EFFECTS OF CREDIBILITY OF MONETARY POLICY: CASE OF KAZAKHSTAN AND MOLDOVA

by

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Abstract

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The study investigates the implications of credible monetary policy during disinflation period in Kazakhstan and Moldova. For this purpose a small forward looking macroeconomic model is constructed, where inflation expectations explicitly include credibility index. By setting different levels of credibility we estimated the period when macroeconomic variables converge to their long run values. We found that under low credible monetary policy inflation met its target in a two-fold longer period. However if Central Banks would gain half of public's trust the paths of output gap as well as inflation were approaching ones under full credibility.

TABLE OF CONTENTS

LIST OF TABLES

Number *Page*

LIST OF FIGURES

Number *Page*

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GLOSSARY

CB –Central Bank

Credibility - objective and subjective components of the believability of a source or message

Full-fledged inflation targeting policy - a clear commitment to an inflation target, institutionalising this commitment in the form of a transparent monetary framework that fosters accountability of the central bank to the target and have low flexibility with respect or other objectives

IT – inflation targeting

Chapter 1

INTRODUCTION

Until late '70s the economic literature on monetary policy modeling rarely considered the role of expectations. Lucas (1976) was among the first researchers to incorporate forward-looking expectations in macroeconomic models arguing that analysis of future consequences of economic policies based on past history is not appropriate. His argument was developed by Kydland and Prescott (1977) who introduced the concept of credibility of implemented policies. They claimed that the public assigns a probability to policymakers' commitment to reach some policy targets, and therefore, low credibility rather than irrational decision-making might explain the highly persistent inflation in an economy.

During the last three decades the literature on credibility of central banks has grown fast. Lalonde (2005) even tried to delimit the difference in agents' behavior based on the so-called credibility index. According to him, the latter is a combination of output and action credibility. The first is made of backward-looking agents who assign the level of credibility according to the previous ability of monetary policy to meet its targets while the action credibility is formed by forward-looking agents who consider a policy to be credible if it is able to meet the target according to the inflation expectations. In addition, Lalonde's paper emphasizes the importance of including endogenous policy credibility in a model to evaluate its implication on macroeconomic variables. It is assumed in that paper that under a credible announcement the disinflation costs are lower since the economy does not have to pass through the inflation-unemployment trade-off while trying to attain low inflation rates.

Hence, the problem of policy credibility lies in asymmetric information that arises between the central bank (CB) and the public. When CB announces its monetary

policy public has little information on further actions of CB and policymakers commitment to it. One way to show its commitment is to undertake a strategy that could be clearly observed by the public like central bank independence or fixed exchange rate, which was argued to be more costly to renege from rather than to revoke from a simple commitment (Keefer and Stasavage, 2002). Fixed exchange rate has been a popular policy in countries like China, Malaysia, and most of the former Soviet Union countries. However, it proved to be a bad instrument for the long run monetary and fiscal stability (Bernanke, 2005).

An innovative policy, namely inflation targeting was introduced by the Central Bank of New Zealand in 1989. Basically it promises to maintain a fixed level of inflation and adjust monetary policy instruments to bring the inflation back to its target level. In 2006 there were 23 countries, which already followed inflation targeting policy (IMF report, 2006), among which 16 were non-industrial economies. However, the effectiveness of this monetary policy highly depends on the level of credibility which influences expectations that are formed by the public.

In order to achieve a stable economic growth, policy-makers in the countries of the Former Soviet Union (FSU) also looked for appropriate monetary policy, and some of them (for example, Georgia, Kazakhstan, Moldova, Armenia) tried to pursue the inflation targeting policy. Credible policy has become especially important since the currency crisis of 1998 which significantly decreased people's confidence in monetary institutions. That is why the major goal of this study is to analyze the implications of the Lucas critique, namely the effect of expectations and monetary policy credibility on economic performance in the FSU countries. Specifically we would like to shed some light on how monetary policy credibility influences inflation expectations, output and other macroeconomic variables through their responses to the shocks to the interest rates.

The importance of the above mentioned issues comes from the following facts. Firstly, studies of credibility of monetary policy in the FSU countries have been primarily based on the exchange rate credibility. There is little evidence on the impacts of monetary policy on the price level in terms of potential disinflation programs. Soon after 1998 crisis, some countries of FSU began to implement policies, which gradually would permit them to become full-fledged inflation targeters. They started to announce inflation targets for the succeeding years and adopted floating exchange rate regime (leaving the right to intervene in FOREX market only in cases of speculative attacks). The weak point of this policy is gaining credibility so that inflation-output tradeoff is minimum during disinflation period. Therefore, the major goal was to pursue a credible inflation target policy. Hence, we would like to fill this gap and to study credibility of the latter monetary policy as well as to estimate to what extent a credible policy increases macroeconomic performance.

Moreover, the overwhelming majority of literature (see, for example, Laxton and N'Diaye (2002), Goncalves and Salles (2005), and others) that studies gains (losses) from the credibility of monetary policy is associated with the countries that implemented the full-fledged inflation targeting (IT) policy, which means "a clear commitment to an inflation target, institutionalising this commitment in the form of a transparent monetary framework that fosters accountability of the central bank to the target and have low flexibility with respect or other objectives"[1]. In this study, we want to test some findings of that literature for the countries that do not have explicit IT policy.

In economic literature small macroeconomic models are usually estimated by FIML, GMM or 3SLS. Unfortunately, all models developed for the transition countries are associated with the use of short time series that does not allow for

[1]"Inflation Targeting Regimes", IMF Working Papers 2003.

enough variability in the data and such estimation procedures as GMM are data demanding. In order to overcome this problem a 3SLS technique is used in this study. Received results will be used for Impulse Response analysis. The model developed in this paper is primarily based on a standard monetary policy framework, described by the Philips curve, IS curve and monetary reaction function. Credibility parameter is introduced in the way suggested in Laxton and N'Diaye (2002).

Data for estimation are collected from official sites of Central Banks and National Bureaus of Statistics of Moldova and Kazakhstan. The model will be estimated for the period of 8 years on the basis of quarterly data, from 2000 to 2007, when all the above-mentioned countries started to announce a specific level of annual inflation.

C h a p t e r 2

LITERATURE REVIEW

This section is organized as follows. First part describes theoretical findings and the main instruments which has been used to measure credibility and extent to which it affects the macroeconomic outcomes. The second part discusses empirical works, with emphasis on comparison between findings for transition and developing countries.

Measuring Credibility

Several credibility indicators have been developed in the literature. In general, a credibility indicator is not directly observable since it is associated with people's perception of the policy-makers' commitment to some rules. Therefore, it is important to find the "right" credibility measure that reflects the existing economic circumstances the best. The first mention of the credibility index in macroeconomic context was by Fellner (1976). Since then different ways to design it have been proposed.

Seminal papers by Kydland and Prescott (1977) and Barro and Gordon (1983) treat credibility as discrepancies between socially optimal inflation target and the one actually observed. In a theoretical framework the authors argued that in the long run policymakers should commit to rules in order to attain a socially desirable equilibrium. Yetman (2001), in a simple framework, showed that high degree of transparency of a monetary policy through publishing of reports and forecasts allows public to adjust their expectations which eventually decreases the gap between the perceived and actual levels of inflation. On the other hand,

Ferrero (2004) argues that it is not always optimal to commit to some rules. The author developed a model with rational expectations in which he showed that it is better to not react to perceived targets quickly but rather to allow for a slow convergence to rational expectation equilibrium (REE) when the perceived targets are lower than REE.

However, most of the studies did use some specific indicators for measuring the impact of credibility. Indicators used can be classified as those that remain constant and those that vary over time. Among fixed indicators, the one most quoted is the Central Bank Independence (see, for example, Alesina and Summers (1993), Maliszewski, 2000, Neyapti (2001), Loungani and Sheets (1997))

Alesina and Summers (1993), for example, use Kydland and Prescott model. According to that model, under an independent Central Bank (CB) optimal level of inflation, the one that minimizes the social welfare loss function, is lower than the one under a politically dependent Central Bank. They argue that an independent CB is more inflation averse, and that is why it will commit to its targets. On the other hand, they do not find any effect on macroeconomic variables, which, as they state, supports the money neutrality argument. Thus, credibility of CB plays an important role in maintaining a reasonable level of inflation, but does not have any significant impact on output and unemployment according to this study. An independence indicator itself is said to depend on the procedure to assign the head of a CB, relationship between government and CB, frequency of meetings between those two as well as the role of the government authorities in CB decisions.

Based on the same arguments, Maliszewski (2000) has empirically tested twenty Central European (CE) and ten FSU transition countries during periods of high inflation and found that CB independence does help to prevent the excessive expansionary monetary policy. However, an independent CB was not enough to

stabilize an economy which is partially consistent with the findings of Alesina and Summers (1993).

However, Loungani and Sheets (1997) and Neyapti (2001) using a more complicated indicator for CB independence, which was based on 14 and 16 different aspects respectively, found a significant negative correlation between the CB independence and inflation in 25 and 8 transition countries respectively.

Another fixed credibility indicator was proposed by Tanuwidjaja and Choy (2005). They introduced a forward-looking Small Scale Macroeconomic Model for Indonesia and evaluated the importance of the credibility indicator by including it as a coefficient in the equation of the expected inflation (normalizing it in the range from 0 to 1). In doing so they were able to detect a steady credibility effect with respect to inflation behavior.

However, the fixed indicator approach fails to take into consideration the fact that with passage of time public is likely to change their beliefs about CB commitment to its goals which points to a varying credibility indicator over time. The critique of a fixed credibility indicator has been presented in studies by Taylor and Agenor (1991), Arestis and Mouratidis (2005), Lalonde (2005), etc. Taylor and Agenor (1991) proposed a two step model based on the systematic and transitory components of market premium. They state that under a less credible monetary policy people anticipate high inflation and, trying to avoid an inflation tax, switch to other currencies. This, in turn, leads to depreciation of the exchange rate with an increase in premium. The latter is assumed to affect the public's confidence in monetary policy, and therefore, it is a suitable measure of credibility, which further determines the expected inflation and its diffusion effects. Huh and Lansing (2000) use a (quasi) Bayesian approach to estimate the credibility indicator and its influence on the macroeconomic variables. They tried

different scenarios for expectations formation and levels of credibility in order to find the one that better fits the co-movements of the US macroeconomic data.

To evaluate credibility Arestis and Mouratidis (2005) used deviation of a monetary policy from its target level in terms of Markov regime-switching model. They assumed that there is some uncertainty concerning the type of a CB. In their opinion, behavior of a CB can be explained by two types: The one that has output and unemployment as its targets, called a wet type, and the one with inflation as a target – a dry type. The authors argue that CB follows Markov Regime Switching Process while choosing its type of behavior. That is, if CB is of wet type in a given period t than it has a probability p to follow this behavior in the next period, and $1-p$ probability to switch to another type. This is also true for the dry type. Credibility is measured as deviation of domestic interest rate from its target value, where the latter is the interest rate of a credible bank - in this case, it is a combined rate of 11 EMU countries. In such a case, variance associated with the interest rate shows the risk premium associated with the wet type CB that does not follow its committed policy, and, therefore, the extent to which it is credible.

A particularly vast literature studied small macroeconomic models with different inflation regimes to estimate the differences that arise as a result of inclusion/exclusion of some credibility index. For example, a small forward-looking model that describes inflation expectations as a mix of forward- and backward-looking agents that form a time varying credibility index is proposed by Lalonde (2005). The credibility index is defined as a proportion of inflation rate deviations from its target level under high and low credibility regimes. A similar model that contains an endogenous credibility index was proposed by Argov, Epstein et al. (2007). They extend a standard simple model of Israeli economy for the period of 1997-2006, specifically estimating the deterioration in monetary credibility and output cost in 2001-2003.

