ESTIMATING THE NATURAL RATE OF INTEREST. CASE OF UKRAINE.

by

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Abstract

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Successful monetary policy is one of the aspects of the stabilization policy that is extremely important for transition economy. However, monetary authority needs a good indicator of the stance of the economy. During the last years natural interest rate becomes more and more important as the monetary policy indicator. In this paper we have estimated the natural rate of interest for the Ukrainian economy using structural VAR model.

Natural rate of interest was found to be volatile, but less than the real interest rate. Thus, high variability of the natural rate of interest could make it difficult for the monetary authority to follow its trend closely.

Besides, during the years 2001-2002 of stable inflation and high economic growth it was registered a convergence of the real interest rate to the natural rate. Moreover, it was found that natural rate of interest is going up with GDP upturns and decline during the recession, thus, inducing economy for further growth. Thus, natural rate of interest could become an important indicator for the National Bank of Ukraine to improve its monetary policy, and adjust instruments more quickly to the shocks.

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Chapter 1

INTRODUCTION

A concept of the natural rate of interest is now extensively discussed in the context of the monetary policy and its ability to achieve stable inflation figures. The term of the natural rate of interest was firstly considered by Wicksell (1898), however, only in the mid nineties it was recovered and is developing till present. But before going into detail further, let us firstly define the natural rate of interest.

> Wicksell defined it as follows: "There is a certain rate of interest on loans which is neutral in respect to commodity prices, and tends neither to raise nor to lower them." (1898). However, there exist other ways to define the natural rate of interest, like a short-term real interest rate that is associated with output converging to its potential (natural) level consistent with stable inflation (Laubach, Williams, 2001).

Interest rate, as a tool, is now becoming more and more popular among the monetary authorities in different countries. In the seventies U.S. Federal Reserve System was first to refuse monetary aggregates as a primary monetary instrument and has mostly concentrated on interest rates. This could be explained by increasing difficulties, delays, and inaccuracies in estimating money supply. On the contrary, interest rates are observed daily without any measurement biases. But still inflation stability is hardly achieved by the monetary authorities around the world. In this respect there were developed models that verified the relationship between inflation, output level and interest rates. *Precisely, we would define natural rate of interest as a rate that could stabilize inflation.* Thus, the estimates of natural rate of interest could be an important tool for the monetary authority that aims to keep inflation low and stable. However, the natural rate of interest is a theoretical concept and could not be observed in real economy. But within a theoretical framework that relates real variables to the unobservable ones the latter could be estimated. And finally, result obtained from the model in the form of the estimated series could become very useful and powerful tool for the monetary authorities. With the data for the natural rate of interest and with the well defined theoretical model for a given country there could be implemented and governed inflation targeting policy on the strong theoretical grounds that would help to minimize the errors of the policy actions. This is supposed to have a positive effect on the overall economic performance since stable inflation means predictable economic environment, and thus have a positive effect on the level of business activity and economic growth.

The latter issues are urgent for the Ukrainian economy. In this respect there could be described casual relationship between price stability and the level of economic and social development. For example, Ukraine has now very low figures for the income per capita together with high income inequality, however, this problems could be overcome by preserving high economic growth figures.

But the latter depends also on the macroeconomic stability level, which in turn has stable inflation as one of the main issues. Thus, we can conclude that natural interest rate estimations for the Ukrainian economy could be important for the improvement of the overall economic stance also through adequate monetary policy. Of cause, this is not a panacea, but still very important aspect of economic policy.

There exist few models and techniques that could help to estimate the unobservable series. Their advantages and shortcomings will be briefly discussed further in the text. This paper, however, will be focused mainly on the Structural vector autoregressive (SVAR) model.

Data will be taken monthly starting from 1999 to 2004 for the CPI, and real interest rate. Precisely, the real interest rate will be proxied by the monthly average interbank short-term (up to one month) interest rate. This is similar to the U.S. Federal fund rate that is the targeting interest rate of the Fed's monetary policy, and which is used in the model, mentioned above.

Thus, the main purpose is to estimate the natural rate of interest series for the Ukrainian economy, and to test few hypothesis on the relationship between the natural rate of interest and other macroeconomic variables in the transition Ukrainian economy. Precisely, we will test whether the positive gap between the natural rate of interest and the real interest rate creates inflationary pressure in the economy. Moreover, during the last two year Ukraine experienced stable and low inflation figures. Therein, there could be examined existence of convergence of the rate of interest to its natural level. Finally, few policy implications could be brought out from the estimation and testing results.

