INSTRUMENTS AND TARGETS OF MONETARY POLICY IN UKRAINE.

by

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Abstract

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The paper aims at determining the optimal instrument of monetary policy in Ukraine. For this purpose the approach of disutility minimization is employed. Having estimated empirically the structure imposed on the domestic economy and the central bank’s reaction function, I am able to recover the explicit form of the function describing the disutility felt by the National Bank when the values of price level, exchange rate and the gap between the Russian and Ukrainian discount rates deviate from their target values. All the information mentioned was used to derive the criterion enabling comparison of the efficiency of the discount rate vs. statutory reserve requirements – the two instruments of NBU monetary policy.

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Section 1

INTRODUCTION.

Monetary policy of the National Bank of Ukraine is one of those features that determine the overall health of the Ukrainian economy and thus affect us all. Because of its far-reaching effects on economic activity it is important to understand what are the targets of the policy and what instruments are used by the Bank in order to achieve these targets.

This paper is a modest attempt to explain what levers are employed in Ukraine to accomplish two ultimate objectives of monetary policy - stable price level and exchange rate of domestic currency. I will also try to answer whether the instruments used are the best ones to achieve the targets. For this purpose the reaction function approach will be employed.

Therefore, the paper has the following structure:

First (Section 2), I briefly present classical theory on a central bank's disutility function, that is necessary to understand optimal choice of instruments in a stochastic model, which is also discussed. (This theoretical framework is used further in Section 5) Then I describe (Section 3) monetary instruments used by the National Bank and the way they are used. Accompanied by the policy chronology (Section 4), it will be useful while applying the stochastic model to Ukrainian situation (Section 5) in order to examine which of the major instruments used is optimal for the country in a sense of disutility minimization.

CENTRAL BANK'S DISUTILITY AND REACTION FUNCTIONS[1].

2.1 The Targets of Dynamic Policy.

Assume a central bank aims its monetary policy at achieving $Y_t^?$ output level, $U_t^?$ unemployment rate and price index $P_t^?$. Also it tries to keep the difference between the domestic and U.S. short-term interest rates $?r_t\ ?\ r_t^{U.S.}?$ (nominal) within a certain range. The later objective reflects the fact that the central bank is uncomfortable when $?r_t\ ?\ r_t^{U.S.}?$ rises accelerating capital inflow, or falls leading to foreign exchange loss.

In this situation a static quadratic disutility function[2] can be written as

$$d_t\ ?\ w_1(Y_t\ ?\ Y_t^?)^2\ ?\ w_2(U_t\ ?\ U_t^?)^2\ ?\ w_3(r_t\ ?\ r_t^{U.S.})^2\ ?\ w_4(P_t\ ?\ P_t^?)^2 \qquad \textbf{(1)}$$

This function, however, has one unfeasible property. Namely, if all w_i are positive, the marginal disutility of deviation in either direction from each target is positive. That is, the marginal disutility of $U\ ?\ U^?$ is just as positive as when $U\ ?\ U^?$. But in the cases of real output and employment, it is more

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[1] Theoretical part of my paper borrows the idea from Dean, James. W (1974) "Problems in the Specification and Interpretation of Central Bank Reaction Functions."

[2] For more details, see John H. Wood "A Model of Federal reserve Behavior" in George Howich, ed., Monetary Process and Policy: A Symposium. (Irwin, 1967) p.p. 135-66.

likely to assume insatiability of utility at arbitrarily high (for real output) or low (for unemployment rate) values. Thus, (1) should be modified to

$$d_t \; ? \; ? \, w_1 Y_t^2 \; ? \; w_2 U_t^{\,2} \; ? \; w_3 (r_t^{?} \; ? \; r_t^{?U.S.})^2 \; ? \; w_4 (P_t \; ? \; P_t^{?})^2 \qquad \textbf{(2)}$$

where all $w_i > 0$.

The bank minimizes (2) subject to its view of the constraints imposed on the economy, that can be characterized by a set of equations[3]:

$$Y_t \; ? \; a_1 R_t \; ? \; b_{11} U_t \; ? \; b_{12} P_t \; ? \; b_{13} S_t \qquad \textbf{(3.1)}$$

$$U_t \; ? \; ? \, a_2 R_t \; ? \; b_{21} Y_t \; ? \; b_{22} P_t \; ? \; b_{23} S_t \qquad \textbf{(3.2)}$$

$$r_t \; ? \; ? \, a_3 R_t \; ? \; b_{31} P_t \; ? \; b_{32} S_t$$
(3.3)

$$P_t \; ? \; a_4 R_t \; ? \; b_{41} U_t \; ? \; b_{42} Y_t \; ? \; b_{43} S_t \qquad \textbf{(3.4)}$$

(3.1) - (3.4) is a system of linear, simultaneous equations including all “non-controlled’ or “target” variables accept $r^{U.S.}$ and $P^{?}$ which are assumed exogenous. Each target variable is expressed as a function of the other target variables as well as of the instrument variable R - reserves. Note that interest rate plays a double role – an instrument and a target. A new exogenous variable S - government debt is introduced. The reason behind introduction of this variable into the model resides in the fact that as debt accumulates authorities are likely to finance it printing money that, in turn, can affect the price level.

[3] The precise specification of these equations is a matter of empirical estimation. They do not necessarily correspond to any accepted macroeconomic theory.

Substituting (3.1) - (3.4) into (2) and minimizing with respect to R, one obtains:

$$\frac{? d}{? R} ? ?2w_1a_1 ? a_1R ? b_{11}U ? b_{12}P ? b_{13}S ? ? 2w_2a_2 ? ? a_2R ? b_{21}Y ? b_{22}P ? b_{23}S ? ?$$
$$2w_3a_3 ? ? a_3r ? b_{31}P ? b_{32}S ? r^{U.S.} ? ? 2w_4a_4 ? a_4R ? b_{41}U ? b_{42}Y ? b_{43}S ? p^{?} ? ? 0$$

Solving for R yields:

$$R ? ? ? ? w_2a_2b_{21} ? w_4a_4b_{42} ? Y ? ? ? w_1a_1b_{11} ? w_4a_4b_{41} ? U ? ? w_1a_1b_{12} ? w_2a_2b_{22} ? w_3a_3b_{31} ? P ?$$
$$? ? ? w_1a_1b_{13} ? w_2a_2b_{23} ? w_3a_3b_{32} ? w_4a_4b_{43} ? S ? w_3a_3r^{U.S.} ? w_4a_4P^{?} ? / k$$

(4a)

where $k ? (? w_1a_1^2 ? w_2a_2^2 ? w_3a_3^2 ? w_4a_4^2).$

or $R ? k_1Y ? k_2U ? k_3P ? k_4S ? k_5^{'}r^{U.S.} ? k_6^{'}P^{?}$

(4b)

In (4b) $k_1 ? (? w_2a_2b_{21} ? w_4a_4b_{42}) / k$ similarly for k_2 - k_4, k_5? and k_6?

