other developing countries which is around -0.7% per year (Roger and Stone, 2005).

The disinflation process in Indonesia has to be gradual due to imperfect credibility of monetary policy. An overly aggressive monetary policy to speed up the disinflation process may entail a high cost in terms of output loss and sacrifice ratio. In the context of a small open economy, the impact of a rapid reduction in the inflation rate with imperfect credibility would put a lot of appreciation pressure on the exchange rate, thus exacerbating the inflation-output trade off\textsuperscript{13}. Therefore, the strategy of gradual disinflation is taken in consideration of factors such as high prevailing double-digit inflation, moderate degree of persistence, and expectation behaviour that is backward-looking.

Chart 2.4
Projection of Disinflation Process

With this strategy, the achievement of the long-term inflation target in Indonesia is expected to take quite a while. Moreover, it is also highly influenced by the credibility progress of monetary policy itself and the dynamics of public learning. Related to this issue, an empirical study by Cukierman (2005) shows that one of the characteristics for the stabilisation of inflation from double digits to low single-digit inflation would be gradual disinflation. Experience from some countries, such as Chile shows that the process of disinflation to low levels in the ITF would require more or less 36 quarters, or nearly 9 years (Schmidt-Hebbel and Werner, 2002). In fact, apart from Indonesia, there are still some developing countries implementing ITF with on-

\textsuperscript{13} When monetary policy is not fully credible, the slow decline in interest rates could possibly generate a larger output loss. Monetary policy that is too tight would affect the behaviour of economic agents causing consumption to slow down. Furthermore, it affects the production side and output would decrease, impacting the Sacrifice Ratio.
going disinflation processes, such as the Philippines (since 2002), Colombia (since 1999), Romania (since 2005), and Turkey (since 2006) (Roger, 2009).

2.4 Various Measurement of Monetary Policy Credibility

Implementation of monetary policy in an inflation targeting framework (ITF) cannot be separated from the inflation expectations of economic agents. In the setting of inflation targets by central banks, there are two polar possibilities taken by economic agents in terms of “confidence” or “no confidence”. The level of economic agents’ confidence is an abstract concept but it has high implications for the achievement of the inflation target. In other words, the level of confidence of economic agents is directly proportional to the level of central bank credibility. The higher the level of confidence of economic agents, the higher the credibility of monetary policy. Inflation expectations are therefore vital for anchoring the inflation target of monetary authorities.

Blinder (1999) defines credibility as “words matching deeds”. Compatibility between words and actions is actually the core of credibility. In the inflation-targeting context, an institution is considered credible if it implements its monetary policy to achieve what has been explicitly stated. This definition is similar to Svensson (1999) who shows that a credible monetary policy is reflected in the close relationship between inflation targets and inflation expectations of economic agents, as against policies which are not credible. Despite the varying general definitions, there are several options that can be considered in the technical measurement of credibility (credibility index). Given the qualitative characteristic, the level of credibility is generally defined in the form of a value in the range from 0 (not credible) to 1 (perfectly credible).

Valentin and Rozalia (2008) offers a method for measuring the credibility of monetary policy, formulated as follows:

\[
ICI_{\text{adj}} = \begin{cases} 
1 - \frac{\pi^e - \pi_{\text{target}}}{\pi_{\text{target}}}, & \text{if } |\pi^e - \pi_{\text{target}}| < \pi_{\text{target}} \\
0, & \text{if } |\pi^e - \pi_{\text{target}}| \geq \pi_{\text{target}} 
\end{cases}
\]

With \( \pi^e \) being inflation expectations of economic agents (private sector) and \( \pi_{\text{target}} \) the central bank inflation target. For illustration, in terms of perfectly successful anchored inflation expectations on the inflation target (\( e\pi = \text{target } \pi \)), the equation above would provide a valuable index for credibility or perfect credibility. Conversely, if inflation expectations are very high or higher than twice the inflation target, the credibility index would then be valued at 0 or is not credible (no credibility). It is worth mentioning that this approach imposes “symmetric punishment”.

As an alternative measurement of the credibility of monetary policy, Cecchetti and Krause (2002) formulates the following:
With $\pi_c$ as inflation expectations of economic agents (private sector) and $\pi_{\text{target}}$ the central bank’s inflation target. If inflation expectations miss the upper bound of 20%, then the credibility index would be 0 automatically (not credible). Unlike previous measures, Cecchetti and Krause (2002) does not impose symmetric punishment and inflation expectations moving in sync with an inflation target represent a success for the central bank and therefore the credibility index value is 1 (perfect).

Credibility of the ITF is crucial, particularly for central banks in developing countries which are usually not independent from the influence of government or political establishments. This credibility can also be developed through communication and transparency to further enhance public trust and inflation expectations on the inflation target. As a low and stable inflation rate is a prerequisite for sustained macroeconomic development, central banks have substantial flexibility in conducting monetary policy. Thus, the ITF framework is often described as “constrained discretion” (Bernanke and Mishkin, 1997). Constraint is manifested through high transparency and accountability of central banks, in order to generate credibility of monetary policies on the disinflation process and to reduce the problem of time-inconsistency.

