INTEREST RATES AND THIER ROLE IN THE ECONOMY DURING TRANSITION. THE PROBLEM OF HIGH INTEREST RATES. CASE OF UKRAINE.

by

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Abstract

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Chairperson of the Supervisory Committee: Professor Serhiy Korablin, Institute of Economic Forecasting at Academy of sciences of Ukraine

The paper presents the analysis of the interest rates behavior in Ukraine during the period of transition. Absence of developed government bonds market does not let use usual proxy of interest rate – yield to maturity on this market, used by many economists in the analysis of the developed markets. For these reasons Ukrainian rates are approximated by the credit rate of commercial banks, perhaps the only rate that is set by market forces in Ukraine.

The paper explores relationship between interest rate and inflation in Ukraine. Ex-post real interest rates are found to be highly negatively correlated with inflation, indicating for short-run rigidity of nominal interest rates, though long-run Fisher effect is present. The analysis of relationship between changes in real money supply and changes in interest rates shows the presence of strong liquidity effect. The role of interest rate in economy is analyzed using simultaneous equations model based on IS-LM macro model. The results of modeling show that interest rates have statistically significant, but quantitatively small influence on real GDP.

Obtained results and further simulation of National Bank of Ukraine policies show that high lending rates cannot be lowered using monetary expansion through increase in monetary base because of matching liquidity and price level effects within one quarter. Greater role of NBU in regulating market failures, such as bank insolvency, by more intensive deposit insurance together with greater role of discount lending and maintaining macroeconomic stability may lead to decrease in overall level of interest rates in Ukraine. This, in turn, may boost investments and economic growth.

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GLOSSARY

Adverse selection	The problem caused by asymmetric information *before* transaction occurs. The borrower who is not financially sound is more likely to receive a loan due to his seeking efforts
Asymmetric information	Unequal knowledge of agents about each other and transaction
Central bank	The government agency that oversees the banking system and is responsible for the amount of money and credit supplied in the economy
Collateral	Property that lender receives from the borrower as a guarantee of loan repayment
Creditor	A holder of debt
Credit rationing	Refusal of creditor to make loan more than stated amount to one borrower
Credit risk	Risk of borrower's default
Default	A situation in which the debtor is unable to pay interest or principal to the creditor
Discount rate	The interest rate set by central bank on its loans to banks
Fisher effect	The positive relation between expected inflation and nominal interest rates, named after Irving Fisher
Inflation rate	The rate of change of the price level, measured as a percentage change per period
Interest rate	The cost of funds borrowing, measured as percentage per period

ICPS	International Center for Policy Studies
M1	A measure of money that includes currency, traveler's checks, checkable deposits
M2	A measure of money, which includes M1 and deposit accounts
Monetary policy	Policy aimed to control money supply and interest rates
Moral hazard	The problem caused by asymmetric information *after* transaction occurs.
NBU	National Bank of Ukraine, central bank of Ukraine
UEPLAC	Ukrainian-European Policy and Legal Advice Centre
Real interest rate	Interest rate adjusted for expected inflation, true costs of borrowing
Risk premium	Difference in the interest rate between risk-free and risky loans

INTRODUCTION

The functional role and determinants of the interest rates in the economy were intensively studied by economists for a long time. Due to multiple roles played by interest rates in the economy and complex relations with other economic indicators, interest rate behave differently in different countries under various circumstances. Thus, theoretical methods and models developed and tested in, say, developed country with established financial and credit market with low level of inflation, may not always be appropriate when they are applied to transition, inflationary or other economy. Moreover, using different methods and models, economists may reach different conclusions even in the same country.

Despite the theoretical importance of interest in economy, transition economies, particularly Ukraine, very often do not exhibit this importance (Gronicki and Pietka (1998), CASE (1999)). The problem of high interest rates has been important for Ukraine for a long time: this problem does not allow the companies to invest as much as they want, since they can not return more than they can earn from doing business. During transition from state ownership with budget financing to private ownership enterprises face the problem of budget constraint. Newly organized private firms cannot rely on budget financing and bank loans are the only source of external financing for them. Therefore, bank loans and the price of loans play very significant role for the businesses and their willing to produce goods or services. But loans are very often hard to obtain due to bank's risk consideration, and even if it is possible to get credit, the price of it is too high. Financially constrained firms are forced to rely only on their own capital, which slows their development. Additionally, interest rates influence consumers' decisions to consume or save their incomes, serving as opportunity costs of consumption.

All these issues cause interest in studying the problem. The main interests of this paper are:

- whether Ukrainian agents have constant expectations of real interest rates and can nominal interest rates be used as a predictor of inflation in Ukraine
- what is the path of interest rates after monetary expansion or contraction in the economy
- relation between interest rates and other macroeconomic indicators, such as money supply, inflation, aggregate demand, exchange rate and others, in particular, whether decrease in interest rates may increase real GDP.
- how the role of interest rates in Ukrainian economy changed over time
- determinants of interest rates in Ukraine, the problem of high rates and analysis of factors which cause the rates to be high.

I also wanted to investigate an ability of government and NBU to solve the problem of high interest rates, particularly whether monetary policy, implemented by NBU, may effectively influence the level of interest rate and consequently expand output. This especially concerns discount rate policy, which is a powerful policy tool in many developed countries, where interest rates have become a very important method of speeding up or slowing the economy.

Chapter 1 presents a review of results and opinions of economists and experts who worked in this field before in Ukraine and in the world. Many results, thoughts and advises are of a great interest for evaluating policy measures which may be implemented. In chapter 2 theoretical background concerning interest is presented: theory of interest, factors, which according to theory may have influence on interest, qualitative relation between interest rates and other indicators. Description of the methodology of analysis, data used and empirical results obtained are given in chapter 3.

Chapter 4 presents estimation of the simultaneous equations model and simulations of policies aimed at lowering commercial interest rates in the economy. In Conclusion I summarize my findings and give recommendations on the policy concerning decreasing interest rates in Ukraine.

Chapter 1

LITERATURE REVIEW

The role of interest rate in Ukraine has been studied by many Ukrainian and foreign economists. Gronicki and Pietka (1998) present the analysis of the role of interest rates in real economy of Ukraine until the beginning of 1998. The paper briefly describes the situation on the money market of Ukraine in general. The authors state that financial market of Ukraine is not well developed, monetization of the economy is low and, therefore, the impact of interest rates on real economy is not very significant. They also test a hypothesis that increase of interest from already high level would not lead to significant changes on the real economy. They simulated a change in credit rate using a quarterly macroeconomic model for Ukraine, developed at Harvard Institute for International Development (HIID). The results of simulation show that influence of interest rates on GDP, private consumption, investment and inflation is not significant. They explain such a weak response of economy to change in interest rate by small share of investment credit in total investments.

The analytical studies of interest rates in Ukraine were also conducted by CASE in 1999. This analysis concerns the study of availability of using discount rate policy to increase investments in Ukraine. They concentrated on the exploring the relationship between NBU discount rate and commercial banks rates and showed that NBU rate is only one factor which determines price of loans. Thus, the impact of discount rate policy is not straightforward and a drop in the discount rate may lead to deficit of credit resources and increase in commercial interest rates through income and inflation effect. This conclusion is made after analytical investigation of the problem, but no empirical evidence was suggested. Therefore, this leaves

another problem for more thorough analysis. The paper also presents a brief review of factors that determine demand and supply of credit resources and states that many factors have upward influence on interest rates in Ukraine. Using the study of the same problem in Poland as an example, authors conclude that interest rate policy plays limited role in Ukraine, since other factors are more important. Finally, according to Polish experience, the increase in the amounts of credit to economy may increase only together with GDP growth of the country and after structural reforms. When this paper was published, Ukraine had still a fall in GDP, but during 2000 and 2001 GDP was growing and the relation between GDP growth and interest rates change was interesting to test in these conditions.

The analysis of interest rates as a part of monetary sector in Ukrainian economy is also presented in the paper of Sultan, Lukyanenko, Gorodnichenko (2000). They build a large quarterly macromodel of Ukrainian economy. Analysis of interest rates within monetary sector shows that expansionary money supply reduces interest rates significantly, whereas inflation, budget deficit, real GDP growth increase the rates. Macromodels are extremely useful in modeling and forecasting policy effects. I use the model developed by Sultan, Lukyanenko and Gorodnichenko as a base to build my own model, which would concentrate on the behavior of interest rates after adding or deleting some variables and extending time series to 2000-2001.

Feldstein and Eckstein (1970) developed and estimated the series of equations that explain the long-term interest rate in terms of four types variables: liquidity, inflation, government debt and short-run expectations. These equations integrate Keynesian liquidity preference theory and Fisherian approach to the estimation of real interest rates. The model explains well the changes in interest rate and is also useful in the analysis of interest rates in Ukraine.

Testing the relationship between inflation and interest rates is crucial for determining whether the decrease in inflation may lead to decrease in interest rates. This is very important for policy makers. The technique for estimating this relationship is provided by Fama (1975), (1977), Blejer (1978), Mishkin and Simon (1994). Fama showed that Fisher effect is present at US financial market and the hypothesis of constant expected real interest rate could not be rejected. He also showed that US financial market is efficient as it uses all available information about future inflation in setting interest rates.

Mishkin and Simon examined Fisher effect in Australia. What they have found is that Fisher effect exists in long-run in Australia, but not in the short-run. This implies that short-run changes in interest rates reflect change in monetary policy and real interest rate, and long-run levels indicate inflationary expectations. Again, it is very important for policy planning to distinguish these effects in order to reach macro targets without failures.

Blejer investigated the relation between money supply and interest rates for the case of inflationary economy, namely, Argentina. The results he obtained show that in countries with long history of inflation monetary expansion lead to fast increase in nominal interest even within the quarter in which the monetary change takes place. This work can be useful in analysis of Ukrainian economy, since Ukraine, like Argentina, has also an inflationary and unstable economy with fast changes in the economic environment.

Ukrainian economists have also contributed to the analysis of monetary policy consequences and possible results of this policy on change in the interest rate. Dziubliuk (2000) researched the problem of low monetisation of the Ukrainian economy during transition and compared this level with that of other, including developed countries. He found that the coefficient of monetisation of the economy, calculated as ratio of monetary aggregate

M2 to the level of GNP, is at very low level – about 15-17% in 1999-2000. He showed that this coefficient is less than in some other developed countries, such as Great Britain and France – about 100% and 65% respectively. The monetisation of the Ukrainian economy was decreasing since 1992 (monetisation was 80%) to the beginning of 1997 (11%) and then began to rise slightly up to 17% in 2000. Dziubliuk states that disadvantageous comparison of Ukrainian monetisation with other countries leads to the conclusion that higher monetisation of the economy is necessary for Ukraine. But the ways to reach higher monetisation are not so clear. He claims that it is dangerous to understand higher monetisation just as an increase in money supply to pump more money in the economy and also he undermines the role of National Bank in this process. The main reason for low monetisation of the economy is insufficient credit activity of the commercial banks system, since credit activity of the banks, but not issuing activity of NBU, is the main factor of money supply. The author conclude that the criterion for the sufficiency of money in the economy should be real economic growth supported by inflow of credit resources in the economy, but not the coefficient of monetisation, which is rather consequence of the economic situation, but not the reason. This paper is also very useful in the analysis of Ukrainian monetary sector and effects of increase in money supply on interest rates.

Gladkykh (1999) explored the influence of money supply on the level of inflation and the price of credit resources in Ukraine. The author incorporated analytical research in the paper and found that there was an increase in the absolute and relative amount of monetary base M0 in M3 aggregate. He suggests that the expansion of shadow economy, which requires mainly cash for settlements, affected mostly the increase in M0. This factor also may have been the main reason for the drop in demand deposits weight in M3. The money supply plays two roles in the inflationary processes, according to the author: active, when money supply goes after

increase in prices and passive, when excess money expansion leads to the inflation. The author concludes that increase in money supply during long periods always resulted in the increase in inflation, and money supply is not the only, though very important factor of the inflation. After the analysis of relationship between inflation and money supply, Gladkykh considered the effect of money supply changes on the interest rates on credit resources. He presented mainly theoretical concepts concerning this effect, but no sufficient empirical research was conducted and no figures which would show the countable effect of the factors was presented, which is the weakness of the paper. The few empirical conclusions reached by the author are as follows: main reason for underdevelopment of medium and long term credit in the economy is lack of deposits with appropriate maturity; decrease in money supply together with the existence of budget deficit lead to the increase in interest rates for government securities; finally, increase in inflation leads to increase in interest rates and vice versa.

Azarov (1999) researched the problem of credit and interest rate formation in Odessa region of Ukraine. He presents the figures that describe situation on the credit market and show that fundamentals for developing this market are not optimistic. So, there are more than half loss suffering companies in the region, one fifth of the amount of sold commodities involves barter transactions. The feature of credit portfolio is such that most loans are short-term and are given to the sectors with high velocity of funds – trade, restaurants, café etc. Only about 20% of loans is given to industry, and only 3,7% to agriculture. The low level of financing industry and agriculture the author explains by high level of loss makers there – 51% and 82% respectively. The paper considers also the problem of high interest rates for banks loans. There is an interesting comparison of the level of interest rates among banks, which differ by size and age. So, the lowest rate was offered by large and old or "system" banks, as they called in Ukraine, and the highest was offered by new banks and especially by branches of the new

banks. Analyzing interest rate level formation, Azarov calculates an average costs of deposit and credit activities of commercial banks and show that costs are rather high, so banks cannot decrease the credit rate without losses. Though it is not obvious, why the costs are so high, the author concludes that lending interest rate is not so high relative to deposit rates and such level of interest does not prevent the region's economy development.

The problem of high interest rates in Ukraine was also analyzed by Chaika (1999). He agrees with the fact that interest rates are high in real terms. The comparison of the Ukrainian interest rates with that of developed countries shows that such countries as Ukraine, Russia, Armenia and Bulgaria suffered from high rates, which were much higher than rates of other countries, such as USA, Estonia, Croatia. According to the author, the reasons for high rates in Ukraine are: very large demand for credit resources from the side of government, which resulted in intensive borrowing and budget spending, increase in money supply and subsequent increase in inflation and rates. Budget expenditures crowded out private expenditures, which is consistent with the work of Feldstein and Eckstein (1970), who received similar results in USA, and of Sultan, Lukyanenko, Gorodnichenko (2000). Chaika also considers the ways to reduce the rates and criticizes such ways as "point" emission and decrease of NBU rate. The optimal ways in tackling with the problem, according to the author, would be to diminish government spending which support old inefficient economy, increase the trust to the bank system from the side of population, optimize legislation in the field of collateral and bankruptcy. The weak side of the paper is absence of empirical research of the problem, thus, it leaves the problem to be investigated empirically.

It is necessary to mention that such problem exists in many Ukrainian publications: they lack empirical part and are based only on the theory, thus,

it cannot be decided unambiguously whether one factor or another actually affects the variable and what is the size of this effect in Ukraine. But, anyway, it is necessary to consider the works of Ukrainian economists as a starting point for further research in this field, combining with methods and technique of foreign studies in this field. And this is what I do further in the paper.

Chapter 2

THEORETICAL FRAMEWORK

2.1. Theory of interest, the role of interest rates in the economy.

The interest rate determination in the economy was intensively studied by many economists. Two of the most influential heories are Irving Fisher's classical approach, extended to loanable funds theory, and liquidity preference theory, developed by John M. Keynes.

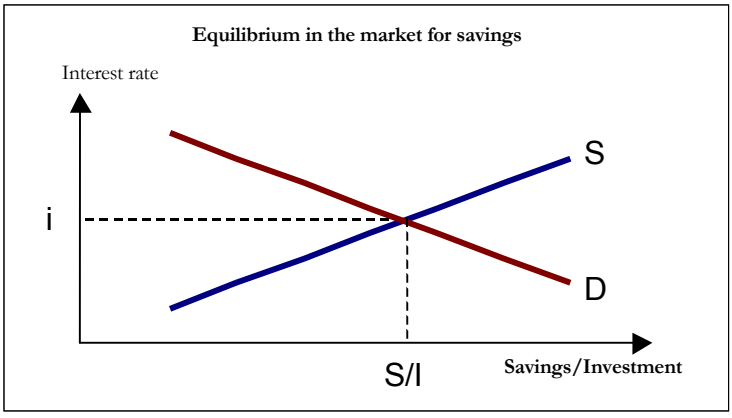
Interest rate is determined as the price paid by borrower (debtor) to a lender (creditor) for the use of resources during some interval [Fabozzi, Modigliany, Ferri, 1998]. There is no single measure of interest rate in the economy and yield to maturity on an asset is accepted by most economists as a measure of interest rate (Mishkin, 2001).

According to Fisher, individuals may either consume or save their incomes. Individuals save when they consider future consumption as preferable to current consumption, they consume less now to be able to consume more later. The factors that influence saving decisions differ between individuals. First affecting factor is income. With higher income individual may save more, though the decision to save is determined not only by the level of income, but also by expectations about future income, marginal propensities to consume and save - preferences to interchange consumption and saving between time periods. Moreover, these preferences may change after change in the level of income. Another factor affecting the level of savings is compensation obtained by individual for lending his saving to another individual, who needs additional funds and ready to pay for their use. This compensation or payment for use of funds is interest rate. The more the interest rate, the more individual's opportunity costs of consumption, and the

more he will save. The total savings in the economy is a sum of all individuals' savings. Interest rate is positive if there is demand for the savings from the side of borrowers. Borrowers are willing to pay for saving if there are profitable opportunities to invest. The cost of funds for borrowers is interest rate. The more interest rate, the less borrowers will invest, so investments is a negative function of interest rate. Borrowers will be willing to invest as long as marginal benefit from investments equals marginal cost, or interest rate. Total demand for investment in the economy is determined as the sum of individual demands.