The expression (4b) is called the reaction function consistent with the disutility function (2) and economic structure (3).

As can be easily verified once a_i and b_{ij} are known, the coefficients k_1 - k_4, k_5? and k_6? overdetermine w_1 - w_4. This problem is removed if the disutility function is revised to

$$d_t ? ? w_1Y_t^2 ? w_2U_t^2 ? w_3(r_t^{?} ? w_5r_t^{?U.S.})^2 ? w_4(P_t ? w_6P_t^{?})^2$$

(4)

where w_5 and w_6 are weights attached to $r^{U.S.}$ and $P^{?}$, all $w_i>0$.

For the new reaction function (4), k_5? and k_6? become

$$k_5 \ ? \ w_3 w_5 a_3 / k$$
$$k_6 \ ? \ w_4 w_6 a_4 / k$$

2.2 Optimal Choice of Instruments in a Stochastic Model.

William Poole's "Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model" shows that the two instruments which are (like r and R) linearly related in a nonstochastic model are perfect substitutes. In other words if r? and R? are those levels of r and R, respectively, which, ceteris paribus, minimize disutility d, then attainment of r? implies the same minimum disutility as does attainment of R?.

Let us add stochastic terms u_1 - u_4 to each of (3.1) - (3.4), assuming that $E(u_i)=0$; variances $E(u_i^2)=?_{ui}^2$ (for all i) and covariances are $E(u_i u_j) = ?_{uiuj}$ (for all i?j), and take the expected value of disutility function (2).

The property of **"certainty equivalence"** for quadratic disutility functions subject to linear constraints, proved by Theil[4], states that

"maximization of (such a) welfare function subject to (such a) nonstochastic constraint y = f(x), the disturbance vector being replaced by its mean value, gives the same instrument vector (or set of instrument vectors) as maximization of the mean value of the welfare function subject to stochastic constraint y = f(x)+u, provided such a maximum exists."

[4] See H. Theil, Economic Forecasts and Policy (North Holland, 1965), pp.404-424, especially theorem1, p.415 ff.

In terms of our model it implies that adding u_1 - u_4 to (3.1)-(3.4) does not change the locus of R? (it is still determined according to (4)); similarly for r?

However, although optimal values of individual instruments do not differ between the deterministic model and its stochastic equivalent, under uncertainty instruments are no longer perfect substitutes.[5] In other words, even though the introduction of uncertainty does not affect the loci of r? and R?, $E(d_{min})|r? ? E(d_{min})|R?$.

To obtain an operational criterion that could serve as a test of the relative efficacies of reserves and interest rate policies, denote the actual disutility minimizing values under reserves policy by Y^R, U^R, R^R and P^R, so that

$$Y^R ? Y^T ? u_1$$
$$U^R ? U^T ? u_2$$
$$r^R ? r^T ? u_3$$
$$P^R ? P^T ? u_4$$

(5)

where Y^T, U^T, R^T and P^T are nonstochastic values of the endogenous targets that minimize disutility under certainty. Then express all variables in terns of R and substitute (5) into E(d), where d is given by (2). One will have the expected value of disutility under the reserves policy:

[5] For the proof see Dean (1974)

$$E(d)|_{R^?} ? E ? w_1(Y^T ? u_1)^2 ? w_2 ?U^T ? u_2?^2 ? w_3 ?r^T ? u_3 ? w_5 r^{U.S.}?^2 ? w_4 ?P^T ? u_4 ? w_6 P^? ?^2 ? ?$$

$$? ? w_1 ?Y^T?^2 ? w_2 ?U^T?^2 ? w_3 ?r^T ? w_5 r^{U.S.}?^2 ? w_4 ?P^T ? w_6 P^? ?^2 ? w_1 ?_{u1}{}^2 ? \overset{3}{\underset{i?1}{?}} w_i ?_{ui}{}^2 ?$$

$$? d_m ? w_1 ?_{u1}{}^2 ? \overset{3}{\underset{i?1}{?}} w_i ?_{ui}{}^2 \qquad \textbf{(6)}$$

where d_m is minimum disutility under certainty.

In contrast, when we minimize with respect to r, we must express all endogenous targets in terms of r Similar to the previous case, the actual disutility minimizing values differ only by the stochastic terms from Y^T, U^T, R^T and P^T, so that

$$\begin{aligned} &Y^r ? Y^T ? (a_3u_1 ? a_1u_3)/a_3 \\ &U^r ? U^T ? (a_3u_2 ? a_2u_3)/a_3 \\ &r^? ? r^T \\ &P^r ? P^T ? (a_3u_4 ? a_4u_3)/a_3 \end{aligned} \qquad \textbf{(7)}$$

(Note that, since r is set precisely at $r^?$, it is now nonstochastic).

Under interest rate policy minimum expected disutility is (upon substitution (7) into E(d)):

$$E(d_m)|r^? ? d_m ? w_1(a_3^2 ?_{u1}^2 ? a_1^2 ?_{u3}^2 ? a_1a_3 ?_{u1u3})/a_3^2 ? w_2(a_3^2 ?_{u2}^2 ? a_2^2 ?_{u3}^2 ? a_2a_3 ?_{u2u3})/a_3^2 ?$$

$$? w_4(a_3^2 ?_{u4}^2 ? a_4^2 ?_{u3}^2 ? a_3a_4 ?_{u3u4})/a_3^2) \qquad \textbf{(9)}$$

Now we can compare (6) to (9) and claim that the interest rate policy will be superior when

$$?E(d_m)|r^? ? d_m? ? ?E(d_m)|R^? ? d_m?$$

that is, when

$$(w_2 a_2^2 \ ? \ w_4 a_4^2) ?_{u3}^2 \ ? \ w_4 a_3 a_4 ?_{u3u4} \ ? \qquad \textbf{(10)}$$
$$(w_3 a_3^2 \ ? \ w_1 a_1^2) ?_{u3}^2 \ ? \ w_1 a_1 a_3 ?_{u1u3} \ ? \ w_2 a_2 a_3 ?_{u2u3}$$