Another approach that assumes a varying level of credibility is proposed by Laxton and N'Diaye (2002). They showed that inclusion of the credibility index into regression increases explanatory power of the model. They found statistically significant coefficient associated with the credibility index for 17 industrialized countries. The credibility index was defined in terms of the ratio of deviations from the long-run interest rates. The authors assumed that the latter contained inflation premium that could signal about different periods of credibility. This latter approach will be used for measuring credibility in our model. It is a good approximation for measuring public's expectations[2] on the one hand, and given data limitation for transition countries could be evaluated successfully on the other.

Empirical evidence

Empirical studies on this topic can be categorized as follows. There are two groups of studies: (i) the ones that have tested credibility rigorously (Laxton and N'Diaye, 2002, Maliszewski (2000), Loungani and Sheets (1997), etc.), and (ii) the ones based on best judgment in assigning the values to key parameters which then were used to evaluate the influence of credibility on macroeconomic variables (Lalonde, 2005, Argov E., Epstein N., et al, (2007), etc.). As well it should be noted that empirical findings for developed countries (Alesina and Summers (1993), Laxton and N'Diaye, 2002) and transition countries (Maliszewski (2000), Loungani and Sheets (1997)) do not show contradictory results emphasizing the fact that more credible policies produce better economic outcomes. So we will go on with the overview of the works that tested directly the effects of varying credibility indicator on macroeconomic variables. Then we

[2] Goodfriend (1993) states that variation in long term interest rate has proved to be a good proxy for inflation fears as in the period of relatively high inflation variation in long term interest rate is rather due to changes in risk premium than deviation in real interest rate.

will discuss some evidence of the papers which were based on the calibration approach.

As it was mentioned earlier the vast majority of literature that studies the effect of credibility of monetary policy on macroeconomic variables was done using Central Bank Independence as indicator of policy credibility (Alesina and Summers (1993), Maliszewski, 2000, Neyapti (2001), Loungani and Sheets (1997), etc.). Alesina and Summers (1993) used a very simple approach by plotting measure for central bank independence and various macroeconomic indicators for 16 developed countries. They found an almost perfect negative correlation between Central Bank Independence (CBI) and inflation level, as well as inflation variability. However they do not find particular relationship between CBI and other macroeconomic variables, motivating it as being the result that supports the theory of money neutrality. In contrast to findings of significant negative relationship between CBI and price level in developed countries, in transition countries literature fails to find any significant negative relationship (see for ex. Akhand, 1998). But as, Cukierman, Kalaitzidakis, Summers, and Webb (1993) argues this may stem from the fact that in developing countries the actual independence of CB differs from legal one. Hence they use 2 instruments for measuring CBI, namely Central Bank turnover and its political vulnerability. Using these indicators they found that low CBI produces worse economic outcomes, having negative impacts on growth and level of inflation. These findings are later confirmed by Maliszewski (2000), Loungani and Sheets (1997). The latter authors use two CBI indices: first measuring the similarities between Bundesbank (which is argued to be one of the most independent Central Banks in the world) and the second covering political and economic independence. They found a significant negative relationship between CBI and inflation rate in 1993 for 14 transition countries even after controlling for reform progress. Maliszewski (2000) using both time series and cross section data find a similar

result obtained by Loungani and Sheets (1997). Both economically and politically independent central bank deals better with inflation, where political independence have a higher absolute value of coefficient. He explains it invoking that a politically independent CB could be stricter concerning government lending.

Now we will turn to papers that used other approaches for credibility indicator and the extent to which it affects the macroeconomic variables. In order to stress the relevance of including varying credibility indicator Laxton and N'Diaye (2002) compares measures of goodness of fit and out of sample forecasting accuracy for two frameworks: general model which includes a credibility indicator (see above the specification) and conventional model without it. They found that for 17 industrial countries root mean square error (RMSE) for general model is larger than for conventional model, being able to produce much higher forecast accuracy including credibility indicator. Authors explain this result by the fact that general model is able to explain historical movements in unemployment and inflation. As well they argue that credibility effects reduce the sensitivity of inflation to unemployment gap which is equivalent with the conclusion that the model with zero credibility produces biased downward coefficients on the level of unemployment gap. Another paper that shows a better performance of the model using an endogenous credibility indicator was performed for Israel by Argov, Epstein et al. (2007). They use an eclectic approach calibrating the coefficient for the model based on the previous findings in the related literature. Hence, on including credibility indicator the dynamic responses to shocks resemble more closely characteristics in 2001-2003 period data.

Unfortunately there is little evidence on performance of macroeconomic outcomes as a result of changing policy credibility. However there is a large literature related to findings on economic performance of inflation versus non inflation targeting countries (Goncalves, Salles 2005; Mishkin 200, IMF Inflation Report 2006). These findings are particularly related to the issue of credibility

since committing to policy rules is one of the indicators to promote a credible policy (Keefer and Stasavage, 2002). Results show the targeters register lower level and variability of inflation. However, there are some critiques to the findings. Firstly, still short period of time has elapsed since Inflation targeting has been implemented. Secondly, the better results could be due to the fact that there has been a general trend in the global economy of improving results. Another important fact is that inflation targeting usually is implemented with a range of other reforms that also affect the performance of macroeconomic outcomes.

Hence, our goal is to use a small forward looking macroeconomic model which will include a credibility indicator and show the effects that it has on dynamic of macroeconomic variables for transition countries that do not have an explicit inflation targeting regime, comparing it to the results of previous findings. The model is adjusted to former countries' characteristics, which will be made clearer later on.

To our best knowledge, the specification of the model described further has not been used for assessing the changes in macroeconomic outcomes as a response to modification of level of credibility indicator. As well, this paper presents a forward looking framework which permits taking into consideration economic agents' expectations that has not been used before for these particular countries.

Chapter 3

METHODOLOGY

The major focus of this study is on the responses of various macroeconomic variables to the shocks to interest rate under different levels of credibility. In particular, we would like to estimate the period of time, which is needed for the response of a macroeconomic variable to the shock to die out. According to the existing economic literature, the higher is the credibility level, the less time is needed for the variable to converge to its long-term value. The background model used for this purpose is the one that describes the monetary policy transmission mechanism in a small open economy.

The model is based on the New Keynesian approach with the following assumptions. Firstly, it is a short-run model with "neutral money" in which deviations of real variables from their trends die away over time. Secondly, it assumes economic agents with rational expectations. One of the basic features of this model is that due to the price rigidity market mechanism fails to attain potential output instantly. Therefore, a reasonable intervention of Central Bank might help the real variables to converge to their steady states faster. Hence, a credible monetary policy is the only factor that determines desired outcomes.

It is worthwhile mentioning that the New Keynesian approach has become the basis for modeling monetary policy in many developed countries (see for ex. Kamada and Muto (2000), Lalonde (2005), Lansing and Huh (2000)). As well, this model was estimated in a variety of developing and transition countries (Arreaza, Blanco et al. (2003), Tanuwidjaja and Choy (2005)). Although each country's model is different in its complexity, basic framework consists of four fundamental blocks: an aggregate demand equation, a price equation, an exchange rate equation (uncovered interest rate parity) and a policy rule.

As already mentioned, the model is set in terms of the short-run deviation of real variables from their long-run trends. These deviations (gaps) are computed using Hodrick-Prescott filter with appropriate coefficients for quarterly data. All these variables are expressed in logarithms except for interest rate and inflation.

I. The IS equation is a forward-looking aggregate equation derived from the Euler's consumption equation. The inclusion of the forward-looking (lead) output gap in IS is motivated by the results of optimization problem discussed by McCallum and Nellson (1999)[3]. Hence, deviation of output from potential value depends directly on its lead gap, previous gaps, change in real exchange rate, real interest rate and de-trended government expenditures.

IS equation

$$\Delta y_t = \beta_{11}\Delta y_{t+1} + \beta_{12}\Delta y_{t-j} + \beta_{13} r_t + \beta_{14}\Delta s_t + g_{t-j} + \varepsilon_{yt} \quad (1)$$

where Δy_t - output gap, r_t – short-term real interest rate, Δs_t- deviation of real exchange rate, g_t- de-trended government expenditures

The real exchange rate is computed according to a popular in the literature assumption of purchasing power parity, which is $s_t = e_t + p_t^* - p_t$, where e_t – log level of nominal exchange rate, p_t^*- foreign prices given by log CPI and p_t - domestic prices given by domestic log CPI. In order to take into consideration multiple economic international partners of a country, a real effective exchange rate will be used as alternative specification.

[3] The appropriateness of the lead output gap usage in the specification of the IS curve is as well shown in Lalonde (2007) and Tanuwidjaja et al.(2005)

Real interest rate is given by Fisher's identity $r_t = i_t - E(\pi_t)$, where i_t is the nominal interest rate, given by the policy interest rate.

II. The Inflation equation is defined by Philips curve. By tradition, the price equation in a forward-looking framework depends only on expected inflation. However, some studies show that inclusion of a lagged inflation improves regression because it takes into consideration the trade-off between inflation and output on the one hand, and captures inflation persistence on the other (Rudd and Whelan, 2003; Rudebush, 2002). Hence, inflation depends on the weighted expected and lagged inflation, output gap and deviation of real exchange rate that reflects the external supply shocks. A similar specification of the price equation for transition countries was used by Tanuwidjaja and Choy (2000), Arreaza et al. (2003).

Philips equation

$$\pi_t = \beta_{21}\pi_t^e + (1-\beta_{21})\pi_{t-1} + \beta_{22}\Delta y_{t-1} + \beta_{23}\Delta s_{t-1} + \varepsilon_{\pi t} \quad (2)$$

where π_t- 4 quarter change in the CPI, π_t^*- target level of inflation, s_t - deviation of real exchange rate.

Despite the fact that Central Banks of the countries that are subjects of our analysis do not conduct an explicit inflation targeting, their primary goal of the monetary policy is to maintain a reasonable inflation rate, which is announced prior to the beginning of the fiscal year.

Assumptions of the price rigidity and rational agents imply that agents can not adjust prices instantaneously, and that they set them according to the expected level of inflation. Inflation expectations are formed according to the following rule:

$$\pi_t^e = (C_t)\pi_t^* + (1 - C_t)\pi_{t+1} \quad (3)$$

where C_t is a credibility indicator. Such a specification captures the agents' beliefs about monetary policy. If the policy is credible, which means $C_t = 1$, agents will make decisions based on target inflation π^*; if not then the expected rate of inflation will be formed according to the information they possess. In our case, agents are assumed to perfectly foresee the inflation which implies that when C_t=0 expected inflation equals π_{t+1}.

Following Laxton and N'Diaye's (2002) approach, credibility parameter is proposed to be the ratio of the gaps between observed long term interest rates according to the formula

$$C_t = \frac{(R_t - R^H)^2}{(R_t - R^H)^2 + (R_t - R^L)^2} \quad (4)$$

where R_t is the long-run interest rate; indexes H and L stand for the highest and the lowest values that R_t can take on. The logic behind such a measure of credibility is driven by the fact that the long-term interest rate is composed of two components: real interest rate and inflation expectations. And much of the deviations in the long-term interest rate is driven by the inflation variation. Hence, it might serve as a good proxy for the people's beliefs concerning future expected inflation (Goodfriend (1993)). Therefore, if R_t is high, which implies high inflation component, then credibility parameter tends to zero, and vice versa, if R_t is low than policy is perfectly credible (C=1). Consequently, in the equilibrium (i.e. no deviations in output and exchange rate), under perfectly credible policy, inflation will be equal to the target inflation rate.

III. Exchange rate equation (Uncovered Interest Parity Identity (UIP)). Inclusion of this equation is motivated by the fact that as a rule Central Banks promote floating exchange rate regime, which means that the exchange rate is determined endogenously. Thus deviations of nominal exchange rate are explained by the expected exchange rate and changes in nominal domestic and foreign interest rates, denoted respectively i_t and i_t^*. The risk premium is assumed to be determined exogenously and is included in the error term.