3. Methodology & Model

3.1 Model Structure and its Transmission Mechanism

The ARIMBI with Imperfect Credibility is a small scale model of the quarterly macroeconomic model adopted from the Global Projection Model (GPM) of the IMF with the added feature of monetary policy credibility. However, because Indonesia does not have a good source for unemployment data, the unemployment rate equation is not included. This model is a gap model comprising the main macroeconomic variables such as output, inflation, short-term interest rate, exchange rates and monetary policy credibility. The gap of each variable to the value of balance is the essence of the model. In addition, it also includes other variables and the complement of the identity equation.

Before further review of the equations in each model, we must first briefly explain the relationship between the macroeconomic variables and the transmission mechanism of the model.

3.1.1 Model Structure

The relationships between the variables in the ARIMBI with Imperfect Credibility is described in the following diagram:
Diagram 3.1 above shows that there are four primary behavioral equations in the model, namely the inflation equation of the New Keynesian Phillips Curve (NKPC), the output gap, uncovered interest rate parity (UIP) and the Taylor’s rule. The inflation equation, besides being influenced by forward- and backward-looking inflation, is also affected by the output gap, changes in oil prices and real exchange rate. The output gap equation is affected by the backward- and forward-looking variable itself, the real interest rate, real exchange rates and external demand (captured by the US GDP). The Taylor’s Rule equation for determining the nominal policy interest rate is influenced by the real interest rate, deviations of inflation from target and output gap while the UIP, which is a deviation between the expectations of the exchange rate and interest rate differentials are influenced by both domestic and foreign (rest of the world) factors.

One important assumption of the model is that the attainment of inflation targets with minimum cost is strongly influenced by the credibility of monetary policy. There are two ways to capture the dynamics of the credibility of monetary policy in a model and these are the exogenous and endogenous factors. Modelling exogenous credibility of monetary policy assumes that the credibility of monetary policy moves to follow the auto regressive AR (1). Meanwhile, modelling the endogenous credibility of monetary policy is to assume that the credibility of monetary policy is in the nature of stock and would be increased or decreased in accordance with the past performance of the previous inflation target. In this case, the better the past performance, the more credible is monetary policy from the previous. In other words, increasing the credibility of monetary policy would cause inflation expectations to become closer to the inflation target, and the forecast of future inflation would get closer to the inflation target. Therefore, the higher
the credibility of monetary policy, inflation expectations and actual inflation would be anchored sooner to the inflation target.

3.1.2 Transmission Mechanism of Monetary Policy and Credibility

As a model designed to support the inflation targeting framework, the ARIMBI with Imperfect Credibility tracks the transmission mechanism of the BI rate as the monetary policy tool to achieve the inflation target. The model has an inflation target as an anchor. If, for example, there is a shock which affects the attainment of the target, the model can be used to simulate an appropriate monetary policy to drive inflation towards the target, in addition to the use of professional judgment.

Interest rate as a monetary policy instrument is expected to drive inflation towards the target via multiple transmission channels. Interest rates could affect inflation through the output gap and real exchange rate. The output gap could directly affect inflation via the existence of excess demand, while the real exchange rate could directly (direct pass-through) affect inflation via imported inflation. Exchange rates could also indirectly (indirect pass-through) impact inflation through the output gap as export activities increase aggregate demand. Meanwhile, as earlier stated, the transmission mechanism of monetary policy credibility depends on the confidence of economic agents on monetary policy in achieving the inflation target.

3.2 Data

The model utilises eight variables, namely real GDP, CPI inflation, short-term interest rate, exchange rate, U.S. inflation, Fedfund rate, U.S. GDP and world oil prices (Minas). Before the filtering process to separate the variables and its gap and trend, the seasonal effects of the variables are removed by employing the X12 US Census Bureau. The filtering process generally comprises the HP filter method with some adjustment to the level and trend growth in the variable.

The data range used is 2000:Q1 to 2009:Q4. Indonesia does not utilise long historical data for several reasons - before 1997, Indonesia implemented a fixed exchange rate regime and there is significant jump in the data due to economic crisis in the late 1990s.

3.3 Calibration Parameters

Behavioral parameters determine the dynamics of the model for long-term equilibrium or steady state. Behavioral parameters in the ARIMBI model use the parameter calibration approach based on parameters in other models such as the BISMA of Bank Indonesia and other studies on countries which have the same characteristics of the Indonesian economy. The following baseline parameters used in ARIMBI are as follows:
In addition to behavioral parameters, there are steady-state parameters that must be included. These parameters reflect a state in the long term that would be aimed for. The magnitude of these parameters is obtained based on historical average considerations of existing conditions coupled with the Indonesian government’s vision for the long term. Some of the steady-state parameters included in the model are presented in Table 3.2.

<table>
<thead>
<tr>
<th>No</th>
<th>Parameter</th>
<th>Description</th>
<th>Value %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>growth_ss</td>
<td>GDP Growth</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>r_us_ss</td>
<td>US Real Interest Rate</td>
<td>0.5</td>
</tr>
<tr>
<td>3</td>
<td>dz_ss</td>
<td>Real Exchange Rate Depreciation</td>
<td>-1.5</td>
</tr>
<tr>
<td>4</td>
<td>prem_ss</td>
<td>Risk Premium</td>
<td>2.5</td>
</tr>
<tr>
<td>5</td>
<td>pietar_ss</td>
<td>Inflation Target</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>dcpi_us_ss</td>
<td>US Inflation</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>cpiplus</td>
<td>Maximum Punishment on Inflation</td>
<td>0.5</td>
</tr>
</tbody>
</table>

* Endogenous Credibility Model only
Assuming a steady-state value as stated above, it implies that the steady-state real interest rate is 1.5\%, the nominal interest rate is 4.5\%, U.S. nominal interest rate is 2.5\% and the nominal exchange rate appreciation is -0.5\%. In other words, in a steady state, the Rupiah (Indonesian currency) would appreciate by 0.5\%. Cpiplus parameter is a new feature in this model that illustrates how much additional maximum inflation is added to the variable inflation expectations if the central bank has no credibility. Further discussions on this would be included in next section.

