THE MAXIMUM SEIGNORAGE AND HIGH INFLATION: CASE OF BELARUS, RUSSIA AND UKRAINE

by

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Abstract

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The goal of the paper is to analyze the effect of inflation on seignorage revenue in three countries: Belarus, Russia, and Ukraine, in the period 1992 - 2000. The paper estimates the relationship between high inflation and maximum seignorage. In particular, the aim of the analysis is to estimate whether the rate of money growth in the high inflation period in these countries exceeded the revenue-maximizing value. The research is based on two models for determination of maximum level of seignorage: static and dynamic. The former is elaborated on the basis of Cagan's (1956) seminal paper, the latter was developed by McCallum(1989) and applied by Aschauer (1997) to Ukraine in the period of 1993-1996. The analysis reveals that, in the period of high inflation, the rate of money growth was higher than the revenue maximizing one in Belarus and Ukraine. This fact is viewed as one of the reasons of the hyperinflation in Ukraine in 1994. After the introduction of stabilization policy, money growth rates became lower than the revenue-maximizing ones. The analysis also shows that in Russia the rate of money growth never exceeded the revenue – maximizing level. I also find a positive relation between seignorage and budget deficit in Belarus and Ukraine.

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GLOSSARY

Adaptive expectations – expected inflation is a function of current inflation and past expected inflation.

Inflation Tax – capital losses that money holders incur as a result of inflation.

Partial adjustment model (PAM) of money demand –money demand is a function not only of the nominal interest rate and real income, but also of the lagged value of real balances

Rational expectations – expectations where the expected value is the mathematical expected value implied by the particular model. Expected inflation is based on all available information.

Revenue-Maximizing Rate of Money Growth – rate of money growth that gives the maximum amount of seignorage.

Seignorage – revenue that the government receives from its money-printing monopoly.

Seignorage Loss – difference between the maximum level and actual seignorage.

INTRODUCTION

In 1991, the collapse of the Soviet Union led to the appearance of new independent states that inherited depressed inflation and inefficient production. The most crucial task of the new governments was to resolve these problems. It required significant amounts of spending for the creation of new infrastructure, market institutions and for technological improvements. The tasks were complicated because of unproductive agriculture and industries as well as destruction of economic links between different regions of the former USSR. All this involved a reduction in the tax base and inability of governments to cover their expenditures by tax collections.

At the same time, independence allowed the newly created central banks to print money. Despite the fact that new states started their transformation from a centrally planned economy to the market one, at the initial stage the principles of governance and conduct of many policies remained the same as in the Soviet times. In particular, central banks of the new independent states remained under control of the governments. As a result, the latter financed their excessive expenditures with seignorage.

Seignorage is the revenue from the monopoly power to print money. There is a maximum level of seignorage that the government can obtain. In general, it is possible to draw a Laffer curve for seignorage with respect to the rate of money growth. Although the process of printing money itself is almost costless, there are significant social costs from printing money that is not supported with goods or services. These costs are the result of inflation.

In economic literature, there are three related points of view that relate the value of seignorage and inflation. According to Sargent and Wallace (1973), when the economy is on the upward sloping part of the Laffer curve, the government strives to make maximum level of seignorage through money emission and in such a way stimulates inflation. Bruno and Fischer (1990) argued that inflation is induced by printing money if the economy is on the downward sloping part of the Laffer curve. In accordance with Kiguel (1989), high inflation results from the attempts of the government to receive seignorage that is above its maximum level.

The objective of this paper is to analyze the economic situation in three countries Belarus, Russia, and Ukraine in the period between 1992 and 2000. At the beginning of this period, all these countries suffered from high inflation. On the average, the monthly rate of inflation was about 30 percent. The governments of these states used extensive money emission as a main source for financing budget deficits. The aim of the analysis is to estimate whether the rate of money growth was below, equal, or above the revenue-maximizing value. The hypotheses are the following. In the period of high inflation, the rates of money growth were higher than the revenue maximizing levels, i.e. the value of seignorage was on the downward sloping side of the Laffer curve. As a result, an increase in the rate of money growth led to a decrease in the amount of seignorage. The second hypothesis suggests that, after the introduction of stabilization policy in the three countries, money growth rates fell below the revenue-maximizing ones.

The research is based on two models of the determination of the maximum level of seignorage: a static and a dynamic models. The static model is elaborated on the grounds of Cagan's (1956) money demand function. According to this model, the optimal rate of money growth is inversely related to the elasticity of money demand with respect to the nominal interest rate. The basic assumption of the static model is the maintenance of steady-state conditions. However, in Belarus, Russia, and Ukraine the steady-state conditions were not always met during the period under consideration. That is why the analysis uses the dynamic model that was developed by McCallum(1989) and applied by Aschauer (1997) to Ukraine in the period.