UIP

$$e_t = E(e_{t+1}) - i_t + i_t^* + \varepsilon_{et} \quad (5)$$

However empirically this equation fits the data rather badly (see for ex. Argov et al. (2007)). This is usually explained by the large shocks to which small open economies are exposed. As a result, Central Banks do intervene in the Forex market. Hence, we expect similar results in our study since Central Banks in the FSU countries aggressively intervene in the case of large fluctuations of exchange rate.

IV. The Policy rule function is given by a modified Taylor Rule. A similar equation has been used in analysis for a series of emerging countries such as Chile (Cespedes and Soto, 2005), Poland, Hungary and Czech Republic (Golinelli and Rovelli, 2001), and relatively recently have been tested among other policy rules specification for Russia (Vdovichenko and Voronina, 2004). It is a modified Taylor Equation including a lagged nominal interest rate and real exchange rate. The latter is adopted to transition countries since Central Banks in these countries pay special attention to the exchange rate shocks. Lagged nominal interest rate differential allows to smooth the time path of the interest rate.

Policy rule function

$$i_t = \beta_{30} + \beta_{31} i_{t-1} + \beta_{32}(\pi_t - \pi_t^*) + \beta_{33}\Delta y_t + \beta_{34} s_t \ + \varepsilon_{it} \quad (6)$$

Summarizing the above discussion, our *structural theoretical model* is:

$$\begin{aligned}\Delta y_t &= \beta_{11}\Delta y_{t+1} + \beta_{12}\Delta y_{t-j} + \beta_{13} r_t + \beta_{14}\Delta s_t + \beta_{15} g_{t-j} + \varepsilon_{yt}\\ \pi_t &= \beta_{21}\pi_t^e + (1-\beta_{21})\pi_{t-1} + \beta_{22}\Delta y_{t-j} + \beta_{23}\Delta s_{t-j} + \varepsilon_{\pi t}\\ i_t &= \beta_{30} + \beta_{31} i_{t-1} + \beta_{32}(\pi_t - \pi_t^*) + \beta_{33}\Delta y_t + \beta_{34} s_t + \varepsilon_{it}\end{aligned} \quad (7)$$

This is a dynamic simultaneous equations model with expectations of the following type

$$\boldsymbol{y}_t = \Theta \boldsymbol{Y}_t + F\boldsymbol{Y}_{t+1}^e + B(s)\boldsymbol{X}_{t-s} + \Phi(k)\boldsymbol{Y}_{t-k} + \boldsymbol{\varepsilon}_t \quad (8)$$

or

$$\Gamma \boldsymbol{Y}_t = B(s)\boldsymbol{X}_{t-s} + F\boldsymbol{Y}_{t+1}^e + \Phi(k)\boldsymbol{Y}_{t-k} + \boldsymbol{\varepsilon}_t \quad (9)$$

where Γ, B, Φ(j), F – parameteres of interest; $\boldsymbol{Y}$ – vector of endogenous variables, which in our model are $\Delta y, \pi, r, i$ and $\boldsymbol{X}$ – vector of exogenous variables $\Delta s, g, \pi^*$, and $\boldsymbol{Y}_{t-k}$- vector of predetermined endogenous variables.

Expectations are formed given all the information given at time t: $\boldsymbol{Y}_{t+1}^e = \boldsymbol{Y}_{t+1} + \boldsymbol{\epsilon}_{t+1}$

Taking the last rule into account, (9) can be re-written in the following way:

$$\Gamma \boldsymbol{Y}_t = B(s)\boldsymbol{X}_{t-s} + \Phi(k)\boldsymbol{Y}_{t-k} + F\boldsymbol{Y}_{t+1} + F\boldsymbol{\epsilon}_{t+1} + \boldsymbol{\varepsilon}_t \quad (10)$$

$$\Gamma \boldsymbol{Y}_t - \Phi(k)\boldsymbol{Y}_{t-k} - F\boldsymbol{Y}_{t+1} = B(s)\boldsymbol{X}_{t-s} + F\boldsymbol{\epsilon}_{t+1} + \boldsymbol{\varepsilon}_t \quad (11)$$

or in the reduced form

$$A(L)\boldsymbol{Y}_t = B(L)\boldsymbol{X}_{t-1} + \boldsymbol{\varepsilon}_{t-1} + F\boldsymbol{\epsilon}_t \quad (12)$$

$$\boldsymbol{Y}_t = A^{-1}(L)B(L)\boldsymbol{X}_{t-1} + A^{-1}(L)\boldsymbol{\varepsilon}_{t-1} + A^{-1}(L)F\boldsymbol{\epsilon}_t \quad (13)$$

$$\boldsymbol{Y}_t = \Pi \boldsymbol{X}_{t-1} + \Upsilon \boldsymbol{u}_t \quad (14)$$

where $A(L) = -F + \Gamma L - \ldots - \Phi_{k+1} L^{k+1}$; $B(L) = B_1 L + \ldots + B_{s+1} L^{s+1}$

and $\Pi = A^{-1}(L)B(L)$; $\Upsilon = A^{-1}(L)$; $u_t = \boldsymbol{\varepsilon}_{t-1} + F\boldsymbol{\epsilon}_t$, $\boldsymbol{u}_t$ is assumed to be a white noise disturbance.

Equation (13) in economic literature is refered to as the final form where the time pathes of the exogeneous variables and disturbances determine the pressent value

of the endogenous variables. Hence imposing shocks on either exogenous variables or disturbances we can obtain impulse response functions for the endogenous variables.

The model will be estimated by 3SLS technique - the one often used for simultaneous equations[4]. This approach performs well even when some variables are not stationary given that they are cointegrated. When heteroscedasticity is present, GMM is more efficient in terms of the results. However, if disturbances are homoscedastic assymptotically, eventually GMM estimators converge to 3SLS parameters. On the other hand, in a finite sample, since the latter is less data demanding, it is more likely for 3SLS to be feasible compared to GMM estimation. This is crucial in our case since short-time series are used (for more details see Golinelli and Rovelli (2001)). This results are obtained on the basis of optimal weighting matrix which in GMM estimation depends on the fourth moment condition. In order to obtain reasonable estimates of the latter, one needs large sample sizes.[5] VARX which is used for dynamic simultaneous equations can not be used in this case, as future values are not present in the policy rule equation which gives a singular matrix F (equation 11) of contemporaneous relationships of variables after transformation (equation 12).

Parameters of the structural models can be obtained as folows

System(7) in matrix form can be presented as

$$\boldsymbol{y}_t = \Theta \boldsymbol{Y}_t + F\boldsymbol{Y}^e_{t+1} + B(s)\boldsymbol{X}_{t-s} + \Phi(k)\boldsymbol{Y}_{t-k} + \boldsymbol{\varepsilon}_t \tag{15}$$

or

$$\boldsymbol{y} = \boldsymbol{\delta Z} + \boldsymbol{\varepsilon} \tag{16}$$

[4] Hsiao (1997, p. 395) - "in a structural approach one still needs to worry about the issues of identification and simultaneity bias, but one need not worry about the issues of non-stationarity and cointegration."

[5] C. Baum, M. Schaffer, et al., 2003 "Instrumental Variables and GMM: Estimation and Testing", p.11

which means

$$\begin{bmatrix} \boldsymbol{y_1} \\ \boldsymbol{y_2} \\ \vdots \\ \boldsymbol{y_M} \end{bmatrix} = \begin{bmatrix} \boldsymbol{Z_1} & \boldsymbol{0} & \cdots & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{Z_2} & \cdots & \boldsymbol{0} \\ \vdots & \vdots & \vdots & \vdots \\ \boldsymbol{0} & \boldsymbol{0} & \ldots & \boldsymbol{Z_M} \end{bmatrix} \begin{bmatrix} \boldsymbol{\delta_1} \\ \boldsymbol{\delta_2} \\ \vdots \\ \boldsymbol{\delta_M} \end{bmatrix} + \begin{bmatrix} \boldsymbol{\varepsilon_1} \\ \boldsymbol{\varepsilon_2} \\ \vdots \\ \boldsymbol{\varepsilon_M} \end{bmatrix} \tag{17}$$

where $E[\varepsilon]=\boldsymbol{0}$

and $$E[\varepsilon\varepsilon'] = \begin{bmatrix} \sigma_{11}I & \sigma_{12}I & \ldots & \sigma_{1M}I \\ \sigma_{21}I & \sigma_{22}I & \ldots & \sigma_{2M}I \\ \vdots & \vdots & \vdots & \vdots \\ \sigma_{M1}I & \sigma_{M2}I & \ldots & \sigma_{MM}I \end{bmatrix} = \Sigma \otimes I \tag{18}$$

Vector X_t is the vector of all exogenous and predetermined variables in the system. For each included endogenous variable in the equation should be at least as many excluded exogenous variables (including predetermined variables).

System of equations contains following included endogenous variables for which are used instruments provided by other equations: Δy, π , r , i . For these regressors will be used instrumental variables given by predetermined and other exogenous variables provided in the system. Hence for endogenous variable in one equation are used exogenous variables from specification of other equation. For example in order to estimateΔy_{t+1}, r_t in PC equation lagged variables of inflation, deviation from previous level of real exchange rate and nominal interest rate are used.

3SLS procedure is a combination of 2SLS and SUR econometric methods. Therefore in order to estimate efficient 3SLS parameters, receivied 2SLS coefficients are estimated using Generalized Least Squares.

Hence, performing 2SLS estimation equation by equation we receive consistent although inefficient parameters.

$$\hat{\delta}_{IV} = [\hat{Z}'Z]^{-1}\hat{Z}'y, \tag{19}$$

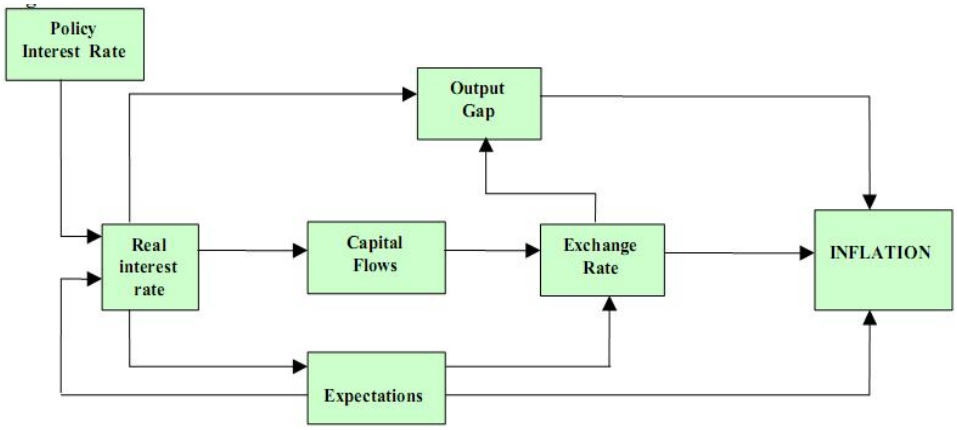
where $$\hat{Z} = \begin{bmatrix} X(X'X)^{-1}X'Z_1 & 0 & \dots & 0 \\ 0 & X(X'X)^{-1}X'Z_1 & \dots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \dots & X(X'X)^{-1}X'Z_1 \end{bmatrix} \tag{20}$$

Using GLS an efficient 3SLS coefficient is estimated.

$$\hat{\delta}_{IV} = \left[\hat{Z}'(\Sigma \otimes I)Z\right]^{-1}\hat{Z}'(\Sigma \otimes I) \tag{21}$$

The transmission mechanism in a model of a small open economy works through 3 channels: aggregate demand, expectations and exchange rate (see figure 1).