3.4 Equations

The ARIMBI with Imperfect Credibility has several advantages in that it provides reasonable fit, good theory model structure as well as it can be be used for forecasting and policy simulation (FPAS). The equations used in the model reflect the characteristics of the Indonesian economy. There are a number of key assumptions in the model. That Indonesia is a developing and open economy in comparison with the rest of the world (ROW), and is assumed not affecting ROW, but is instead affected by shocks that occur in the ROW.

3.4.1 Main Equations

The trend variable is denoted by using alphabet letters with symbols line or bar on top, while the gap is denoted by using alphabet letters with symbols hat or cap on it. The annual rate year-on-year (y-o-y) variable is represented by four digits after the variable name, while the annual rate of quarterly (quarterly annualised) variable is denoted by four scoreless after the variable name, for example y-o-y CPI inflation is denoted by $\pi_{t}^{\text{CPI}}$. The growth variable is generally denoted by the letter d in front of a variable, e.g. GDP growth y-o-y denoted by $dy_{t}$.

The gap is the difference between the variable and its potential value. The variable $y$ is defined as 100 multiplied by the log of real GDP, $y_{\text{bar}}$ as 100 multiplied by the log of output potential and $y_{\text{hat}}$ as the output gap in percentage units, deriving $\hat{y} = y - \bar{y}$. The annual rate of quarterly inflation ($\pi_{t}^{\text{CPI}}$) is defined as 400 times the first difference of log CPI. While inflation y-o-y ($\pi_{t}^{4\text{CPI}}$) is defined as 100 multiplied by the difference between inflation at this quarter and its previous four quarters. Several other important variables include $i$ which is nominal interest rate, $r$ the real interest rate, $s$ the nominal exchange rate Rupiah per U.S. Dollar and $z$ the log real exchange rate Rupiah compared to the U.S. Dollar.

(i) Main Equation

Equations (3.1) to (3.4) are the main behavioral equations which describe the transmission mechanism in the model.

$$\hat{y}_{t} = \beta_{1}\hat{y}_{t-1} + \beta_{2}\hat{y}_{t+1} - \beta_{3}\hat{z}_{t} + \beta_{4}\hat{r}_{t} + \beta_{5}\hat{r}_{t} - \beta_{6}(\hat{h}_{t}^{\text{RPOIL}} - \bar{d}_{t}) + e_{t}$$  \hspace{1cm} (3.1)
Equation (3.1) is a behavioral equation for the output against the value of its lag and lead (a measure of backward- and forward-looking), real interest rate gap, the real exchange rate gap, output gap in other countries, inflation in the real world oil prices and disturbance terms.

Equation (3.2) is a New Keynesian Phillips Curve equation to determine the level of inflation, where inflation is described by past and future inflation, output gap, real exchange rate, and real world oil prices to the inflation disturbance term. The output gap is the variable that links the real side of economy with the inflation rate. The inflation rate is also influenced by changes in the Indonesian real exchange rate (Rupiah) against the U.S. bilaterally.

\[ \pi_t^{PL} = \lambda_1 \pi_{t-1}^{PL} + (1 - \lambda_1) E_t \pi_{t+1}^{PL} + \lambda_2 \tilde{y}_t + \lambda_3 \tilde{z}_t + \lambda_4 (\pi_t^{EOM} - \tilde{d}_t) - \sigma_t^{PPL} \]  

Equation (3.3) above is the Taylor’s rule equation used to determine the nominal value of short-term interest rates, which in this case can be interpreted as the Indonesian policy rate (BI Rate). The value of the interest rate is defined as a function of its lagged value (a smoothing device for capturing short-term rate changes) and the central bank’s response to changes in the deviation of the output gap between the expectations of inflation with the target inflation. In other words, Bank Indonesia seeks to achieve long-term equilibrium interest rate (which is the sum of the equilibrium real interest rates and one quarter ahead expectation inflation), where interest rates could also be adjusted in response to a deviation from expectations. The year-on-year inflation rate fourth quarter would come from the inflation target, \( \pi_t^{ACPI} - \pi_t^{TAR} \), and against the current output gap. This equation also has disturbance term to accommodate the adjustment of nominal interest rates if the results generated by the above equation are not fitting.

\[ i_t = \gamma_1 i_{t-1} + (1 - \gamma_1) (\tilde{r}_t + \pi_t^{TAR} + \gamma_2 (\pi_t^{EPL} - \pi_t^{TAR}) + \gamma_3 \tilde{y}_t) + \sigma_t \]  

Equation (3.4) is the uncovered interest parity (UIP), which is the expected depreciation \( (E_t s_{t+1} - s_t) \) equals to the nominal interest rate differential between the U.S and Indonesia. This calculation also includes the balance of risk premium, whereby if the interest rate in Indonesia is higher than US, there are one of two possibilities that could happen, or a combination of the two possibilities, namely whether the nominal exchange rate of Indonesia against the U.S. would experience a depreciation in the period Next \( (E_t s_{t+1} \) higher than \( s_t \)), or the nominal interest rate balance between Indonesia and the US is different because of the risk premium. A disturbance term is also included.