The remainder of the paper is organized in the following way. Chapter 2 will examine the literature concerning the estimation of the natural rate of interest in other countries, as well as the theoretical grounds for the models specification. Chapter 3 will present estimation methodology of the SVAR models. There will be provided general model specification for the simple case as well the estimation procedure. Data will be described in Chapter 4. Chapter 5 will consist of the model's specifications for the case of Ukraine and estimation results, including the testing procedures. Chapter 6 will conclude.

Chapter 2

LITERATURE REVIEW

Before going into the estimation details of the natural rate of interest, analysis and implications, it will be extremely useful to understand the possible use of natural rate of interest and its advantage over the other monetary instruments.

Monetary authorities all over the world conduct monetary policy in order to achieve important for the society macroeconomics goals. Mishkin (2000) define the following six policy objectives: high employment, economic growth, price stability, interest-rate stability, stability of financial markets, stability in foreign exchange markets. Although all these goals are of the extreme importance for the strong and developed economy as well as for the social welfare, some of them could be in conflict with each other. For example, price stability often conflicts with the stability of interest rates and high employment in the short-run, however, this is considered by Mishkin not to be the truth in the long-run. As a result a monetary authority, for example Federal Reserve System (Fed) of the U.S., was always making a choice of one or other group of goals, usually in accordance to the political or economic needs. For instance, during the World War II Fed was keeping the interest rates low in order to help the government to finance huge budget deficit, but then such a policy resulted in high inflation figures. Many years then monetary policy not only in the U.S. was influenced by the so called "political cycle". This means that before the elections monetary authority was somehow forced to achieve high employment and low interest rates goals, but after the elections an economy should pay for low rates with higher inflation figures as is emphasized in Mishkin (2000).

However, as monetary authorities not only in the developed but also in developing countries are becoming more independent nowadays they are tending to the price stability target. Since inflation has tight relationships with interest rates, it is much easier to achieve price stability goal by influencing interest rate. Thus, increasing popularity of the interest rates as a monetary tool is explained by the inflation targeting policy.

A discussion about the relationship between interest rates and prices was started by Wicksell. The main thesis of his paper (1907) was that the lowering of an interest rate below its natural level by one percent and keeping for several years would driven the prices up almost to the infinity; and the opposite: rising an interest rate above its natural level could force the prices to go down. Indeed, this proposition showed its credibility during the huge rise of inflation in the U.S. in the 50^{th}, after the years of compulsory low interest rates.

But even during the last few decades when U.S Fed used the interest rates as a primary tool to achieve its goal of price stability, there were periods with high inflation volatility. As a result many researchers have started to explore the concept of the natural rate of interest and the gap between it and market interest rate.

One of them was John B. Taylor, who presented his influential paper "Discretion versus policy rules in practice" in 1992. Taylor had found a simple rule that could describe monetary policy. Precisely, he used multicountry rational expectation model and then simulated economic performance of the G-7 countries with different monetary policies. Then he ranked those policies in accordance with their successfulness, and formulated a rule that could be described as follows: deviation of the interest rate from its baseline (natural level) could be presented as a difference in inflation and in the output. He also presented estimated coefficient for the U.S. economy. This paper made a stimulus for further research in this field.

The main proposition of the recent papers in this topic is that the estimates of the natural rate of interest could be a good tool for the monetary authorities to achieve stable inflation target. That is by increasing an interest rate above its present natural level inflation could be put down and then after the restoration of the natural rate of interest stable inflation figures could be observed.

But researchers have used different estimation methodologies for the estimation of the natural rate of interest. There were developed a lot of different techniques recently, however, they were mostly used for the purposes of estimating the potential output.

As was mentioned above this paper will concentrate on the SVAR model. This decision was not made by throwing a coin, but basing on the comparison of the different approaches, estimated models and their results. SVAR models are often used to recover time series of the unobserved variables. For example, for the euro area Chagny and Döpke (2001) explored SVAR model to find the natural rate of interest. Brzoza-Brzezina studied U.S. and Polish monetary policy using the SVAR model. He found highly volatile natural rate of interest. Moreover, he had found positive correlation between the natural rate of interest and the economic cycle.