Figure 1. Transmission Mechanism



Source: Arreaza et al., 2003

According to economic theory, aggregate demand channel specifies the passthrough mechanism of interest rate on output gap and consequently on inflation. A change in the policy interest rate affects real interest rate which in turn determines the consumption and investment thereby modifying the ouput gap. The latter affects the inflation rate through the price equation.

Therefore, an increase in output gap (as well as positive deviation of actual inflation from its target) urges a CB to raise policy interest rate in order to prevent rising inflation. An increase in aggregate demand forces prices to go up. Higher real interest rate makes investments less attractive thus diminishing the output level. A similar scenario is expected for the real exchange rate. Depreciation of the real exchange rate leads to an increase in net exports since domestic goods become cheaper than foreign ones. This, in turn, has a positive effect on aggregate demand which puts pressure on the domestic prices. Thus, all coefficients in the Policy Rule Function are expected to be positive. As well, positive relationships appear between regressors and regressand in the Inflation Equation. Following the reasons explained above, the coefficient of the real interest rate in AD equation should be negative but coefficent of the deviation of the real exchange rate should be positive.

Expectations channel shows the transmission of changes in expectations on other economic variables and eventually on inflation. Expectations are reflected in real interest rate, nominal exchange rate and inflation.

Exchange rate channel reflects the passthrough mechanism of changes in exchange rate on inflation which is effected directly via the price equation and indirectly via the AD eqaution.

Estimation is performed in two steps. In order to emphasize the importance of Lucas critique, firstly, the model is estimated under assumption of backward-looking agents who form adaptive expectations. Then expected inflation is introduced in the way it was specified above in order to see the implications it has on the coefficients and explanatory power of the model. According to economic literature, agents form rational expectations, hence the model performs better when expectations are not strictly adaptive. These findings have been tested empirically by Laxton and N'Diaye, 2002, Basdevant, 2003.

The effects of credibility are estimated under different scenarios obtained by calibrating the values of credibility index. It means assigning different values to the credibility index to test for volatility of output and inflation as their responses to the shocks to the interest rate. Following the same procedure, we estimate the response of inflation to the shock to output as well as the cost in terms of the changes in interest rate to regain credibility. Finally, out of the sample simulation is performed to analyze convergence to steady state, which is defined by the following long-run identities:

$$\pi_t = \pi_t^* \qquad i_t = i_t^* \qquad \Delta e=0$$

Chapter 4

DATA DESCRIPTION

The model is estimated for the period of 8 years from Q1 2000 to Q4 2007 based on quarterly data, when all the above-mentioned countries started to announce a specific level of annual inflation. Since Kazakhstan is a major oil exporter and Moldova's economy depends heavily on remittances, both economies are highly sensitive to changes of situation in global markets. Hence the global crisis which started in USA in late 2007 is likely to result in new structural breaks. Short period after previous economic turmoil and little trust towards public policies conducted by monetary and fiscal authorities is likely to make people revise their beliefs. That is why our sample was limited to Q4 2007.

Data for estimation is collected from official websites of Central Banks and Statistics Agencies of Moldova and Kazakhstan[6] as well as other websites of International Organizations[7]. More in detail information about each variable provenience can be found in appendix (Table 1). For interest rate, we are going to use the policy interest rates for these countries, namely the base rate for Moldova (2 months REPO), and refinancing rate for Kazakhstan.

Inflation is calculated as annual change in CPI. All variables except interest rates, real effective exchange rate and inflation are expressed in logarithms. Long run interest rates used for estimation of the credibility index for different countries differ as there is still lack of the long-term monetary instruments used

[6] http://nbg.gov.ge/?lng=eng

http://bnm.md

http://www.nationalbank.kz

http://www.statistica.md

[7] http://w3.unece.org/pxweb/Dialog/, http://www.imfstatistics.org/imf/

by CBs. Therefore, the long-term treasury bonds interest rates have been approximated by the following series. For Moldova, it is interest rate for 5-year loans given by the CB for state projects. For Kazakhstan, we take interest rates on Government bonds with 2-10 years maturity.

Credibility indicator has been constructed according to Laxton and N'Diaye (2002) where R^H is the highest value in the sample for each country accordingly and R^L equal to 5 in the case of Kazakhstan and 8 in the case of Moldova. This latter assumption is based on the long–run target inflation, which is assumed to be the lowest value during this period plus 2 decimal points for earning[8]. The graphs below illustrate this procedure.

For example, in the case of Kazakhstan, the credibility indicator reaches very high level in 2004 as a result of actual inflation being equal to the target inflation during previous years. On the other hand, Moldova shows two periods of dynamics, which corroborates the theory concerning behavior of the public as a response to the Central Bank actions. When the Central Bank fails to bring inflation to its target level, the credibility indicator falls (observed during Q1 2003 – Q3 2004). Once Central Bank succeeds to bring inflation to its preannounced rate during several periods, it gradually gains the public's credibility (Q4 2004 – Q4 2005). Still since deviation from the target level during succeeding periods is high, credibility does not exceed the level of 0.76.

[8] Laxton D. and N'Diaye P. (2002) show that the results are not sensitive to particular values of R^L

Figure 2. Evolution of Credibility Indicator for Kazakhstan and Rep. of Moldova

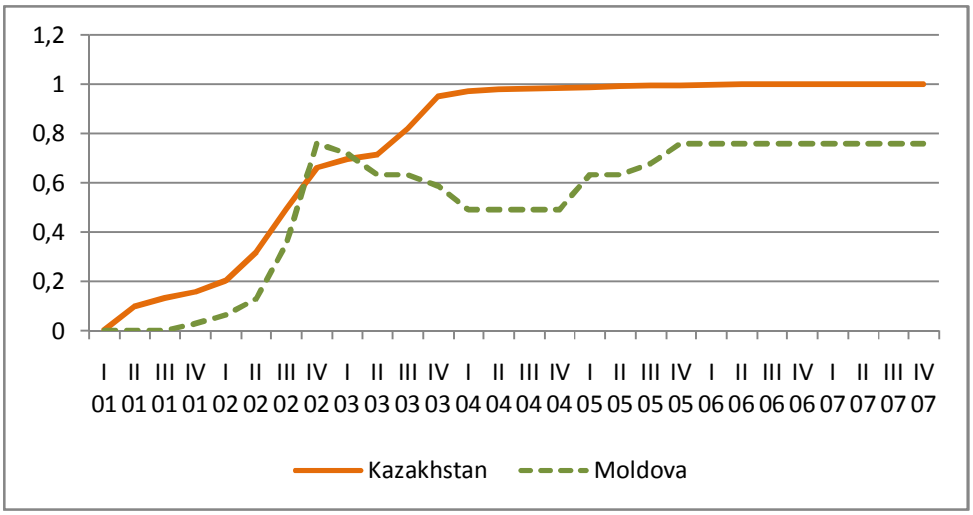


Figure 3. Evolution of targeted and actual inflation in Rep. of Moldova

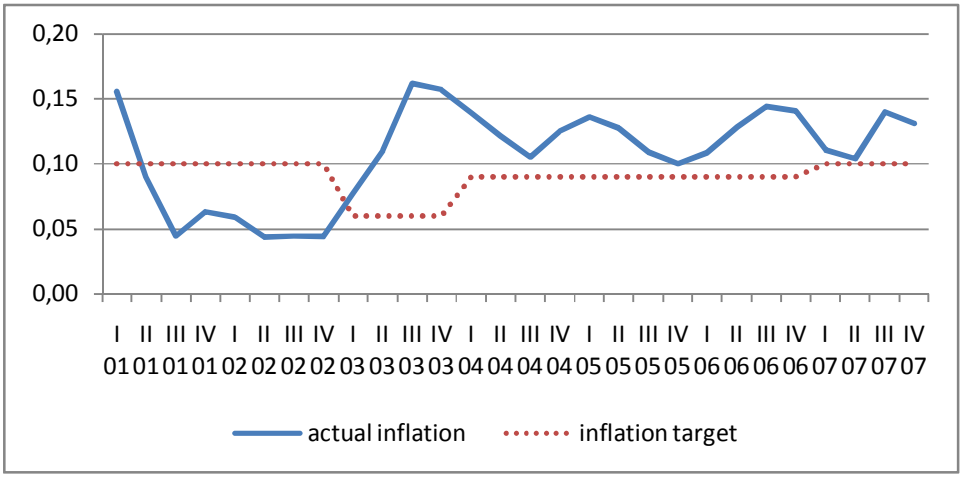
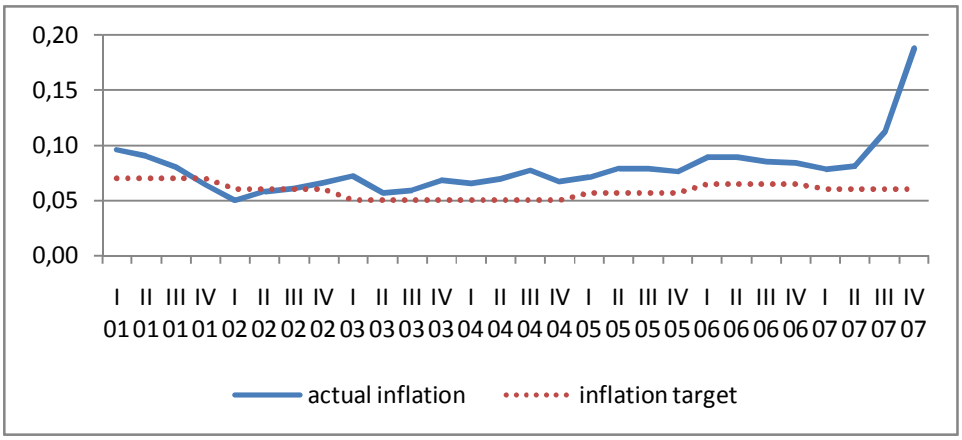


Figure 4. Evolution of targeted and actual inflation in Kazakhstan



Description of other model's variables, specific data source as well as descriptive statistics is presented in the appendix (Table 1).

Chapter 5

EMPIRICAL RESULTS

This section addresses stationarity issues first followed by estimation of the model and out of the sample simulations.

Stationarity of variables in the model was tested using Dickey Fuller test (DF) with constant, followed by Durbin's test for autocorrelation to confirm the validity of the DF test's results. As well, Phillips-Perron test was used since it allows for autocorrelation in residuals. Both tests rejected unit root at 1% level of significance for output gap, policy interest rate, computed expected inflation using credibility index, deviation of government spending for both countries. However, the tests showed that real interest rate for Kazakhstan follow unit root process. Since Phillips-Perron and Dickey Fuller tests tend to perform poorly in small sample size series, KPSS (Kwiatkowski, Phillips, Schmidt, Shin) test was used. The latter did not reject the null of stationary process for above mentioned seemingly non-stationary variables. The results of the above performed tests are shown in the appendix (Table 8 and Table 9).

Estimation of the model

Our model was initially estimated under assumption of backward looking agents, assumption that has been extensively used for estimation of macroeconomic models for post-Soviet space. For this reason, in the benchmark model we excluded forward looking terms. As well in the policy rule equation, policy interest rate was determined by the deviation of actual inflation from previous

period inflation instead of target inflation. Then we used our benchmark model to estimate a small macroeconomic model.

Because of a small sample size, in all our estimations we included only one lag which was not higher than order three. For the same very reason we used just few exogenous variables. Estimation results are reported below (see Table 1). Lag order in each equation was chosen according to the best fit and magnitude of parameter estimates.