Interest rate is cost of borrowing for one individual and payment for lending for others. The equilibrium interest rate equates total amounts of savings demanded and supplied. Equilibrium interest rate and amount may be represented on the following graph.

Figure 1. **Equilibrium in the market for savings**.



Fisher theory states that long-run interest rates is determined by interaction of supply and demand for savings, which, in turn, depend on marginal propensity to save and marginal productivity of capital, respectively.

There is a distinction between nominal and real interest rates. Fabozzi, Modigliani and Ferri (1998, p.201) determine nominal interest rate as the

number of monetary units to be paid per unit borrowed and real interest rate as the growth in the power to consume over the life of a loan. Had the economy no inflation, there would be no difference to individuals whether interest rate is nominal or real. Fisher was one of the first developers of the theory of interest rates and he was one of the first who introduced this distinction. During inflation nominal rate exceeds real and during deflation real rate exceeds nominal. The relationship between nominal and real interest rates, known as Fisher law, is expressed as follows:

$$(1+i_t) = (1+r_t) \times (1+\pi^e{}_t) \qquad (1.1)$$

where i is nominal interest rate at time t, r – real at time t and π^e - is expected inflation level in period *t*.

This expression is usually simplified and, after transforming and eliminating small numbers[1], economists use the following approximated expression:

$$i_t = r_t + \pi^e{}_t \qquad (1.2.)$$

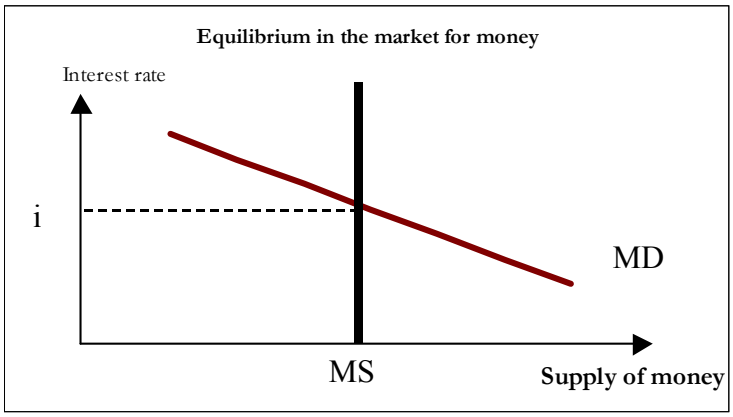
Fisher suggests that in the long-run real interest rate is constant and expectations about inflation affect only nominal interest rate.

Fisher's theory is very general and does not take into account many factors influencing the level of interest rates. The Loanable Funds Theory extends Fisher's approach and incorporates into the analysis government actions, banks, bonds and cash investments. The results are similar to classical approach – interaction of total demand for funds, negatively related to interest rate, and total supply of funds, positively related to interest rate, determines the equilibrium interest rate and amount of savings or investments.

[1] $1+i = (1+i_r)(1+\pi^e) = 1+i_r+\pi^e+(i_r*\pi^e)$. Last term $(i_r*\pi^e)$ is usually a small value and may be omitted. After subtracting 1 from both sides, we can get (1.2)

The Liquidity Preference Model, introduced by John Maynard Keynes, is an alternative approach to the determination of interest rate in the economy. This model analyses the behavior of interest rates as a reaction to changes in money supply and money demand, rather than changes in supply and demand for savings. The model assumes only two assets: money and bonds. The logic of the model is following: individuals hold money for current transactions and hold bonds that earn interest. Interest rate in this case is an opportunity cost of holding money, since individual may convert money into bonds and earn more. If the interest rate for bonds is low, opportunity costs are not high and individual more freely hold cash balances. If the rate is high, opportunity costs increase and people are less willing to hold money instead of profitable bonds. Thus, there is a negative relationship between money demand and interest rate in this theory. Keynes assumes that money supply is not affected by the level of interest rate and government and central bank control money supply. Graphical representation of the model is given below:

Figure 2. **Equilibrium in the market for money**



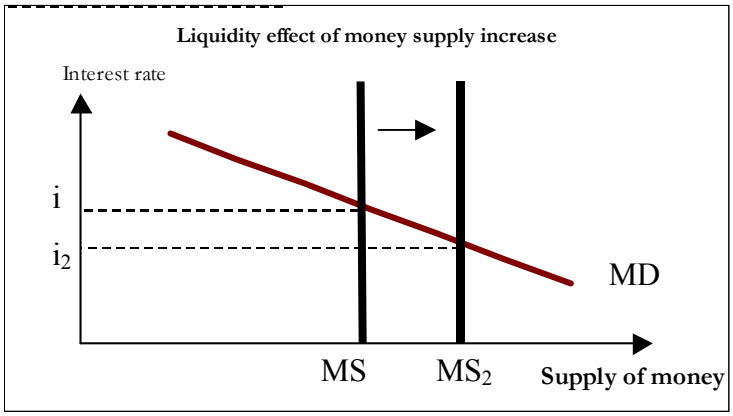
The change in the equilibrium interest rate may happen due to either supply or demand side changes. Main factors that affect the demand for money in the Liquidity Preference Theory, are level of income and price level in the economy. Increase in income, increases the demand for money due to higher

liquidity of money, and the MD curve shifts to the right and up, resulting in increase in interest rate. The same effect has an increase in price level. People want to hold real money balances to be able to buy the same goods as before inflation, and thus increase their demand for money holding. It also shifts MD curve outwards and increase interest rate.

Operations of central bank and commercial banks affect money supply. Sachs and Larrain (1993), Mishkin (2001) state that Central bank controls monetary base (MB), which is currency in circulation and reserves, through several tools, such as open market operations -purchase and sale of bonds, discount lending to banking system, reserve requirements on deposits in the banking system and foreign currency market operations. Discount rate is especially important tool of influence on interest rates in the economy, since it not only influences the price of credit resources for the banks, but also contains information on level of interest rates in the economy, so may be followed by commercial rates. The extent to which increase in monetary base may increase money supply is affected by the level of required reservation, currency/deposit and reserves/deposit ratios, or money multiplier. Sachs and Larrain (1993) determine the money multiplier as follows: $\phi = \frac{c_d + 1}{c_d + r_d}$, where c_d and r_d are currency/deposit and reserve/deposit ratio respectively. Money supply increase is thus money multiplier times increase in monetary base. The result of money supply increase on interest rate is ambiguous, since, according to Mishkin (2001), this contains different effects on the interest rate; namely liquidity effect, income effect, price level effect and expected inflation effect.

Liquidity effect theoretically reduces interest rate by shifting money supply curve to the right, and new equilibrium is with lower interest and larger money supply. This effect, though, may be followed by other effects, which would reverse the fall in interest.

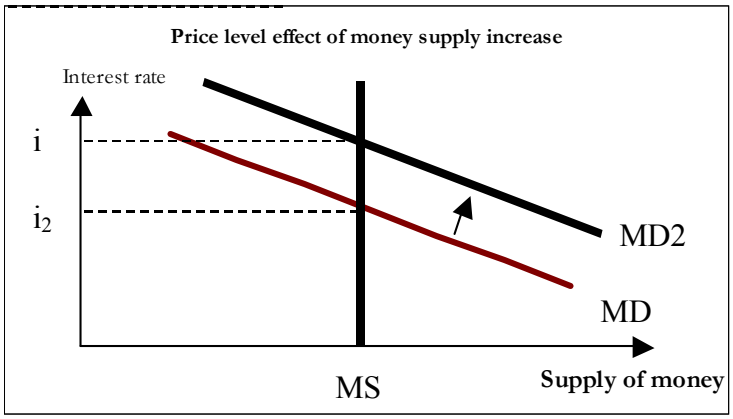
Figure 3. **Liquidity effect of money supply increase**.



Income effect through influence of the expansion on aggregate demand will tend to increase demand for money and the effect is clear: it will increase interest rate, shifting MD curve outward.

Price level effect of the increase in money supply also increases demand for money and, consequently, interest rate. This effect works in similar fashion as income effect. If economy produces at full employment, increase in money supply most likely will lead to increase in inflation, and this, recalling Fisher's Law, will increase nominal interest rate.

Figure 4. **Price level effect of money supply increase**.



In practice, it is impossible to predict which effect is prevalent after money supply increase. These effects will differ in different economies or even in one economy during different stages.

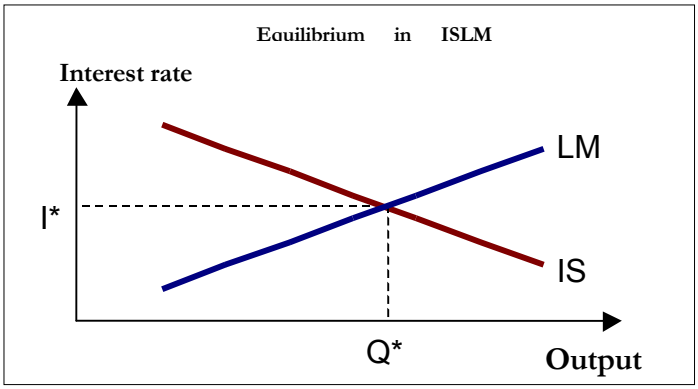
2.2. Interest rate and factors affecting its level in context of ISLM model

Interaction of interest rates and other macroeconomic indicators can be studied using ISLM model, developed by John Hicks on the basis Keynes's work (Mishkin, 2001). Interest rate in ISLM model is a linking chain between monetary and real sectors of economy. This model is very useful for policy evaluation purposes, since it allows to forecast effects of monetary and fiscal policies under different exchange rate policies on economy.

The ISLM model has such name due to two curves – IS (investment-saving) curve, which shows relationship between aggregate output and interest rates. Normal IS curve is downward sloping since with higher interest rates less output will be produced due to higher costs of production and higher opportunity costs of production and consumption.

Thus, investment, consumption and export must fall with higher interest rate. LM (liquidity-money) curve shows relationship between interest rate and aggregate output, for which quantity of money demanded equals quantity of money supplied. Normal LM curve is positively sloping since with higher output level demand for money increases, causing rise in interest rate. Equilibrium levels of interest rate and aggregate output are established by intersection of IS and LM curves.

Figure 5. **Equilibrium in ISLM model**.

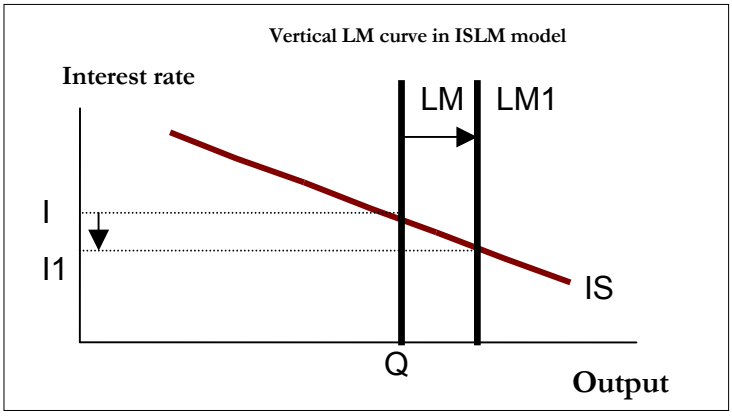


Rightward shift of IS curve, caused by increase in aggregate demand due to increase in government spending or other constituent, causes both interest rates and output to increase. Outward shift in LM curve may be caused by increased money supply, and leftward shift – by increased money demand, unmatched with increased money supply. Thus, fiscal policy has power to

control IS curve of the model, while monetary policy may control LM curve.

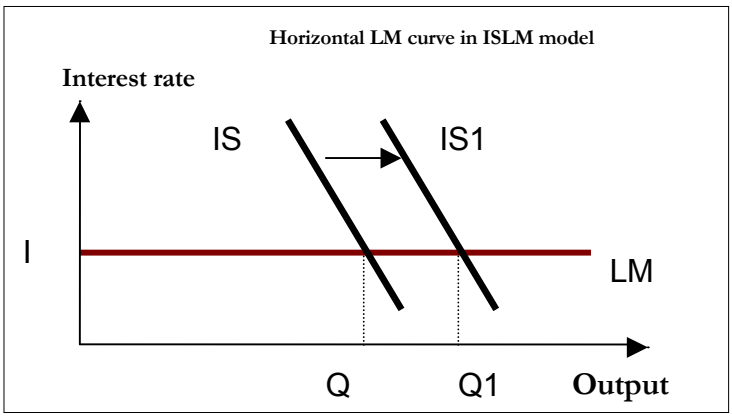
There are also extreme cases of the slopes of IS and LM curves. For instance, insensitivity of money demand to change in interest rate results in vertical LM curve. In this case, fiscal policy has no effect on the output, it only raises the interest rate, crowding out private investments, whereas monetary policy is effective in this case.

Figure 6. **Extreme cases: vertical LM curve**.



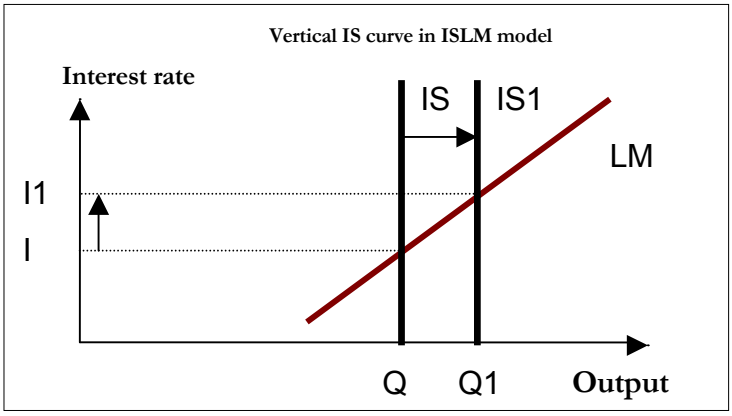
Horizontal LM curve occurs if money demand is infinitely responsive to interest rate. Such situation is also called "liquidity trap" and occurs when interest rates are very low. When LM curve is horizontal, fiscal policy is a powerful tool to increase output without changing interest rates.

Figure 7. **Extreme cases: horizontal LM curve**.



Vertical IS curve characterizes situation when aggregate demand is irresponsive to interest rates. In this situation, monetary policy has no effect on output, while fiscal one affects output without crowding out private consumption and investment (assuming they stay irresponsive to increase in interest rate).

Figure 8. **Extreme cases: vertical IS curve**.



The effects of different policies in ISLM model depend on variety of factors, such as regime of exchange rate, size of the country, openness to foreign trade and capitals, stability of IS or LM curves, duration of the policy and others. Such variety of possible outcomes makes the ISLM model even more useful policy model.

Incorporation of exchange rate into ISLM model does not alter the main results. Domestic interest rate and exchange rate are inversely related through interest rate parity (approximated)[2]: $i_d = i_f + (E^e - E)/E$, where i_d and i_f are interest rates for domestic and foreign currency assets, E and E^e are current and expected exchange rates. If domestic currency is expected to depreciate,

[2] Initial conditions for interest rate parity is $(1+i_d) = (E^e_{+1}(1+i_f))/E$. This is equivalent to $i_d = \frac{E^e_{+1}(1+i_f)}{E} - \frac{E}{E}$ or $i_d = i_f + \frac{E^e_{+1} - E}{E} - \frac{E^e_{+1} - E}{E} * i_f$. The last term is usually a small number, so it can be omitted.

then domestic interest rate will be higher in given period. Consequently, interest rate will be permanently higher in the economy if its currency depreciates. If domestic assets market is considered as risky, then risk premium should be added to the foreign interest rate, which means that higher domestic interest is required by investors to compensate for risk: $i_d = i_f + (E^e - E)/E + r$, where r is a risk premium. Fall in interest rate in given period causes depreciation of the currency in present period to compensate for future appreciation and improves current account through effect on terms of trade.

This effect of fall in interest rate on increase in real GDP through effect on exchange rate contributes to direct effect on domestic consumption and investment. Lower real interest rates make loans cheaper for enterprises, decrease opportunity costs of funds, thus firms invest more willingly. Lower opportunity costs also decrease willingness to save for individuals and increase consumption. Thus, theoretical effect of fall in interest rate is to increase aggregate output.

If country is open to foreign capital and goods flows, then, given the same risk level, domestic interest rate will be equal to world level of interest rate. In such situation the crucial effect on the policy choice will have exchange rate regime: whether it is fixed or flexible. Under fixed exchange regime government lose monetary policy as a tool, and because it must keep exchange rate constant, any excess liquidity should be immediately absorbed. Under fixed exchange rate regime fiscal policy is more powerful policy. Conversely, under flexible exchange rate, monetary policy is appropriate, while fiscal policy, having negative influence on current account through currency appreciation, does not allow to reach output targets.