2.3 Specification and Identification of the Policy Model.

? **Specification of the Disutility Function.**

Disutility function specified in quadratic form (1) has two desirable properties: a unique extremum with respect to instruments and, in combination with linear constraints, certainty equivalence. As it was explained above, it was rejected in favor (2) because of unrealistic property that deviations of Y and U on either side of their targets gave rise to the same marginal disutility. But the trouble with (2) is that it implies that as Y(U) rises it decreases (increases) disutility at an increasing rate (i.e., $\frac{?\ ^2 d}{? Y^2} \ ? \ ?2 w_1$ $\frac{?\ ^2 d}{? U^2} \ ? \ 2 w_2$)

To avoid this problem it is useful to re-specify (2) as:

$$d \ ? \ ?Y \ ? \ w_2 U \ ? \ w_3 (r \ ? \ w_5 r^{US})^2 \ ? \ w_4 (P \ ? \ w_6 P^{?})^2 \qquad \textbf{(11)}$$

It can be verified that (11), similarly to (2), possesses the same two properties desirable for the optimization procedure: extremum with respect to the instruments, certainty equivalence holds.

In this case to obtain the disutility minimizing value of R one should substitute the constraints (3.1) – (3.4) expressed as a functions of reserves,

$Y=k_1 R+\ldots$ **(12.1)**

$U=k_2 R+$ **(12.2)**

$r=k_3 R+$ **(12.3)**

$P=k_4 R+$ **(12.4)**

into (11), and differentiate with respect to R:

$$\frac{? d}{? R} ? ? k_1 ? w_2 k_2 ? 2 w_3 (r ? w_5 r^{U.S.}) k_3 ? 2 w_4 (P ? w_6 P^{?}) k_4 \qquad \textbf{(13)}$$

Solving $\frac{? d}{? R} ? 0$ for R yields

$$R^{?} ? R^{?}(Y,\ U,\ r,\ P,\ P,\ r^{U.S.}\ \ or\, a\, subset\ \ of\ \ these\ \mathrm{var}\, iables) \qquad \textbf{(14)}$$

(14) determines the value of R that minimizes (11) subject to (12). All the endogenous variables will also take on optimal values.

? **Identifiability of the Model and the Complications for Determinatedness of the Disutility Weights**.

System (12) -- (14) can be viewed as a system of simultaneous equations, where Y, U, r, and P are endogenous.

Now add random terms $u_1 - u_5$ to (12.1) – (12.4) and (14), so that $E(u_i)=0$, variances $E(u_i^2)=?_{ui}^2$ (for all i) and covariances are $E(u_i u_j) = ?_{uiuj}$ (for all i?j), i,j=1-5.

From the property of certainty equivalence we know that the optimal reserves will be independent of $u_1 - u_4$; the term u_5 thus must be interpreted as the error in the monetary authority's reaction to the target and (14) must be re-written as

$$R \; ? \; R^{?} \; ? \; u_5 \qquad \textbf{(15)}$$

where R is determined by (14).

Thus, it is the property of certainty equivalence that insures that $\overset{?}{u}_5 \; ? \; (R \; ? \; \overset{?}{R})$ can be interpreted as the error in the reserves policy, rather than some amalgam of policy-error and the error terms u_1 – u_4. (R is the regression estimate here). That is any deviation of actual reserves, R, from their desired level is independent of uncertainty about the structure of the economy and arises purely from unwanted variations in reserves.

The five equations (12) and (15) form a stochastic simultaneous system[6]. To estimate the coefficients, it is possible to use the method of indirect least squares (ILS). However the ILS work only when the structural model is exactly determined. If it is overidentified other procedures (such as two-stage least squares – TSLS) are feasible. It is, however, impossible to obtain consistent estimates of the parameters of the underidentified system. That is why we must be sure that (12)+(15) is (at least) identified. For this purpose we will add the minimum number of exogenous variables to the model necessary to insure identifiability.

Let us now consider the determinatedness of the weights $w_2 \ldots w_6$. If we ensure the identifiability of all parameters of (12) and (15), then the equations $h_i \; ? \; \overset{?}{h}_i$, where h_i and $\overset{?}{h}_i$ are the true and estimated values of the parameters

[6] Theory on simultaneous equations systems is given in more details in Ramu Ramanathan. Introductory Econometrics with Applications. 3rd ed., 1995.

of (15), will determine the $\hat{w}_j$ if and only if there are as many h_i as w_j. That is, since the h_i are functions solely of the parameters of (12) and of the w_j the only unknowns of the equations $h_i ? \hat{h}_i$ are the $\hat{w}_j$. We are in trouble, because j=5 but i=3.

Note that we have

$$R ? h_1 ? h_2(r \ or \ P) ? h_3 r^{U.S.} ? u_5 \quad \textbf{(15)}$$

However, by imposing the relatively plausible restrictions $w_5=1$ and $w_6=1$, the rest of w's may be determined.

Thus the relative disutility weights on national income and employment may be determined even though neither target is present in the estimating form of the reaction function.

In order to apply the above theory to Ukraine it is necessary to know which macroeconomic variables are chosen as targets of monetary policy and which serve the role of instruments. The next two Sections are a brief description of how monetary instruments such as reserve requirements, discount rate and open market operations are used by the National Bank of Ukraine to achieve its ultimate goal: maintaining the internal (price level) and external (exchange rate) value of the domestic currency - the hryvnia.

Section 3

MONETARY INSTRUMENTS IN UKRAINE.

Monetary instruments can be divided into three basic types:

reserve requirements
open-market operations (OMO)
standing facilities.

3.1 Reserve requirements

Reserve requirements are the percentage of the liabilities that commercial bank is required to hold as reserves at the central bank. Banks are penalized if they do not maintain the necessary reserve amount. It is a rather simple instrument and is often used for “rough tuning”. This instrument is often a means to ensure that banks have sufficient liquidity in case of withdrawal of deposits. (Fabozzi, 1997) In the sphere of monetary policy, reserve requirements have two main roles:

(i) money management (short-run) - to avoid excessive volatility in market interest rate on a day-to-day basis.

(ii) monetary policy (longer-term) - as a tool to influence the level of banks' own lending and deposit rates and the quantity of credit and deposits.