The expected nominal exchange rate is weighted by the nominal forward exchange rate that would occur with the assumption of perfect foresight, \( s_{t+1} \) expectations, with its variable lag, \( s_{t-1} \), which is added to twice the trends of exchange par for each quarter, \( 2(\tilde{d}_t + \pi_t^{TAR} - \pi_t^{CPI, US, SS})/4 \) because the nominal exchange rate variable has a trend.

\[ E_t s_{t+1} = \sigma s_{t+1} + (1 - \sigma)(s_{t-1} + 2(\tilde{d}_t + \pi_t^{TAR} - \pi_t^{CPI, US, SS})/4) \]  

24
(ii) World Oil Price Equation

World oil price data is the price of oil that comes from Minas (USD/barrel). Incorporating world oil prices into the model requires several steps. Assuming that US inflation from the world representing the real world oil price levels could be calculated with the equation:

\[ p_t^{\text{RPOIL US}} = p_t^{\text{OIL US}} - \pi_t^{\text{CPI US}} \]  \hspace{1cm} (3.6)

Then the filtering process is carried out by separate variables for trends and gaps in the real world oil price levels

\[ p_t^{\text{RPOIL US}} = \hat{p}_t^{\text{RPOIL US}} + \hat{P}_t^{\text{RPOIL US}} \]  \hspace{1cm} (3.7)

It is assumed that the growth trend of real world oil price is zero, so

\[ \hat{p}_t^{\text{RPOIL US}} = p_{t-1}^{\text{RPOIL US}} + \epsilon_t^{\text{RPOIL US}} \]  \hspace{1cm} (3.8)

While in the real world oil price gap is modeled by an AR (1)

\[ \hat{P}_t^{\text{RPOIL US}} = (1 - \rho_\epsilon^{\text{RPOIL US}}) \hat{P}_{t-1}^{\text{RPOIL US}} + \epsilon_t^{\text{RPOIL US}} \]  \hspace{1cm} (3.9)

The calculation of real world oil price inflation is

\[ \pi_t^{\text{RPOIL US}} = 4(p_t^{\text{RPOIL US}} - \hat{P}_t^{\text{RPOIL US}}) \]  \hspace{1cm} (3.10)

Hence, the real world oil price inflation is converted from units of (USD/barrel) in local currency,

\[ \pi_t^{\text{RPOIL US}} = \pi_t^{\text{RPOIL US}} + d_z \]  \hspace{1cm} (3.11)

(iii) Equation Variable Trend /Potential

For potential output variables, the shock is assumed to occur only in the growth rate of potential output. This shock causes a persistent deviation between potential output growth and value growth in the long-run steady-state it.

\[ \bar{dy}_t = \rho_d^{\text{SS}} \bar{dy}_{t-1} + (1 - \rho_d^{\text{SS}}) \bar{dy}^{\text{SS}} + \epsilon_t^{\text{dy}} \]  \hspace{1cm} (3.12)

Equation (3.12) states that the growth of potential output, in the long term is equal to the value growth of steady-state is, but could deviate from the growth of its steady state depending on the value of error, whether negative/ positive. Furthermore, it would return to the steady-state growth gradually, with a speed in accordance with its parameter values, whereby the greater the value, the faster potential output leads to the steady state.

For the target variables of inflation - the risk premium and real interest rates of U.S. trends - the same assumptions as the potential output variables in the equation (3.12) are used.
Meanwhile, for the variable trend of real interest rates and trend real exchange rate depreciation, the same assumptions as the UIP relationship are followed or:

\[
\bar{\pi}_t = \pi^{\text{US, SS}}_t + d_s^{\text{SS}} + \text{prem}_{t}^{\text{SS}} \\
\frac{\pi^{\text{US}}_t - \bar{\pi}^{\text{US}}_t - \text{prem}_t}{\pi^{\text{US}}_t} = \frac{d_s^{\text{SS}}}{\pi^{\text{US}}_t} - \text{prem}_t
\]  

(iv) Identity Equation

The identity equation is divided into three parts, namely the equation for calculating an annualised year-on-year quarterly growth, as in the following equations:

\[
\pi^{\text{CPI}}_t = 4\left(P^{\text{CPI}}_t - P^{\text{CPI}}_{t-4}\right)  \\
\pi^{\text{CPI, US}}_t = 4\left(P^{\text{CPI, US}}_t - P^{\text{CPI, US}}_{t-4}\right)  \\
\pi^{\text{4 CPI}}_t = 4\left(P^{\text{4 CPI}}_t - P^{\text{4 CPI}}_{t-4}\right)  \\
\frac{dy_t}{\pi^{\text{CPI}}_t} = 4\left(y_t - y_{t-1}\right)  \\
\frac{dy_t}{\pi^{\text{US}}_t} = 4\left(y_t - y_{t-1}\right)  \\
\frac{dy_t}{\pi^{\text{4 CPI}}_t} = 4\left(y_t - y_{t-4}\right)  \\
\frac{dz_t}{\pi^{\text{CPI, US}}_t} = 4\left(z_t - z_{t-1}\right)  \\
\frac{dz_t}{\pi^{\text{US}}_t} = 4\left(z_t - z_{t-1}\right)
\]