The level of interest rates contains in itself, according to CASE (2001), real risk-free interest rate and several premiums: inflation, default or risk, liquidity, maturity. Inflation premium is included to compensate for inflation and keep

desired real interest rate. Default premium is to compensate for borrower's possible insolvency. The riskier the loan, the higher will be risk premium. The level of risk premium and, thus, interest rate, depends on thorough evaluation by the bank of borrower's activities and loan repayment. This evaluation depends on transparency of borrower activity, macroeconomic stability and bank's human resources. Lending is very complex process, involving elements of game theory, adverse selection and moral hazard issues as well as agent-principal problem. These inefficiencies increase risk of lending.

As Gardner (1995) shows, financial institution (bank) plays a game with depositor while accepting the deposit. In this game a depositor chooses whether to deposit in the bank, buy lower risk asset or withhold from buying anything (holding cash). In Ukraine foreign currency serves very often as a lower risk asset instead of government bonds. Banks also play similar game with borrowers while lending money. Now a bank is in position of depositor and must choose between lending to a firm or individual and buying foreign currency, securities, government bonds or lending to another bank. Bank accepts all deposits and firm accepts all loans, which is reasonable assumption. Now the agent-principal problem arises. If a bank cannot monitor and enforce efficient use of a loan, or if costs of enforcement are high, bank will put low effort into enforcement and low efforts make investment for depositor more risky. This would be the case if bank were not obliged to repay lost money to depositor. In practice banks fully responsible for repayment, so if enforcement costs are high, they may reject lending and choose lower risk operation instead of putting low efforts in high-risk operation. Since lending legislation and banks require that loans must be backed by collateral, risk of losing money for bank and, consequently, for depositor is reduced, as long as collateral is liquid. Collateral requirement can substantially reduce agent-principal problem in relations between bank and borrower. The necessary condition for this requirement to reduce risk in lending is clear legislation base in property rights transfer, enforcement of collateral contracts and liquidity of collateral. In contrast to lending

operations, there is no collateral in relations between bank and depositor. The role of collateral in such operations may play deposit insurance. In USA, all deposits are insured to be repaid [Fabozzi, Modigliany, Ferri, 1998], so depositors may not care about risks of deposit repayment, and this insurance increases amount of deposits in the economy.

The default risk aspect has self-enforcement effect on the level of interest. From the one side, the higher the default risk of the agent, the higher the interest rate should be to compensate for this risk. From the other hand, the higher the interest rate the higher the probability of default. Such opposite forces make banks to seek an optimal rate, which would guarantee both repayment of the loan and receiving profit from the loan. Thus, it is not in interest of bank to set very high interest rate.

Summarizing, interest rates are influenced by many economic variables and it itself influences most macro indicators. Fortunately, according to ISLM model, government has under control most macroeconomic indicators, and varying its policy and policy features, may affect economy, and interest rates in particular.

Chapter 3

EMPIRICS

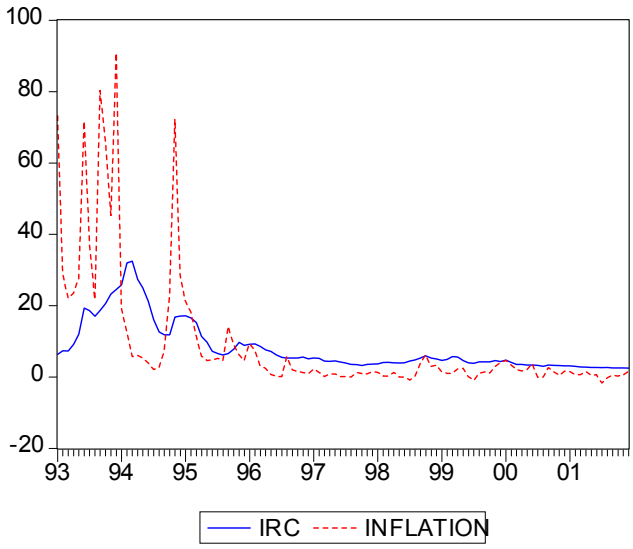
3.1. The history of Interest rates in Ukraine: institutional aspects.

There is no single interest rate in the economy since there exist several rates on several assets and it is crucial to determine which rate it would be possible to use for the analysis. Among different markets in Ukraine, it is possible to mark market of government bonds (OVDPs), interbank loans market, time deposits market, commercial loans market, banks refinancing market. Another market, which also has influence on interest rates, is Ukrainian stock market, since company may choose between taking a loan and public offering to attract additional funds.

Actors that are engaged in determining commercial credit interest rates are: commercial banks, which give loans and take deposits; National Bank of Ukraine, which supervises bank system, regulates it, and also gives loans to the banks; borrowers – mostly local companies and individuals-legal entities; lenders – companies and individuals - private persons.

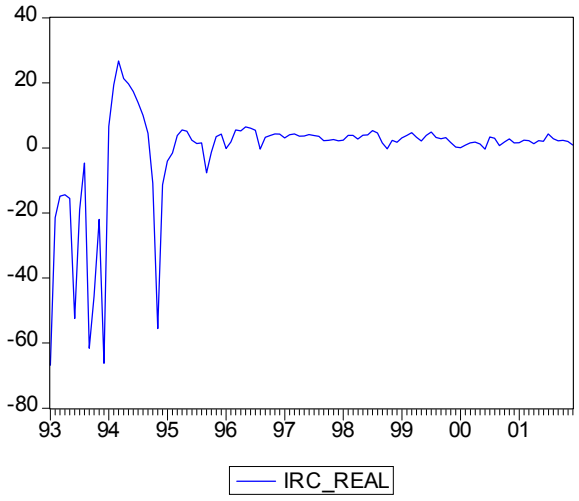
Interest rates on commercial credits were high in Ukraine since early years of transition. The rates are high comparative to developed countries in both terms, nominal and real (Chaika, 1999). Graph of monthly nominal interest rates and inflation for the period 1993-2001 is presented below:

Figure 9. **Interest rate and inflation in Ukraine: 1993:01-2001:12, p.a.**



The ex-post monthly real interest rate (calculated as a difference between nominal interest rate and actual inflation after the inflation became known) graph is presented below.

Figure 10. **Real interest rate in Ukraine: 1993:01-2001:12, p.a.**

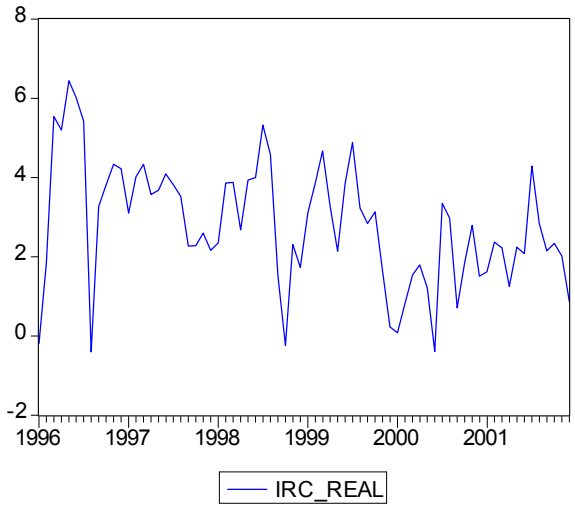


As it can be seen from the graph, real interest rates stabilized at positive values only after 1996, when government and NBU managed to stop high inflation. Negative values of real interest rates do not, however, mean that

credits were unprofitable to banks and extremely profitable to borrowers. As Chaika (1999) explains, this means that loans were granted on very short time periods, allowing to earn positive profit for banks. But in such short-term credit conditions there is no way to invest in production or other long-term asset. In terms of high and uncertain inflation, monthly real interest rates do not reflect real cost of borrowing if the loans are granted for short time, and, unfortunately, there is no possibility to track all loan contracts in this time to calculate true real interest rate.

After 1996 inflation was stabilized, which allowed to decrease nominal interest rates and keep real interest rates at positive levels in monthly calculations. The relationship between interest rates and inflation after 1996 is presented below on the graph:

Figure 11. **Real interest rate: 1996:01-2001:12, p.a.**



As the graph shows, real rates ranged from about 0 to 6 percent monthly with approximately 3 percent average. It is rather high interest for monthly level, since in annual terms it constitutes approximately 36%. Comparing 36% rate with annual prime rates for loans in developed countries, for

instance, USA-6%, Canada – 5.25%, Germany – 3.75, Britain – 4.75[3], it can be inferred that Ukrainian rates remain extremely high.

The problem of high interest rate is extremely sharp in Ukraine because it receives small amounts of investments comparatively to other transition countries from outside the country. So, Hungary and other East European countries attract much more foreign investments. In Hungary, for example, about 80% of export is produced by foreign owned companies (Mankovska, 2001). In such situation, the role of interest rate as an essential factor influencing endogenous level of investment in the economy is increasing.

The banking system of Ukraine remains nearly the only source of external financing for private and mixed property firms. Other financial markets, above all stock market, are not well developed to be used for financing, through public offering or bond issue, for instance. The banking system of Ukraine works in advanced technical environment, which allows settlements and money transfers in a very short time. The borrowers are usually under strict control of commercial bank that gave the loan, therefore borrowers cannot use funds on other purposes not mentioned in the loan contract. Thus, the problem of moral hazard is not crucial for loan market.

The legislation base, however, is not perfect for these markets. One of the main problems that does not allow the loans market to develop is imperfection of bankruptcy and enforcing contracts legislation. In the case borrower does not return loan, it is very difficult for the bank to enforce borrower to do so. These facts mention many economists who worked on the problems of Ukrainian economy (Gronicki and Pietka, (1998), Chaika (1999), CASE (2001) and others). There is also a break of bank secret practice in Ukraine, and tax authorities can get information about lenders from the banks, which is not the case for most other countries. Thus,

[3] Source: Wall Street Journal Europe, vol XIX, N 163, Monday, September 24, 2001, p 21.

institutions of this market are not perfect and have their negative influence on its efficiency.

3.2. Model and methodology

To research the role and determinants of interest rate in the economy I study pairwise relation between interest rate and others variables and use small simultaneous equations macromodel on the base of ISLM model to estimate parameters simultaneously. The use of such model enables the simulation of possible policies and it is possible to estimate expected results of the policy and impact of different factors on interest rates.

As it is seen from theoretical part, interest rates depend on many factors, so estimating influence of these factors it is necessary to avoid the problem of multicollinearity. Multicollinearity may yield insignificant or wrong sign parameters in estimated relationship, while true relationship shows strong and correct signed dependence. Because of this I first investigate pairwise relations between variables, including testing Granger causality, that is significance of one lagged variable in determining another current variable. Granger causality tests are also useful in specifying model in Chapter 4 of this work.

I use simultaneous equations model with 5 endogenous variables. The endogenous variables are: Interest Rates Commercial, Exchange Rate, Consumer Price Index, M2 real money, GDP real. I base the specification of this model mainly on the work of Sultan, Lukyanenko, Gorodnichenko (2000). I change the specification and add or exclude variables, however, if it is necessary for developing simple model for 5 equations.

The model, which may be used, with description of variables and specification of equations is presented below[4]:

[4] More detailed description of variables is given in Appendix A

1) Loanable funds and Liquidity preference theories stand that interest rates are affected by real M2 monetary aggregate, real income (real GDP) and Inflation level (see Chapter 2). Estimation with all these variables, however, may be complicated because of multicollinearity. Budget Balance variable is included because budget deficits increase demand for borrowings from the side of the government and thus may increase interest rates. NBU discount rate is included as variable containing information on cost of borrowing in the economy. So, even if NBU does not lend much to banking system, its rate contains information on interest rate trend in the economy and this may influence commercial banks decisions. Actual reservation (ratio of total reserves held by commercial banks (including at NBU) to deposits in banking system) may directly affect interest rate by Loanable funds theory, since it affects the amount of funds banking system can lend. Change in Exchange rate may be included in the equation to capture the effect of foreign exchange market on interest rates through interest rate parity. So, if national currency is expected to depreciate, then interest rates in national currency must increase to compensate cost of holding national currency instead of foreign. Real payables between enterprises may be considered as a substitution for borrowing, so may also affect the demand for loans and interest rates, decreasing it. From the other hand, payables in the economy may serve as an evidence of general credibility of enterprises, so that in this case interest rates may go higher with increased payables. Adjustment of present interest rate level to past changes in variables is allowed by including lagged value of interest rate. Representation of the Interest rate equation is summarized below:

$IRC_t = f\,[\,(M2/CPI)_t,\ GDP\_real_t\ ,\ d(CPI_t)/CPI_{t-1},\ (Inflation_t),\ BudgetBal_t,\ NBU_t,\ Reserve_t,\ change\ in\ ER_t\ (Payables/CPI)_t, IRC_{(t-1)}\,]$,

*w*here IRC_t is Nominal Interest Rate for Credits; *M2/CPI* is monetary aggregate M2 real; *GDP_real* – real GDP for the period, $d(CPI_t)/CPI_{t-1}$ is

growth index of CPI (Consumer Price Index), this is simply Inflation for the period, *BudgetBal* is Budget Balance as % of GDP; *NBU* – discount rate of NBU; *Reserve* – actual reserve ratio, %; *ER* – exchange rate, *Payables/CPI* – is amount of real payables on the balances of firms.

2) Price level in the country is presented by CPI. According to monetary identity M*V=P*Y, where M is quantity of money, V- money velocity, Y – is output, P- price level, I include M2 level, velocity of M2 circulation and GDP as most influencing factors of CPI. I also add Exchange rate to the equation to capture its effect and effect of change in imported goods prices on domestic prices. To allow adjustment of prices according to adaptive inflationary expectations I add lagged value of CPI into equation:

$CPI_t = f[M2_t, GDP\_real_t, M2\_velo_t, CPI_{t-1}, ER_t]$,

*w*here *CPI* is Consumer Price Index, *M2* is monetary aggregate M2, *GDP_real* – real GDP for the period, *M2_velo* is velocity of M2; *ER* – exchange rate in the period.

3) Real M2 is a function of Monetary Base (see Chapter 2). Interest rate level influences M2 through influence on deposit amounts: if interest rates are higher, saving rate is higher according to classical theory of interest, opportunity costs are higher also and, therefore, amount of deposits may be increased, increasing M2. Level of real GDP directly influences real money through monetary identity M*V=P*Y. Money supply may also be affected by the amounts of debts in the economy. If economy substitute money transactions for nonpayments, money supply will decrease. There is also possiblity that there would be multicollinearity in this equation if I include both monetary base and real GDP, since in both cases correlation between variables is strong. Exchange rate level may also explain the demand for real money.

Lagged value of money will catch adjustment effect if it present. Real money supply equation is summarized below:

$(M2/CPI)_t = f\ [(MB/CPI)_t, IRC_t, GDP\_real_t, (Payables/CPI)_t, ER_t], MB(-1)/CPI(-1)_t]$

where *(M2/CPI)* is monetary aggregate M2 real; MB/CPI is monetary base real; IRC- Interest Rate Commercial, Payables/CPI – is amount of payables on the balances of firms;

4) Exchange rate is a function of price level in the country by Purchasing Power Parity, so that increase in price level in Ukraine will lead to depreciation of national currency to adjust relationship price levels between countries. In inflationary economies national currency does not function as a store of value, so foreign currency may be used widely. If this occurs, demand for foreign currency may be significant and may influence exchange rate. Ukraine use mostly US dollars as a second currency, so level of dollar transactions in the economy should be included in the model. Balance of payment of the country may also affect exchange rate. If, for instance, demand for foreign currency from the side of importers is greater than supply of foreign currency from the side exporters, foreign currency will gain in value, so exchange rate will rise. To allow adjustment of exchange rate to exogenous shocks lagged value of exchange rate is included in the equation. Exchange rate equation is thus looks as follows:

$ER_t = f\ [ER_{t-1}, CPI_t, Dollarization_t TB_t],$

where *ER* – exchange rate in the period, *CPI* is Consumer Price Index, *Dollarization* – ratio of deposits amount in foreign currency to deposits in national currency (used as a proxy for share of transactions in foreign currency), *TB* is trade balance in given period.

5) Real GDP is presented in the model as a function of real interest rates by Loanable funds theory. Higher interest rates decrease

consumption and investment. Exchange rate influences foreign trade, so has effect on domestic output. Moreover, lagged values of exchange rate may also be significant. Real money supply affects through monetary identity (M*V)/P=Y. Producers may take into account not only previous period quarter output, but also rely on previous year output. Thus, lagged for one year value of output is included to allow seasonal adjustment in output. Growth in real payables level may suppress output, especially if firms are credit rationed:

$GDP\_real_t = f\,[IRC\ Real_t, ER_t, ER_{t-1}, M2/CPI_t, GDP\_real_{t-4}, (Payables/CPI)_t]$

Where *GDP_real* is level of real GDP, *IRC Real* is real interest rate, *ER* – exchange rate, *MB/CPI* is monetary base real, *Payables/CPI* – is amount of real payables on the balances of firms.

Other variables, such as dummies or trends, may also be included if necessary to control for exogenous shocks.