In Ukraine, among other things to control the amount of hryvnia supply, the NBU imposes the norm of obligatory reservation of banks' attracted funds. A method of calculating reserve requirements contains a seasonal pattern. The Ukrainian regulation implies that banks must meet the required level of reserves in the middle and at the end of every month.(NBU,1996 [6])

Information on the reserve requirements usage is briefly summarized in the table below:

	1992	1993	1994	1995	1996	1997	1998
Norm of obligatory reservation	13%	25%	15%	15%	15%	15%	16.5%
Reserve money, mln UAH	18.1	301.2	1528.2	3557.1	4979.9	7410.5	8628.1
Money supply M3, mln UAH	25.2	481.5	3215.7	6846.3	9379.0	12541	15718
Discount Rate	80%	240%	252%	110%	62%	24%	62%

TABLE 1. (Source: Monetary and banking statistics, NBU [7])

As is obvious from the table, before 1996 usage of reserve requirements could not affect the money supply to a significant extent. (The money supply grew quickly, because the obligatory reserve requirement remained the same). In other words, the government kept creating money all this time. Only at the end of 1996, when money emission was stopped and the rate of required reserves was raised, did effective control over money supply became possible.

3.2 Open Market Operations

Open Market Operations[7] - central bank can buy and sell, in open debt markets, government securities for its own account. In contrast to reserve requirements, OMO are a very flexible monetary instrument. Institutions'

[7] For broader discussion see, for example, Mishkin, [1992], pp.458 – 461.

participation is on a voluntary rather than compulsory basis. This operation can be performed as frequently as needed and in any quantity. In addition, OMO do not impose a tax on banks - more appropriate technique to foster financial competition. Open market operations can be performed in both the primary (through new issues of government and central bank securities) and secondary markets. Secondary markets offer the central bank greater flexibility, but primary markets may be more common in the early stages of the liberalization in countries like Ukraine before secondary markets have been established. Usually, secondary market operations are defined to include collateralised lending, outright transactions in suitable assets, repurchase agreements (REPOs) using securities, and foreign exchange swaps.

Open Market Operations in Ukraine are performed by means of buying and selling the domestic T-bills (OVDP) by the National Bank. (NBU,[8]) These are discount debt instruments with maturities from 1 to 3 months, 6 months, 9 months, 12 months and 18 months. Acquisition of OVDP by the Central Bank temporary increases the money supply. When the redemption occurs, money is taken out of circulation. Thus, the NBU is capable of "finer tuning" of money supply compared to that of reserve requirements. The National Bank trades OVDP in both primary and secondary markets. In the primary market it participates in so called primary T-bill auctions. As will be discussed below, due to the specificity of Ukrainian OVDP market, the NBU is often the largest player in these auctions.

In the secondary market, the Ukrainian central bank engages in REPOs operations using OVDP as a collateral. This instrument operates in a similar way to open market operations in OVDP. REPOs are relatively new for Ukraine - the NBU introduced them only in 1997. According to Ukrainian legislation[NBU,[9]) only commercial banks that are licensed to deal with government securities can be a counterpart of the National Bank in REPO operations.

The NBU conducts REPOs by immediate agreement with commercial banks or organizes tenders. In the later case a commercial bank - potential tender participant - submits application with propositions on prices and terms of transaction. The deal is made with a winner - the bank offering the most attractive terms. The National Bank is obliged to inform the counterpart about its intention to engage in REPO within the next business day after the decision has been made. If the REPO operation is conducted with an immediate agreement the NBU chooses its potential partner without any competition among banks, usually, from those meeting a particular requirements.

?**Effects of introducing OVDP operations**.

I will now describe the evolution of OVDP market since it is one of the crucial factors shaping the monetary policy implementation.

Domestic T-bill market started operating in 1995. Its establishment shifted the focus from printing money to financing budget deficit through debt. Thus, for the first time since Ukraine's independence a significant amount of total budget deficit (27.2%, 1995) (HIID, 1998,[10]) was financed through non-emission sources (domestic and public debt).

Introduction of the OVDP market decreased the pressure on the monetary policy from the budget side and helped bring down inflation significantly. Low inflation, the establishment of currency corridor, as well as the reform package discussion in Parliament in 1997, raised confidence in the OVDP market stimulating demand among investors, especially among foreigners, whose share grew to about 60% (see Chart 1)

?**Problems in the OVDP Market**.

However, when Parliament rejected the package in July, investors' trust faded. This was exacerbated by the financial crisis in East Asia, which undermined the general confidence in emerging markets, including Ukraine. Foreigners began to withdraw their funds from the Ukrainian T-bill market. As they were getting rid of OVDP, the majority of those securities was purchased by the National Bank. As a result, the average yield , which had dropped to 21.4% in September 1997, rose until it reached above 46% in December (HIID, 1998,[10]).

In 1998 the situation became even worse. The burden of redemption had become so high up to April 1998 that T-bills issued were not sufficient to redeem past debts. This led to serious inflationary expectations in the domestic market and additional difficulties in regulating money supply. Bottom line: Because of the problems mentioned above banks and their customers lost their credit to government securities and open market operations turned to be inefficient as an instrument of monetary policy. As a result the NBU had to raise the rate of required reserves (see above) and the discount rate.

3.3 Standing Facilities.

These are borrowing of deposit facilities available at the initiative of banks usually within limits set by the central bank. The central bank has control over provision of liquidity and standing facilities over which it has much less control are used infrequently. In many cases (for example, “late lending” facility in the UK, Germany’s Lombard facility, the US discount window) there are additional, non-price mechanisms for restricting use. (Access may be restricted to a percentage of relevant bank’s capital). Central banks in most developed countries provide standing credit facilities in the form of collateralized lending to the banking system at a margin above the central bank’s intervention rate; borrowers cannot bid for the rate. Standing facilities may also take the form of a discount facility - the outright purchase of bills.

The discount rate operation in Ukraine builds on the principle of the discount window - commercial banks borrow from the central bank at the discount rate. In Ukraine it is also called the refinancing rate. From the Table 1, we see that the hyperinflation period was characterized by an extremely high discount rate reaching 200 – 250%. However by sound monetary policy that figure was reduced to 24% in 1997. This could have been a good start for investment growth. But the necessity to protect hryvnia from devaluation, as will be discussed below, forced the NBU raise its refinancing rate to 40% in February 1998, then to 82%in July and finally to 92% in August.

Section 4.

BRIEF CHRONOLOGY OF UKRAINIAN MONETARY POLICY.