Kazakhstan

Table.1 Estimates of the backward looking model and forward looking model (Kazakhstan)

IS equation						
		Δy_{t-1}	r_t	Δs_t	g_t	cons
BWL	-	-0.7469	-0.028	-0.012	0.175	-0.007
		(-5.39)***	(-0.93)	(-2.03)**	(1.71)*	(-0.56)
	0.25	-0.695	-0.005	-0.016	0.23	0.008
FWL	(1.74)*	(-5.47)***	(-0.29)	(-2.65)***	(2.63)**	(0.28)
PC equation						
	π_{t+1}	π_{t-1}	Δy_{t-1}	Δs_{t-1}		cons
BWL	-	0.681	0.172	0.104	-	2.33
		(7.47)***	(0.14)	(1.55)		(3.33)***
	0.029	0.971	-1.14	0.076	-	-0.067
FWL	(0.37)	(12.84)***	(-0.83)	(1.08)		(-0.48)
Policy rule						
	i_{t-1}	$\pi_t - \pi*$	Δy_t	Δs_t		cons
BWL	0.784	-0.12	0.943	0.043	-	1.72
	(17.94)***	(-0.5)	(1.08)	(1.31)		(4.3)***
	0.803	0.535	0.033	-0.049	-	0.726
FWL	(25.97)***	(5.44)***	(0.04)	(-1.21)		(2.41)***

*-10%
**-5%
***-1%

As a result of our estimation, we obtained negative coefficients for real effective exchange rate, which is contrary to the traditional Mundell-Fleming model. On the other hand, same result has been found in other studies for developing countries (see for ex. Berument and Pasaougullari (2003)). The reason for this result might be as follows. Real devaluation of domestic currency should affect long-run prices. Hence, the cost of production will rise over time, followed by the increased future expenditures. This forces consumers to cut on their current consumption which eventually decreases output. Another explanation of the negative relationship between output gap and changes in real exchange rate can be given by a necessity to tighten monetary policy to address the inflationary gap.

One more interesting finding is presence of a constant term in Philips Curve equation in backward looking model. However, this term does not significantly differ from zero in forward looking model. Therefore, we can infer that forward looking specification captures some effects that backward looking fails to do. In addition, in the former, coefficient of the lead output gap is significant at 1% level of significance and it explains 27% of variations of current output gap. Still the coefficient of the expected inflation does not significantly differ from zero, and lagged output better explains deviation of inflation in forward looking model than in backward looking. This could be a result of a poor credibility index approximation. Estimations of other fixed credibility parameters are provided below. However, all results should be interpreted with caution due to a small sample size.

As well coefficients of the regressors in the policy rule equation are of some special interest. Backward looking model produces only two significant parameters, the ones associated with lagged interest rate and constant rate. Changes in all other variables, namely inflation deviation, output gap and difference of real exchange rate do not affect interest rate. However, estimation of the forward looking model showed that coefficients of the lagged interest rate

and inflation deviation have correct signs, and they significantly differ from zero. Positive deviation of current inflation from target by 1% increases policy interest rate by 0.53%. This result is still small for the usual Taylor rule equation estimated for inflation target, which value is supposed to be greater than one. Output gap and real exchange rate deviations do not affect policy interest rate. These results support the claim that this particular country has put much more weight on inflation targeting rather than on other intermediate targets such as exchange rate or output growth. Nevertheless, estimation of the forward looking model shows that agents are more backward than forward looking in forming their expectations which can be seen through higher coefficients on lead terms than on lagged ones.

A visual comparison of these two specifications can be performed by looking at the Figure 5 below that depicts fitted dependent variables for both specifications with respect to their actual values. From those graph it can be noticed that forward looking model fits the data slightly better than backward looking one.

Figure 5. Fitted values of output gap generated by Backward Looking Model and Forward Looking Model and actual output gap (Kazakhstan)

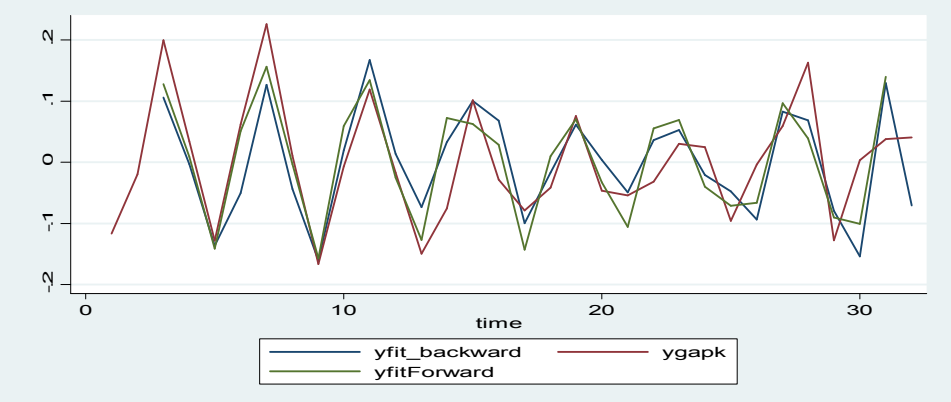
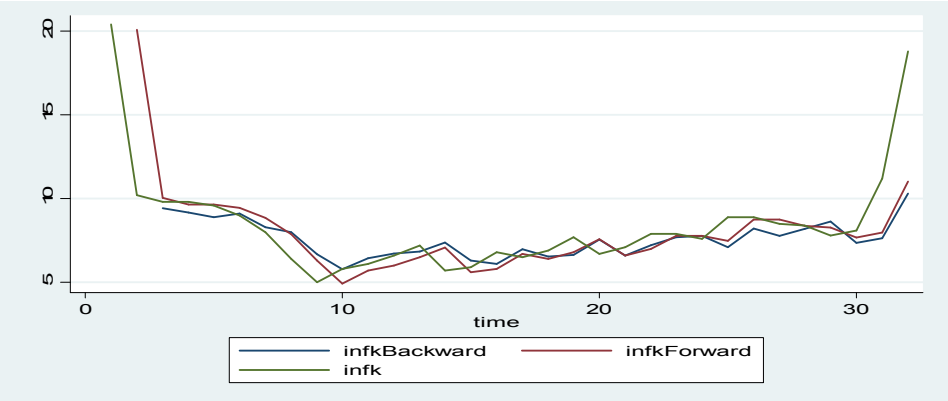


Figure 6. Fitted values of inflation generated by Backward Looking Model and Forward Looking Model and actual inflation (Kazakhstan)



Moldova

The very same approach has been applied for Moldova. Graphical analysis along with estimates shows that forward looking model performs slightly better than backward looking.

Table.2 Estimates of the backward looking model and forward looking model (Moldova)

IS equation						
	Δy_{t+1}	Δy_{t-1}	r_t	Δs_t	g_t	cons
BWL		-0.98	-0.028	0.01	0.017	-0.002
		(-16.54)***	(-3.03)***	(2.26)**	(1.78)*	(0.16)
	0.001	-0.91	-0.014	-0.004	-0.08	0.05
FWL	(0.14)	(-17.04)***	(-1.13)	(-1.98)*	(-0.86)	(-1.67)
PC equation						
	π_{t+1}	π_{t-1}	Δy_{t-1}	Δs_{t-1}		cons
BWL		0.71	-0.702	0.04		3.01
		(7.51)***	(-0,53)	(0.38)		(2.66)***
FWL	0.25	0.75	0.006	-0.083		-0.48

	(1.75)*	(5.39)***	(0.01)	(-0.7)	(-0.86)
Policy rule					
	i_{t-1}	$\pi_t - \pi*$	Δy_t	Δs_t	cons
BWL	0.56	-0.68	-0.03	0.063	5.58
	(1.85)**	(-1.9)*	(-0.03)	(0.47)	(1.36)
FWL	0.63	0.263	0.78	0.049	4.36
	(12.79)***	(4.52)***	(0.89)	(1.23)	(5.87)**

*-10%
**-5%
***-1%

Similar to the case of the backward looking model for Kazakhstan, Moldova's Philips Curve equation has significant parameter estimates of lagged inflation and a constant. The latter is not explained by the theoretical model, and can be interpreted as capturing some effect of more or less permanent inflation rate given by inflation target.

However, policy rule function gives us the wrong sign for parameter estimate of the inflation deviation. Hence, according to the results, an increase in inflation deviation from previous period leads to a negative change of interest rate. It could be justified only in the case when inflation rises permanently but at a slower rate. Since during this period inflation has decreased, these results can be interpreted as follows: Rising inflation leads to a decrease in the policy interest rate.

On the contrary, forward looking model gives us the correct signs for all significant variables. As well, it should be mentioned that a 1% rise in expected inflation increases current inflation by 0.26%. Still output gap as well as deviation of real effective exchange rate does not affect inflation movements.

One more point is significance of inflation deviation parameter estimate in policy rule equation. Similar to Kazakhstan policy interest responds only to inflation deviation from target rate, taking into consideration a smoothing effect

represented by previous period policy interest rate. Empirically supported fact that National Bank of Moldova follows an inflation targeting regime is insignificance of the coefficients of real exchange rate deviations and output gap.

However, in comparison with Kazakhstan interest rate responds to an even lesser extent to inflation deviation. Hence an increase in current inflation above its target by 1% will increase the policy interest rate only by 0.26%. This is due to the fact that National Bank of Moldova (NBM) does not use the policy interest rate as its primary goal for bringing inflation down. This can be explained by under-development of financial markets.

Similar to Kazakhstan, in the case of Moldova people tend to be backward rather than forward looking while forming their expectations - responding to a higher extent to past values rather than expected ones. This could be explained by the fact that both countries are in transition when fixed exchange rate policy is being gradually substituted by the inflation targeting. Therefore, people are most likely to form their expectations based on previous observations as they lack information about effects of a new regime. Taylor (1975) and Huh and Lansing (2000) argue that people are less rational when there is a major change in monetary policy. The authors argue that people should be given much more time to learn the specification and the possible outcomes of the new regime.

Graphical representation of fitted values estimated from both backward and forward looking model and actual values of output gap and inflation rate are presented bellow.

Figure 7. Fitted values of output gap generated by Backward Looking Model and Forward Looking Model and actual output gap (Moldova)

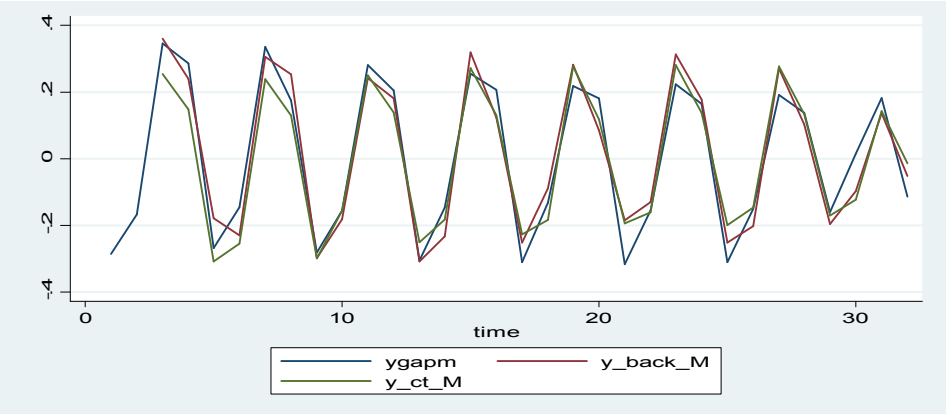
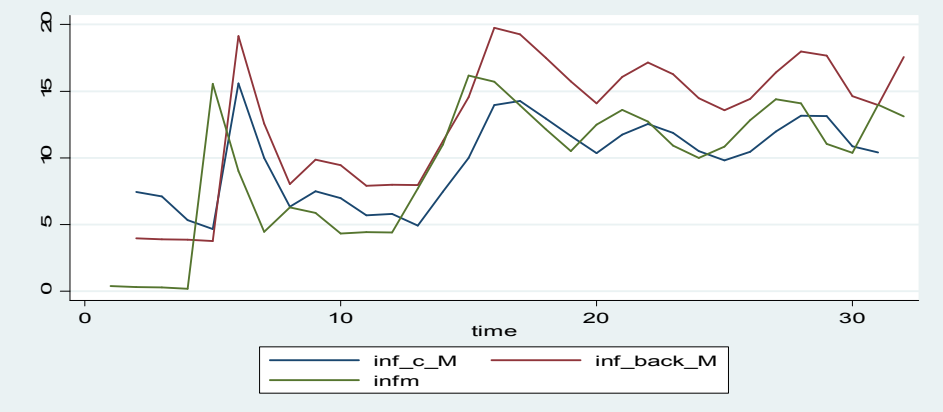


Figure 8. Fitted values of inflation generated by Backward Looking Model and Forward Looking Model and actual inflation (Moldova)



Hence, in the case of forward looking specification, fitted inflation deviation from actual inflation is less than in the backward looking model in the major portion of the output gap path. Fitted values of output gap estimated for the latter model tend to be overestimated in most cases.