Or the equation that represents the identity of the filtering process to separate the trends and gaps between variables, such as the following:

\[
y_t = \tilde{y}_t + \hat{y}_t \\
z_t = \tilde{z}_t + \hat{z}_t \\
r_t = \tilde{r}_t + \hat{r}_t
\]

The last is the equation of identity that reflects the relationship that comes from such a simple economic theory: equation (3.30) and (3.31) define the real interest rate as the difference between the nominal interest rate and CPI inflation expectations at a subsequent quarter.

\[
r_t = \pi_t - \pi^{\text{CPI}}_{t-1}  \\
r^{\text{US}}_t = \pi^{\text{US}}_t - \pi^{\text{CPI, US}}_{t-1}
\]

Equation (3.32) is the relationship of real exchange rate, \(z_t\) at the rate of nominal, \(s_t\) which is defined as the Indonesian currency (Rupiah) as compared to the U.S. Dollar, added to the CPI
\( (P_{t}^{CPI,US}) \) in the US, less the CPI, Indonesia \( (P_{t}^{CPI}) \). An increase in the value \( z_{t} \), denotes a real depreciation in Indonesian Rupiah against the US dollar.

\[
z_{t} = (s_{t} + P_{t}^{CPI,US}) - P_{t}^{CPI}
\]

(5) **Equation Rest of the World**

With the assumption that the Indonesian economy is a relatively small open economy, the Rest of the World equation is modelled by an AR (1):

\[
\begin{align*}
\hat{y}_{t}^{*} &= \rho_{\hat{y},US} \hat{y}_{t-1}^{*} + e_{t}^{*} \\
i_{t}^{US} &= \rho_{i,US} i_{t-1}^{US} + (1 - \rho_{i,US})(\bar{n}_{t}^{US} + \pi_{t}^{CPI,US}) + e_{t}^{US} \\
\pi_{t}^{CPI,US} &= \rho_{\pi,US} \pi_{t-1}^{CPI,US} + (1 - \rho_{\pi,US})\pi_{t}^{CPI,US} + e_{t}^{\pi,US}
\end{align*}
\]

3.4.2 **Credibility Equations**

The new features of this model are the credibility variables. These include \( 1-INCRE\_D_{t} \), so variables that are explicitly used is variable \( INCRE\_D_{t} \) or a variable that represents credibility of the central bank. \( INCRE\_D_{t} \) that has a value one (1) denotes that the central bank has no credibility at all, while a \( INCRE\_D_{t} \) value of 0 denotes full credibility.

In principle, adding credibility is done by changing the inflation expectations variable \( \pi_{t+1}^{CPI} \) with perfect foresight previously assumed to be variable for inflation expectations. The equation contains elements of penalties depending on the credibility of central banks, or is written as:

\[
E_{t}\pi_{t+1}^{CPI} = \pi_{t+1}^{CPI} + cpiplus \cdot INCRE\_D_{t}
\]

Where, as previously described, the parameter \( cpiplus \) illustrates how much additional maximum inflation is added to the inflation expectations variable if the central bank has no credibility. For example, if the central bank has no credibility at all, it would mean that the variable \( INCRE\_D_{t} \) has a value of one while the value of \( cpiplus \) would be 0.5, meaning that the inflation expectations is 0.5% higher than inflation expectations with perfect foresight.

In this paper, we model two types of credibility, namely exogenous and endogenous. The ARIMBI with exogenous credibility simply feeds the variable \( INCRE\_D_{t} \) into the AR (1) towards the value of steady state of zero, or in other words, assumed credibility would be increased from time to time to the credibility of management (full credible)

\[
INCRE\_D_{t} = \rho_{INCRE\_D} INCRE\_D_{t-1} + e_{t}^{INCRE\_D}
\]

Meanwhile, the model with endogenous credibility adds the past performance of the attainment of inflation to its target into the equation above:

\[
INCRE\_D_{t} = \rho_{INCRE\_D} INCRE\_D_{t-1} + (1 - \rho_{INCRE\_D})\alpha(\pi_{t-1}^{CPI} - \pi_{t-1}^{TAR}) + e_{t}^{INCRE\_D}
\]
In endogenous approach, we try to incorporate credibility which does not always increase from time to time, but depends on the past performance.

3.5 Measurement of Monetary Policy Credibility

In the development and usage of the ARIMBI with Imperfect Credibility, we need to know the value of central bank credibility under current conditions as an initial value. From the perspective of forecasting, the credibility value is entered as the initial value at the time when data with the actual date is available. For example, if forecasting begins in 2009:Q2, the credibility indices that are to be used would be the initial value in 2009:Q1.

The credibility index measurement of Bank Indonesia uses the two approaches of Valentin and Rozalia (VR, 2008) and Cecchetti and Krause (CK, 2002). The inflation target uses annual data 2002-2009 of both the targets set by BI as well as by the government with input from the central bank. Inflation expectations use three sets data, namely: Business Survey (Survey SKDU BI), Consensus Forecast (CF) and Actual Inflation. Therefore, six BI credibility indices can be derived as a result. Previous research (Harmanta, 2009) using the Bayesian estimation of DSGE models of small open economy for the data period 2000-2008 produced an index figure of 0.4. Generally, it is believed that the current monetary policy credibility of Bank Indonesia is not completely perfect (imperfect credibility). However, in the long term, coupled with the communication and transparency as well as policy consistency of Bank Indonesia, the credibility of monetary policy is expected to increase slowly but surely.