4.1 Hyperinflation Period

The recent history of Ukrainian monetary policy is closely connected with the overall transition to a functioning market economy. As prices were mostly controlled by the authorities before 1992, this period serves as a convenient starting point for the analysis. Price liberalization was seen as an integral part of the economic stabilization effort. The resulting rapid rise in the price level reduced the excessive amount of liquidity in the economy and enabled the realignment of relative prices closer to those that would prevail in a market economy. This was the initial burst of inflation following the price liberalization. It was followed and magnified by another surge. The reason was that Ukraine, like most developing economies had problems balancing its budget. The most reasonable way to deal with the problem is to cut down government expenditures, but Ukraine failed to do this. Instead it started printing money to finance the government. Hence, the money supply grew at an enormously high rate during 1992-mid-1996. (See Figure 1)

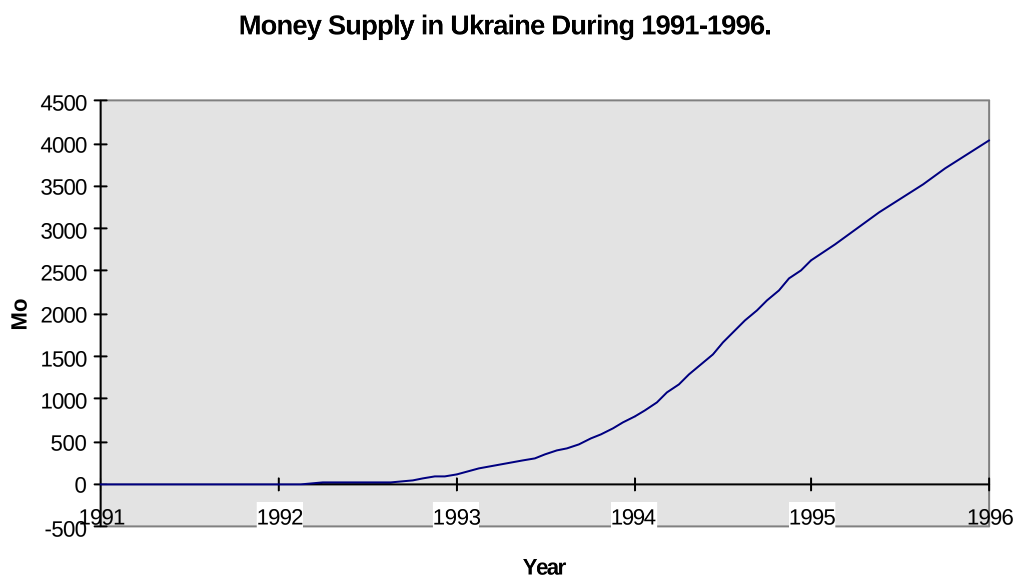

Figure 1 Money Supply in Ukraine During 1991-1996.
(The data to plot the graph were borrowed from NBU,[7])

As a result of a very loose monetary policy, the country experienced hyperinflation roughly as predicted by the traditional quantity theory of money: in September, 1993 the monthly rate of inflation was 80%, in October - 66%, in December - 91%. (NBU, Kyiv, [2])

4.2 Shift away from monetary finance of the deficit

In March 1995, for the first time in its history the government shifted from financing the deficit through monetary creation to borrowing as was described above. This enabled the National Bank to tighten monetary control. Thus, from 1996, as a result of decreased pressure from the budget side and institutional changes within the NBU, the Ukrainian central bank announced its determination to follow strict monetary policy aimed at maintaining the external (exchange rate) and internal (price level) values of domestic currency (see Report, 1996, [11]). A new currency - the hryvnia (UAH) was introduced after the monetary reform in the fall of 1996.

4.3 Exchange Rate Policy.

The NBU chose a policy of fixing the exchange rate, expressed as implementation of the currency corridor, keeping hryvnia within announced limits. The target of the stable exchange rate was given the top importance as the Ukrainian economy greatly depends on critical imports (the ratio of imported good to GDP is 44%)(Report, 1998,[11]). Thus, increases in the exchange rate (i.e., domestic depreciation) immediately translate into price level increases, leading to destabilization. Another advantage of exchange rate targeting is that the exchange rate can be easily observed compared to the inflation rate and is considered by most people as a kind of stability indicator. Thus the stable price of hryvnia in terms of dollars could lessen the inflationary expectations.

4.4 Results.

To give the National Bank its due, it was able to achieve its goals and the exchange rate was stable during 1996. (NBU, [7]). The central bank also remained faithful to its promise to tighten the money supply. In 1996 Mo was increased by 54% compared with 1995, the hryvnia devalued by only 5.23% and the inflation rate was reduced to 39.7%.(Report, 1998, [11]). Taking into account the country's painful experience of the last four years, this was considered as the first sign of stabilization.

The tendency towards stabilization was preserved in 1997. Inflation was at a 10.1% level (in quite good agreement with its target level of 10-12%), and the hryvnia devalued by only 0.32% (Effects,[12]). However in the fall investors' panic on T-bill market mentioned above caused speculative attack on the domestic currency, which, in turn, led to its depreciation. But this did not undermined the targets of monetary policy significantly - the NBU was able to preserve the exchange rate from sharp depreciation, although only at the expense of foreign currency reserves.

4.5 The Russian Crisis.

Rapid decline in hryvnia value at the and of summer 1998 was caused by the Russian financial market's crisis.

In the beginning of August everything was seemingly going on as usual. The hryvnia exchange rate lowered slowly. But Ukraine then began experiencing certain difficulties with redemption of its domestic and external bonds (see p.20). However this did not threaten the national currency with considerable devaluation since the NBU strictly controlled the setting of the exchange rate in the Ukrainian Interbank Currency Exchange and endeavored not to go beyond the limits of the currency corridor announced for 1998. But as soon as the crisis broke out in Russia, the Ukrainian currency value started declining. From the middle of August hryvnia quotation began to decrease rapidly in the interbank and exchange markets. The hryvnia exchange rate fell by approximately 1.7% on August 17 (NBU, [7]). The fall in the domestic currency value led to the growth of dollar demands by banks and their clients, which was stimulated by high devaluation expectations. A daily decrease in hryvnia exchange rate caused also a booming demand for dollars in the cashless and cash sales markets. Despite this all NBU Governor Victor Yushchenko declared that Ukraine would not review its monetary policy, because the situation in Ukraine differed substantially from that in Russia. But as soon as the next business day NBU raised its discount rate from 82% to 92% (NBU, [7]) to protect hryvnia from the pressure of rouble devaluation through the trade channel (40% of Ukrainian exports are exported to Russia (Effects,[12])). Also, from September 1, 1998, to reduce the amount of hryvnia supply in the foreign exchange market the norm of obligatory reservation of banks' reserve requirement was raised from 15 to 16.5%.(NBU, [7])

Aggravation of the situation in the Ukrainian financial market and a decrease in the National Bank's currency reserves (to USD 900mln in October 1998, that is approximately one half of that in March 1998, and by February only about USD 600 mln (NBU, [7])) forced the NBU to reconsider its exchange rate policy. Currency corridor borders were extended on September 5 from 1.8 - 2.25 hryvnias per dollar to 2.5 - 3.5 (up to 4 on the black market) [2]. Gradual decrease in hryvnia's exchange rate was accompanied with rising commodity prices - in December 1998 CPI=120%, PPI=135%((NBU, [7]), December 1997 - a base). So, the situation became more complicated than the NBU anticipated and to monitor it the central bank will, probably, be very strict using its monetary instruments in the future, especially if it is not going to deviate from the declared policy.