However, researchers also used other approaches for the estimation purposes. For example, in the paper of Laubach and Williams (2001) the natural rate of interest was estimated using a state-space model with multivariate Kalman filter for the U.S. economy 1960-2000. They took quarterly data of GDP, inflation rate and federal funds rate and estimated potential output and natural rate of interest. Natural rate of interest was found to change with time, however, it was less volatile than federal funds rate. Moreover, theoretical relationship between the inflation and interest rate was confirmed. And discrepancy between the natural rate of interest and federal funds rate was large up to the ninetieth when they converged greater.

Moreover, Neiss and Nelson (2001) that studied the natural rate of interest for UK using the dynamic stochastic general equilibrium model (DSGE). Households were modeled by choosing consumption, leisure, nominal money, bonds, capital in order to maximize lifetime utility function. Producers' side was described by monopolistic competitive firms, that chose price, labor and capital to maximize profit. They had Cobb-Douglas production function. Also economy has a resource constraint. In this framework they defined the natural rate of interest as a rate that prevails under flexible prices. They have estimated the interest rate gap and tested its relationship with other macroeconomic variables. Precisely, they have found incorrect predictions for the correlation between inflation and interest rates with output. However, they have found benefits in forecasting inflation.

Thus, it could be argued that still estimation methods for the natural rate of interest are not perfect and there exist a vast area for further research.

Chapter 3

ESTIMATION METHODOLOGY

SVAR models are extensively used for the time series analysis, and especially for investigation of the monetary policy's impact on the macroeconomic variables in the economy of a country. In the SVAR models on the contrary to the VAR models, variables under study are assumed to be driven by the unobserved shocks. However, there are developed techniques that are helpful in estimating these unobservable shocks. Precisely, one could estimate corresponding VAR model by maximum likelihood, and then decompose residuals into structural shocks. But researcher should impose restrictions on the shocks and on the coefficients in order for the model to be identified and estimable. SVAR approach is based on the assumption of the normality and orthogonality of the structural shocks. The other restrictions are imposed basing on the economic theory assumptions about the economic relationship under study. (Blanchard, Quah, 1989)

Let us then specify the general functional form of the model.

$$X_t = C(L)\varepsilon_t, \tag{1}$$

where X_t is a vector of the dependent variables, and ε_t is a vector of normally distributed, independent structural shocks. In order to recover ε_t from the model above we should estimate it as a VAR model of the following specification:

$$X_t = A(L)X_{t-1} + e_t, \tag{2}$$

where A(L) is an n-dimensional lag polynomial.

However, we could rewrite the above VAR model in the MA form because we are interested in the impulse response functions.

$$\Delta X_t = S(L)e_t, \tag{3}$$

where $S(L) = (I - A(L)L)^{-1}$ (4)

Then we could recover the structural shocks from $e_t = C(0)\varepsilon_t$ (5)

This technique was firstly proposed by Blanchard and Quah (1989) for the estimation of potential output. Then it was incorporated by Brzoza-Brzezina (2002) for the estimation of the natural rate of interest for the U.S. economy. We would proceed for the Ukrainian case as follows. Firstly, let us define the real interest rate as a sum of the natural rate of interest and the gap between the interest rates, moreover, let natural rate of interest and interest rate gap follow stationary autoregressive processes.

$$r = r^* + GAP \tag{6}$$

$$r_t^* = \Phi_1(L)r_{t-1}^* + \varepsilon_{1,t} = (I - \Phi(L)L)^{-1}\varepsilon_{1,t} \tag{7}$$

$$GAP = \Phi_2(L)GAP_{t-1} + \varepsilon_{2,t} = (I - \Phi(L)L)^{-1}\varepsilon_{2,t} \tag{8}$$

where, r is real interest rate,

r^* is the natural rate of interest,

GAP is a gap between the interest rates as defined in (6),

$\varepsilon_{1t}, \varepsilon_{2t}$ are structural unobserved shocks that are assumed to be normally distributed with zero mean and variance σ^2,

$\Phi(L)$ are lag polynomials.