4. Results and Analysis

4.1 Initial Credibility Index

As already mentioned above, the index measuring the credibility of monetary policy is modelled after VR 2008 and CK 2002. For the measurement of CK 2002, loose adjustments of 20%-15% are made over the previous limit. This is in consideration that Indonesia is a developing country and its business environment is relatively more uncertain compared to developed countries. Based on the historical data of Indonesia, the highest CPI (y-o-y) in Indonesia was 17.11% in 2005 but has never reached 20%.

Using expectations data (Survey SKDU BI, Consensus Forecast and Actual Inflation), we obtained the values for BI’s Credibility Index BI as follows:

<table>
<thead>
<tr>
<th>No</th>
<th>Data for Expectation</th>
<th>Credibility Index (VR 2008)</th>
<th>Credibility Index (CK 2002)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Survey SKDU- BI</td>
<td>0.604</td>
<td>0.664</td>
</tr>
<tr>
<td>2</td>
<td>Consensus Forecast</td>
<td>0.789</td>
<td>0.841</td>
</tr>
<tr>
<td>3</td>
<td>Actual Inflation</td>
<td>0.581</td>
<td>0.740</td>
</tr>
</tbody>
</table>
Table 4.1 above shows that how different inflation expectations data and measurement indices produces different results, ranging from 0.581 till 0.841. The results show that the credibility of monetary policy in Indonesia during the period 2000 - 2009 is not completely perfect (imperfect credibility). Based on these results and taking into account other previous results (such as Harmanta (2009) which showed 0.41 and 0.51 number of companies that inflation expectations anchored to the target), for the next section we use a conservative value of 0.50 as the initial credibility value.

4.2 Assumption of Steady-state Variables

Several important assumptions and conditions in simulation and forecasting for aggregate macroeconomic variables in the study are taken as follows:

- Long-term inflation target to be achieved with the implementation of the ITF in Indonesia amounting to 3% + 1% (see, for example, Monetary Policy Report of Bank Indonesia).

- Medium-term inflation target of Indonesia up to 2014-2015 of 4.0% (plus minus 1%), in line with the economic recovery process in order to achieve an economic growth of about 7.0% - 7.5% in the year 2014-2015, as targeted by government.

- In line with the measurement of the credibility of monetary policy as mentioned earlier (based on the measurement method of Cecchetti and Krause (2002), the SKDU Survey results and some results of previous studies (Harmanta, 2009), the initial value of the credibility of monetary policy is about 0.5.

- To gauge the impact of monetary policy credibility on the dynamics of macroeconomic variables, especially on the medium-term inflation target length with minimal cost, there are three scenarios of monetary policy credibility, namely: (i) the credibility of the baseline with the initial value of 0.5, (ii) less credible with initial value of 0.1, and (iii) more credible with the initial value of 0.9.

- Disinflation strategy for achieving low and stable inflation: (i) the long disinflation time required to reach the target medium-and long-term inflation, and (ii) the cost of disinflation: Sacrifice Ratio, i.e. the output loss that occurs for each decline in inflation by 1%.

The simulation results of policies and projections in this study are as follows:

4.3 Simulation Results of Exogenous Credibility

The simulation results and projections of macro variables with some degree of exogenous credibility are presented in the chart below:
Based on the chart above, the baseline scenario, with the assumption of monetary policy credibility with the initial value of 0.5 and considering the existence of inflationary pressures beginning in Quarter-10 (Q-10), the nearing of the upper limit of the inflation target in line with global and domestic economic recovery, interest rates (the optimum Taylor’s rule based on the endogenous ARIMBI), needs to be raised starting in Q-8 and gradually lowered beginning in Q-12. On the one hand, the path of inflation is likely to be anchored to 4.0% + 1% in Q-24. However, on the other hand, the path of interest rates would lead to an economic growth about 5.5% to 6.4% in next few quarters before going to achieve 7.0 - 7.5% in Q-24. In line with the path of interest rate and the trajectory of inflation and GDP, exchange rates would slightly appreciate before staying steady at Rp. 9300-9750/USD in the medium and long term.

In the less credible scenario, with the initial assumption of lower credibility value of 0.1, the path of inflation is higher than the baseline - inflation in Q-9 to Q-12 would approach the upper limit of the target. Hence, inflation starting in Q-13 would pass through the upper limit of the inflation target. Considering the existence of higher inflationary pressure compared to the baseline, the central bank should raise interest rates higher that those of the baseline to achieve the medium-term inflation target of 4% (plus minus 1%) in Q-24. The path to higher interest...
rates would lead to lower economic growth compared to the baseline to about 5.5% to 6.2% up to Q-12. For the overall cost of disinflation, the scenario of less credible monetary policy would result in the Sacrifice Ratio (output loss that occurs for the decline in inflation of 1%) being higher than the baseline. In the medium to long term, the less credible scenario also causes the trajectory to weaken the exchange rate as compared to the baseline.

For the more credible scenario which assumes a higher initial credibility value of 0.9, the path of inflation is lower than the baseline where inflation moves closer to the midpoint or the lower limit of the inflation target. Considering that the trajectory of inflation is lower than the baseline and has been anchored relative to the inflation target, the current interest rate could be maintained until Q7, before being lowered gradually. The path to lower interest rates would lead to higher economic growth compared to the baseline, to about 5 – 6% in next few quarters. From the perspective of disinflation cost, the scenario of a more credible monetary policy would cause the Sacrifice Ratio (output loss that occurs for the decline in inflation of 1%) to be lower than the baseline. In the medium to long term, a more credible scenario would cause the trajectory to further strengthen the exchange rate compared to baseline.