Section 4.

OPTIMAL INSTRUMENT CHOICE FOR UKRAINIAN ECONOMY.

This Section applies the theoretical framework presented in Section 2 to the monetary policy conducted by the Ukrainian Central Bank to discover what instrument of the policy is optimal (in a sense of disutility minimization) given the structure of the Ukrainian economy.

If one defines an instrument as a policy-controlled variable whose value can be exactly set, the only instruments available to the National Bank of Ukraine are the discount rate and the required reserves (Section 3 gives a broader description of these instruments).

The discount rate, however, plays a double role. On the one hand, it is a lever of monetary control, on the other hand the difference between the Russian and Ukrainian discount rates is a matter of constant concern for domestic authorities. The reason resides in the fact that the two economies are very closely interrelated. Thus the gap between the interest rates causes significant capital inflows/outflows that very often have unfavorable consequences for the Ukrainian economy. The most eloquent proof of this point is the dramatic increase in the domestic discount rate that followed the Russian crisis in August, 1998 (see Subsection 4.3 for more details).

Contrary to the interest rate, which is considered as a kind of “proximate” target, the exchange rate and prices, as was already mentioned in Section 4, are the ultimate goals of the NBU monetary policy.

Thus, based on the fundamental macroeconomic theory and the main features of the Bank strategy, one can expect the structure imposed on the economy (analogies to equations (3.1) – (3.4)) to be of the form:

Price level = f(Exchange Rate; Discount Rate, Commercial Banks' Reserves; National Debt; Central Bank's Gross Currency Reserves; Interest rate on OVDP; Russian Discount Rate or a subset of these variables).

Exchange rate = f(Price level; Discount Rate, Commercial Banks' Reserves; National Debt; Central Bank's Gross Currency Reserves; Interest rate on OVDP; Russian Discount Rate or a subset of these variables).

Discount rate = f(Exchange Rate; Price Level; Commercial Banks' Reserves; National Debt; Central Bank's Gross Currency Reserves; Interest rate on OVDP; Russian Discount Rate or a subset of these variables).

5.1 Data description.

To establish the actual functional form of the structure of the economy I have collected data on the Ukrainian and Russian discount rates, Ukrainian OVDP rate, nominal exchange rate (number of hryvnias per 1 USD), Ukrainian CPI, stocks of Ukrainian internal and foreign debts, reserves of commercial banks on the National Bank's account and gross currency reserves of the NBU. These are the monthly time-series data from January, 1995 to December, 1998 i.e., 48 observations on each variable.

The data on Ukraine were obtained from *UEPLAC (Ukrainian European Policy Legal and Advice Center)* and NBU web-page statistics. The data on Russian interest rates were borrowed from the Central Bank of Russia web-page.

In the regression analysis I use the following notation:

CPIUK --- Ukrainian consumer price index, base – January, 1995.

UKRREFRATE – the discount rate of the National Bank of Ukraine.

RUSREFINRATE – the discount rate of the Russian Centrobank.

EXRATE – exchange rate, #hryvnia for 1 dollar.

BANKRESERVES – the gross amount, that commercial banks keep on the NBU account as required reserves.

RESERVES – gross currency reserves of the NBU.

BORG – stock of national debt, generated as internal debt + external debt * exchange rate.

5.2 Model Estimation.

I have tried many different specifications of the system under consideration. The specification that gives the most plausible results (taking into account both the macroeconomic theory and statistical results) is:

CPIUK=A1*EXRATE+A2*BANKRESERVES+A3*UKRREFRATE **(16.1')**

EXRATE=A4*RESERVES+A5*BORG +A6*UKRREFRATE **(16.2')**

UKRREFRATE=A7*RUSREFINRATE+A8*BANKRESERVES **(16.3')**

The estimation method I used is Weighted Two Stage Least Squares. This procedure was employed mainly because one can not be sure that the system is exactly identified. Regression analysis gives the following results:

CPIUK=1.577*EXRATE+0.017*BANKRESERVES – 0.012*UKRREFRATE (16.1)

EXRATE= – 0.412*RESERVES+0.205*BORG +0.044*UKRREFRATE (16.2)

UKRREFRATE=0.489*RUSREFINRATE – 0.021*BANKRESERVES (16.3)

As one can judge from the equation (16.1) there is a strong positive correlation between the exchange rate and price level – corresponding coefficient equals 1.577. Price level is positively affected also by the amount of reserves and negatively by the level of discount rate. All regression coefficients are statistically significant (t-statistics for A_1, A_2 and A_3 are equal, respectively, 4.87, 1.46 and -5.51). explanatory power of the model: R^2=54% (adjusted).

Equation (16.2) implies that exchange rate depends negatively on gross currency reserves of the NBU (regression coefficient equals -0.412 and is statistically significant – t-statistic=-4.33), stock of national debt (coefficient equals 0.205, t-statistic=12.8) and the discount rate (A_6 =0.044; t-stat.=3.33). Adjusted R-squared equals 0.52.

The discount rate according to (16.3) can be explained by the discount rate of Russian Centrobank and the gross amount of reserves. The former a relatively strong impact on the discount rate (regression coefficient equals 0.489 and is statistically significant), while the later has much weaker influence on the dependent variable (coefficient is statistically significant and equals -0.021)

The value of Durbin – Watson statistics can imply the serial correlation in the data. To remove this problem and improve the fit of the model one can incorporate time-trend or lagged dependent variable into the model.

(The complete statistical results are given in Appendix 1.)
The reaction function of the Ukrainian Central Bank is estimated using the same statistical tools. It is obtained in the form

$$\text{BANKRESERVES} = \underset{(B_1)}{0.271}\text{*UKRREFRATE} - \underset{(B_2)}{0.346}\text{*RUSREFINRATE} + \underset{(B_3)}{0.437}\text{*EXRATE} \qquad (17)$$

enabling us to conclude, judging from the values and significance of the regression coefficients, that the amount of reserves is positively correlated with the discount rate and the exchange rate. The discount rate of Russian Centrobank influences BANKRESERVES in a negative way.