Further,

$$r = (I - \Phi_1(L)L)^{-1}\varepsilon_{1,t} + (I - \Phi_2(L)L)^{-1}\varepsilon_{2,t} \tag{9}$$

$$\Delta\pi = \psi(r - r^*) = \psi GAP = \psi(I - \Phi_2(L)L)^{-1}\varepsilon_{2,t} \tag{10}$$

where $\Delta\pi$ is a monthly percentage change in the inflation rate.

Finally, we would end with a SVAR model of the following specification, see in matrix form:

$$\begin{bmatrix} \Delta\pi_t \\ r_t \end{bmatrix} = \begin{bmatrix} C_{11}(L) & C_{12}(L) \\ C_{21}(L) & C_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \tag{11}$$

However, we are not able to estimate this model in its structural form, thus we should estimate VAR and then decompose residuals into structural shocks.

$$\begin{matrix} \Delta\pi_t \\ r_t \end{matrix} = \begin{pmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{pmatrix} \begin{pmatrix} \Delta\pi_{t-1} \\ r_{t-1} \end{pmatrix} + \begin{pmatrix} e_{1,t} \\ e_{2,t} \end{pmatrix}, \tag{12}$$

or in MA form

$$\begin{bmatrix} \Delta\pi_t \\ r_t \end{bmatrix} = \begin{bmatrix} S_{11}(L) & S_{12}(L) \\ S_{21}(L) & S_{22}(L) \end{bmatrix} \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \tag{13}$$

New residuals are related to the structural ones as follows

$$\begin{pmatrix} e_{1,t} \\ e_{2,t} \end{pmatrix} = \begin{pmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{pmatrix} \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \tag{14}$$

First restriction that we could recover from the equation (10) is that $S_{11}(L) = 0$ because ε_{1t} does not impact change in inflation. (15)

The other restrictions we should impose on the basis of the economic theory about inflation and interest rates. For example, Brzoza-Brzezina (2002) assumed $S_{12}(1)$ to be equal to zero having the insights that innovation to the interest rate gap will have no impact on the inflation in the current month. As theory predicts, monetary transmission mechanism will take for longer time than one month. Besides, it was assumed that in the long run shocks to the natural rate of interest will not affect the inflation figures, thus $S_{11}(1) = 0$

Under the stated constraints, we could estimate the S components and get the estimates for the natural rate of interest

$$r_t^* = S_{21}(L)u_{1t} \tag{16}$$

Chapter 4

DATA DESCRIPTION

For the estimation purposes of the models described above monthly data for the Ukrainian economy will be used. Since we are going to estimate the natural rate of interest by definition we will require only the series of the real interest rate and inflation. These variables as well as the real GDP that will be used for the analysis further are one of the most monitored variables, thus we could expect to have minor measurement bias if any.

Data is available starting from the August 1999 Nominal interest rate is proxied by the interbank short-term interest rate. For the model, however, we are interested in the real interest rate. Thus, we would substract expected inflation from the nominal interest rates in order to get the real rate according to the Phillips rule. Data is used from the different sources: National Bank of Ukraine, UEPLAC, and IER (Institute of Economic Research).[1].

[1] See the data tables in Appendix 1.

Chapter 5

ESTIMATION RESULTS

Let us first start with the model we want to estimate:

$$\begin{bmatrix} \Delta\pi_t \\ r_t \end{bmatrix} = \begin{bmatrix} C_{11}(L) & C_{12}(L) \\ C_{21}(L) & C_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \tag{11}$$

where, $\Delta\pi_t$ is difference in monthly inflation, and r_t is the real interest rate

Unfortunately, we are not able to estimate structural shocks $\begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$ with a help of this model, and we have to incorporate modification in standard VAR form.

$$\begin{bmatrix} \Delta\pi_t \\ r_t \end{bmatrix} = \begin{bmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{bmatrix} \begin{bmatrix} \Delta\pi_{t-1} \\ r_{t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \tag{12}$$

Further, we would proceed with the VAR model, and then return back to the model under research.

First of all, we should verify stationarity of the time series because it is one of the main requirements of the VAR modeling.