In the case of Philips Curve equation, a better performance of forward looking model is seen even more clearly. Fitted inflation rate of backward looking model significantly overestimates the actual inflation.

Simulation

In order to exclude inappropriate specification of credibility index and for comparison, the model used for simulation was estimated assuming zero credibility for both Moldova and Kazakhstan. Although this is rather an extreme case, nonetheless it is not completely theoretical. Firstly, both Central Banks did not adopt a full-scale inflation targeting regime. Therefore, economic agents still think of little commitment of the banks to the preannounced inflation targets. Secondly, the period described by the model comes right after the regime change, and studied time period is not enough for people to learn the effects of policy. Another important factor is associated with financial crisis of 1998-1999 which contributed to the low credibility of Central Banks. It means that a brand new policy was received by economic agents skeptically.

As well, analyzing the above-described empirical results with a varying credibility index, it is possible to conclude that the banks gained little credibility during this period of time. In the case of Kazakhstan, coefficient of expected inflation is close to zero, which means that people are backward looking in their expectations formation. Therefore, although NBK met its target during this period, nonetheless it failed to gain credibility. In the case of Moldova, the same conclusion can be made. Credibility index for Moldova is even lower than in the case of Kazakhstan, and NBM hardly met its inflation target as see in Figure 3. As well, coefficient of inflation expectations is still low, and agents are more backward looking when forming their expectations. Hence, as it appears to be, zero credibility could be justified in both cases.

Consequently, for simulation purpose the following model is used for Kazakhstan:

$$\Delta y_t = 0.37\Delta y_{t+1} + 0{,}177\Delta y_{t-1} - 0.005 r_{t-3} + 0{,}01\Delta s_t - 0.05 g_{t-1}$$

$$\pi_t = 0.267\pi_t^e + 0.733\pi_{t-1} + 0.006\Delta y_{t-4} - 0.132\Delta s_{t-1}$$

$$i_t = 1.117 + 0.805 i_{t-1} + 0.2377(\pi_t - \pi_t^*) + 1{,}367\Delta y_t + 0{,}0098\Delta s_t$$

$$e_t = (e_{t+1}) - i_t + i_t^*$$

In the case of Moldova, the estimated model used for out of sample simulation is:

$$\Delta y_t = -0{,}93\Delta y_{t-2} - 0.007 r_{t-1} - 0.0016\Delta s_{t-1}$$

$$\pi_t = 0{,}502\pi_t^e + 0.498\pi_{t-1} - 0{,}082\Delta y_{t-3} - 0{,}107\Delta s_{t-2}$$

$$i_t = 3{,}33 + 0.715 i_{t-1} + 0.15(\pi_t - \pi_t^*) + 0{,}74\Delta y_{t-1} + 0{,}083\Delta s_t$$

$$e_t = (e_{t+1}) - i_t + i_t^*$$

In order to simulate out of sample response of macro variables it is necessary to do the following.

Firstly, we need specify terminal conditions for exogenous variables. According to the theory, long run values of π_t equals π_t^*, i_t equals i_t^* and $\Delta e=0$. Since inflation target during estimation period varies, the initial value is assumed to be the mode of the sample period. As well, in order to ensure convergence to long run values we need to know how the expectations are formed.

Following Huh and Lansing (2000), agents' expectations are specified in terms of the first order VAR coefficients with constants which ensure long run equilibrium. Although this approach is a form of quasi-adaptive expectations case, nonetheless it is appropriate to use it for this particular study. As it was mentioned above, estimation period is a period of transition to a new regime which assumes that economic agents need some time to learn new policy. Hence, they are less than rational in forming their expectations. The latter issue is also mentioned by Taylor (1975) and Friedman (1979).

So, expectations are constructed in the following way:

$$\begin{pmatrix} \Delta y_{t+1}^{e} \\ \pi_{t+1}^{e} \\ i_{t+1}^{e} \end{pmatrix} = A \begin{pmatrix} \Delta y_t \\ \pi_t \\ i_t \end{pmatrix} + \begin{pmatrix} c_1 \\ c_2 \\ c_3 \end{pmatrix}$$

Matrix A and all coefficients as well as exogenous variables specified above are presented in the appendix (Table 12 and Table 13).

For each country, responses of output gap and inflation are evaluated under two policy specifications. Firstly, it is evolution of both from the long run value under different credibility index values as a response to impulse applied to the policy interest rate. Secondly, a disinflation policy is assumed in terms of lower inflation target. Below we analyze responses of macro variables assuming three values of credibility index: two extreme cases (c = 0, c = 1) and one intermediate case (c=0.5).

I. Response on change in interest rate

In order to study reaction of inflation and output gap under different values of credibility index, a positive interest rate shock of 0.25% was introduced in the first quarter.

Kazakhstan

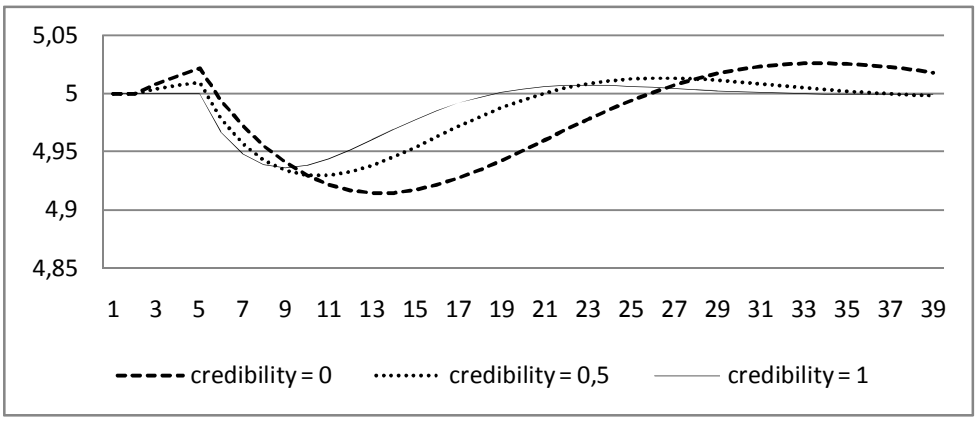
As it can be seen from Figure 9, an increase in nominal interest rate by 0.25% takes almost 20 quarters for inflation to come back to its target under fully credible policy. Mostly this influence is caused by real exchange rate. However, its impact is partially neutralized since there are 2 effects at play: (i) positive indirect through AD equation, and (ii) negative direct through PC equation. Still such a long period of convergences can be explained only by little influence of inflationary expectations: 1% of previous inflation will account for 0,75% of current inflation other things being equal. However, it should be mentioned

that an increase in interest rate by 0.25% decreases inflation by maximum of 0,06%. Minimal peak is reached in 9 quarters or two years approximately, which is quite a long response period.

Under a non credible policy it takes twice as long for inflation to come to its initial value, and its magnitude is slightly higher.

However it is of interest that ensuring a half credible policy it is enough to bring the evolution of inflation much closer to that where it is perfectly credible.

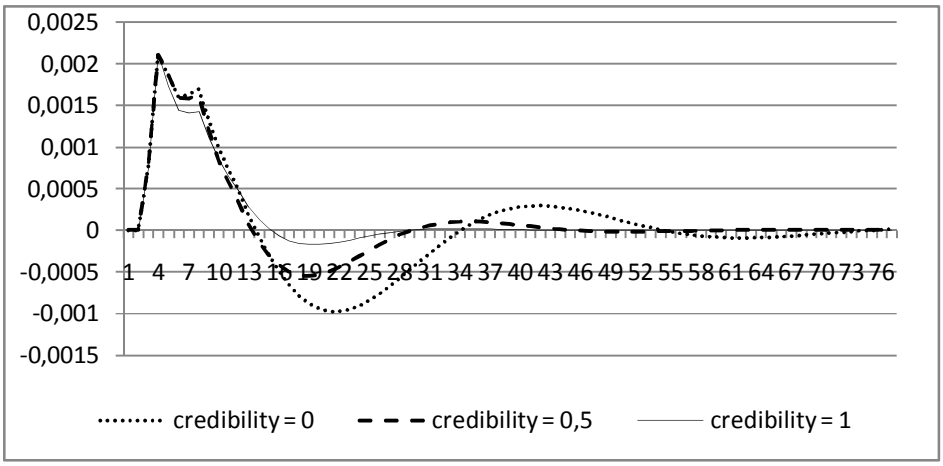
Figure 9. Effects of credibility in achieving long run value of inflation. (Kazakhstan)



Output gap follows the pattern of inflation with several lags. Hence during first periods it overshoots due to positive change in interest rate and due to an increase in real exchange rate. Similar to inflation, it takes a very long time to converge to the long run value because of little response of interest rate to inflation deviation which further affects the output gap.

The paths of output gap under three different specifications of credibility are quite similar, especially for totally and partially credible policies. However, there is a much higher deviation of output gap when people do not belief the Central Bank will commit to its announcement, which results in higher sacrifice ratio (sum of output losses).

Figure 10. Effects of credibility in achieving long run value of output gap. (Kazakhstan)



Moldova

Similar conclusions can be deduced from response functions of inflation and output gap for Moldova.

Under full credibility, inflation converges to its target in 20 periods. Under non credible policy it takes almost 30 quarters to bring inflation to its targets. As well, if Central Bank is able to gain at least 50% percent of credibility, although it has a slightly larger deviation than inflation under full credibility it as well converges in approximately 20 quarters.

It is worth mentioning that in case of a non credible policy inflation rate hits its lowest value approximately four quarters later than under a credible policy. This evidence corroborate with Kydland and Prescott argument that Central Banks are likely to break the commitment rule in order to achieve the desired results much faster. Hence, taking into consideration that inflation is affected with a 3 quarters lag it reaches the lowest value under a credible policy in approximately 2-3 quarters later, while under a non credible policy it takes 4-5 additional quarters.

Comparing to Kazakhstan's case, response of output gap is almost the same for all three specifications of credibility index (c=0, c=0.5, c=1). Thus, credibility

plays little role in evolution of output gap when an external shock to policy interest rate is introduced while keeping the same targets.