The plan of the paper is as follows. The next section provides an overview of existing literature on seignorage. In particular, it considers different viewpoints on the problem of seignorage and surveys existing models of the determination of the maximum level of seignorage. Section 3 presents the theoretical framework for the static and dynamic models. The empirical part of the paper, section 4, presents the results and their interpretation for Belarus, Russia, and Ukraine. Conclusions and policy recommendations are in the last section

Chapter 2

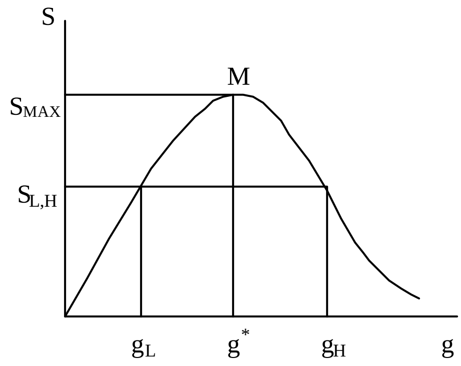
LITERATURE REVIEW

In economic literature, seignorage is defined as the revenue that government receives from printing money (see, for example, Sachs and Larrain 1993; Romer 1996). The value of seignorage may be estimated as the purchasing power of the money issued into circulation in a given period and thus can be computed as a product of the rate of money growth and the real money balances.

According to Sachs and Larrain (1993), it is important to distinguish between seignorage and the closely related inflation tax. While money emission that is not supported by goods and services brings the government revenue which can be spent on financing budget deficit, inflation spurred by this policy leads to capital losses for money holders. These losses are considered the inflation tax and can be measured as the product of the rate of price growth (tax rate) and the real money balances (tax base). In stationary conditions, when individuals maintain a constant amount of real money balances*, the values of seignorage and inflation tax are equal. However, in case of rising inflation, in order to diminish capital losses individuals reduce real money balances. Hence a rise in inflation tax may lead to a decrease in seignorage.

Taking into account the relationship between seignorage and inflation tax, it is possible to draw the Laffer curve for seignorage (S) with respect to the rate of money growth (g).

* By the quantity theory of money this requires that real income and velocity be constant.



For low rates of money growth real money balances are high but the inflation rate is low and so is seignorage. For small rates of inflation, changes in the rate of money creation have a small effect on real money balances[*]. As a result, an increase in money growth raises seignorage. However, there is a point on the Laffer curve (M) after which further rise in money growth results in a large reduction in real money balances which exceeds the increase in rate of money growth. As a result, the value of seignorage begins to fall. The Laffer curve illustrates two important points. First, there exists a rate of money growth (g^*) that maximizes level of seignorage (S_{MAX}). Second, the "bell-shaped" form of Laffer curve shows that the same level of seignorage ($S_{L,H}$) can be obtained at (at least) two different rates of money growth (g_L and g_H). If the revenue-maximizing rate is unknown to the government, then the economy may get to the downward-sloping section of the Laffer curve without the government realizing the real causes of high inflation and seignorage losses.

According to Barro (1997), cross-sectional analysis for 109 countries for the period of 1960 - 1990 shows the existence of negative relationship between the average growth rate of real gross domestic product and the average rate of

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[*] This requires that the elasticity of real money demand with respect to the rate of growth of money supply is less than one.

consumer price inflation*. Thus, excessive money emission leads not only to a decrease in seignorage, but also slows down economic growth.

The transactions motive has been the focus of Baumol (1952) and Tobin (1956) who develop the so-called money demand inventory model. In their approach, they compared the behavior of individuals in holding inventories of money with the behavior of firms in holding inventories of goods and services. Money balances allow individuals to reduce transaction costs associated with converting their assets into money but, on the other hand, the higher are their real balances, the lower is the nominal return on households' assets, as money pays no interest and they loose the interest they would have earned if bonds were held instead. In the Tobin-Baumol model, the money demand function is the demand for real money balances. It means that people do not have "money illusion": they are concerned solely with the purchasing power of currency, but not with its nominal value. In general, real money demand is a decreasing function of the nominal interest rate and the cost of conversion of bonds into cash, and an increasing function of real income or consumption.