4.4 Simulation Results of Endogenous Credibility

Chart 4.2
Simulation Results of Endogenous Credibility
In the baseline scenario with the initial assumption of 0.5, considering the credibility of inflation pressure from Q-10 which approximates the upper limit of the inflation target, interest rates (optimum based on the Taylor’s rule in ARIMBI endogenous) need to be raised gradually from Q-6 and lowered gradually beginning in Q-11. With this interest rate path, the inflation target of 4.0% is likely to be achieved in the medium term. This interest rate path would also bolster economic growth to around 5.5% to 6.2% in next few quarters before achieving a steady economic growth of around 7.0% - 7.5%. In line with the path of interest rate and the trajectory of inflation and GDP, exchange rates would be stronger (appreciation) at around Rp. 9150-9550/USD.

In the less credible scenario, with the initial assumption of credibility of 0.1, the trajectory of inflation is higher than the baseline where inflation in the year 2011 would approach the upper limit of the inflation target. Considering the existence of higher inflationary pressure compared to baseline, the central bank should raise interest rates more than the baseline to achieve the inflation medium to term target of 4%. However, the path to higher interest rates would lead to lower economic growth compared to the baseline. From the cost of disinflation perspective, the less credible scenario would cause the Sacrifice Ratio (output loss that occurs from the decline in inflation of 1%) to be higher than the baseline. In the medium to long term, the less credible scenario also causes the trajectory to weaken the exchange rate compared to the baseline.

For the more credible scenario, the credibility index is assumed at 0.9. The trajectory for inflation is lower than the baseline - moving closer to the midpoint or lower limit of the inflation target. Considering the lower inflation trajectory than the baseline and relative anchoring to the inflation target, the current interest rate could be maintained up to Q-7, before being lowered gradually. Obviously, the path to lower interest rates would lead also to higher economic growth compared to the baseline (around 5.5 % to 6.5% in next few quarters). From the disinflation cost perspective, the more credible scenario would result in a lower Sacrifice Ratio (output loss that occurs for a decline in inflation of 1%) than the baseline. In the medium to long term, the more credible scenario would strengthen the exchange rate compared to baseline.

4.5 Simulation Results : Comparison of Baseline and Late Scenario

To analyse whether the timing of interest rate policy response affects the dynamics of the key macroeconomic variables, we simulate a late response rate (Late Scenario) compared to the baseline (optimum response rates), as presented in the chart below:
In the late scenario, with the assumption that monetary policy credibility of the initial value is equal to the baseline of 0.5, any delay in the hike of the policy response rate would cause the trajectory of inflation to be higher than the baseline. As we can see from Chart 4.3, inflation is near the upper limit of the inflation target up to the next eight quarters and pass the upper limit of the inflation target starting in Q-9. In order to achieve the medium-term inflation target (4% in Q-24) and considering that the inflation trajectory is higher than the baseline, interest rates need to be raised higher than the baseline before they can be reduced gradually from Q-16. This higher interest rates path would affect medium-term economic growth which is lower than the baseline. In terms of the cost of disinflation, the late scenario would yield a higher Sacrifice Ratio (output loss that occurs for a decline in inflation of 1%) than the baseline, especially in the medium term. Therefore, in the medium to long term, the slow response of monetary policy would lead to a path of a weaker exchange rate compared to the baseline.

Based on the above simulation results, this study shows that the delay in the response rate
would result in a higher inflation path and could even exceed the inflation target. Consequently, bringing down inflation back to the path of the target necessitates very high interest rates. Obviously, this in turn would slow economic growth. The trade off between inflation and higher output has the impact of increasing the Sacrifice Ratio, thus for every endeavor to decrease the inflation, a higher output loss is required. An implication of these findings is that Bank Indonesia would need to maintain timely consistency in responding to inflationary pressures with the optimum level of interest rates. Therefore, any delay in the monetary policy response could have an impact on the cost of disinflation.

4.6 Periods for Disinflation Process

In terms of the time frame of disinflation, Table 4.8 presents the simulation and projection length of disinflation for the medium-term target (4%) and long-term target (3%).

<table>
<thead>
<tr>
<th>Credibility Type</th>
<th>Periods for Disinflation Process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medium Term (4%)</td>
</tr>
<tr>
<td>Exogen</td>
<td></td>
</tr>
<tr>
<td>Initial cred = 0.1</td>
<td>25 quarters</td>
</tr>
<tr>
<td>Initial cred = 0.5</td>
<td>19 quarters</td>
</tr>
<tr>
<td>Initial cred = 0.9</td>
<td>11 quarters</td>
</tr>
<tr>
<td>Endogen</td>
<td></td>
</tr>
<tr>
<td>Initial cred = 0.1</td>
<td>31 quarters</td>
</tr>
<tr>
<td>Initial cred = 0.5</td>
<td>19 quarters</td>
</tr>
<tr>
<td>Initial cred = 0.9</td>
<td>11 quarters</td>
</tr>
</tbody>
</table>