Figure 11. Effects of credibility in achieving long run value of inflation. (Moldova)

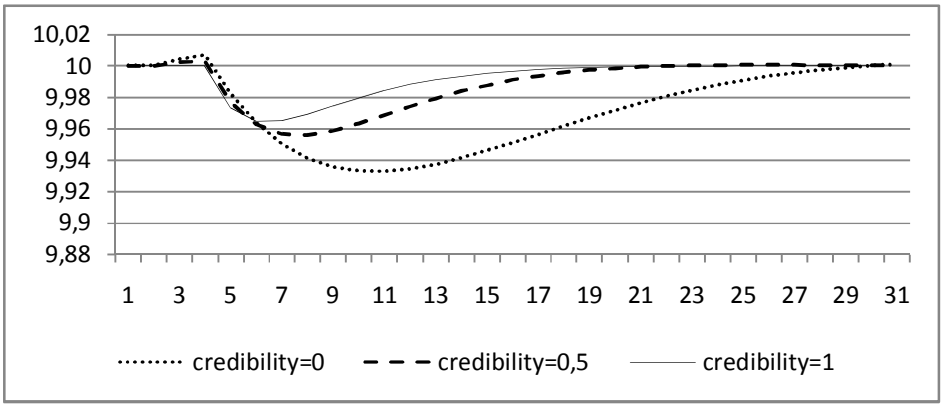
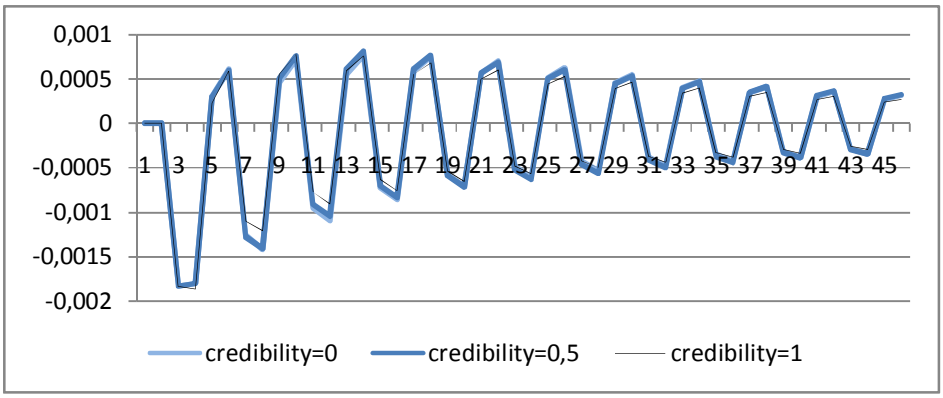


Figure 12. Effects of credibility in achieving long run value of output gap. (Moldova)



II. Response on reduction of inflation target

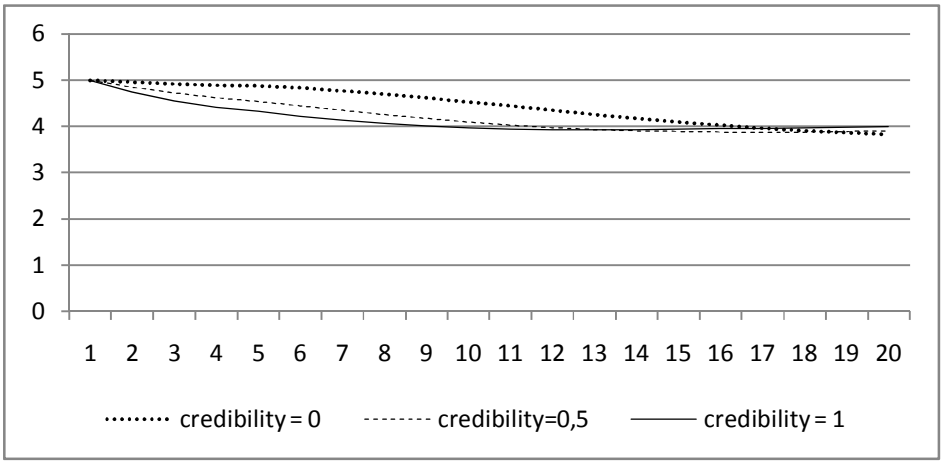
According to theoretical models, presence of credible policies is particularly important during disinflation period. It is stated by literature that when CB can efficiently signal its commitment to a policy announcements, it brings inflation down much faster than without credibility. Even partial credibility helps to avoid

much of inefficiencies in terms of output losses. Therefore, further a disinflation period is assumed, during inflation target is lowered by 1%.

Kazakhstan

Figure 13 shows that in extreme case when people fully trust Central Bank's announcements, the inflation is brought to its new target in 8 quarters (2 years). A non credible policy prolongs this period up to 8 more quarters. It is worth mentioning that a half credible policy is able to bring inflation in approximately 10 quarters which is very close to the length of disinflation period under a fully credible policy. Hence, it is enough for Central Bank to provide at least some signals of commitment, not necessarily to gain full credibility, in order to shorten the disinflation period from 16 to 10 quarters.

Figure 13. Effects of credibility in achieving inflation target. (Kazakhstan)

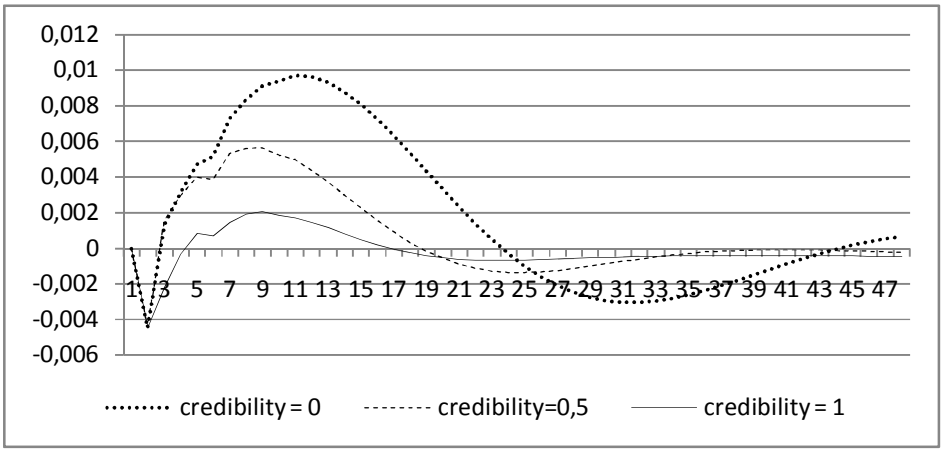


Similar conclusions can be made for output gap. In the case of fully credible policy, output gap has a much lower deviation, registering a maximum of 0.002 (minimum -0.04) converging in approximately 20 quarters. Bringing inflation target down by 1pp for a non credible commitment causes high deviation of output gap from its long run value, achieving a maximum at 0.01. As well, output

gap fails to converge in 50 quarters. This causes much higher losses. For comparison, sacrifice ratio (here presented as sum of output losses) is equal approximately 0.009 for the economy with credibility index of 1, while it reaches 0.04 under non credible policy. Similar to inflation path, it is enough for Central Bank to gain at least half of credibility to considerably shorten the period of convergence of output gap to its long run value decreasing sacrifice ratio to 0.016.

As well it should be mentioned that the new inflation target results in new equilibrium long run value of output gap, below the previous one.

Figure 14. Effects of credibility in achieving long run value during disinflation period. (Kazakhstan)

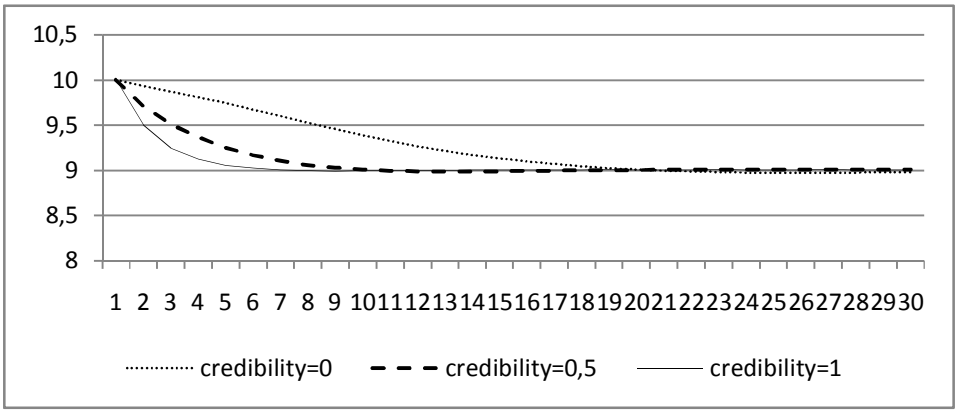


Moldova

Similar conclusions can be made for the case of Moldova. Lowering inflation target brings inflation under credible commitment of Central Bank much faster comparing to a non credible one. Hence, to achieve the new target when public fully trust Central Bank takes approximately 6 quarters. However, in case when public assigns zero credibility, convergence period is extended 12 quarters more.

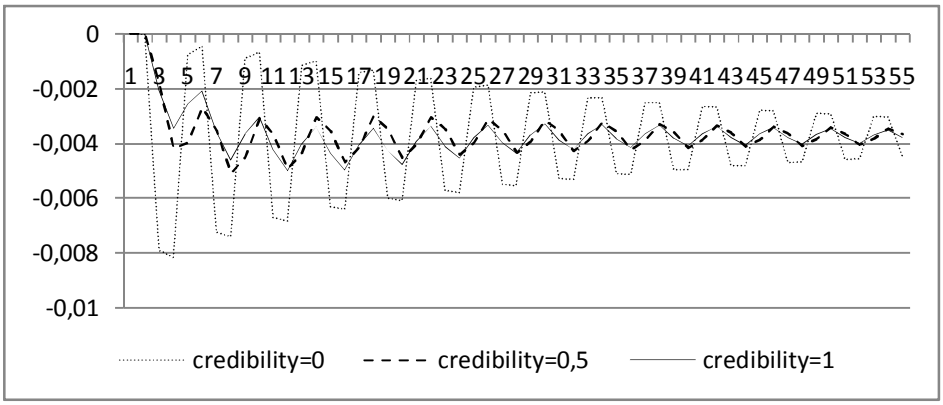
As well, in order to shorten this period from 20 to 10 quarters it is enough for Central Bank to gain at least half of public's trust.

Figure 15. Effects of credibility in achieving inflation target. (Moldova)



Similar to Kazakhstan, output gap for Moldova converges to a new lower long run value under a decreasing inflation target. Deviation under a fully credible policy is much lower than in the case of a non credible one. Converging period accounts for approximately 50 quarters with c=1 and c=0.5; and more than 55 quarters for c=0.

Figure 16. Effects of credibility in achieving long run value during disinflation period. (Moldova)



So, implications of the above presented results are as follows. In order to ensure lower period of convergence to the new targets and consequently a lower sacrifice ratio, it is not necessary for Central Banks in both countries to conduct a fully credible policy. It appears to be that gaining just half of public's trust is enough to bring inflation and output gap patterns closer to those under fully credible policies. These results are consistent to previously findings for developing countries which have already adopted inflation targeting regime (see for ex. Tanuwidjaja and Choy (2006)).

Chapter 6

LIMITATIONS AND EXTENSIONS

This study's goal was to provide some evidence on importance of a credible monetary policy in developing countries. Although obtained results are consistent with economic theory and empirical studies for developed economies as well as transition countries that already implemented full-fledged inflation targeting regime, nonetheless it is necessary to mention some of this study's limitations.

The model has been specified assuming inflation targeting regime. Operating targets used for these regimes are short term interest rates. However, both Kazakhstan and Moldova does not have a developed financial market which would respond appropriately to changes in interest rate. As well, they did not claim a full commitment to meeting announced targets, leaving the right to react to changes in exchange rate in case of speculative attacks. Hence, commonly used policy rule for this type of research - Taylor rule - can be a less preferred specification. However, both CBs assert that primary instruments for conducting monetary policies are REPO; as well we receive consistent predictions of economic theory reflected in the significant coefficients on variables of interest. Therefore, we assumed Taylor rule to be a good approximation for purpose of this study. Specification of a policy rule that would take into consideration economic characteristics of these countries is left for further research.

As a caveat to the conclusion made from out of sample simulation, we note that result might slightly change depending on the rule which specifies how public's expectations form. In this study we assumed that expectations follow a quasi-adaptive rationale for reasons provided above. However, for further studies a more cumbersome specification can be used, namely bringing the system of equation to its characteristic equation and solving for eigenvalues, respectively

eigenvectors. The latter are used for specification of the rule the expectations are formed.