Based on the Baumol-Tobin model, Goldfeld (1973) investigate money demand in the United States during the period of 1952 – 1972. It was found that money demand is a demand for real money balances. Nevertheless, in contrast to Baumol-Tobin approach, Goldfeld uses partial adjustment model (PAM). He considers money demand as a function not only of the nominal interest rate and real income, but also of the lagged value of real balances. Goldfeld's argument is that, in reality, individuals adjust actual money balances to their ideal level determined by changes in income and interest rate with a delay. There are two main reasons for lagged adjustment. First, there are costs of adjustment

* The result is statistically significant for inflation rates in excess of 40%. Under reasonable assumptions about the real interest rate and the growth rate of the economy, the results are economically significant.

associated with transaction costs of currency converting and opening new accounts; second, expectations are assumed to adjust slowly. It should take time for households to believe that changes in interest rate were permanent and correspondingly adjust their real balances.

Fair (1987) applies PAM to investigate demand for money in 27 countries. His research covered the period from late 1950s to mid 1980s. He finds that, on average, income and interest elasticities for OECD countries were similar to those for the United States.

Goldfeld's (1973) partial adjustment model worked well until the mid 1970s. After 1974, money demand equation started to overestimate the actual level of money balances. The first author to notice the phenomenon of "missing money" was Goldfeld (1976) himself. Later "missing money" were found for other countries as well. The overprediction can be explained by the fact that the Baumol-Tobin model as well as Goldfeld's PAM assume that transactions costs are constant. They neglect the influence of financial innovations on money demand. In 1970s substantial financial innovations and banking deregulation facilitated the conversion of bonds into cash, reducing their cost. In other words, financial innovations led to an increase in velocity. As a result, the amount of money that was needed to serve the same volume of transactions decreased and the value of actual real money demand became smaller than the forecasted one.

Thus, it is important to introduce into the model the relationship between demand for real money balances and changes in transaction costs. However, Goldfeld and Sichel (1990, 323) note that, from the econometric viewpoint, it is very difficult to create a model of financial innovations because of the absence of "reliable direct data on transaction costs". There are two types of innovations: exogenous and endogenous. The former reflects technological improvements in computers and telecommunications, the latter relates to the choice of firms to invest in new transaction technologies. In some empirical works a time trend is used as an instrument that reflects the influence of exogenous innovations on money demand, while the function of the previous peak interest rates are applied as a proxy for endogenous technological changes. Unfortunately, these variables do not capture the effect of financial innovations completely and, thus, the results of estimation should be taken only as one of the possible approximations.

Cagan (1956) in the seminal paper assumes that the real money demand function is of the constant elasticity form. He discussed the cases of financing of the budget deficit that exceeded the maximum level of seignorage. Under hyperinflationary conditions, which he defines as monthly inflation rate in excess of 50 percent, nominal interest rate is determined almost exclusively by the expected rate of inflation that significantly exceeds the value of real interest rate. That is why he assumes that, in the period of very high inflation, the demand for money can be viewed as a function of expected rate of inflation rather than the nominal interest rate. Furthermore, the influence of changes in income or consumption on money demand is so amped by the effect of the large changes in expected inflation. He finds that, during the initial acceleration of inflation, individuals underestimate the inflation rate and do not adjust their real money balances correctly. As a result, the government can temporarily obtain seignorage that exceeds the maximum level. Eventually, however, individuals start to forecast inflation correctly, and seignorage revenue falls. Further increases in money growth only stimulate significant increases in the price level. Thus, the government's revenue from printing money declines in spite of the fact that rate of money growth continues to increase. The economy finds itself on the downward sloping side of the Laffer curve.

In economic literature that studies the relation between seignorage and inflation, many researchers emphasize the important role of expectations formation. Under the adaptive expectations formulation, individuals review their estimates of inflation each period, based on their previous estimates of price level and actual changes in inflation. Under the rational expectations approach that was first introduced by Muth (1961) and popularized by Lucas (1972,1973) and others, individuals forecast future prices based on expectations about future government policy, but not on the past as in case of adaptive expectations. As a result, the expected rate of inflation is equal, on the average, to the actual one.

Bruno and Fischer (1990) show that, in case when the government finances budget deficit through money emission, two possible stable equilibria might exist. The argument can be easily seen in the “bell-shaped” form of the Laffer curve. A high inflation equilibrium, which is the result of financing the budget deficit at the higher rate of money growth, is stable under rational expectations of future inflation. It can be explained by the fact that the individuals more quickly adjust to the changes in the inflation rate and promptly diminish their demand for real money balances with the rise in the level of prices. When expectations adjust to the rate of inflation slowly, equilibrium at the lower rate of inflation is the stable one. This equilibrium may be reached either under adaptive expectations of future inflation or under partial adjustment of real money balances in case of rational expectations. They also show that, in case of large budget deficit, stable equilibria do not exist.