First I estimate each equation separately by Ordinary Least Squares (OLS) and Two Stage Least Squares (2SLS) to determine more precisely the specification form of the equations. The weak side of the OLS estimation in this case is that OLS estimates are biased if there exists endogeneity between variables. In the case of macromodel, many variables must influence each other, so to tackle with endogeneity problem, I estimate the model simultaneously using 2SLS procedure, instrumenting endogenous variables, and by three stage least squares (3SLS), also using set of instruments. 3SLS gives more precise estimates, but consistency of the whole set of estimates may suffer from specification errors in any equation. After this I am able to use a model for simulation.

3.3. Data description

As the most appropriate approximation to the single Ukrainian interest rate I have chosen commercial loans rate, since it reflects expectations of agents and involves rational behavior in predicting future situation. The bankers and borrowers are assumed to behave rationally, since they use all available information from the past and all information about expected changes in their credit activity. Other markets do not have such properties: treasury bonds market is not liquid after financial crisis of 1998, and mostly all issues were sold to National Bank of Ukraine only, which is the main holder of these bonds. Interbank rates are too volatile and very short-term to use these rates for analysis in my work. The weak side of using deposits rates as an approximation is that deposit rates are often set by one side – by bankers, and are not negotiable, thus do not reflect expectations of other side – the lender.

Therefore, commercial interest rates, which are published by NBU as monthly average rates, would be the best proxy for interest rate in Ukraine during transition despite in most developed countries government bonds rates are used for these purposes (Sultan et al. (2000), Gronicki and Pietka (1998), also use lending rates as market interest rate in Ukraine).

Data on macroeconomic indicators are available from official sources, such as NBU, DerzhComStat (The State Committee of Statistics), UEPLAC, ICPS and others. These institutions publish their reports and the information can be found at the following official websites:

NBU: www.bank.gov.ua., DerzhComStat: www.stat.gov.ua,
UEPLAC: www.ueplac.kiev.ua, ICPS: www.icps.kiev.ua.

I use monthly and quarterly data from January 1993 until December 2001 on most variables. Unfortunately, some series are not available before 1994, which diminishes the size of the sample. Use of monthly model has an

advantage in comparison with quarterly if the variables are volatile within one month, which is the case for Ukraine, especially for monetary variables. Another advantage is that monthly series extend the number of observations in the analysis, which gives better estimates. Thus, I use both monthly and quarterly data for analysis. Quarterly data model has some advantages before monthly because it is possible to incorporate data, which exist only as a quarterly, such as investment, inventories, export, import and quarterly data allow also to exclude excess volatility of variables, which is present in monthly data. The weak side of the model with quarterly data is that number of observations is much less than in monthly model. The list of variables used in the analysis in this work is presented in Appendix A.

Unfortunately, highly inflationary periods of early transition years caused most variables to be volatile. The Augmented Dickey-Fuller tests show that almost all variables are non-stationary in levels, while most variables are stationary in first differences. ADF Tests results are given in Appendix B.

3.4. Empirical results.

3.4.1. Relations between Commercial Interest Rates and Inflation. Is Fisher effect present in Ukraine?

I begin with analyzing relationship between inflation and interest rates in Ukraine. Fisher effect is estimated using procedure outlined in Fama (1975), Mishkin and Simon (1994). The model for testing the Fisher effect is the following:

$$\text{Inflation}_t^e = \alpha + \beta * \text{IRC}_t + \eta_t, \qquad (3.1)$$

where Inflation_t^e is future inflation rate from time *t* to *t+1*, IRC is nominal interest rate set at time *t* and η is error term. η is orthogonal to IRC by construction and assuming rational expectations on expected inflation, which

is reasonable assumption for financial markets. Thus, a test of the correlation of interest rates with actual future inflation is also a test for the correlation of interest rates and expected inflation and OLS estimation gives consistent estimate of β (Mishkin and Simon (1994)). The null hypothesis for this equation is that β is significant and equals 1, so information on changes in inflation at time *t* is fully predicted and contained in interest rate at time *t*.

If variables are nonstationary, however, this may affect the validity of inferences. According to nonstationary tests presented in Appendix B, both inflation and nominal interest rate are nonstationary in 1993:01-2001:12 sample. This requires using of other technique to estimate long-run Fisher effect. According to Mishkin and Simon (1994), long-run Fisher effect given nonstationarity of the variables is present if inflation and interest rates exhibit common trend, i.e. if they are cointegrated. To estimate cointegration it is suggested that equation (3.1) is estimated by OLS, and then residual series ε is tested for nonstationarity. If η is stationary, that is integrated of order 0, then cointegration of non-stationary variables is present. The results of long run Fisher effect for monthly data estimation are presented in Appendix C, Table C1. ADF tests suggest that residuals are stationary for both samples: full sample and moderate inflation sample. Thus, cointegration tests show that long-run Fisher effect is present in Ukrainian economy, since inflation and interest rate are cointegrated. OLS estimates of IRC show that inflation level was higher than interest rate in full sample, but after 1996 the effect was reversed. Wald tests show that there is only small probability (3-4%) that β equals 1. This means that despite the presence of common trend, there is no perfect matching effect in long-run. These results are confirmed by quarterly data, with coefficient higher than 1 in full sample and smaller than 1 in latest years. Surprisingly, testing of residuals reveals non-stationarity in residuals after 1996, which I would explain by high volatility of inflation and low volatility of nominal interest rates in this period.

Short-run Fisher effect means according to Mishkin and Simon (1994) that change in inflation is immediately followed by change in interest rates, so that the model can be represented as follows:

$$\Delta(\text{Inflation}_t) = \phi + \gamma * \Delta(\text{IRC}_t) + \varepsilon_t \qquad (3.2)$$

The null for such specification is similar to that of long-run relationship: γ is significant and equals 1. Results of regressions for monthly and quarterly data are presented in Appendix C, Table C2. Estimated coefficients confirm the previous pattern of behavior - both sample estimates for monthly data are significant, so there is relationship between interest rates and inflation within monthly periods. Large γ coefficients may be explained by greater volatility of inflation. This suggests that interest rate level is much more rigid than inflation level. Testing coefficients for equality to 1 does not allow to make decisive inference that coefficient equals 1, thus hypothesis of strong short-run Fisher effect can be rejected. In addition, high Durbin-Watson statistics suggest that there is strong autocorrelation in residuals for such specification. This may be caused by the fact that interest rates do not contain full information on expected inflation and expectations on about future inflation take into account other factors, first of all past inflation, therefore presence of short-run Fisher effect may be doubted. Similar results I obtained when I used quarterly data instead of monthly, except that coefficient of nominal interest rate is even insignificant for series 1993:01-2001:4.

Thus, in all cases nominal interest rates do not contain full information on future inflation rate. Summarizing results of the Fisher effect testing, I would argue that short-run Fisher effect is rather weak. R-squared is low, estimated coefficients point that volatility of inflation exceeded volatility of interest rates for both monthly and quarterly data and Wald tests show that there is only a small probability that $\gamma=1$. There is certain response of interest rates to change in inflation even within one month, which is consistent with study of Blejer (1978), in which he shows that in inflationary economy Fisher effect

occurs in short period of time. But this response is not so strong in monthly data as well as quarterly to say that strong short-run Fisher effect is present.

To explore the relationship between inflation and interest rate further, I tested causality in this relationship by pairwise Granger causality tests (please refer to Appendix D for more details). In these tests current values of dependent variable are regressed by own lagged values and regressor's lagged values. These tests have more sense, however, if inflation and interest rate do not show perfect correlation in the same period, which is the case for Ukraine, where short-run Fisher effect is not strong. If correlation is not perfect, then adjustment of interest rate will take place within some period. Correlation between interest rates and inflation was far from perfect for both monthly and quarterly data for different specifications – about a half for most specifications.

The results of the tests for different specifications are given in Appendix D, Table D1. They show that lagged values of inflation were significant in determining interest rate for the whole sample, while this is not true for the latest stable inflation years (p-value less than 0.1 leads to rejection null hypothesis of no causality). This fact suggests that either bankers could predict future inflation better and inflation was not unexpected in recent years or that bankers set interest rates on certain, high enough level to ensure positive real interest rates and keep nominal rates rigid. Indeed, despite large fluctuations in inflation rate, real interest rate rarely was negative in resent years. Weak short-run response of interest rate to inflation is also seen from relationship between real interest rate and inflation. This relationship shows large negative correlation of -0.93 for the whole sample and correlation of -0.69 for the sample from 1996. Graphical representation of relationship between interest rates and inflation, real interest rates and inflation is shown below on figures 12 and 13 respectively.

Figure 12. Interest rate and inflation in Ukraine: 1996:01-2002:01.

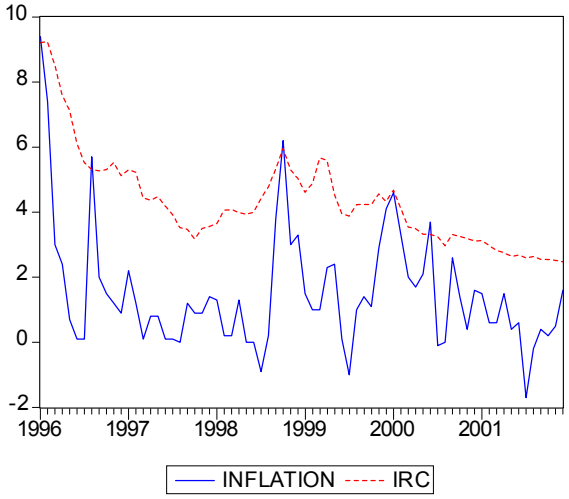
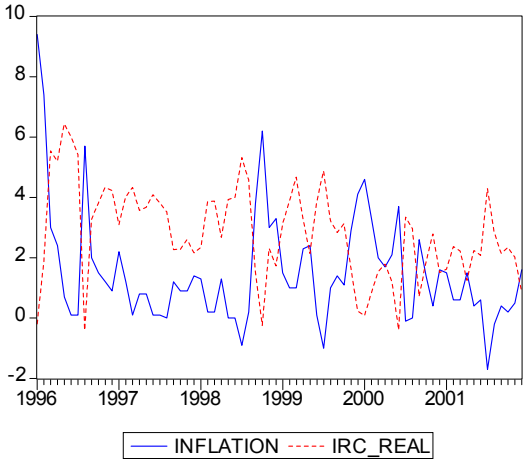


Figure 13. **Real interest rate and inflation in Ukraine: 1996:01-2002:01**.



Strong negative correlation between real interest rate and inflation indicate for the presence of volatile real interest rates in the short-run. There is also an evidence of rigidity of interest rate in the short-run, while long-run Fisher effect is present.

3.4.2. Relations between NBU discount rate and Commercial Interest Rates and Deposit Interest Rates.

National Bank of Ukraine has theoretically an ability to affect the level of interest rates in the economy particularly through discount rate policy.

Discount rate became useful instrument of influence on economy in developed countries. Influence of discount rate of NBU was doubted by many economists (see Gronicki and Pietka, 1998; CASE, 2001). They argue that discount rate in Ukraine plays the role of short-run liquidity insurance for banking system. Moreover, discount rate is not the only and not the main influencing factor on interest rate and amount of credit to economy. Nevertheless, discount rate remains one of instruments that may be used to cause lowering of interest and credit expansion.

I study the relation between deposit and credit interest rates and NBU discount rate analyzing correlation between them in full data series and series after 1996 for both monthly and quarter data. To analyze the relationship more thoroughly and exclude influence of nonstationarity of variables I use different specifications, namely levels, first differences and previous period indices, monthly and quarterly. Monthly data in level show almost perfect correlation between these variables for the whole sample from 1993:01. So, deposit and credit rates have correlation of 0.98 (see Appendix D, Table D3). Correlation between NBU rate and IRC and IRD is about 0.9, which suggests fast adjustment and strong interdependence. Correlation between variables in other specification is somewhat lower, but generally remains high. Quarterly data show higher correlation than monthly and I would explain this by the fact that most adjustment takes place within the quarter. So past quarterly values supposedly are not so significant for determining present values as past monthly values. This is generally confirmed by causality tests for one quarter lag. Larger lags testing perhaps has no great economic sense for these particular variables. Summarizing, monthly and quarterly Granger causality tests allow to conclude the following:

- past values of deposit and credit rates contemporaneously influence each other, that is deposit rate, which may be considered as cost of borrowing for bank, influence credit rate, which is gain from lending NBU rate. Vise versa, credit interest influences the rate banks can pay for deposits.

- past values of NBU rate influences credit and deposit rates more than past values of these rates influence NBU rate.

Last property is very important for policy developing, since it suggests that actors use information on NBU rate level during setting deposit and credit rates. However, since NBU rate is also set using information on the level of lending interest rates, so abuse in manipulation of NBU rate would not affect lending rates and strong correlation may break down. If NBU practice discount lending in greater amounts, theoretically it would set its rate slightly above the market value to avoid arbitrage (see Mishkin, 2001). Setting discount rate below market value of commercial loan, which was the case in latest periods, proves that NBU rate is mostly informative rate rather than actual discount rate. It has less possibility to affect lending rates than it would have under wider discounting, and the larger the difference between NBU rate and market lending rate, the weaker impact of official rate. Discount lending from NBU might partially become a substitute for deposits and lower costs of borrowing, consequently, lending. Such conclusion may be inferred from strong interdependence between deposit and lending rates. This suggests that lending rate may be lowered after decrease in cost of borrowing. Reasons for high costs of credit resources may be found in works of Gronicki and Pietka (1998), Azarov (1999), Chaika (1999), Gladkykh (1999), Savluck and Sugoniako (1999). These are mainly undeveloped financial markets with small ratio of credit to GDP and low monetisation of the economy, intensive government borrowing and others. Moreover, discount lending, as one of monetary policy tools, would also affect M2, enforcing liquidity effect. Longer term NBU deposits might may also enforce longer term lending.

The history of Ukrainian financial system was full of financial frauds and bank debt crises, for instance, recent bankruptcy of one of the largest and oldest bank "Ukraina". Such environment in addition to inflationary and currency depreciation expectations does not contribute to low deposit rates availability. To avoid inflation and depreciation effect it is possible for depositors to

convert UAH into foreign currency and deposit it. Banks, in turn, could ensure real returns for depositors by issuing inflation/depreciation indexed deposit certificates. Bank crisis thread cannot be avoided by depositors or other market agents, however. This suggests that government and NBU should take part in regulation of bank insolvency and make it safety for depositors to deposit. This is partially done by setting deposits guarantee funds, but the maximum amount which can be repaid is low to attract large amount deposits.[5] To decrease cost of borrowing for banks, which should decrease costs of lending, it is necessary to proceed further in safe deposits direction.

3.4.3. Relations between Interest Rate and other macroeconomic variables.

Among other relationships, which include interest rate, relations between interest rate, real GDP, exchange rate and money supply are of extreme importance for economy. So as for other variables relations, I study these relationships by analyzing correlation between variables and Granger causality in different specifications, namely levels and first differences, monthly and quarterly. Obtained results are presented in Appendix D.

Analysis of the relation between nominal and ex-post real interest rates and real GDP shows that both nominal and real interest rate and real GDP were negatively correlated for all specifications. Note that correlation coefficients for the period after 1996 are all negative and range from –0.03 to –0.26 for real rate and –0.06 to –0.41 for nominal. However, correlation between these variables was not large, so response of output to change in interest rate was weak, which is consistent with previous findings (see Chapter 2). Nevertheless, presence of negative correlation suggests that decrease in

[5] Now the maximum amount returned is 1200 UAH according to the Law of Ukraine on Guarantee Fund for Individual Depositors N2740-III dated September 20, 2001.

interest rates in the economy may affect output and, therefore, should be considered by authorities as one of possible policy ways for economic growth. Granger causality tests, unfortunately, do not reveal clear direction of causality. So, for quarterly data in level, for 2 lags testing, real GDP Granger causes nominal interest rates for full time series while IRC does not cause real GDP, while both real GDP and ex-post real interest rate Granger cause each other, with lower real GDP's p-values. Full sample monthly data show similar pattern of causality. After 1996 the effect for monthly and quarterly data is reversed: both real and nominal interest rates' causal effects have lower p-values than real GDP's, though p-values are rather high to conclude that causal effect is strong. After specifying the variables in first difference, the test does not show clear causality direction, but real GDP is more significant in this sense here too. Such results also confirm weak responsiveness of real sector to interest rate. I would explain stronger Granger causality from the side of real GDP in full sample by impact of risk factors: the lower real GDP, the higher risks of bad loans, and vise versa. Banks therefore might adjust the level of interest rates according to overall lending risk in the economy, which can be reflected by dynamics of real GDP. So, GDP growth had rather negative effect on interest rates, and income effect was dominated by overall lending improvement environment effect. This result is similar to results obtained by CASE, 2001 in Poland. Stabilization in the economy after 1996 diminished the effect of GDP on interest rates, but this effect stays strong in late years.

Interest rates and money supply show stronger relationship than that of interest and GDP. I test the relationship between nominal, real interest rates and M2 growth rate and real M2. For levels, there is negative correlation for most periods. Nominal interest rates correlate positively with money variables only in the full sample, which I would explain by dominating inflationary effect in highly inflationary period 1993-1996. Causal effect has clear direction from money side for all variables and specification, moreover, this effect is much stronger in full sample. Negative correlation and strong causal effect of

money let me conclude that there is strong liquidity effect in the monetary sector, which allows a conduct of effective monetary policy.