The hypothesis for augmented Dickey-Fuller test are:

$$H_0 : \delta = 0, \quad Series \quad nonstationary$$
$$H_1 : \delta < 0, \quad Series \quad stationary$$

And δ is a coefficient of the following equation:

$$\Delta RRATE_t = m + \delta RRATE_{t-1} + \sum_{i=1}^{k} \delta_i \Delta RRATE_{t-i} + \varepsilon_t \tag{17}$$

Firstly, we have tested nominal interest rate for stationarity, and have found that this series is not stationary but I(1), that is stationary in first differences.[2] However, for our model, as was mentioned above, we are interested in real interest rate series rather than nominal. Thus, we should extract expected inflation from nominal interest rate. Theory predicts that inflation is also I(1), then real interest rate will be I(0) – stationary series. Let us firstly test whether inflation is I(1).

Truly, inflation was found to be not stationary in levels, thus we would estimate further stationarity in first differences.[3]

Next, we will examine DINFL series.

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[2] See Appendix 2 for the test results.

Table 1. ***ADF test statistics for the difference of inflation.***

ADF Test Statistic	-6.231117	1% Critical Value*	-3.5398
		5% Critical Value	-2.9092
		10% Critical Value	-2.5919

The hypothesis for augmented Dickey-Fuller test are:

$$H_0 : \delta = 0, \quad \textit{Series} \quad \textit{nonstationary}$$
$$H_1 : \delta < 0, \quad \textit{Series} \quad \textit{stationary}$$

And δ is a coefficient of the following equation:

$$\Delta INFLD_t = m + \delta INFLD_{t-1} + \sum_{i=1}^{k} \delta_i \Delta INFLD_{t-i} + \varepsilon_t \qquad (18)$$

We could see from the table that null hypothesis is rejected at all significance levels, thus, we may conclude that INFLD is stationary series.

Thus, inflation is I(1) as we expected, thus we extract inflation from nominal interest rate series and get RRATE that is expected to be I(0). And we could see that this is true from the table below.

Table 2. ***ADF test statistics for the real interest rate.***

ADF Test Statistic	-3.962148	1% Critical Value*	-3.5398
		5% Critical Value	-2.9092
		10% Critical Value	-2.5919

[3] See Appendix 2 for testing inflation in levels.

We could see from the table that null hypothesis is rejected at all significance levels, thus, we may conclude that RRATE is stationary series.

Thus, we can proceed further with VAR model. Since we have monthly data I have firstly examined the model with 12 lags. However, a lot of coefficients were found to be insignificant, moreover, LR and Schwartz criteria suggested further reduction of the model up to 2 lags without loosing much in the goodness of fit measures.

Thus, we have finished with the VAR(2) model:[4]

In order to check the reliability of the estimates we have performed number of standard test.

Table 3. ***LM test statistics for autocorrelation in error terms.***

Lags	LM-Stat	Prob
1	0.794401	0.9392
2	2.098876	0.7176

As can be seen from the Table 3 , hypothesis of zero autocorrelation in the residuals is not rejected.

[4] For the estimation output see Appendix 3.

Further we would perform a joint test for heteroscedasticity with null hypothesis of no heteroscedasticity in error terms. As could be seen from the Table 4, we can not reject the null hypothesis.

Table 4. ***White test statistics for heteroscedasticity.***

Chi-sq	Prob.
24.22945	0.4485

Finally, let us perform normality test for the residuals. Null hypothesis is that residuals are multivariate normal. As could be seen from the table we can not reject this hypothesis for each of the two residuals separately as well as for the joint test.

Table 5. ***Residuals normality test.***

Component	Jarque-Bera	Prob.
1	2.099143	0.3501
2	1.767331	0.4133
Joint	3.866474	0.4244

Thus, we may conclude that our model is correctly specified because all the main classical assumptions are satisfied. However, we are not interested in the coefficients of the VAR model in this case, and we should recover the structural coefficients and shocks out from the estimated VAR model.

This could be easily done in few steps.