Easterly, Mauro, and Schmidt-Hebbel (1995) develop a model of money demand, inflation, and seignorage on the basis of a variable semielasticity form of demand function (unlike the constant elasticity specification used by Cagan). They show that the higher is the rate of substitution between money and bonds in consumer portfolio, the higher is the possibility of obtaining maximum level of seignorage for the government. The results are obtained from the estimation of the model using eleven high inflation countries during the period of 1960-1990.

Cohen (1971) suggested that the size of seignorage for the country whose currency is used internationally depends on the position of this country as a monopolist as issuer of international money. In the case when the country is an absolute monopolist, it obtains significantly higher levels of seignorage compared to the cases when the country faces competitors. He suggests that the country should pay interest to foreigners so that they agree to hold the country's currency. Therefore, the volume of seignorage will be reduced by the amount of these interest payments. However, they still get all domestic seignorage.

Bailey (1956) finds that, for a stationary economy, inflation rate between 12 and 44 percent makes it possible for the government to maximize the revenue from money emission.

Kiguel (1989) discusses the case when the government attempts to obtain seignorage collection that exceeds the maximum one. He shows that such kind of policy leads to hyperinflation.

Kiguel (1995) analyzes whether the rate of inflation in Argentina in 1979-1987 was above the level that maximized budget revenues. The distinctive feature of the research was that he takes into account different exchange rate regimes prevailing in Argentina during the period under consideration. Kiguel shows that in 1978-1981 the level of seignorage was lower than maximum and though, the rates of inflation in Argentina were higher than the world standards, there was no risk of hyperinflation. However, in the period of 1981-1984, the level of seignorage was higher than the maximum one. This resulted in rates of inflation that were twice higher than in the previous period.

Budina, Hanousek, and Tuma (1994) apply a static model based on Cagan's real demand function to determine whether the level of seignorage was maximum in the Czech Republic, Bulgaria, Poland, and Romania in the period of 1990-1993.

They find that this model worked for the Czech Republic and Poland and the volume of seignorage was close to the maximum level. In case of Bulgaria and Romania, where rates of inflation were high, steady-state conditions were not met and the results of estimation were statistically insignificant.

Aschauer (1997) applies dynamic model of optimal seignorage based on the stock-adjusted model of money demand for Ukraine in 1993-1996. The dynamic form of model is more suitable for transition economies where steady-state conditions are not always maintained. The model is used for estimation of seignorage losses from stabilization policy in Ukraine. He finds that, in general, these losses amounted to about 2 – 5 per cent of GDP.

To summarize this section, seignorage can be calculated as a product of rate of money growth and real money balances. In this paper, the demand for real money balances will be estimated by using two types of models. The first is based on the Cagan's money demand function that implies the existence of steady-state conditions and unit elasticity with respect to real income. The second takes into account that individuals adjust their real money balances to the ideal level with delay. In the next sections, theoretical background for estimation of revenue-maximizing rate of money growth is presented based on the two models and empirical results are discussed.

Chapter 3

STATIC AND DYNAMIC MODELS

After the collapse of the Soviet Union, Belarus, Ukraine and Russia suffered a period of huge inflation. One of the reasons of such inflation was monetization. The authorities received the revenue from issuing money – seignorage. The purpose of this section is to present the static and dynamic partial adjustment models of the demand for real money balances in these countries in 1992-2000.

3.1 Static Model of Maximum Seignorage

The static model of optimal seignorage is based on the Cagan's real money demand function (Cagan 1956). The formal backgrounds of this model is taken from Romer (1996). Cagan's real money demand function has the following form:

$$\frac{M}{P} = L(i, Y) = L(r + p^{e}, Y) \quad (1)$$

where

- M is nominal money balances held by individuals;
- P is consumer price index;
- i is nominal interest rate;
- r is real interest rate;

- p^e is expected inflation;
- Y is real income

Thus, the real money demand *(M/P)* depends on the nominal interest rate (i) and real income *(Y)*. By the Fisher equation, nominal interest is approximately equal to the sum of the real interest rate (r) and expected inflation (p^e). Thus, the real money demand can be expressed as function of real interest rate, expected inflation and real income.

Under steady state conditions, the real interest rate (r) and real income (Y) are constant. The same is true for real balances as well. As a result, the rate of money growth (g_M) is equal to the rate of inflation (p). For simplicity assume the actual and expected rate of inflation are equal: $p = p^e$. Thus,

$$\frac{M}{P} = \frac{M_{-1}}{P_{-1}} \quad ; \quad \frac{M}{M_{-1}} = \frac{P}{P_{-1}}$$

$$g_M = p = p^e$$

$$\frac{M}{P} = L(\bar{r} + g_M, \bar{Y}) \qquad (2)$$

where a bar over a variable means that its value is constant.