Exchange rate also had significant influence on the level of interest rates. These variables, both in nominal and real terms, were negatively correlated during all periods for level specification. Difference specification shows mainly positive correlation, though. This suggests that the pattern of relations cannot be specified in levels. According to interest rate parity, agents in setting interest rate level would rather take into account change in exchange rate than its level. Indeed, correlation between nominal interest rates and change in exchange rate is positive for period after 1996, though not large. Negligible correlation in full sample suggests that impact of exchange rate on determination of nominal interest rates was not so significant as, for instance, impact of inflation.

Among other relations in the economy, I would stress on positive impact of depreciation on real GDP and strong positive relation of real GDP and monetary shocks, in addition nominal exchange rate and monetary expansion Granger cause real GDP. There is strong correlation between M2 and Exchange Rate with almost absent causal effect, and ER and CPI with strong simultaneous causality.

Next chapter contains estimation of simultaneous equations model and simulation of policies aimed at lowering interest rates.

Chapter 4

SIMULATION OF GOVERNMENT AND NBU POLICIES AFFECTING INTEREST RATES

The simulation is based on the model specified in section 3.2. I assume a non-linear relationship between variables and for these purposes I use natural logarithm transformation. I leave the variable as it is if variable has negative values, so that log transformation is impossible. So I estimate the model simultaneously in loglevels by instrumenting endogenous variables. Despite the fact that most variables are nonstationary and are integrated of order 1, as ADF tests show (see Appendix B), I may estimate the model in levels because inferences from estimates in simultaneous equation models under 2SLS estimation are correct and follow standard procedures (Hsiao, 1997): "It is shown that in a structural equation approach what one needs to worry about are the classical issues of identification and estimation, not nonstationarity and cointegration."

There two rules to determine identification of the model: order and rank conditions. Suppose, M is number of endogenous variables in the model, m-number of endogenous variables in a given equation, K – is a number of predetermined (exogenous and lagged endogenous) variables in the model, k – number of predetermined variables in a given equation. Order condition states that "In a model of N simultaneous equations, in order for an equation to be identified, the number of predetermined variables excluded from the equation must not be lerss than the number of endogenous variables included in that equation less 1, that is $K-k \geq m-1$. If $K-k=m-1$, the equation is just identified, if $K-k>m-1$, it is overidentified (Gujarati, 1995). Order condition is necessary condition for identification, but not sufficient. Rank condition is sufficient and Gujarati defines it as follows: "In a model containing M

equations in M endogenous variables, an equation is identified if and only if at least one nonzero determinant of order (M-1)(M-1) can be constructed from the coefficients of the variables (both endogenous and predetermined) excluded from the particular equations of the model". The model I estimate contains 14 predetermined variables and 5 endogenous. All equations are clearly overidentified (see Table 1):

Table 1. Order condition for identification

Equation	(K-k)	(m-1)	Identification
IRC	9	3	Overidentified
CPI	11	3	Overidentified
M2/CPI	11	3	Overidentified
ER	10	1	Overidentified
GDP Real	11	4	Overidentified

Rank condition for identification is also satisfied, so all equations in the model are identified and the model may be estimated. I use quarterly data model and incorporate 5 structural equations into it. I estimate the model after 1996 to avoid the impact of highly unstable and inflationary years on estimates. To avoid multicollinearity I chose the specification that is most appropriate for the determination of the endogenous variable from theoretical and causal perspectives.

So, for instance, in estimating effect on exchange rate I chose CPI as influencing factor and not M2, which also has influence on exchange rate as well as on CPI. So, information on M2 level is already contained in CPI variable. Moreover, price level is more important in determining trade level and exchange rate through Purchasing Power Parity (PPP), so I chose M2 as influencing factor for CPI, and CPI as influencing factor for ER. Similar logic I used for other structural equations.

Separate estimation of each equation by OLS and 2SLS (see Appendix E) shows that most theoretical expectations on behavior of macroeconomic

indicators hold for Ukraine. Overidentifying restrictions tests point that instruments chosen are valid, because p-values are greater 10%. Moreover, this specification works well for the whole sample data and sample from 1996 and gives comparable results. Model specification passed battery of tests for serial correlation in residuals (Breusch-Godfrey Serial Correlation LM Test), Ramsey RESET test for correct specification, White heteroskedasticity test, and normality test. The null hypothesis under Breusch-Godfrey Serial Correlation LM Test is that there is no serial correlation of residuals. If p-value (probability of accepting the null) is greater than 0.1, we can accept the null hypothesis. Ramsey RESET has null that equation has correct specification, that is there is no heteroskedasticity, no omitted variables and functional form is correct. White Heteroskedasticity test has null that there is no heteroskedasticity in residuals and there is also no specification error. Finally, test for normality of residuals has the null that residuals are distributed normally.

Obtained test results for OLS and 2SLS estimation for both samples show that model is generally correctly specified, there is no autocorrelation in residuals and residuals are normally distributed. There is presence of heteroskadasticity in residuals in some equations, however this is not a crucial problem, since both OLS and 2SLS estimates are unbiased under heteroskedasticity (Johnston and DiNardo, 1997). Therefore, to obtain consistent standard errors I use White correction technique for these equations.

Predicting power of the equation may be tested by formal statistics. Such statistic as Mean Absolute Percentage Error (MAPE) is useful for comparing different models, since it gives percentage error and invariant to absolute values of variables. Another scale invariant statistic is Theil Inequality coefficient. This coefficient lies between 0 and 1 and is an important indicator of model's precision. If it goes to 0, then predicting power is very high. The Theil - coefficient may be decomposed into bias proportion, which shows

how far the mean of the forecast is from the mean of the actual series. The variance proportion shows how far the variation of the forecast is from the variation of the actual series. The covariance proportion measures the remaining unsystematic forecasting errors. These three proportions sum up to 1. If predicting power is high, bias and variance proportions should be small and most of the bias will be in covariance proportions. According to above criteria all equations in the model have high predictive power: MAPE does not exceed 10% and average MAPE is approximately about 5%. Theil Inequality Coefficients are small with most bias in covariance proportion.

Estimation of Interest Rate equation shows that interest rates, as was expected, decrease with increase in real money and budget proficit. Increase in payables in the economy also has negative effect, but significance of coefficient does not allow to make clear inference on payables' effect from this estimation. NBU rate, as expected, shows significant and positive relationship with Interest Rates, as well as actual reservation ratio. Real GDP growth also increases interest rates, but conclusion is not decisive because of insignificance of coefficient.

CPI equation also confirms theoretical expectations and reacts positively to increase money supply M2 and M2 velocity. Obtained results allow to state that increase in real GDP decreases price level in the economy. Surprisingly, increase in exchange rate has negative impact on price level, though t-statistic is not significant. Nevertheless, I would explain such result by multicollinearity, so information on impact of exchange rate is already present in other variables.

Real money supply shows strong positive dependence on real monetary base and depends negatively on nominal interest rates and real payables in the economy. So, the more debt arrears between firms the less money they demand, consequently less money is supplied. Surprisingly, real GDP has negative coefficient, which is perhaps due to multicollinearity.

Exchange rate shows strong positive dependence on price level and dollarization ratio. Changes in trade balance, as well as level of trade balance do not have significant impact on exchange rate within a quarter. Dummies are included in the equations to capture exogenous shocks of rapid increase in exchange rate.

Finally, real GDP shows negative dependence on real interest rate, though elasticity is small. This shows that real sector weakly responds to changes in interest rates. Current exchange rate has negative impact on real GDP, whereas lagged for one period exchange rate has positive influence on real GDP. This means that depreciation of national currency increases real GDP according to this equation, which is consistent with the theory. After 1996, however, both real interest rate and exchange rate have insignificant impact on real GDP. As was expected, level of real money positively affects the level of real GDP. Seasonal adjustment is also significant in determination of current GDP values.

Estimation of the system by 2SLS and 3SLS has both advantages and disadvantages. Advantage of 2SLS technique is that it is possible to estimate equations separately and reduce the impact of misspecification. 3SLS is more efficient since it takes into account correlations in residuals between equations, but in case if equations are misspecified, this may lead to inconsistency estimates. Estimated parameters and graphs with comparison of actual and modeled series are presented in Appendix F. As it is seen, all methods, OLS, 2SLS and 3SLS, give similar results with respect to the signs and significance of coefficients. Similarity in results for the full sample and period after 1996 suggests that model is correctly specified and describes macroeconomy well, so may be used in further analysis for simulation. So, modeling after 1996 shows that elasticity with respect to nominal interest rates of real money was (–0.38), of NBU rate – (+0.3), of Actual Reservation – about (+0.2), Budget Balance – (+0.01). Real GDP and real Payables have statistically insignificant coefficients.

I simulated the possible policies of NBU and government aimed at lowering interest rates. Unfortunately, there are not many pure policy variables in the model and in the economy. Inflation and exchange rate, which are among the main influencing factors on the level of interest rates are endogenous variables, so they cannot be changed exogenously, except for highly regulated exchange regime. Pure policy variables are NBU rate, MB, BudgetBal and partially Reservation (it must respond positively to change in official NBU reserve requirements).

For instance, I increase or decrease, depending on impact on nominal interest rates, these variables by 20%.[6] The obtained results show that decrease in budget deficit, decrease in NBU rate and actual reservation ratio in banking system have ability to reduce nominal interest rates (see Appendix G and Table 2.) The most influential ability have NBU rate regulation and Actual reservation in the banking system – simulated values are 0.91 and 0.94 of forecasted by the model values respectively. Monetary expansion through increase in monetary base, however, has negligible effect due to its simultaneous impact on price level, thus leaving real M2 almost unchanged. If NBU practice more intensive discount lending, this would directly affect the amounts of deposits and reserves in banking system and would have additional liquidity and cost effect on interest rate. The model shows that this effect may be partially compensated by increase in price level. On the other hand, successful lending policy will cause GDP growth, pushing price level down. Therefore, total effect on price level after wide discount lending is ambiguous. Unfortunately, limited use of discount lending in latest years does not let investigate this issue in details, leaving the field for further research.

The results of simulation with ratio of simulated values to forecasted by the model are presented below in Table 2.

Table 2. Ratio of simulated IRC values to modeled IRC values, expost simulation 1996:1-2001:3.

Simulation in variable	Magnitude of simulation shock	Ratio of simulated to modeled values
Monetary Base	+20%	0.98-0.99
NBU rate	-20%	0.91
Budget Balance	+20%	0.96-0.99
Actual Reservation	-20%	0.94

Combination of these policies may also be used to reduce interest rates. Institutional changes in the economy, which are not accounted for in this model, may also contribute to stabilization of interest rates on the level, low enough for profitable investment.

[6] 20% is an abstract number. It is used only to research an effect of change in variables on interest rates.

Conclusions

Analysis of relationship between interest rates and other indicators in the economy showed that despite theoretical importance of bank lending and commercial interest rate as its price for output growth, Ukrainian banking system does not influence real sector of economy as much as many economists and politicians would like. The price of loans, nominal as well as real, is so high that borrowing from the bank becomes a burden for a firm, and it can afford borrowing only for very short-term. In such situation interest rate may be paid by the borrower only if he can earn income very fast or if he is engaged in risky activity. There are few possibilities for large firms requiring long term investments to borrow cheaply.

The level of interest is determined on the level of bank and borrower or bank and depositor as well as on macro level. Thus, the problem of high rates is complicated by existence of the hardnesses on both levels. Since it is mutual interest that lending occur, and it is mutual interest for sides to use all available information in negotiations, the problem on micro level may be resolved with mutual benefit. This leaves macro environment the most significant determinant of level of interest rates in the economy. In my work, I analyzed the problem of high commercial interest rates mainly from macroeconomic side. Uncertain inflation and depreciation expectations, high cost of borrowing because of bank failures risks, cause both nominal and ex-post real interest rates to be high relative to other countries.

I analyzed the pairwise relationship between interest rates and inflation, exchange rate, money supply, real GDP and NBU discount rate. Analysis showed that respond of change in nominal interest rates on changes in inflation is not immediate, pointing out on volatility in real interest rate. Exchange rate dynamics was also significant influencing factor. Exchange rate and price level in the country are found to be highly correlated, so depreciation/devaluation of national currency is reflected in increase of

nominal interest rate through increase in price level and through interest rate parity (change in real returns for domestic assets). Interest rates had not significant influence on real GDP during the whole period of transition, whereas in last years this significance is increasing. Negative correlation between interest rates and money variables, and strong causal effect of money showed the presence of short-run liquidity effect. NBU official discount rate, which role for commercial interest rate is argued by many Ukrainian bankers and economists, shows strong positive correlation and causal effect.

Simultaneous equations modeling allowed to estimate simultaneous impact of macro variables on each other. This gave an opportunity to simulate the effect of a policy on the whole economy, which would not be possible under other technique. Simulation of the policies aimed at decrease in commercial interest rate revealed weakness of monetary expansion through increase in monetary base because of matching of price level and liquidity effects. This suggests that banking system should seek other sources of liquidity, mainly from attracting new deposits. Simulations of change in purely exogenous variables, however, showed possibility to reduce interest rates through decrease in NBU discount rate, reservation requirements and budget deficit. NBU discount rate, now serving as informative benchmark rate rather than actual discount rate can become even more useful policy instrument if NBU practice more intensive discount lending. This might reduce the costs of borrowing for banking system, prolong terms of deposits and, consequently, reduce price of loans. Moreover, wider discount lending would be reflected in NBU rate, making official NBU rate more precise indicator of interest rate level in the economy and, thus, more powerful policy tool. NBU should concentrate on further reduction of borrowing cost for banks through decrease of deposits risks by enforcement of deposit repayments and providing low cost discount lending. Banks, in turn, may attract deposits by ensuring real returns for depositors. These regulations in addition to maintaining budget proficit, low and stable inflation, stable rate of currency depreciation may lead to reduction of lending rates in the economy of Ukraine.

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APPENDIX A: LIST OF VARIABLES USED.

N	Name of variable	Units	Description of the variable	Source	Status in the model*	Pe-riod*
1	IRC	% per period	Interest rate for Credit, weighted average (w.a)	NBU	Endo	M, Q
2	IRC_Real	% per period	Interest rate for Credit real	UEPLAC	Endo	M, Q
3	IRD	% per period	Interest rate for Deposit (w.a)	NBU	(n.u.)	M, Q
4	CPI	index	Consumer Price Index	NBU, UEPLAC	Endo	M, Q
5	Inflation= CPI growth	% per period	Monthly percentage change of CPI	DerzhComSta t, UEPLAC	Endo	M, Q
6	ER	UAH/USD	Exchange rate	UEPLAC	Endo	M, Q
7	M2	Mln. UAH	Monetary Aggregate M2	NBU	Endo	M, Q
8	M2/CPI	Mln. UAH	Monetary Aggregate M2 real	Own calc.	Endo	M, Q
9	GDP_nom	Mln. UAH	Nominal Gross Domestic Product	UEPLAC	(inst)	M, Q
10	GDP_real	Bln. Constant roubles of 1990	Real GDP index	UEPLAC	Endo	M, Q
11	BudgetBal	% of nominal GDP per period	Budget Balance (+) - proficit, (-) – deficit	UEPLAC	Exo	M, Q
12	NBU	% per period	NBU discount rate	NBU	Exo	M, Q
13	Reservation	% ratio	Actual reserve ratio in banking system	UEPLAC	Exo	M, Q
14	Cons_real	Bln Constant roubles of 1990	Real Consumption of households	UEPLAC	(inst)	M, Q
15	MB/CPI	Mln. UAH	Monetary Base real	UEPLAC	Exo	M, Q
16	Payables /CPI	Bln. Constant roubles of 1990	Payables of Ukrainian enterprises registered on their balances real	UEPLAC	Exo	M, Q
17	M2_velo	coefficient	Velocity of M2 monetary aggregate	UEPLAC	Exo	M, Q

18	Dollarization	% ratio	Dollarization level in the economy (ratio of foreign currency deposits to domestic currency deposits)	UEPLAC	Exo	M, Q
19	Tradebal	Mln. UAH	Trade Balance	UEPLAC	Exo	Q

* Endo – endogenous variable; Exo – exogenous variable; M- monthly data; Q- quarterly data; (n.u.) - Not used in the model; (instr.) – used only as instrument;

APPENDIX B: RESULTS OF ADF TESTS FOR VARIABLES STATIONARITY: Quarterly data.