Both Kazakhstan and Moldova are still going through transition period, which assumes implementation of new laws and policies of financial and fiscal development. All of these affects economic agents' beliefs and is likely to result in time varying coefficients. Still, after 2000 there were no major changes in economic policies as well as there was no evidence of significant external factors that could affect strongly perception of the ongoing policy and cause major changes in specification of the model. Moreover, dividing data in even smaller samples or adding control variables might result in less efficient and consistent results. Therefore, for this particular study we assumed no changes in model specification with fixed structural coefficients over time.

One of the major limitations of this study is a small sample size. Hence, our estimations do not allow us to obtain consistent results and adding more variables that would explain better the model. Although 3SLS results in unbiased parameter estimates, confidence intervals are likely to be larger which could result in some coefficients to be insignificant.

Chapter 7

CONCLUSION

This study attempted to emphasize the importance of monetary policy credibility in achieving long run equilibrium levels of macroeconomic variables during disinflation period or situations when economy is hit with external shocks.

For this purpose we developed a simple small macroeconomic model for two transition countries: Kazakhstan and Moldova. To my best knowledge this was the first attempt to construct a forward looking model for post-soviet countries and to test the implications of rational expectations on current variables. Inclusion of lead variables showed better fit results compared to backward looking model. Still, economic agents in both countries are more backward looking when making their decision, resulted in less weight on lead variables.

As well, we explicitly include credibility index in specification of inflation expectations. By varying the credibility index we were able to show the extent to which a credible policy shortens the period of convergence of macroeconomic variables. The results show that if people do not believe CB to commit to its announcements inflation targets are met in a more than twice larger period. However, it should be mentioned that gaining at least half of public's trust, CB can meet the target in a period very close to that of full credibility. The latter has an enormous implication in transition economies which are characterized by having low trust for policymakers' announcements. Hence despite the fact that coefficients on deviation variables in policy rule are much lower than that of inflation targeters and public is more backward looking when forming its expectations, it is enough for CB to get half of credibility to meet the targets in a much shorter period.

Our results go in line with the previous findings of lower output losses during disinflation period when credibility is higher. As well, similar to findings on convergence period of inflation, when credibility index equals to one half, output gap path is very close to that of full credibility.

Taking into considerations previous research on post-soviet countries that argue about the important role played by exchange rate in making policy decision, we included it in the model specification. The estimates show that indeed exchange rate influence inflation and output gap, however it does not affect directly the decision of setting policy interest rate which is an evidence of both CBs to follow an implicit inflation targeting regime.

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APPENDIX

Table 3. Model Variables

Label 1*	Label 2**	Description	Source***		
			USA	Kazakhstan	Moldova
gdp(i)[1)]		quarterly real GDP, Ml. NCU (nominal GDP/CPI) (2000=100)		IFS	IFS
ygap(i)	Δy	quarterly real GDP gap (using Hodrick Prescott filter with lambda=1600)		Computed	Computed
er(i)		nominal exchange rate USD		NBG	NBG
inf(i)		inflation adjusted anually (decimal)		Computed	Computed
reer(i)	s	REER (average monthly change in a quarter),% (M1 2000=100)		NBK	IFS
LTRK	R	interest rates on GOV Bonds (2-10 years)		NBK	-
LTRM	R	interest rates on loans to Government projects (>5)		-	NBM
ciK5	C	Credibility index for Kazakhstan with R low = 5		Computed	-
ciM8	C	Credibility index for Moldova with R low = 8		-	Computed
IT(i)	i	inflation target		NBK	NBM
IP(i)	π^*	Policy interest rate		NBK	NBM
CPI(i)		consumer price index		NBK	NBM
G(i)	g	Government expenditures, Ml. NCU		IFS	IFS
ipus	i^*	Policy interest rate of USA	IFS	-	-
cpius		Consumer price index of USA	IFS	-	-
pi_e(i)	π^e	Expected inflation (c*IT+(1-c)*l.infk)		Computed	Computed
r1(i)	r	Real interest rate (ip-pi_e)		Computed	Computed
r2(i)	r	Real interest rate (ip-f.inf)		Computed	Computed
r3(i)	r	Real interest rate (ip-l.inf)		Computed	Computed
Inf_dev(i)	$\pi - \pi^*$	Deviation of inflation from target		Computed	computed

* - Label 1 stands for specification of variables used for regressions

** - Label 2 stands for specification of variables used in the model description

*** - IFS = International Financial Statistics, NBK = National Bank of Kazakhstan, NBM = National Bank of Moldova, NBG = National Bank of Georgia

1) - (i) stands for country : K=Kazakhstan, M=Moldova,

Table 4. Descriptive statistics of the variables (Kazakhstan)

	Mean	Maximum	Minimum	Std. Dev.	Observations
CIK7	0.266190	0.906962	0.000000	0.357467	32
CPIK	102.1721	109.0515	100.1018	1.557891	32
ERK	138.8302	154.7167	120.8454	10.91896	32
GDPK	1547943.	3534031.	502530.2	861977.3	32
INFK	8.475000	20.40000	5.000000	3.264471	32
IPK	9.333333	17.33333	7.000000	2.734356	32
ITK	6.025000	7.000000	5.000000	0.747900	32
LTRK	9.551979	17.52333	5.473333	4.337451	32
REERK	97.63265	106.7051	89.54061	4.627466	32

Table 5. Descriptive statistics of the variables for 2000-2007 period (Kazakhstan)

Year	2000	2001	2002	2003	2004	2005	2006	2007
GDP (Bln. NCU)	2539,8	3202,1	3720,1	4536,8	5769,7	7448,5	10011	12305
Exchnage rate*	142,41	146,94	153,45	149,39	136,98	133,21	125,70	122,57
Annual Inflation (%)	12,55	8,25	5,88	6,40	6,98	7,63	8,68	11,48
Real Effective Exchange Rate (%)*	100,37	99,40	94,49	90,38	94,17	96,15	102,37	103,72
Long Term Interest Rate (%)*	17,02	14,78	11,83	9,04	6,61	6,08	5,56	5,50
Target Inflation (%)	7,00	7,00	6,00	5,00	5,00	5,70	6,50	6,00
Policy Interest Rate (%)*	15,17	11,67	8,08	7,25	7,00	7,71	8,63	9,17

* - average quarterly rate

Table 6. Descriptive statistics of the variables (Rep. of Moldova)

	Mean	Maximum	Minimum	Std. Dev.	Observations
CIM8	0.525158	0.764151	0.000000	0.286248	28
CPIM	174.6488	253.1437	125.9148	39.63275	28
ERM	12.88021	14.19203	11.30340	0.712005	28
GDPM	8239.959	15948.47	3145.371	3424.772	28
INFM	10.78539	16.18541	4.344820	3.687000	28
ITM	9.000000	10.00000	6.000000	1.333333	28
IPM	13.53571	20.50000	9.500000	2.493761	28
LTRM	11.61012	15.00000	10.50000	1.479095	28
REERM	102.3269	111.6030	89.09300	6.075535	28

Table 7. Descriptive statistics of the variables for 2001-2007 period (Rep. of Moldova)

Year	2001	2002	2003	2004	2005	2006	2007
GDP (Bln. NCU)	18851,0	22403,9	26557,6	31131,7	36825,1	43335,3	51614,3
Exchnage rate*	12,88	13,60	13,81	12,14	12,60	13,14	12,00
Annual Inflation (%)	8,83	4,76	12,64	12,27	11,81	13,05	12,13
Real Effective Exchange Rate (%)*	104,12	98,56	93,09	106,77	109,05	102,85	101,85
Long Term Interest Rate (%)*	14,63	12,38	10,96	11,50	10,81	10,50	10,50
Target Inflation (%)	10,00	10,00	6,00	9,00	9,00	9,00	10,00
Policy Interest Rate (%)*	17,71	11,29	11,25	14,17	12,92	12,83	14,58

* - average quarterly rate

Table 8. Unit root tests

	Kazakhstan		Moldova	
Variable[1)]	ADF[2)]	PP[3)]	ADF	PP
ygap	-5.506**	-6.353**	-5.519**	-10.017**
r1	-1.901	-1.932	-5.377**	-5.387**
d.r1	-6.560**	-7.229**	-	-
r2	0.283	-0.334	-1.749	-2.029
d.r2	-0.735	-1.242	-4.248**	-4.204**
r3k	-3.345**	-3.335**	-3.558**	-3.643**
dif_rer	-5.041**	-5.109**	-4.345**	-4.305**
ip	-5.595**	-3.761**	-3.773**	-3.399*
inf	-3.557**	-7.456**	-4.804**	-4.238**
pi_e	-4.896**	-4.035**	-3.994**	-4.007**
dev_lg	-6.548**	-6.741**	-2.787*	-2.801*
inf_dev	-3.565**	-3.881**	-3.910**	-3.722**

1) - variables are defined in table 1.
2) - augmented Dickey-Fuller
3) - Phillips Perron

Table 9. KPSS test for selected variables

Variables[1)]	Lag order [2)]					
	0	1	2	3	4	5
r1k	.0826	.0686	.0724	.0807	.101	.121
r2k	.124*	.0941	.089	.0906	.0955	.101

1)- variables that follow unit root process according to DF and PP.
2) – test statistic 10% - 0.0119; 5% - 0.146; 1% - 0.216.

Table 10. Estimates of the forward looking model used for simulation procedures with C=0 (Kazakhstan)

IS equation					
Δy_{t+1}	Δy_{t-1}	r_{t-1}	Δs_t	g_t	cons
0.37	0.177	0.005	0.02	-0.05	-0.01
(0.88)	(0.47)	(0.46)	(1.08)	(-0.39)	(0.02)
PC equation					
π_{t+1}	π_{t-1}	Δy_{t-4}	Δs_{t-3}		cons
0.267	0.733	0.006	-0.13		0.13)
(1.18)	(3.24)***	(0.0)	(1.48)		(-0.19)
Policy rule					
i_{t-1}	$\pi_t - \pi*$	Δy_t	Δs_t		cons
0.8	0.238	1.37	0.009		1.117
(26.16)***	(4.71)***	(1.95)*	(0.34)		(3.86)***

*-10%
**-5%
***-1%

Table 11. Estimates of the forward looking model used for simulation procedures with C=0 (Moldova)

IS equation					
Δy_{t+1}	Δy_{t-2}	r_{t-1}	Δs_{t-1}	g_t	cons
0.002	-0.93	0.007	-0.002	0	-0.005
(0.04)	(-18.37)***	(2.36)**	(-0.86)	(0.01)	(-0.43)
PC equation					
π_{t+1}	π_{t-1}	Δy_{t-3}	Δs_{t-2}		cons
0.502	0.498	-0.81	-0.107		-1.517
(3.29)***	(3.25)***	(-0.4)	(-0.92)		(2.56)
Policy rule					
i_{t-1}	$\pi_t - \pi*$	Δy_t	Δs_t		cons
0.714	0.15	0.74	0.08		3.336
(17.02)***	(3.11)***	(0.85)	(1.58)		(5.13)***

*-10%
**-5%
***-1%

Table 12. Coefficients used for out of sample simulation (Kazakhstan)

matrix A			constant	Pi target	i*
-0,0368	-0,0081	0,0081	0,009691	5	5.82
2,86135	0,8053	0,12691	0,039319		
0,02189	0,11102	0,86635	0		

Table 13. Coefficients used for out of sample simulation (Moldova)

matrix A			constant	Pi target	i*
-0,00019	-0,00123	0,001657	9909,643	10	11.7
-0,60599	0,858878	0,034085	0,871281		
-0,58708	0,268363	0,737718	0		