The value of seignorage *(S)* is determined as the increase in nominal money stock *(M)* divided by the price level. Under steady state the seignorage is equal:

$$S = \frac{\Delta M}{P} = \frac{\Delta M}{M}\frac{M}{P} = g_M \frac{M}{P} \qquad (3)$$

Combining (2) and (3):

$$S = g_M L(\bar{r} + g_M, \bar{Y}) \qquad (4)$$

$$\frac{dS}{dg_M} = L(\bar{r} + g_M, \bar{Y}) + g_M \frac{dL(\bar{r} + g_M, \bar{Y})}{dg_M} = L(\bar{r} + g_M, \bar{Y}) + g_M L_1(\bar{r} + g_M, \bar{Y}) \qquad (5)$$

Assuming that real money demand is unit-elastic with respect to real income, Cagan's demand function has the following form:

$$\ln \frac{M}{P} = a - bi + \ln Y \quad , \quad b>0 \qquad (6)$$

Hence, the real money function is:

$$\frac{M}{P} = e^{a-bi} Y \qquad (7)$$

Combining (4) and (7) the value of seignorage is given by:

$$S = g_M e^a \bar{Y} e^{-b(\bar{r} + g_M)} = C g_M e^{-b g_M} \text{, where } C \equiv e^a \bar{Y} e^{-b\bar{r}} \qquad (8)$$

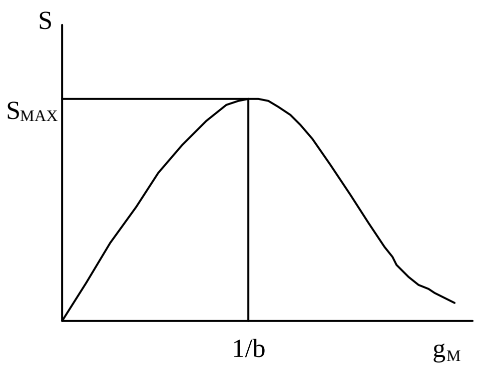
In order to find the revenue-maximizing rate of money growth it is necessary to differentiate the seignorage function (8) with respect to the rate of money growth and equate it to zero:

$$\frac{dS}{dg_M} = C e^{-b g_M} - bC g_M e^{-b g_M} = (1 - b g_M) C e^{-b g_M} = 0 \qquad (9)$$

$$(1 - b g_M) = 0$$

$$g_M^* = \frac{1}{b} \quad (10)$$

Thus, the government can obtain the maximum level of seignorage if the rate of money growth is equal to the inverse of the elasticity of real money demand with respect to nominal interest rate. If the actual rate of money growth is less than revenue-maximizing one, the economy is on the upward-sloping part of the Laffer curve. Otherwise, the economy is on the downward-sloping part of the Laffer curve.



In order to determine the revenue-maximizing rate of money growth for Belarus, Russia and Ukraine in period of 1992-2000 I estimate the following real money demand function:

$$\ln \frac{M_t}{P_t Y_t} = a - bi_t + e_t \quad (11)$$

where

- M denotes nominal money balances held by household ;
- P is the price level measured by CPI;

- *Y* is real total income. As data on real income are not available, I proxy it with the real wage time the level of employment;

- *i* is average weighted nominal interest rate.

The analysis covers the periods I.1994-IV.1999 for Belarus, II.1995-IV.2000 for Russia and I.1993-IV.2000 for Ukraine. For all three countries estimation is based on quarterly data obtained from *Belarus Economic Trends, Russian Economic Trends, Goskomstat and Ukrainian Economic Trends.*

As the time series data are not stationary, OLS procedure can be applied after taking the first differences of the money demand function (11).

The results of estimation are presented in table 1 and Appendix A:

Table 1. Cagan's Money Demand Function

	Belarus I.94 – IV.99	Russia II.95 – IV.00	Ukraine I.93 – IV.00
b *(s.e.)*	-0.001654 *(0.001)*	-0.000761 *(0.002)*	-0.000941 *(0.001)*
Durbin-Watson	1.85	1.63	1.73
R^2	0.18	0.23	0.04

The results show that the elasticities of money demand with respect to nominal interest rate are very small in all three countries. Only for Belarus is the value significant at 10% level. In general, the explanatory power of the regressions is low.