Firstly, let us transform our VAR model into the MA representation, that is

$$\begin{bmatrix} \Delta\pi_t \\ r_t \end{bmatrix} = \begin{bmatrix} S_{11}(L) & S_{12}(L) \\ S_{21}(L) & S_{22}(L) \end{bmatrix} \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \tag{19}$$

where, $S(L) = (I - A(L)L)^{-1}$ (20)

further, we could see that

$$\begin{bmatrix} C_{11}(0) & C_{12}(0) \\ C_{21}(0) & C_{22}(0) \end{bmatrix}^{-1} \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \tag{21}$$

Thus we could easily recover structural innovations $\begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$ as soon as we are able to estimate C(0) matrix. But in order to estimate C(0) matrix we should impose few restrictions such that our structural model will be identified. According to the equation (3) u_{1t} does not influence $\Delta\pi$, thus we could set $C_{11}(L) = 0$. Further, we set standard restriction for this type of models, that is, shocks have variance equal to 1. And the last restriction is based on the assumption that innovation to the interest rate gap has influence on the inflation with lag, and not in the current month. Thus, $c_{12}(0)=0$

We could estimate the C(0) matrix from the following formulas:

$$
\begin{aligned}
c_{11}(0) &= \pm\sqrt{\operatorname{var}(e_{1t})} \\
c_{21}(0) &= \mp\left(\frac{S_{11}(1)}{S_{12}(1)}\right)\sqrt{\operatorname{var}(e_{1t})} \\
c_{22}(0) &= \sqrt{-2\frac{c_{21}(0)}{c_{11}(0)}\operatorname{cov}(e_{1t},e_{2t})+c_{21}^{2}(0)+\operatorname{var}(e_{2t})}
\end{aligned}
\qquad (22\text{-}24)
$$

However, the same estimations could be done by Eviews.[5]

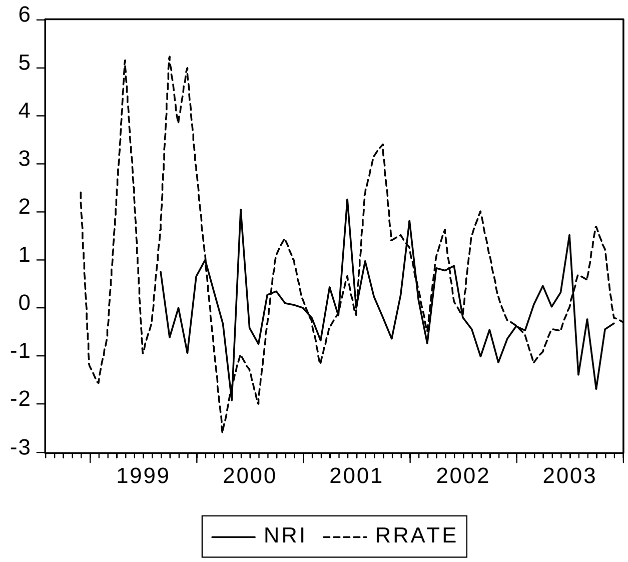
$$C(0)=\begin{pmatrix} 0.975471 & 0 \\ -0.404282 & 0.712603 \end{pmatrix}$$

Further we could easily recover structural shocks, and estimate the natural rate of interest from the following formula

$$r_t^{*}=C_{21}(L)\varepsilon_{1t} \text{ where C(L) = S(L)C(0)} \qquad (25\text{-}26)$$

[5] See the Eviews output in Appendix 3.

Figure 1. ***Natural rate of interest and real interest rate, 1999-2004***

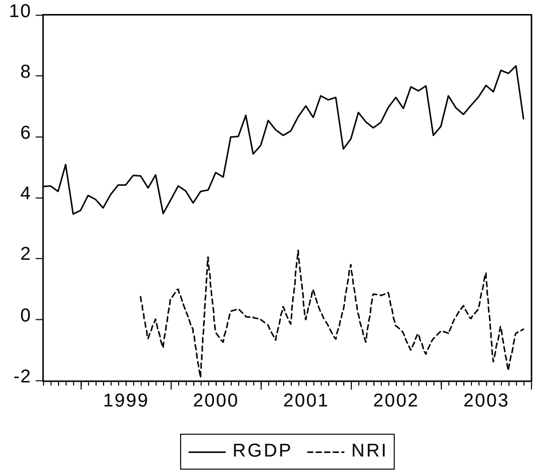


As can be seen from the Figure 1 natural rate of interest and real rate of interest have very similar patterns, this could be proved by the positive correlation of 0.29 between this series. However, real rate respond to the changes in the natural rate with lag that changes from three to seven months. These results are not surprising because central bank should have time to adjust its instruments to the shock. In this respect updated estimates of the natural rate of interest as a policy rule could decrease the time of adjustment, and this could positively influence economy. Besides, natural rate of interest was found to have large standard deviation, however, it is twice as smaller as the standard deviation of the real interest rate. Our result is somewhere in between of the results received by Laubach and Williams (2001) that reported much lower variance of natural rate of interest for the U.S. economy in comparison with the real rate and Brzoza-Brzezina (2002) and Rotenberg at al (1997) that reported high variance of the natural rate of interest. Lower volatility of the natural rate of interest makes it reasonable to use its estimates for the purpose of the monetary policy.