	1993:1-2001:4			1996:1-2001:4		
Variable	**ADF Test Statistic**	**Critical Value***		**ADF Test Statistic**	**Critical Value***	
IRC	**-1.282**	1%	-3.64	**-4.23**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-3.69**	1%	-3.64	**-1.98**	1%	-3.73
differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
* Here and further MacKinnon critical values for rejection of hypothesis of a unit root.						
IRC_real	**-3.48**	1%	-3.64	**-3.653**	1%	-3.73
Levels, 2 lagged		5%	-2.95		5%	-2.99
differences		10%	-2.61		10%	-2.63
IRD	**-1.82**	1%	-3.64	**-4.30**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-2.75**	1%	-3.64	**-3.76**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
CPI	**-0.70**	1%	-3.64	**-0.34**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-2.75**	1%	-3.64	**-2.67**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
Inflation	**-1.98**	1%	-3.64	**-3.90**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-6.37**	1%	-3.64	**-3.45**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
ER	**-0.71**	1%	-3.64	**-0.70**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63

1 difference, 2 lagged	**-2.20**	1%	-3.64	**-1.64**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
M2	**2.29**	1%	-3.64	**2.94**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**0.59**	1%	-3.64	**0.60**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
M2/CPI	**-4.69**	1%	-3.64	**1.27**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-10.30**	1%	-3.64	**-2.08**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
GDP_real	**-5.30**	1%	-3.64	**-0.34**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-2.34**	1%	-3.64	**-5.46**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
BudgetBal	**-2.09**	1%	-3.64	**-2.33**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-6.37**	1%	-3.64	**-3.38**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
NBU	**-1.13**	1%	-3.64	**-2.97**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-4.19**	1%	-3.64	**-2.64**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
Reservation	**-5.01**	1%	-3.64	**-1.13**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-3.38**	1%	-3.64	**-2.32**	1%	-3.73
Differences		5%	-2.95		5%	-2.99

		10%	-2.61		10%	-2.63
MB/CPI	**-4.96**	1%	-3.64	**0.86**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-8.04**	1%	-3.64	**-2.78**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
Payables/CPI	**-0.61**	1%	-3.64	**-2.72**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-3.15**	1%	-3.64	**-2.02**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
M2_velo	**-0.84**	1%	-3.64	**-1.61**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-4.20**	1%	-3.64	**-3.48**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
Dollarization	**-2.53**	1%	-3.64	**-1.73**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-3.84**	1%	-3.64	**-2.03**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
TradeBal	**-2.12**	1%	-3.64	**-1.98**	1%	-3.73
Levels, 2 lagged differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63
1 difference, 2 lagged	**-6.03**	1%	-3.64	**-5.53**	1%	-3.73
Differences		5%	-2.95		5%	-2.99
		10%	-2.61		10%	-2.63

APPENDIX C: Long-run and short-Run Fisher effect.

Table C 1: Long-run Fisher effect estimation

Dependent Variable	**INFLATION**		**INFLATION**		**INFLATION**		**INFLATION**	
Method	Least Squares		Least Squares		Least Squares		Least Squares	
Sample	**Monthly**				**Quarterly**			
Sample	**1993:01 2001:12**		**1996:01 2001:12**		**1993:1 2001:4**		**1996:1 2001:4**	
Incl.observ	108		72		36		24	
Variable	**IRC**		**IRC**		**IRC**		**IRC**	
Coefficient	1.46		0.75		2.185		0.74	
(standard error)	(0.22)		(0.12)		(0.53)		(0.168)	
P-value	0.0000		0.0000		0.0003		0.0002	
Wald Test: Null: C(1)=1								
Prob(F-statistic)	0.033		0.04		0.033		0.136	
Prob(Chi-square)	0.031		0.038		0.026		0.122	
R-squared	**0.3**		**0.35**		**0.33**		**0.468**	
Durbin-Watson stat	0.83		0.99		1.36		1.935	
Prob(F-statistic)	0.000000		0.000000		0.000251		0.000226	
Breusch-Godfrey Serial Correlation LM Test								
Prob(F-statistic)	0.000000		0.00022		0.112		0.86	
Prob(Obs*R-squared)	0.000001		0.00037		0.10		0.85	
Residuals Stationarity	ADF Stat.	Critical value	ADF Stat.	Critical value	ADF Stat.	Critical value	ADF Stat.	Critical value
No lagged differences	-6.79	-3.49 (1%)	-5.48	-3.52 (1%)	-4.83	-3.62 (1%)	-5.09	-3.74 (1%)
1 lagged differences	-4.82	-3.49 (1%)	-5.31	-3.52 (1%)	-4.41	-3.62 (1%)	-2.38	-2.64 (10%)
2 lagged differences	-3.81	-3.49 (1%)	-3.95	-3.52 (1%)	-4.29	-3.62 (1%)	-2.28	-2.64 (10%)
3 lagged differences	-4.23	-3.49 (1%)	-3.67	-3.52 (1%)	-16.67	-3.62 (1%)	-1.41	-2.65 (10%)

Table C 2: Short-run Fisher effect estimation

Dependent Variable	**D(INFLA-TION)**	**D(INFLA-TION)**	**D(INFLA-TION)**	**D(INFLA-TION)**
Method	Least Squares	Least Squares	Least Squares	Least Squares
Sample	**Monthly**		**Quarterly**	
	1993:02 2001:12	**1996:01 2001:12**	**1993:2 2001:4**	**1996:1 2001:4**
Incl.observ	107	72	34	24
Variable	**D(IRC)**	**D(IRC)**	**D(IRC)**	**D(IRC)**
Coefficient	2.05	1.89	-0.753*	1.526
(standard error)	(0.84)	(0.50)	(1.23)	(0.52)
P-value	0.0169	0.0004	0.5457	0.0076
Wald Test: Null: C(1)=1				
Prob(F-statistic)	0.216	0.081	0.164	0.322
Prob(Chi-square)	0.213	0.076	0.155	0.311
R-squared	**0.05**	**0.168**	**0.01**	**0.28**
Durbin-Watson stat	2.36	2.26	2.57	2.99
Prob(F-statistic)	0.0168	0.000353	0.5457	0.0076
Breusch-Godfrey Serial Correlation LM Test				
Prob(F-statistic)	0.0054	0.012	0.036	0.009
Prob(Obs*R-squared)	0.0057	0.012	0.033	0.009

*coefficient is insignificant

APPENDIX D: Pairwise Correlations and Granger Causality tests

Table D1: IRC and Inflation, correlation, monthly and quarterly data

Variables:	Correlation			
	Monthly		Quarterly	
	1993:01 2001:12	1996:01 2001:12	1993:1 2001:4	1996:1 2001:4
IRC , INFLATION	0.55	0.59	0.57	0.68
D(IRC) , D(INFLATION)	0.23	0.41	-0.11	0.53

Table D2: IRC and INFLATION, Pairwise Granger Causality, monthly and quarterly data

	P-values of the tests			
	Monthly		Quarterly	
Null Hypothesis:	1993:01 2001:12 Lags: 3	1996:01 2001:12 Lags: 3	1993:01 2001:4 Lags: 2	1996:1 2001:4 Lags: 2
IRC does not Granger Cause INFLATION	0.30	0.003	0.47	0.056
INFLATION does not Granger Cause IRC	1.34e-07	0.152	4.83e-08	0.29
D(IRC) does not Granger Cause D(INFLATION)	0.066	0.062	0.076	0.22
D(INFLATION) does not Granger Cause D(IRC)	0.012	0.28	2.42e-05	0.46

Table D3: IRC, IRD and NBU rate, correlation, monthly and quarterly data

Variables:	Correlation			
	Monthly		Quarterly	
	1993:01 2001:12	1996:01 2001:12	1993:1 2001:4	1996:1 2001:4
IRC , IRD	0.98	0.96	0.98	0.98
IRC, NBU	0.93	0.84	0.92	0.85
IRD, NBU	0.90	0.83	0.91	0.85
D(IRC) , D(IRD)	0.72	0.51	0.90	0.90
D(IRC) , D(NBU)	0.50	0.63	0.68	0.87
D(IRD) , D(NBU)	0.35	0.36	0.60	0.80

Table D4: IRC, IRD and NBU rate, Pairwise Granger Causality, monthly and quarterly data

	P-values of the tests			
	Monthly		Quarterly	
Null Hypothesis:	**1993:01 2001:12 Lags: 3**	**1996:01 2001:12 Lags: 3**	**1993:1 2001:4 Lags: 1**	**1996:1 2001:4 Lags: 1**
IRD does not Granger Cause IRC	0.08	0.0082	0.67	0.470
IRC does not Granger Cause IRD	2.7E-16	0.217	0.323	0.543
NBU does not Granger Cause IRC	2.9E-05	0.0008	0.122	0.091
IRC does not Granger Cause NBU	0.065	0.118	0.703	0.213
NBU does not Granger Cause IRD	0.00043	0.006	0.352	0.235
IRD does not Granger Cause NBU	0.15	0.407	0.218	0.343
D(IRD) does not Granger Cause D(IRC)	0.059	0.089	0.0034	0.858
D(IRC) does not Granger Cause D(IRD)	1.6e-16	0.28	2.1E-06	0.134
D(NBU) does not Granger Cause D(IRC)	8.7E-05	0.0007	0.305	0.042
D(IRC) does not Granger Cause D(NBU)	0.123	0.044	0.233	0.203
D(NBU) does not Granger Cause D(IRD)	8.5E-07	0.00014	0.069	0.027
D(IRD) does not Granger Cause D(NBU)	0.50	0.449	0.042	0.352

Table D5: Interest rate and other macroeconomic variables, correlation, monthly and quarterly data

Variables:	**Correlation**			
	Monthly		**Quarterly**	
	1993:01 2001:12	**1996:01 2001:12**	**1993:1 2001:4**	**1996:1 2001:4**
IRC , GDP real	0.26	-0.42	0.42	-0.41
IRC real, GDP real	-0.47	-0.20	-0.66	-0.24
IRC, M2 index	0.53	-0.13	0.63	-0.22
IRC real, M2 index	-0.43	0.16	-0.57	-0.07
IRC, M2 real	0.09	-0.76	0.04	-0.77
IRC real, M2 real	-0.43	-0.38	-0.29	-0.45
IRC, ER	-0.69	-0.58	-0.71	-0.59
IRC real, ER real	-0.44	-0.45	-0.41	-0.56
IRC, D(ER)	0.006	0.18	-0.02	0.19
IRC real, D(ERR)	0.30	-0.03	0.78	-0.02
ER, GDP real	-0.33	0.42	-0.39	0.33
ER real, GDP real	0.84	0.16	0.74	0.10
GDP real, M2 index	0.65	0.16	0.78	0.27
GDP real, M2 real	0.91	-0.38	0.78	0.63
ER, M2	0.94	0.89	0.94	0.89
ER, CPI	0.96	0.96	0.96	0.96

D(IRC) , D(GDP real)	-0.36	-0.10	-0.61	-0.06
D(IRC real), D(GDP real)	0.24	-0.03	-0.25	-0.26
D(IRC), D(M2 index)	0.09	-0.13	-0.18	0.07
D(IRC real), D(M2 index)	-0.11	0.29	0.08	-0.005
D(IRC), D(M2 real)	-0.49	-0.24	-0.56	-0.04
D(IRC real), D(M2 real)	0.33	0.23	0.36	0.08
D(IRC), D(ER)	0.14	0.38	0.09	0.40
D(IRC real), D(ER real)	0.19	-0.03	0.22	-0.20
D(ER), D(GDP real)	-0.02	-0.02	-0.03	-0.05
D(ER real), D(GDP real)	0.40	0.05	0.43	0.15
D(GDP real), D(M2 index)	0.16	0.55	0.4	0.26
D(GDP real), D(M2 real)	0.55	0.55	0.64	0.56
D(ER), D(M2)	-0.03	-0.06	-0.04	-0.09
D(ER), D(CPI)	0.45	0.41	0.65	0.59

Table D6: Interest rate and other macroeconomic variables, Pairwise Granger Causality, monthly and quarterly data, levels

	P-values of the tests			
	Monthly		**Quarterly**	
Null Hypothesis:	**1993:01 2001:12 Lags: 3**	**1996:01 2001:12 Lags: 3**	**1993:1 2001:4 Lags: 2**	**1996:1 2001:4 Lags: 2**
ER does not Granger Cause IRC	0.10	0.05	0.21	0.087
IRC does not Granger Cause ER	0.56	0.034	0.35	0.53
GDP_Real does not Granger Cause IRC	7.4E-05	0.97	7.6E-05	0.36
IRC does not Granger Cause GDP_Real	0.24	0.22	0.93	0.32
M2_INDEX does not Granger Cause IRC	1.3E-11	0.63	8.2E-08	0.50
IRC does not Granger Cause M2_INDEX	0.28	0.94	1.4E-07	0.28
M2_REAL does not Granger Cause IRC	2.6E-05	0.81	0.0002	0.13
IRC does not Granger Cause M2_REAL	0.23	0.16	0.85	0.08
ERR does not Granger Cause IRC_REAL	2.1E-05	0.073	3.0E-06	0.035
IRC_REAL does not Granger Cause ERR	0.001	0.618	0.08	0.24
GDP_REAL does not Granger Cause IRC_REAL	4.9E-07	0.27	2.2E-06	0.57
IRC_REAL does not Granger Cause GDP_REAL	0.017	0.087	0.004	0.37
M2_INDEX does not Granger Cause IRC_REAL	1.7E-06	0.32	1.8E-10	0.40
IRC_REAL does not Granger Cause M2_INDEX	0.24	0.48	3.1E-09	0.57
M2_REAL does not Granger Cause IRC_REAL	5.6E-06	0.026	9.1E-09	0.04
IRC_REAL does not Granger Cause	9.8E-	0.02	2.4E-05	0.40

M2_REAL	05			
ER does not Granger Cause CPI	0.10	0.003	0.15	0.004
CPI does not Granger Cause ER	0.08	0.25	0.49	0.28
GDP_REAL does not Granger Cause ER	0.80	0.85	0.30	0.52
ER does not Granger Cause GDP_REAL	0.30	0.12	0.076	0.003
M2 does not Granger Cause ER	0.84	0.77	0.99	0.94
ER does not Granger Cause M2	0.71	0.87	0.80	0.81
GDP_REAL does not Granger Cause ERR	0.03	0.88	0.75	0.23
ERR does not Granger Cause GDP_REAL	0.0005	0.40	0.01	0.16
M2_INDEX does not Granger Cause GDP_REAL	0.014	0.21	0.38	0.94
GDP_REAL does not Granger Cause M2_INDEX	0.01	0.59	0.16	0.35
M2_REAL does not Granger Cause GDP_REAL	1.3E-07	0.04	0.05	0.03
GDP_REAL does not Granger Cause M2_REAL	0.003	0.14	0.04	0.47

Table D7: Interest rate and other macroeconomic variables, Pairwise Granger Causality, monthly and quarterly data, first differences

	P-values of the tests			
	Monthly		**Quarterly**	
Null Hypothesis:	**1993:01 2001:12 Lags: 3**	**1996:01 2001:12 Lags: 3**	**1993:1 2001:4 Lags: 2**	**1996:1 2001:4 Lags: 2**
D(ER) does not Granger Cause D(IRC)	0.83	0.03	0.62	0.98
D(IRC) does not Granger Cause D(ER)	0.57	0.061	0.28	0.60
D(GDP_Real) does not Granger Cause D(IRC)	0.75	0.90	0.43	0.38
D(IRC) does not Granger Cause D(GDP_Real)	0.02	0.89	0.64	0.73
D(M2_INDEX) does not Granger Cause D(IRC)	5.1E-09	0.93	0.0003	0.08
D(IRC) does not Granger Cause D(M2_INDEX)	0.62	0.39	0.004	0.31
D(M2_REAL) does not Granger Cause D(IRC)	0.002	0.52	0.01	0.04
D(IRC) does not Granger Cause D(M2_REAL)	0.008	0.74	0.073	0.18
D(ERR) does not Granger Cause D(IRC_REAL)	0.0002	0.3	0.0005	0.28
D(IRC_REAL) does not Granger Cause D(ERR)	0.07	0.52	0.015	0.14
D(GDP_REAL) does not Granger Cause D(IRC_REAL)	2.2E-07	0.17	0.006	0.23
D(IRC_REAL) does not Granger Cause D(GDP_REAL)	0.90	0.13	0.01	0.25
D(M2_INDEX) does not Granger Cause D(IRC_REAL)	0.0007	0.29	1.1E-09	0.07
D(IRC_REAL) does not Granger Cause	0.25	0.54	6.7E-06	0.31

D(M2_INDEX)				
D(M2_REAL) does not Granger Cause D(IRC_REAL)	3.0E-08	0.11	0.000	0.02
D(IRC_REAL) does not Granger Cause D(M2_REAL)	0.01	0.016	1.5E-12	0.38
D(ER) does not Granger Cause D(CPI)	0.24	0.32	0.27	0.23
D(CPI) does not Granger Cause D(ER)	0.08	0.28	0.026	0.03
D(GDP_REAL) does not Granger Cause D(ER)	0.99	0.96	0.38	0.6
D(ER) does not Granger Cause D(GDP_REAL)	0.05	0.008	0.11	0.11
D(M2) does not Granger Cause D(ER)	0.77	0.76	0.70	0.75
D(ER) does not Granger Cause D(M2)	0.55	0.61	0.65	0.84
D(GDP_REAL) does not Granger Cause D(ERR)	0.18	0.97	0.23	0.41
D(ERR) does not Granger Cause D(GDP_REAL)	0.0001	0.015	3.2E-05	0.53
D(M2_INDEX) does not Granger Cause D(GDP_REAL)	0.002	0.03	0.026	0.20
D(GDP_REAL) does not Granger Cause D(M2_INDEX)	0.16	0.07	0.79	0.08
D(M2_REAL) does not Granger Cause D(GDP_REAL)	6.6E-08	0.02	0.001	0.02
D(GDP_REAL) does not Granger Cause D(M2_REAL)	0.01	0.11	0.10	0.02

APPENDIX E: SEPARATE ESTIMATION OF STRUCTURAL EQUATIONS.