Hence, using the Cagan money demand function is not an appropriate approach to determine the revenue-maximizing rate of money growth for Belarus, Russia and Ukraine. It can be explained by two factors. First, steady state conditions did not held in any of the three transition countries. Second, the income elasticity of money demand is not equal to one.[*] Moreover, nominal interest rate can reflect expectations of inflation only if capital market is well-developed. In this case, either the nominal interest rate or inflation rate can be used to estimate the opportunity costs of holding money. However, when interest rates are under administrative control or are subject to ceilings (which was true for transition economies during the period under consideration), inflation is a better measure for alternative costs. According to Franco Modigliani's rule of thumb, "The right measure of the opportunity costs of holding money is the higher of the two, [*nominal*] interest rate or inflation." (Dornbush *et al*, 1998, p.360).

Given the shortcomings of a static model, the partial adjustment model of money demand seems to be more appropriate.

3.2 Dynamic Model of Seignorage

I now turn to the analysis of the revenue-maximizing rate of money growth and maximum seignorage using a partial adjustment model of demand for real money balances. I estimate how demand for real money balances depends on real money balances in the previous period, expected inflation and real income. In particular, it will be shown that the revenue-maximizing rate of money growth depends on the elasticites of real money demand with respect to lagged value of real money balances and inflation.

The analysis is based on the method that Aschauer (1997) applies for Ukraine. His research covers the period of 1993-1996. I extend the investigation to Belarus in 1994 -1999, Russia in 1992 -2000 and Ukraine in 1993 –2000. The model is:

$$m_t - p_t = a_0 + a_1 \cdot t + a_2 \cdot (m_{t-1} - p_{t-1}) + a_3 \cdot p^e{}_t + a_4 y_t \qquad (12)$$

[*] These estimates are reported in the next section.

where

- m is the natural logarithm of nominal money demand from the side of households (M0);
- p is the natural logarithm of the price level (CPI);
- t denotes time. Time is included in order to capture the effect of financial innovations on the demand for real money balances.
- π^e is the expected inflation defined as the natural logarithm of expected rate of inflation, i.e. $\pi^e = \ln(P^e / P_{-1})$.*
- y is the natural logarithm of real total income. As before, I use real wage bill (real wage times the level of employment) as a proxy for real output.

Taking into account theory and previous empirical results I expect that the estimated coefficient values have the following signs:

$$a_1 < 0 \qquad 0 < a_2 < 1 \qquad a_3 < 0 \qquad a_4 > 0$$

The negative sign of the time trend coefficient should reflect the effect of financial innovations on the demand for real money balances. Development of financial system leads to a reduction in transaction costs of cash operations that makes it possible for firms and households to economize on the need for cash balances. Thus, over time, financial innovations diminish the demand for real money balances.

* In this model expected inflation is assumed to measure the opportunity costs of holding money.

The coefficient on lagged real money balances is expected to be between 0 and 1. This is implied by the nature of partial adjustment model. It should take time for individuals to adjust actual real money balances to their ideal level.

In the next step, it is necessary to show how the partial adjustment model of demand for real money balances is used for estimation of seignorage. The revenue of the government from money issuing – seignorage – can be expressed as:

$$S_t = \frac{M_t - M_{t-1}}{P_t} = \frac{M_t - M_{t-1}}{M_t} \cdot \frac{M_t}{P_t} = g_t \frac{M_t}{P_t} \qquad (13)$$

where

- S is the value of seignorage;
- M is the households nominal money balances (*M0*);
- P is the price level;
- g is the rate of money growth.

It is very important to distinguish betwenn two formulation of the rate of money growth. The first is defined as a percentage change in the money supply with respect to the amount of money supply at the *beginning* of the period under consideration. Denote this value as $\boldsymbol{m}$.

$$m_t \equiv \frac{M_t - M_{t-1}}{M_{t-1}} \qquad (14)$$

In the second formulation of the rate of money growth is defined as the percentage change in the money supply with respect to the amount of money supply in the *end* of period under consideration. This definition is used in the formula (13) for estimation of the amount of seignorage and is denoted as $\boldsymbol{g}$. Unlike $\boldsymbol{m}$, its value cannot be more than 1.

Of course, both measures of the the rates of money growth are related:

$$g_t = \frac{M_t - M_{t-1}}{M_t} = 1 - \frac{M_{t-1}}{M_t} \Rightarrow \frac{M_{t-1}}{M_t} = 1 - g_t \Rightarrow \frac{M_t}{M_{t-1}} = \frac{1}{1-g_t} \qquad (15)$$

$$m_t = \frac{M_t - M_{t-1}}{M_{t-1}} = \frac{M_t}{M_{t-1}} - 1 = \frac{1}{1-g_t} - 1 = \frac{g_t}{1-g_t} \qquad (16)$$

From formula (16) it can be seen that when g_t approaches to 1, m_t approaches infinity. This is important in the analysis that follows.