Moreover, from the Figure 1 we could see the periods of both positive and negative interest rate gaps. In the year 1999 we observe positive gap and this could be explained by the policy of the central bank in those years to depress inflation after the crisis of 1998. Further, however, we could see a negative interest rate gap that corresponds to the period of high inflation and high GDP growth. Then we could see two years when real rate of interest was converging to the natural rate of interest. And really, these years in Ukraine could be describes by stable and low inflation and high economic growth. But starting from the year 2003 we could see the increase in the time of adjustment of the monetary policy to the shocks. Finally, during the last half a year we could observe positive gap, and thus, rising inflation. Therefore, central bank could try to stabilize inflation in Ukraine to decrease the real interest rates through sales on the open market or through issuing more credits to the banking system.

Further we tested whether there could be observed any correlation between the real GDP and the estimates of the natural rate of interest.

Figure 2. ***Real GDP and natural rate of interest.***



From the Figure 2 it could be seen cyclical component of the real GDP has a positive correlation with the natural rate of interest. This result goes in line with the outcome of the Laubach and Williams (2001), Brzoza-Brzezina (2002) for the U.S. economy and Brzoza-Brzezina (2003) for the economy of Poland. This result is quite natural because in the recession rate of interest should be decreased in order to induce growth. Thus, natural rate of interest was found to be procyclical. Similar result was also received by other authors, for example, Neiss and Nelson (2000) and Crespo-Cuaresma at al (2002) for the U.K and Euro area economy.

Thus, we may conclude that our model is correctly estimated, and we could suggest the NRI estimates to be rather reliable.

Chapter 6

CONCLUSIONS

Successful monetary policy is one of the aspects of the stabilization policy that is extremely important for transition economy. Stable inflation creates predictable economic environment, and thus can indirectly influence economic growth by increasing the business activity in the country. However, monetary authority needs a good indicator of the stance of the economy. During the last years natural interest rate becomes more and more important as the monetary policy indicator.

There have been written number of papers already that estimated the natural rate of interest for different countries. And the current paper is dedicated to the estimation of the natural rate of interest for Ukraine over the periods 1999 – 2004. For this purpose we used SVAR model. The estimates of the model were shown to be consistent and efficient. Thus, we may conclude that our estimated of the natural rate of interest are reliable.

Further, we examined the statistical properties of the natural rate of interest and it historical behavior. It was found that the natural rate of interest is rather volatile, however, it has twice less standard deviation than the real rate of interest. Thus, monetary authority could use the estimates of the natural rate of interest for the policy improvement purposes. In this respect it was found that real rate and the natural rate of interest have positive correlation, however, central bank adjusted to the changes in the natural rate with a lag, sometimes rather substantial – up to seven months. Moreover, during the years 2001-2002 it was observed a convergence of the real rate of interest to the natural rate. Thus, we could conclude that these years are described by successful monetary policy. Moreover, during this year we also observed stable inflation and high economic growth. Consequently, we may say that successful monetary policy in the sense of preserving the natural rate of interest could have positive impact on the economy.

Besides, it was found that natural rate of interest is going up with GDP upturns and decline during the recession, thus, inducing economy for further growth.

To sum up, high variability of the natural rate of interest could make it difficult for the monetary authority to follow its trend closely, however, real interest rate in Ukraine was shown to be even more volatile during the 1999-2004. Moreover, convergence of the real rates to the natural rate during 2001-2002 are associated with the most successful years for the Ukrainian economy in terms of growth and stable inflation. Thus, natural rate of interest could become an important indicator for the National Bank of Ukraine to improve its monetary policy, and adjust instruments more quickly to the shocks.

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APPENDIX 1

Table A.