Table 4.8 shows that the period length of disinflation for anchoring to the medium-term inflation target which is strongly influenced by the degree of monetary policy credibility. The scenario with the initial baseline monetary policy credibility value of 0.5, either exogenous or endogenous, takes less than 19 quarters to reach an inflation of 4% in the medium term. If the initial value of credibility is decreased to 0.1, the process of disinflation to the 4% medium-term target requires a longer period of 25 quarters (exogenous) or 31 quarters (endogenous). Conversely, if the initial value is increased to 0.9, the process of disinflation to the medium-term target only requires a time period of 11 quarters (exogenous) or 25 quarters (endogenous). Similarly, disinflation to reach the 3% long-term target requires a time frame of 22-24 quarters if the credibility of the initial value is 0.9. In a less credible situation (index set to 0.1), it would take a longer time of 48 quarters (exogenous) or 64 quarter (endogenous). For the baseline credibility of 0.5, it would require 40 quarters (exogenous) or 56 quarters (endogenous) to achieve long-term inflation target of 3%.

Comparing the endogenous and exogenous approaches, it is clear that the exogenous monetary policy credibility method, while simpler, yields less realistic results. This is because exogenous credibility cannot fully capture the reward - punishment factor in the attainment of the inflation targets. In contrast, the modeling of endogenous monetary policy credibility while more
complex, provides more realistic results. It has been argued that endogenous credibility is better able to capture the reward-punishment aspect of inflation target attainment with the inclusion of the specific deviation of inflation to the inflation target. For example, the greater the endogenous credibility of monetary policy, the smaller the deviations of inflation from its target, thus there are rewards for the shorter length of disinflation to 3% in contrast to the exogenous approach. Conversely, the smaller the endogenous credibility, the higher the deviations of inflation from its target and thus punishments for the longer disinflation length to reach the target of 3%. This finding is briefly summarised in the following matrix:

<table>
<thead>
<tr>
<th>Table 4.9</th>
<th>Comparative Matrix of Exogenous &amp; Endogenous Credibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Items</td>
<td>Exogen</td>
</tr>
<tr>
<td>Simple</td>
<td>V</td>
</tr>
<tr>
<td>Better Punishment-Reward Mechanism</td>
<td>-</td>
</tr>
</tbody>
</table>

Based on projected results and simulation of monetary policy credibility, this study specifically shows that:

- Inflation expectations of economic agents are strongly influenced by central bank monetary policy credibility. The more credible the monetary policy, the faster inflation expectations are anchored to the inflation target and thus a greater chance that actual inflation would be anchored to the target. This in turn would accelerate the disinflation process towards low and stable inflation in the medium to long term.

- Disinflation costs are greatly influenced by central bank monetary policy credibility. The more credible the monetary policy, the lower the cost of disinflation (reflected in the Sacrifice Ratio) to achieve low and stable inflation in the medium to long term. This, in turn, would minimise the trade off of output-inflation.

- Better controlled inflation at a low and stable level would provide conducive conditions for sustainable economic growth and less volatile exchange rate.

- Slower response of monetary policy in comparison to baseline optimum conditions may result in trending towards higher inflation, leading to longer time frames, higher interest rates and disinflation costs for the attainment of the inflation target.

5. Conclusions and Policy Implications

- The ARIMBI with Imperfect Credibility is theoretically coherent with reasonable fit. The required data is available and it can be used for forecasting and policy simulation (FPAS).

- The results of the model indicate that monetary policy in Indonesia is not fully credible (imperfect credibility) with a value of approximately 0.5 (a scale of 0 of no credibility and scale of 1 of perfect credibility).
• The projection and simulation results show that the disinflation to the target of low and stable inflation in Indonesia is influenced by the credibility of monetary policy. The more credible the monetary policy, the faster the disinflation process towards the target. In addition, the endogenous approach of monetary policy credibility is more realistic than the exogenous approach.

• The projection and simulation results also show that the disinflation cost of attaining the inflation target, measured as the Sacrifice Ratio, is strongly influenced by the monetary policy credibility. The more credible the monetary policy, the smaller the Sacrifice Ratio, meaning that the efforts to decrease inflation would not result in large output loss. The implication is that a central bank would face a smaller trade-off between stabilising inflation and stabilising output.

• The slow response of monetary policy in comparison to baseline optimum conditions would result in a higher inflation path, leading to longer time frames, higher interest rates and disinflation costs for the attainment of the inflation target.

• In terms of strategies for achieving the inflation target in Indonesia, the results show that as monetary policy conditions are not fully credible (imperfect credibility), the central bank has to implement a gradual disinflation process. A rapid process to the target would have implications on interest rate increases, possibly resulting in very large fluctuations in output and the exchange rate.

• The research shows that inflation expectations are greatly influenced by the credibility of monetary policy. The implication is that the management of inflation expectations while very important remains challenging. The central bank needs to consistently demonstrate its commitment to attain the inflation target.

• The simulation results support the mandate of the Bank Indonesia Act No.23 of 1999 and No.3 of 2004 requiring Bank Indonesia to publicly announce the inflation target and inflation as the overriding objective of monetary policy through the implementation of inflation targeting framework (ITF). The implementation of the ITF is an effort to enhance the credibility of monetary policy through the transparent commitment of achieving the inflation target in order for the expectation of economic agents to feedback realistically to the goal of the inflation target and disinflation programme.

• Related to the limitations and further research opportunities, the dynamics of the credibility of monetary policy is modelled in a linear fashion. Looking ahead, non-linear credibility would be challenging but very useful as it may capture effects of punishment-reward in a better and more realistic way.
References