Table E1. Sample 1993:1 2001:4

Method	**OLS**		**2SLS**	
Equation: IRC				
Variable	**Coeffici ent**	**P-value**	**Coeffi cient**	**P-value**
C	-2.548	0.031	-3.056	0.044
LOG(IRC(-1))	0.304	0.0012	0.3067	0.0048
LOG(M2/CPI)	-0.469	0.0037	-0.52	0.005
LOG(GDP_REAL)	0.471	0.1006	0.595	0.115
LOG(NBU)	0.345	0.000	0.350	0.000
BUDGETB	-0.0045	0.460	-0.005	0.475
LOG(REZERVE)	0.27	0.005	0.275	0.009
LOG(PAYABLES/CPI)	-0.092	0.478	-0.052	0.726
Included Observations	34		33	
R-squared	0.977		0.976	
DW stat	1.96		1.99	
Breusch-Godfrey Serial Correlation LM Test (2 lags):				
	Obs*R^2	p-value	Obs*R^2	p-value
	0.80	0.67	2.02	0.36
Ramsey RESET Test (1 fitted term):				
	LLR	p-value	LLR	p-value
	4.64	0.03	1.7	0.20
White Heteroskedasticity Test:				
	Obs*R^2	p-value	Obs*R^2	p-value
	21.56	0.088	21.8	0.08
Normality Test:				
	Jarque-Bera	p-value	Jarque-Bera	p-value
	0.56	0.76	0.45	0.8
Prediction Power : MAPE	7.842		7.862	
Theil coeff	0.084		0.082	
Bias Proportion	0.007		0.005	
Variance Proportion	0.170		0.154	
Covariance Proportion	0.822		0.839	
Overidentified Resrtictions Test (OIR-test)				
X^2-stat (p-value)	-		5.63 (0.13)	

Equation: CPI				
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
C	2.809	0.0026	2.356	0.0265
LOG(M2)	0.687	0.0000	0.699	0.0502
LOG(GDP_REAL)	-0.700	0.0004	-0.612	0.0639
LOG(M2_VELO)	0.614	0.0000	0.624	0.0225
LOG(CPI(-1))	0.294	0.0003	0.300	0.0870
DUMMY_1993_4	0.668	0.0000	0.658	0.0000
LOG(ER)	-0.002	0.9799	-0.015	0.9215
Included Observations	36		33	
R-squared	0.998		0.997	
DW stat	1.71		1.736	
Breusch-Godfrey Serial Correlation LM Test (2 lags):				
	Obs*R^2	p-value	Obs*R^2	p-value
	0.7	0.7	0.69	0.7
Ramsey RESET Test (1 fitted term):				
	LLR	p-value	LLR	p-value
	1.12	0.29	0.87	0.35
White Heteroskedasticity Test:				
	Obs*R^2	p-value	Obs*R^2	p-value
	15.7	0.15	20.5	0.04
Normality Test:				
	Jarque-Bera	p-value	Jarque-Bera	p-value
	4.1	0.13	3.95	0.14
Prediction Power : MAPE	5.798		5.904	
Theil coeff	0.025		0.026	
Bias Proportion	0.003		0.008	
Variance Proportion	0.101		0.158	
Covariance Proportion	0.895		0.833	
Overidentified Resrtictions Test (OIR-test)				
X^2-stat (p-value)	-		8.28 (0.14)	

Equation: ER				
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
C	-18.42	0.0000	-19.02	0.0000
LOG(ER(-1))	-0.06	0.4433	-0.094	0.2653
LOG(CPI)	1.209	0.0000	1.254	0.0000
LOG(DOLLAR)	1.26	0.0000	1.283	0.0000
D(TRADEBAL)	-1.8E-06	0.8046	-2E-06	0.7825
DUMMY_1994_3	0.457	0.0001	0.474	0.0001
DUMMY_1998_3	-0.35	0.0002	-0.361	0.0001
Included Observations	30		30	
R-squared	0.99		0.99	

DW stat	1.326		1.31	
Breusch-Godfrey Serial Correlation LM Test (2 lags):				
	Obs*R^2	p-value	Obs*R^2	p-value
	2.84	0.24	3.023	0.22
Ramsey RESET Test (1 fitted term):				
	LLR	p-value	LLR	p-value
	4.38	0.036	2.33	0.14
White Heteroskedasticity Test:				
	Obs*R^2	p-value	Obs*R^2	p-value
	8.64	0.57	8.03	0.63
Normality Test:				
	Jarque-Bera	p-value	Jarque-Bera	p-value
	1.363	0.50	1.66	0.44
Prediction Power : MAPE	4.639		4.627	
Theil coeff	0.023		0.023	
Bias Proportion	0.000		0.000	
Variance Proportion	0.000		0.000	
Covariance Proportion	0.998		0.998	
Overidentified Resrtictions Test (OIR-test)				
X^2-stat (p-value)	-		4.55 (0.20)	

Equation: M2/CPI				
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
C	0.39	0.2860	0.52	0.2581
LOG(MB/CPI)	0.935	0.0000	0.939	0.0000
LOG(GDP_REAL)	0.05	0.5830	0.015	0.8942
LOG(PAYABLES/CPI)	-0.13	0.0001	-0.13	0.0002
LOG(M2(-1)/CPI(-1))	0.115	0.0009	0.122	0.0011
LOG(ER)	0.08	0.0000	0.079	0.0000
Included Observations	33		33	
R-squared	0.98		0.98	
DW stat	1.63		1.60	
Breusch-Godfrey Serial Correlation LM Test (2 lags):				
	Obs*R^2	p-value	Obs*R^2	p-value
	0.55	0.76	0.62	0.73
Ramsey RESET Test (1 fitted term):				
	LLR	p-value	LLR	p-value
	1.41	0.23	5.73	0.024
White Heteroskedasticity Test:				
	Obs*R^2	p-value	Obs*R^2	p-value
	21.6	0.02	22.07	0.014
Normality Test:				
	Jarque-	p-value	Jarque-	p-value

	Bera		Bera	
	0.37	0.83	0.19	0.91
Prediction Power : MAPE	2.896		2.859	
Theil coeff	0.009		0.009	
Bias Proportion	0.022		0.021	
Variance Proportion	0.224		0.216	
Covariance Proportion	0.754		0.762	
Overidentified Resrtictions Test (OIR-test)				
X^2-stat (p-value)	-		1.96 (0.58)	

Equation: GDP_real				
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
C	2.79	0.0000	2.80	0.0000
IRC-100*D(CPI)/CPI(-1)	-0.0007	0.0010	-0.0007	0.0010
LOG(ER)	-0.128	0.0523	-0.129	0.0512
LOG(ER(-1))	0.153	0.0199	0.154	0.0194
LOG(M2/CPI)	0.274	0.0000	0.277	0.0000
LOG(GDP_REAL(-4))	0.253	0.0447	0.250	0.0470
LOG(PAYABLES/CPI)	-0.117	0.0290	-0.119	0.0271
Included Observations	33		33	
R-squared	0.85		0.85	
DW stat	1.61		1.60	
Breusch-Godfrey Serial Correlation LM Test (2 lags):				
	Obs*R^2	p-value	Obs*R^2	p-value
	3.26	0.2	3.2	0.2
Ramsey RESET Test (1 fitted term):				
	LLR	p-value	LLR	p-value
	5.03	0.025	0.8	0.38
White Heteroskedasticity Test:				
	Obs*R^2	p-value	Obs*R^2	p-value
	12.04	0.44	11.84	0.46
Normality Test:				
	Jarque-Bera	p-value	Jarque-Bera	p-value
	1.62	0.44	1.63	0.44
Prediction Power : MAPE	5.154		5.150	
Theil coeff	0.029		0.029	
Bias Proportion	0.001		0.001	
Variance Proportion	0.052		0.049	
Covariance Proportion	0.946		0.949	
Overidentified Resrtictions Test (OIR-test)				
X^2-stat (p-value)	-		1.00 (0.80)	

Table E2: Sample 1996:1 2001:4

Method	**OLS**		**2SLS**	
Equation: IRC				
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
C	-0.843	0.3477	-1.185	0.2398
LOG(IRC(-1))	0.299	0.0107	0.276	0.0185
LOG(M2/CPI)	-0.305	0.1104	-0.376	0.0663
LOG(GDP_REAL)	0.150	0.4392	0.211	0.3412
LOG(NBU)	0.309	0.0000	0.309	0.0000
BUDGETB	-0.013	0.0189	-0.013	0.0218
LOG(REZERVE)	0.178	0.0555	0.193	0.0421
LOG(PAYABLES/CPI)	-0.105	0.2931	-0.081	0.4378
Included Observations	23		23	
R-squared	0.98		0.98	
DW stat	2.05		2.10	
Breusch-Godfrey Serial Correlation LM Test (2 lags):				
	Obs*R^2	p-value	Obs*R^2	p-value
	2.02	0.36	2.44	0.29
Ramsey RESET Test (1 fitted term):				
	LLR	p-value	LLR	p-value
	0.26	0.6	0.71	0.41
White Heteroskedasticity Test:				
	Obs*R^2	p-value	Obs*R^2	p-value
	16.2	0.3	15.7	0.33
Normality Test:				
	Jarque-Bera	p-value	Jarque-Bera	p-value
	0.68	0.71	0.68	0.71
Prediction Power : MAPE	3.172		3.059	
Theil coeff	0.017		0.017	
Bias Proportion	0.000002		0.000008	
Variance Proportion	0.0046		0.0105	
Covariance Proportion	0.995		0.989	
Overidentified Resrtictions Test (OIR-test)				
X^2-stat (p-value)	-		4.97 (0.17)	

Equation: CPI				
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
C	3.87	0.0007	4.196	0.0006
LOG(M2)	0.39	0.0349	0.253	0.2809
LOG(GDP_REAL)	-0.28	0.1279	-0.094	0.6888
LOG(M2_VELO)	0.272	0.0734	0.144	0.4442

LOG(CPI(-1))	0.403	0.0049	0.456	0.0085
LOG(ER)	0.043	0.5891	0.107	0.3001
Included Observations	24		23	
R-squared	0.99		0.99	
DW stat	2.36		2.11	
Breusch-Godfrey Serial Correlation LM Test (2 lags):				
	Obs*R^2	p-value	Obs*R^2	p-value
	2.76	0.25	0.42	0.81
Ramsey RESET Test (1 fitted term):				
	LLR	p-value	LLR	p-value
	4.66	0.03	3.64	0.075
White Heteroskedasticity Test:				
	Obs*R^2	p-value	Obs*R^2	p-value
	13.64	0.19	9.49	0.48
Normality Test:				
	Jarque-Bera	p-value	Jarque-Bera	p-value
	1.26	0.53	4.23	0.12
Prediction Power : MAPE	1.467		1.505	
Theil coeff	0.009		0.0105	
Bias Proportion	0.0016		0.003	
Variance Proportion	0.042		0.003	
Covariance Proportion	0.956		0.993	
Overidentified Resrtictions Test (OIR-test)				
X^2-stat (p-value)	-		7.09 (0.21)	

Equation: ER				
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
C	-15.940	0.0000	-16.39	0.0000
LOG(ER(-1))	0.120	0.3473	0.096	0.4764
LOG(CPI)	1.101	0.0000	1.135	0.0000
LOG(DOLLAR)	0.885	0.0000	0.90	0.0000
D(TRADEBAL)	1.21E-08	0.9979	-9.68E-08	0.9829
DUMMY_1998_3	-0.222	0.0017	-0.228	0.0016
Included Observations	23		23	
R-squared	0.99		0.99	
DW stat	1.94		1.93	
Breusch-Godfrey Serial Correlation LM Test (2 lags):				
	Obs*R^2	p-value	Obs*R^2	p-value
	0.58	0.75	0.72	0.70

Ramsey RESET Test (1 fitted term):				
	LLR	p-value	LLR	p-value
	0.9	0.34	0.09	0.77
White Heteroskedasticity Test:				
	Obs*R^2	p-value	Obs*R^2	p-value
	11.31	0.25	10.95	0.28
Normality Test:				
	Jarque-Bera	p-value	Jarque-Bera	p-value
	2.96	0.23	3.52	0.17
Prediction Power : MAPE	2.716		2.731	
Theil coeff	0.017		0.016	
Bias Proportion	0.000		0.000	
Variance Proportion	0.001		0.001	
Covariance Proportion	0.998		0.998	
Overidentified Resrtictions Test (OIR-test)				
X^2-stat (p-value)	-		3.13 (0.37)	

Equation: M2/CPI				
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
C	1.249	0.0094	1.616	0.0068
LOG(MB/CPI)	1.089	0.0000	1.157	0.0000
LOG(GDP_REAL)	-0.114	0.2089	-0.199	0.0849
LOG(PAYABLES/CPI)	-0.137	0.0191	-0.177	0.0093
LOG(M2(-1)/CPI(-1))	0.052	0.5043	0.026	0.7468
LOG(ER)	0.035	0.0996	0.039	0.0814
Included Observations	23		23	
R-squared	0.99		0.99	
DW stat	2.08		2.09	
Breusch-Godfrey Serial Correlation LM Test (2 lags):				
	Obs*R^2	p-value	Obs*R^2	p-value
	0.14	0.93	0.5	0.78
Ramsey RESET Test (1 fitted term):				
	LLR	p-value	LLR	p-value
	0.82	0.36	1.44	0.25
White Heteroskedasticity Test:				
	Obs*R^2	p-value	Obs*R^2	p-value
	7.62	0.67	7.04	0.72
Normality Test:				
	Jarque-Bera	p-value	Jarque-Bera	p-value
	0.28	0.87	0.37	0.83

Prediction Power : MAPE	1.353	1.352
Theil coeff	0.006	0.007
Bias Proportion	0.002	0.000
Variance Proportion	0.050	0.022
Covariance Proportion	0.946	0.976
Overidentified Resrtictions Test (OIR-test)		
X^2-stat (p-value)	-	2.14 (0.54)

Equation: GDP_real				
Variable	**Coefficient**	**P-value**	**Coefficient**	**P-value**
C	2.255	0.0002	2.237	0.0002
IRC-100*D(CPI)/CPI(-1)	-0.0039	0.2345	-0.0039	0.2323
LOG(ER)	-0.0008	0.9945	-0.0016	0.9892
LOG(ER(-1))	-0.041	0.7245	-0.039	0.7384
LOG(M2/CPI)	0.458	0.0001	0.453	0.0001
LOG(GDP_REAL(-4))	0.623	0.0002	0.625	0.0002
LOG(PAYABLES/CPI)	-0.267	0.0016	-0.264	0.0018
Included Observations	23		23	
R-squared	0.82		0.82	
DW stat	1.88		1.89	
Breusch-Godfrey Serial Correlation LM Test (2 lags):				
	Obs*R^2	p-value	Obs*R^2	p-value
	0.11	0.94	0.11	0.94
Ramsey RESET Test (1 fitted term):				
	LLR	p-value	LLR	p-value
	0.59	0.44	1.05	0.32
White Heteroskedasticity Test:				
	Obs*R^2	p-value	Obs*R^2	p-value
	14.86	0.25	14.88	0.25
Normality Test:				
	Jarque-Bera	p-value	Jarque-Bera	p-value
	1.14	0.56	1.15	0.56
Prediction Power : MAPE	3.099		3.10	
Theil coeff	0.017		0.017	
Bias Proportion	0.004		0.004	
Variance Proportion	0.220		0.225	
Covariance Proportion	0.775		0.770	
Overidentified Resrtictions Test (OIR-test)				
X^2-stat (p-value)	-		4.22 (0.24)	

APPENDIX F: SIMULTANEOUS ESTIMATION OF THE MODEL

Table F1: 2SLS ESTIMATION OF THE SYSTEM

System: SYS02
Estimation Method: Two-Stage Least Squares
Sample: 1996:1 2001:4

	Coefficient	Std. Error	t-Statistic	Prob.
C(10)	-1.185570	0.968614	-1.223986	0.2245
C(11)	0.276422	0.104591	2.642880	0.0098
C(12)	-0.376889	0.190319	-1.980301	0.0510
C(13)	0.211489	0.215132	0.983063	0.3285
C(14)	0.309650	0.033403	9.270094	0.0000
C(15)	-0.013127	0.005129	-2.559489	0.0123
C(16)	0.193371	0.087029	2.221921	0.0290
C(17)	-0.081520	0.102254	-0.797234	0.4276
C(20)	3.913136	0.987774	3.961570	0.0002
C(21)	0.428000	0.201429	2.124818	0.0366
C(22)	-0.299451	0.212012	-1.412430	0.1616
C(23)	0.371041	0.143212	2.590845	0.0113
C(24)	0.030245	0.089459	0.338091	0.7362
C(25)	0.291983	0.165534	1.763884	0.0815
C(30)	1.655268	0.502129	3.296499	0.0014
C(31)	1.185567	0.076297	15.53889	0.0000
C(32)	-0.208685	0.103290	-2.020378	0.0466
C(33)	-0.186095	0.052984	-3.512311	0.0007
C(34)	0.042698	0.018061	2.364170	0.0204
C(40)	-16.39615	2.461003	-6.662383	0.0000
C(41)	1.135362	0.184316	6.159882	0.0000
C(42)	0.900125	0.114180	7.883370	0.0000
C(43)	-9.68E-08	4.44E-06	-0.021792	0.9827
C(44)	-0.228657	0.061137	-3.740089	0.0003
C(45)	0.096440	0.132445	0.728156	0.4686
C(50)	2.237379	0.467755	4.783233	0.0000
C(51)	-0.003921	0.003158	-1.241417	0.2180
C(52)	-0.001682	0.122790	-0.013694	0.9891
C(53)	-0.039172	0.115285	-0.339787	0.7349
C(54)	0.453398	0.089358	5.073977	0.0000
C(55)	0.624691	0.127806	4.887828	0.0000
C(56)	-0.264189	0.070827	-3.730075	0.0004