(The complete statistical results are given in Appendix 1.)

5.3 The NBU's Disutility Function.

It can be easily verified that the disutility function corresponding to this reaction function and consistent with the Structure must have the form:

$$D_t \ ? \ w_1 P_t^2 \ ? \ w_2 e_t \ ? \ w_3 (r_t \ ? \ r_t^{Rus})^2 , \qquad \textbf{(18)}$$

where P_t is the price level, e_t – exchange rate, r_t and r_t^{Rus} are the Ukrainian and Russian discount rates respectively.

Indeed, minimizing (18) with respect to the R_t (BANKRESERVES), taking into consideration explicit form of (16.1) – (16.3), and solving the equation

$$\frac{? D_t}{? R_t} \ ? \ 0 \qquad \textbf{(19)}$$

for R_t, one gets the functional form that is similar to (17).

The coefficients of reaction function (17) are equal, respectively

$$B_1 \ ? \ ? \frac{w_1 A_2 A_3}{w_1 A_2^2 \ ? \ w_3 A_8^2};$$
$$B_2 \ ? \ \frac{? \ w_3 A_8 A_7 \ ? \ 1}{w_1 A_2^2 \ ? \ w_3 A_8^2}; \qquad \textbf{(20)}$$
$$B_3 \ ? \ ? \frac{w_1 A_1 A_2}{w_1 A_2^2 \ ? \ w_3 A_8^2}$$

The next step is to determine the disutility weights w_1 – w_3. Notice that the weight coefficient w_2 corresponding to exchange rate has disappeared after the differentiation and is unrecoverable. Therefore, let us assume that there is one-to-one relationship between the currency depreciation and the disutility felt by the NBU i.e., $w_2 = 1$.

To find the remaining two coefficients one has to solve (20) for w_1 and w_3. This is a system of three equations in two unknowns and, generally speaking, there is more than one solution for w's. But it can be easily seen that the third equation of the system does not agree with our initial assumption about the positivity of disutility weights. Indeed, as the denominator is positive, (since we assume w_1 and w_3 positive), for the left – hand side to be positive one must have $w_1<0$ in the numerator. This obviously contradicts our starting point. That is why we neglect the third equation and solve only the first two for the weights.
The solution is: $w_1=1.14$ and $w_3=1.83$.
Thus, the disutility function, we were looking for, is:

$$D_t \ ? \ 1.14\ P_t^2 \ ? \ e_t \ ? \ 1.83(r_t \ ? \ r_t^{Rus})^2 , \qquad \textbf{(21)}$$

5.4 Optimal Instrument of Monetary Policy for Ukraine.

My final goal, is to derive the operational criterion (for analogy see Subsection 2.2, Equation 10) that will allow comparing the relative efficacy of the two monetary instruments – reserve requirements and the discount rate.

If we denote the actual disutility minimizing values under reserves policy by e^R, r^R, and P^R, so that

$$
\begin{aligned}
&P^R \ ? \ P^T \ ? \ u_1 \\
&e^R \ ? \ e^T \ ? \ u_2 \\
&r^R \ ? \ r^T \ ? \ u_3
\end{aligned}
\qquad \textbf{(22)}
$$

where e^T, r^T and P^T are nonstochastic values of the endogenous targets that minimize disutility under certainty. Then expressing all variables in terms of R and substituting (22) into E(d), where d is given by (21),one has

$$
\begin{aligned}
&E(d)\big|_{R^?} \ ? \ E\{w_1(P^T \ ? \ u_1)^2 \ ? \ w_2(e^T \ ? \ u_2) \ ? \ w_3(r^T \ ? \ u_3 \ ? \ r^{Rus.})^2\} \ ? \\
&? \ w_1(P^T)^2 \ ? \ w_2(e^T) \ ? \ w_3(r^T \ ? \ r^{Rus})^2 \ ? \ w_1 ?_{u1}^{\ 2} \ ? \ w_3 ?_{u3}^{\ 2} \ ? \ 2w_3E[rr^{Rus}] \\
&? \ d_m \ ? \ w_1 ?_{u1}^{\ 2} \ ? \ w_3 ?_{u3}^{\ 2} \ ? \ 2w_3[Cov(r, r^{Rus}) \ ? \ \bar{r}\bar{r}^{Rus}]
\end{aligned}
\qquad \textbf{(23)}
$$

where $\bar{r}$ and $\bar{r}^{Rus}$ are the mean values of Ukrainian and Russian discount rates respectively.

For the interest rate policy, expressing all endogenous targets in terms of r, one has:

$$
\begin{aligned}
&P^r \ ? \ P^T \ ? \ (A_8 u_1 \ ? \ A_2 u_3) / A_8 \\
&e^r \ ? \ e^T \ ? \ u_2 \\
&r^? \ ? \ r^T
\end{aligned}
$$

(24)

(Note: the actual disutility minimizing values differ from e^T and P^T by the stochastic terms; since r is set precisely, it is now nonstochastic).

So, under interest rate policy minimum expected disutility is

$$E(d_m)\big|r^? \; ? \; d_m \; ? \; 2w_1P^T E[\frac{u_1A_8 \; ? \; u_3A_2}{A_8}] \; ? \; w_1E[(u_1 \; ? \; \frac{u_3A_2}{A_8})^2] \; ?$$

$$? \; w_1\left\{?^{\,2}_{u1} \; ? \; \frac{A_2^2}{A_8^2}?^{\,2}_{u3} \; ? \; 2\frac{A_2}{A_8}Cov(u_1u_3)\right\}$$

(25)

Similarly to (10), reserves policy is preferable when

$$w_1?_{u1}^{\;\;2} \; ? \; w_3?_{u3}^{\;\;2} \; ? \; 2w_3[Cov(r,r^{Rus}) \; ? \; \bar{r}\bar{r}^{Rus}]$$

is less than **(26)**

$$w_1\left\{?^{\,2}_{u1} \; ? \; \frac{A_2^2}{A_8^2}?^{\,2}_{u3} \; ? \; 2\frac{A_2}{A_8}Cov(u_1u_3)\right\}.$$

Plugging in numerical values into (26)

w_1=1.14; w_2=1; w_3=1.83

$?^2_{u1}$=0.27; $?^2_{u3}$=618.35; Cov(u_1,u_3)=3.17; Cov(r,r^{Rus})=2519.5

$\bar{r}$=62.2; $\bar{r}^{Rus}$=93.7; A_2=0.017; A_8=-0.021

one can easily verify that the right-hand side of inequality (26) is greater than the left-hand side.