Year	Month	Nominal interest rate, % year	CPI, % change to the previous month	Real GDP
1999	8	62.8	101	4.73
	9	60.4	101.4	4.71
	10	74.9	101.1	4.32
	11	59.2	102.9	4.75
	12	55.5	104.1	3.49
2000	1	42.4	104.6	3.92
	2	16.2	103.3	4.38
	3	11.9	102	4.23
	4	10.6	101.7	3.83
	5	7.4	102.1	4.21
	6	10.9	103.7	4.26
	7	17.6	99.9	4.83
	8	12.6	100	4.68
	9	32.9	102.6	5.99
	10	35.9	101.4	6.01
	11	12.9	100.4	6.7
	12	8.7	101.6	5.44
2001	1	4.5	101.5	5.72
	2	7.4	100.6	6.54
	3	5.9	100.6	6.23
	4	20.61	101.5	6.05
	5	9.61	100.4	6.2
	6	34.42	100.6	6.67
	7	31.25	98.3	7.01
	8	29.49	99.8	6.64
	9	18.06	100.4	7.34
	10	21.78	100.2	7.21
	11	19.34	100.5	7.3
	12	17.47	101.6	5.61

2002	1	9.8	101	5.93
	2	10.4	98.6	6.81
	3	7	99.3	6.49
	4	5.9	101.4	6.3
	5	4.8	99.7	6.47
	6	5.3	98.2	6.96
	7	4.4	98.5	7.3
	8	3.5	99.8	6.93
	9	2.8	100.2	7.64
	10	2.3	100.7	7.51
	11	3.8	100.7	7.68
	12	5.8	101.4	6.05
2003	1	3.6	101.5	6.35
	2	4.7	101.1	7.35
	3	7.9	101.1	6.95
	4	5	100.7	6.74
	5	4.4	100	7.03
	6	8.7	100.1	7.32
	7	6.9	99.9	7.69
	8	9.5	98.3	7.47
	9	8.1	100.6	8.19
	10	8.9	101.3	8.08
	11	15.7	101.9	8.33
	12	11.3	101.5	6.59
2004	1	4.1	101.4	6.74

Data source: National Bank of Ukraine, UEPLAC, IER.

APPENDIX 2

Table B. ***ADF test statistics for the nominal interest rate.***

ADF Test Statistic	-2.336756	1% Critical Value*	-4.1420
		5% Critical Value	-3.4969
		10% Critical Value	-3.1772

Table C. ***ADF test statistics for inflation.***

ADF Test Statistic	-1.998374	1% Critical Value*	-2.6013
		5% Critical Value	-1.9459
		10% Critical Value	-1.6186

APPENDIX 3

Table D. ***Eviews estimation output for the VAR(2) model.***

Vector Autoregression Estimates		
Sample(adjusted): 1999:08 2004:01		
Included observations: 54 after adjusting Endpoints		
Standard errors in ( ) & t-statistics in [ ]		
	INFLD	RRATE
INFLD(-1)	-0.410084	-0.306653
	(0.13014)	(0.10931)
	[-3.15100]	[-2.80541]
INFLD(-2)	-0.570097	0.157765
	(0.13777)	(0.11571)
	[-4.13814]	[1.36346]
RRATE(-1)	-0.035016	0.926557
	(0.15523)	(0.13038)
	[-0.22557]	[7.10672]
RRATE(-2)	0.412534	-0.173877
	(0.17036)	(0.14308)
	[2.42157]	[-1.21522]
C	-0.186303	0.037471
	(0.14490)	(0.12170)
	[-1.28570]	[0.30788]
R-squared	0.408037	0.725231
Adj. R-squared	0.358707	0.702333
Sum sq. resids	45.67409	32.21985
S.E. equation	0.975471	0.819297
F-statistic	8.271530	31.67298
Log likelihood	-71.26158	-62.01445
Akaike AIC	2.877796	2.528847
Schwarz SC	3.063672	2.714724

Mean dependent	0.007547	0.447217
S.D. dependent	1.218108	1.501675
Determinant Residual Covariance		0.483197
Log Likelihood (d.f. adjusted)		-131.1332
Akaike Information Criteria		5.325781
Schwarz Criteria		5.697534

Table E. ***Eviews estimation output for the structural coefficients of the C(0) matrix.***

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.975471	0.094746	10.29563	0.0000
C(2)	-0.404282	0.105466	-3.833285	0.0001
C(3)	0.712603	0.069214	10.29563	0.0000
Log likelihood	-131.1332			