Determinant residual covariance 2.08E-16

Equation: LOG(IRC) = C(10) + C(11)*LOG(IRC(-1)) + C(12)*LOG(M2/CPI) + C(13)*LOG(GDP_REAL) + C(14)*LOG(NBU) +C(15)*BUDGETB +C(16)*LOG(REZERVE) + C(17)*LOG(PAYABLES/CPI)
Observations: 23

R-squared	0.981968	Mean dependent var	2.538673
Adjusted R-squared	0.973553	S.D. dependent var	0.297000
S.E. of regression	0.048300	Sum squared resid	0.034993
Durbin-Watson stat	2.107770		

Equation: LOG(CPI) = C(20) + C(21)*LOG(M2) + C(22)*LOG(GDP_REAL) + C(23)*LOG(CPI(-1)) + C(24)*LOG(ER) + C(25)*LOG(M2_VELO)
Observations: 22

R-squared	0.995082	Mean dependent var	12.49410
Adjusted R-squared	0.993546	S.D. dependent var	0.284881
S.E. of regression	0.022887	Sum squared resid	0.008381
Durbin-Watson stat	2.436689		

Equation: LOG(M2/CPI) = C(30) + C(31)*LOG(MB/CPI) + C(32)*LOG(GDP_REAL) + C(33)*LOG(PAYABLES/CPI) + C(34)*LOG(ER)
Observations: 23

R-squared	0.993963	Mean dependent var	-2.820971
Adjusted R-squared	0.992621	S.D. dependent var	0.237499
S.E. of regression	0.020401	Sum squared resid	0.007492
Durbin-Watson stat	2.108736		

Equation: LOG(ER) = C(40) + C(41)*LOG(CPI) + C(42)*LOG(DOLLAR) + C(43)*D(TRADEBAL) + C(44)*DUMMY_1998_3 + C(45)*LOG(ER(-1))
Observations: 23

R-squared	0.993754	Mean dependent var	1.124197
Adjusted R-squared	0.991916	S.D. dependent var	0.484478
S.E. of regression	0.043559	Sum squared resid	0.032255
Durbin-Watson stat	1.930413		

Equation: LOG(GDP_REAL) = C(50) + C(51)*(IRC-100*D(CPI)/CPI(-1)) + C(52)*LOG(ER) + C(53)*LOG(ER(-1)) + C(54)*LOG(M2/CPI) + C(55)*LOG(GDP_REAL(-4)) + C(56)*LOG(PAYABLES/CPI)
Observations: 23

R-squared	0.819303	Mean dependent var	2.838249
Adjusted R-squared	0.751542	S.D. dependent var	0.078527
S.E. of regression	0.039142	Sum squared resid	0.024514
Durbin-Watson stat	1.889814		

Table F2: 3SLS ESTIMATION OF THE SYSTEM

System: SYS03
Estimation Method: Three-Stage Least Squares
Sample: 1996:1 2001:4

	Coefficient	Std. Error	t-Statistic	Prob.
C(10)	-1.270719	0.768766	-1.652933	0.1022
C(11)	0.284225	0.080443	3.533250	0.0007
C(12)	-0.379313	0.148953	-2.546529	0.0128
C(13)	0.216393	0.172162	1.256919	0.2124
C(14)	0.302640	0.025767	11.74532	0.0000
C(15)	-0.013992	0.003962	-3.531227	0.0007
C(16)	0.212669	0.067074	3.170677	0.0021
C(17)	-0.084386	0.081769	-1.032004	0.3051
C(20)	4.074152	0.812816	5.012392	0.0000
C(21)	0.395111	0.165088	2.393342	0.0190
C(22)	-0.228312	0.173352	-1.317039	0.1915
C(23)	0.370672	0.118441	3.129592	0.0024
C(24)	0.052847	0.073167	0.722274	0.4722
C(25)	0.262451	0.135126	1.942267	0.0555
C(30)	1.672863	0.431381	3.877924	0.0002
C(31)	1.188116	0.065868	18.03776	0.0000
C(32)	-0.211743	0.088645	-2.388667	0.0192
C(33)	-0.186440	0.045730	-4.076997	0.0001
C(34)	0.042336	0.015681	2.699732	0.0084
C(40)	-15.87458	2.055844	-7.721686	0.0000
C(41)	1.101723	0.154170	7.146142	0.0000
C(42)	0.862039	0.095609	9.016278	0.0000
C(43)	-1.57E-07	3.65E-06	-0.043011	0.9658
C(44)	-0.186310	0.050279	-3.705550	0.0004
C(45)	0.127821	0.110541	1.156318	0.2509
C(50)	2.188460	0.377219	5.801564	0.0000
C(51)	-0.006234	0.002473	-2.520824	0.0136
C(52)	-0.061086	0.098159	-0.622314	0.5355
C(53)	0.016304	0.092024	0.177171	0.8598
C(54)	0.443279	0.072372	6.125031	0.0000
C(55)	0.640369	0.102176	6.267322	0.0000
C(56)	-0.267678	0.056159	-4.766465	0.0000

Determinant residual covariance 1.63E-16

Equation: LOG(IRC) = C(10) + C(11)*LOG(IRC(-1)) + C(12)*LOG(M2/CPI) + C(13)*LOG(GDP_REAL) + C(14)*LOG(NBU) + C(15)*BUDGETB + C(16)*LOG(REZERVE) + C(17)*LOG(PAYABLES/CPI)

Observations: 23

R-squared	0.981690	Mean dependent var	2.538673
Adjusted R-squared	0.973145	S.D. dependent var	0.297000

S.E. of regression	0.048670	Sum squared resid	0.035532
Durbin-Watson stat	2.177279		

Equation: LOG(CPI) = C(20) + C(21)*LOG(M2) + C(22)*LOG(GDP_REAL) + C(23)*LOG(CPI(-1)) + C(24)*LOG(ER) + C(25)*LOG(M2_VELO)
Observations: 22

R-squared	0.994968	Mean dependent var	12.49410
Adjusted R-squared	0.993396	S.D. dependent var	0.284881
S.E. of regression	0.023151	Sum squared resid	0.008575
Durbin-Watson stat	2.333497		

Equation: LOG(M2/CPI) = C(30) + C(31)*LOG(MB/CPI) + C(32)*LOG(GDP_REAL) + C(33)*LOG(PAYABLES/CPI) + C(34)*LOG(ER)
Observations: 23

R-squared	0.993940	Mean dependent var	-2.820971
Adjusted R-squared	0.992594	S.D. dependent var	0.237499
S.E. of regression	0.020439	Sum squared resid	0.007520
Durbin-Watson stat	2.107037		

Equation: LOG(ER) = C(40) + C(41)*LOG(CPI) + C(42)*LOG(DOLLAR) + C(43)*D(TRADEBAL) + C(44)*DUMMY_1998_3 + C(45)*LOG(ER(-1))
Observations: 23

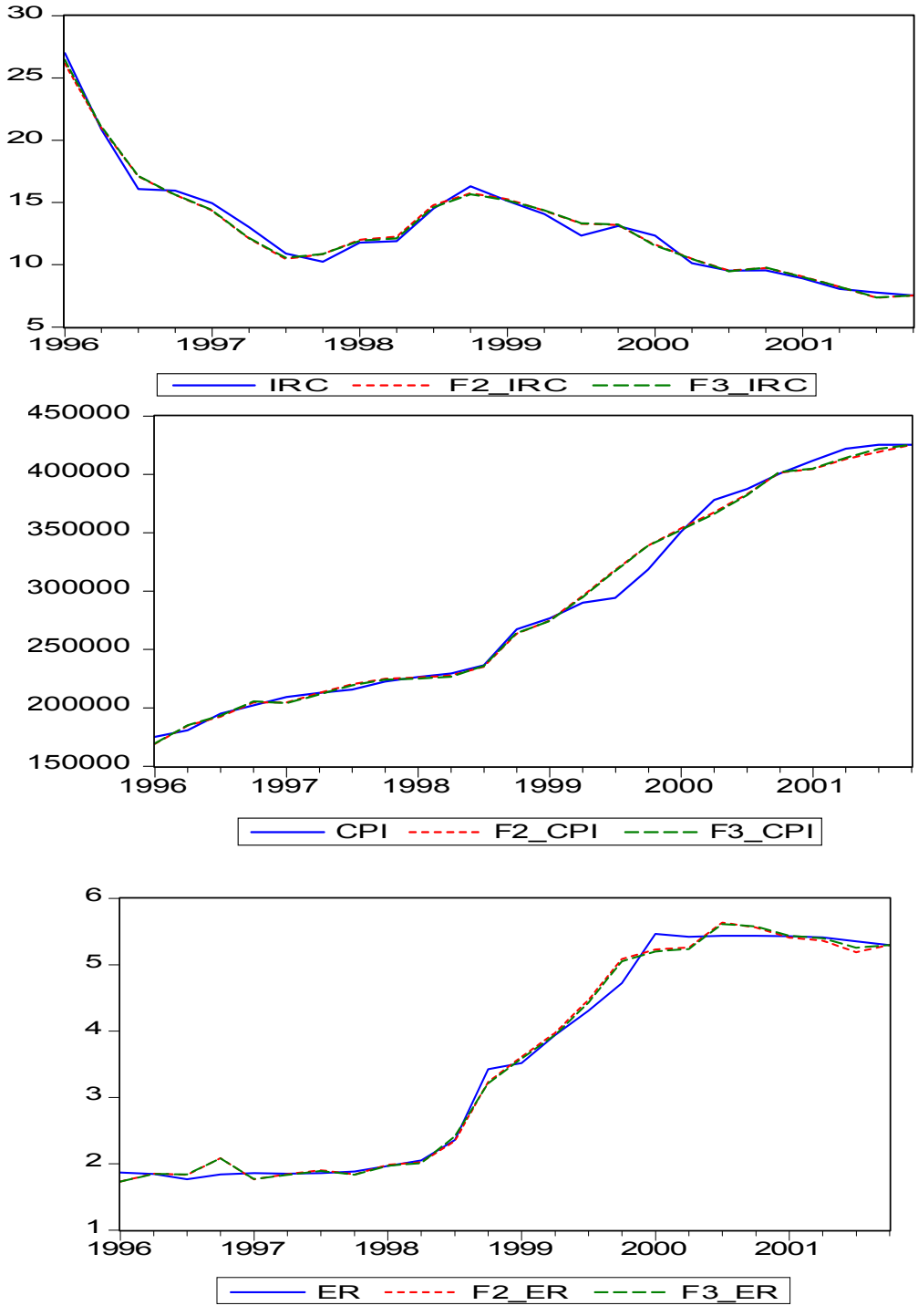
R-squared	0.993576	Mean dependent var	1.124197
Adjusted R-squared	0.991687	S.D. dependent var	0.484478
S.E. of regression	0.044172	Sum squared resid	0.033170
Durbin-Watson stat	2.005272		

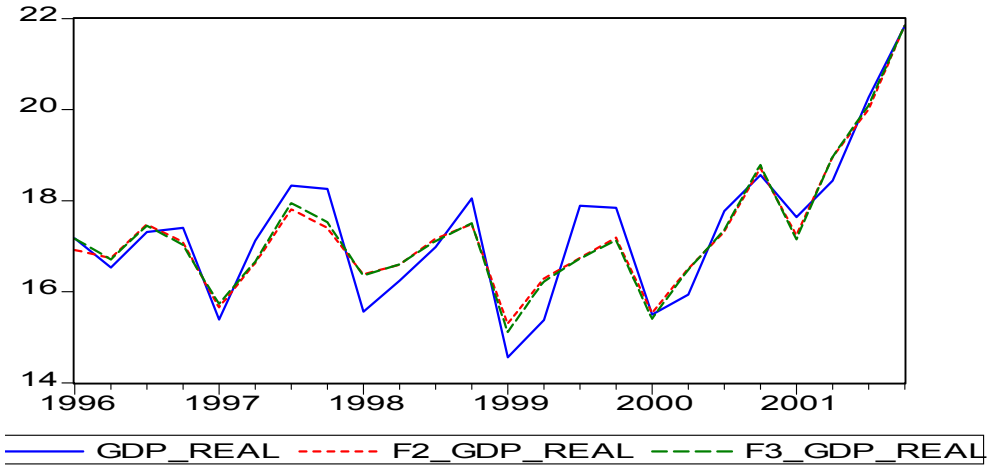
Equation: LOG(GDP_REAL) = C(50) + C(51)*(IRC-100*D(CPI)/CPI(-1)) + C(52)*LOG(ER) + C(53)*LOG(ER(-1)) + C(54)*LOG(M2/CPI) + C(55)*LOG(GDP_REAL(-4)) + C(56)*LOG(PAYABLES/CPI)

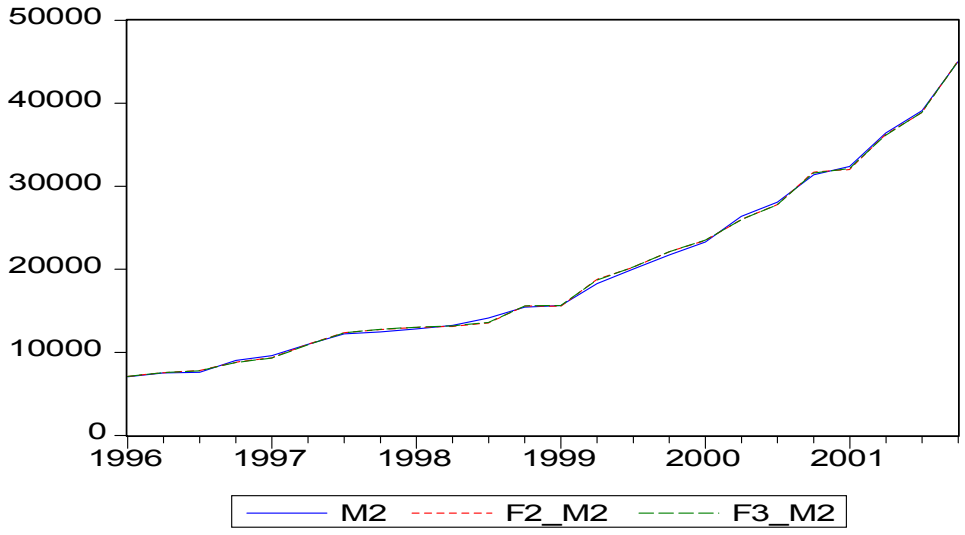
Observations: 23

R-squared	0.810551	Mean dependent var	2.838249
Adjusted R-squared	0.739508	S.D. dependent var	0.078527
S.E. of regression	0.040079	Sum squared resid	0.025701
Durbin-Watson stat	2.054249		

Figure F1: Predictions precision of the model




22
20
18
16
14
1996
1997
1998
1999
2000
2001
GDP_REAL
F2_GDP_REAL
F3_GDP_REAL


50000
40000
30000
20000
10000
0
1996
1997
1998
1999
2000
2001
M2
F2_M2
F3_M2

APPENDIX G: EXPOST SIMULATIONS OF THE POLICIES TO LOWER INTEREST RATE.

Figure G1: Simulation of monetary expansion (Monetary Base is increased by 20%)

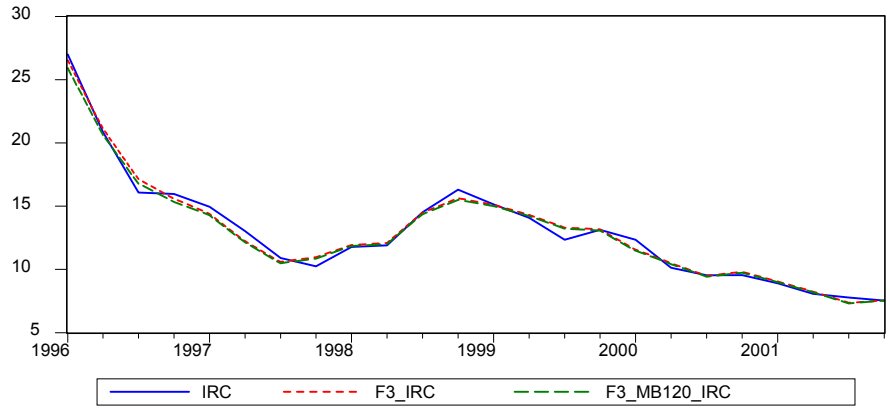


Figure G1: Simulation of discount rate decrease (NBU rate is decreased by 20%)