(All numerical values used are given in the Appendices).

We come to conclusion that discount rate policy gives smaller difference between the expected and minimum values of disutility and is therefore superior to the reserves policy.

Section 6.

CONCLUSIONS.

Monetary policy is one of the crucial factors determining the overall health of the economy. That is why there have been made attempts to model this process. Most models assumed the central bank's policy instrument to be exogenous. A few model - builders estimate central bank behavior functions, thereby recognizing that the instrument variable not only effects macroeconomic variables such as income, prices, and interest rates, but responds to them according to the policy-preferences of the monetary authority. Such functions are called "reaction functions".

This paper is an effort to apply the above framework to the Ukrainian economy in order to examine the central bank preferences among the targets used, and, consequently, to see what instrument is optimal for Ukraine, provided one knows the structure imposed on the economy.

The results (details are given in Section 4) imply that the central bank, the National Bank of Ukraine, behavior can be described by the disutility function, whose arguments are the exchange rate between the domestic currency and USD, the price level, and the gap between the Ukrainian and Russian interest rates. The explicit functional form of disutility function was recovered from the system of four equations – first three describe the structure of the economy, the fourth is reaction function.

Finally, I derived an operational criterion allowing comparison of the two instruments, the discount rate and statutory reserve requirements, according to their relative efficiency in target hitting. Due to this criterion the discount rate is more appropriate for our economy than reserve requirements. This conclusion, derived here ex post, might be predicted from the fact that reserve requirements may be viewed as an implicit tax on the banking system. Since tax levying inevitably creates distortions because of different kinds of evasion and avoidance the policy results are different from anticipated. When the discount rate is used the gap between the expected and real outcome would be much less mainly because it is extremely difficult either to evade or to avoid.

The policy recommendation, stemming from the fact that the difference between the expected value of disutility and minimum expected disutility is smaller under the discount rate, is to give stronger emphasis to the use of the discount rate as an instrument of monetary policy. This may be a step helping to strengthen the monetary management.

APPENDIX 1

Estimation Method: Weighted Two-Stage Least Squares
Sample: 1995:01 1998:12
Instruments: RUSREFINRATE RESERVES BORG

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.576829	0.200309	4.871979	0.0020
C(2)	0.016688	0.00047	1.463936	0.1451
C(3)	-0.011736	0.002128	-5.515478	0.0085
C(4)	-0.041296	9.51E-05	-4.328299	0.0108
C(5)	0.205700	0.016039	12.82511	0.0196
C(6)	0.043788	0.001135	3.336455	0.0000
C(7)	0.488590	0.060838	8.031022	0.0753
C(8)	-0.021303	0.007177	2.968429	0.0070
C(9)	0.271436	1.405858	4.46093	0.0012
C(10)	-0.345919	0.92584	-0.373628	0.7001
C(11)	0.436815	0.026447	2.735388	0.0430

Equation: CPIUK=C(1)*EXRATE+C(2)*BANKRESERVES+C(3)*UKRREFRATE
Observations: 45

R-squared	0.557318	Mean dependent var	3.025809
Adjusted R-squared	0.536238	S.D. dependent var	0.787951
S.E. of regression	0.536595	Sum squared resid	12.09325
Durbin-Watson stat	0.327669		

Equation: EXRATE=C(4)*RESERVES+C(5)*BORG+C(6)*UKRREFRATE
Observations: 45

R-squared	0.543906	Mean dependent var	1.954783
Adjusted R-squared	0.522188	S.D. dependent var	0.476786
S.E. of regression	0.329574	Sum squared resid	4.561991
Durbin-Watson stat	0.373439		

Equation: UKRREFRATE=C(7)*RUSREFINRATE+C(8)*BANKRESERVES
Observations: 45

R-squared	0.587733	Mean dependent var	62.21111
Adjusted R-squared	0.578145	S.D. dependent var	39.16576
S.E. of regression	25.43829	Sum squared resid	27.82559
Durbin-Watson stat	0.345478		

(continued overleaf)

Equation:
BANKRESERVES=C(9)*UKRREFRATE+C(10)*RUSREFINRATE+C(11)*EXRATE
Observations: 45

R-squared	0.472723	Mean dependent var	893.6978
Adjusted R-squared	0.4076186	S.D. dependent var	148.5347
S.E. of regression	22.40948	Sum squared resid	2109.176
Durbin-Watson stat	0.590877		

APPENDIX 2.
Residuals Covariance Matrix.

	CPIUK	EXRATE	UKRREFRATE	BANKRESERVES
CPIUK	0.268739	-0.104832	3.169354	-74.09201
EXRATE	-0.10483	0.101378	-2.915183	38.76384
UKRREFRATE	3.16935	-2.915183	618.3465	-2003.883
BANKRESERVES	-74.0920	38.76384	-2003.883	46870.59

APPENDIX 3.

Numeric Values Used in (25).
Mean value of the Russian discount rate: 93.7
Mean value of the Ukrainian discount rate: 62.2

$Cov(r, r^{Rus})=2519.5$

Participants in the OVDP Market in Ukraine, 1997.

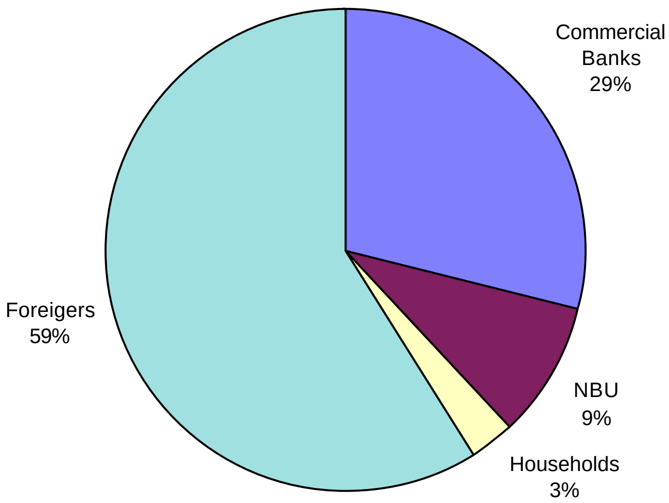

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Chart 1. Structure of Ukrainian OVDP market. (According to the data of Information agency “Ukrainian News” as of November 1, 1997.

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