In what follows, the amount of seignorage is calculated as a product of the “end-period” rate of money growth and real money balances. The latter can be presented as an exponent of a difference between logarithm of nominal money balances and logarithm of price level. Hence, using the partial adjustment model of demand for real money balances (see formula(12)), it is possible to express the real money balances and seignorage as follows:

$$\begin{aligned} \frac{M_t}{P_t} &= \exp[m_t - p_t] = \\ &= \exp[a_0 + a_t t + a_2(m_{t-1} - p_{t-1}) + a_3 p_t^e + a_4 y_t] \end{aligned} \qquad (17)$$

$$S = g_t \frac{M_t}{P_t} = g_t \exp[\boldsymbol{a}_0 + \boldsymbol{a}_t t + \boldsymbol{a}_2(m_{t-1} - p_{t-1}) + \boldsymbol{a}_3 \boldsymbol{p}_t^e + \boldsymbol{a}_4 y_t] \qquad (18)$$

In order to obtain the revenue-maximizing rate of money growth it is necessary to differentiate (18) with respect to the rate of money growth (g_t). It should be noted that the effect of money growth on the demand for real money balances is different in the short run and in the long run.

The long run revenue-maximizing rate of money growth (after a full adjustment of money demand to its steady state growth path) can be obtained taking into account that in the long run individuals will adjust their money holdings completely and so:

$$(m_t - p_t) = (m_{t-1} - p_{t-1}) \tag{19}$$

Thus, in the long run the money demand equation (12) can be expressed as:

$$(1 - a_2)(m_t - p_t) = a_0 + a_1 \cdot t + a_3 \cdot p_t^e + a_4 y_t \tag{20}$$

$$(m_t - p_t) = \frac{1}{1 - \boldsymbol{a}_2}(\boldsymbol{a}_0 + \boldsymbol{a}_1 \cdot t + \boldsymbol{a}_3 \cdot \boldsymbol{p}_t^e + \boldsymbol{a}_4 y_t) \tag{21}$$

Using (19) and assuming that in steady state expected rate of inflation (P_t^e / P_{t-1}) is equal to the actual one (P_t / P_{t-1}) and equal to the rate of change in the nominal money supply (M_t / M_{t-1}) and also applying the relation between the rate of money growth (M_t / M_{t-1}) and g_t from formula (15), it is possible to express the expected inflation as a function of g_t:

$$p_t^e = p_t = \ln\left(\frac{P_t}{P_{t-1}}\right) = \ln\left(\frac{M_t}{M_{t-1}}\right) = \ln\left(\frac{1}{1 - g_t}\right) \tag{22}$$

Differentiating of the long-run real money demand (21) with respect to the rate of money growth we get:

$$\frac{\partial (m_t - p_t)}{\partial g_t} = \frac{\partial}{\partial g_t}\left[\frac{1}{1-\alpha_2}\left(\alpha_0 + \alpha_t t + \alpha_3 \pi_t + \alpha_4 y_t\right)\right] = \frac{\alpha_3}{1-\alpha_2}.\frac{\partial \pi_t}{\partial g_t} =$$

$$= \frac{\alpha_3}{1-\alpha_2}\frac{\partial}{\partial g_t}\left[\ln\left(\frac{1}{1-g_t}\right)\right] = \frac{\alpha_3}{1-\alpha_2}.(1-g_t).\left(\frac{1}{(1-g_t)^2}\right) = \frac{\alpha_3}{(1-\alpha_2)(1-g_t)} \qquad (23)$$

Thus, taking into account the result of formula (23), the differentiation of seignorage with respect to the rate of money growth gives the following long-run revenue-maximizing rate of money growth (g^{LR}):

$$\frac{\partial S_t}{\partial g_t} = \frac{\partial}{\partial g_t}\left[g_t \exp(m_t - p_t)\right] = \exp(m_t - p_t) +$$

$$+ g_t \exp(m_t - p_t)\frac{\partial (m_t - p_t)}{\partial g_t} = \qquad (24)$$

$$\exp(m_t - p_t) + g_t \exp(m_t - p_t)\frac{\alpha_3}{(1-\alpha_2)(1-g_t)} = 0$$

$$1 + g_t \frac{\alpha_3}{(1-\alpha_2)(1-g_t)} = 0$$

Hence, the long-run revenue-maximizing rate of money growth is equal to:

$$g_{LR} = \frac{1-\alpha_2}{1-\alpha_2-\alpha_3} \qquad (25)$$

The short run revenue-maximizing rate of money growth (after taking the current level of real money balances as given) can be obtained as follows. First, using (15), take the first differences of the money demand function (12) for determining the short run relationship between money growth and inflation:

$$\ln\left[\frac{1}{1-g_t}\right] = \boldsymbol{p}_t = \boldsymbol{a}_0 + \boldsymbol{a}_1 t + \boldsymbol{a}_2\left[\ln\left(\frac{1}{1-g_{t-1}}\right) - \boldsymbol{p}_{t-1}\right] + \tag{26}$$
$$+ \boldsymbol{a}_3(\boldsymbol{p}_t - \boldsymbol{p}_{t-1}) + \boldsymbol{a}_4(y_t - y_{t-1})$$

$$\boldsymbol{p}_t = \frac{-\boldsymbol{a}_1 + \ln\left(\dfrac{1}{1-g_t}\right) - \boldsymbol{a}_2 \ln\left(\dfrac{1}{1-g_{t-1}}\right) + (\boldsymbol{a}_2 + \boldsymbol{a}_3)\boldsymbol{p}_{t-1} - \boldsymbol{a}_4(y_t - y_{t-1})}{1 + \boldsymbol{a}_3} \tag{27}$$

$$\frac{\partial p_t}{\partial g_t} = \frac{1}{1+a_3}\frac{\partial}{\partial g_t}\left[\ln\left(\frac{1}{1-g_t}\right)\right] = \frac{1}{1+a_3}(1-g_t)\frac{1}{(1-g_t)^2} = \frac{1}{(1+a_3)(1-g_t)} \tag{28}$$

Thus, the differentiation of real money demand function (12) with respect to the rate of money growth in the short-run gives the following result:

$$\frac{\partial(m_t - p_t)}{\partial g_t} == a_3\frac{\partial p_t}{\partial g_t} = \frac{a_3}{(1+a_3)(1-g_t)} \tag{29}$$

Taking into account the result of formula (29), the short-run revenue-maximizing rate of money growth (g^{SR}) is obtained from:

$$\frac{\partial S_t}{\partial g_t} = \frac{\partial}{\partial g_t}[g_t.\exp(m_t - p_t)] = \exp(m_t - p_t) + g_t.\exp(m_t - p_t).\frac{\partial(m_t - p_t)}{\partial g_t} =$$
$$= \exp(m_t - p_t) + g_t.\exp(m_t - p_t).\frac{a_3}{(1+a_{.3})(1-g_t)} = 0 \tag{30}$$

which implies:

$$g_t^{SR} = 1 + \alpha_3 \tag{31}$$

Once the revenue-maximizing rate of money growth is known, it is possible to find the maximum value of seignorage and thus to determine the seignorage loss that can be estimated as a difference between maximum and actual levels of seignorage.

The seignorage loss from monetary stabilization, L, is:

$$L_t = S_t^M - S_t \tag{32}$$

where

- S_t^M is the maximum level of seignorage;
- S_t is the actual level of seignorage.

The maximum level of seignorage can be estimated as follows. Under steady state, the rate of inflation is equal to the rate of money growth, assuming the effect of changes in income and velocity can be neglected (Cagan, 1956). Thus, in order to calculate the maximum seignorage it is necessary to use the rate of inflation that is equal to the short-run (long-run, respectively) revenue-maximizing rate of money growth. Using (25) and (31), the rate of inflation can be expressed in terms of real money demand elasticities with respect to lagged real money balances and expected inflation:

$$\pi_t = \ln\left(\frac{P_t}{P_{t-1}}\right) = \ln\left(\frac{M_t}{M_{t-1}}\right) = \ln\left(\frac{1}{1-g_t}\right) \approx \frac{1}{1-g_t} - 1 = \frac{g_t}{1-g_t} \tag{33}$$

$$p^{SR} \approx \frac{g^{SR}}{1-g^{SR}} = -\frac{1+a_3}{a_3} \tag{34}$$

$$p^{LR} = \frac{g^{LR}}{1-g^{LR}} = -\frac{1-a_2}{a_3} \tag{35}$$

The demand for real money balances at revenue-maximizing rate of money growth can be determined as follows:

$$(m_t - p_t)^{SRorLR} = a_0 + a_1 t + a_2 (m_{t-1} - p_{t-1})^{SRorLR} + a_3 p^{SRorLR} + a_4 y_t \tag{36}$$

and so the maximum seignorage is:

$$S^{M,SR} = g^{SR} \exp(m_t - p_t)^{SR}$$
$$and \tag{37}$$
$$S^{M,LR} = g^{LR} \exp(m_t - p_t)^{LR}$$

Chapter 4

ANALYSIS OF EMPIRICAL RESULTS

The estimation of the dynamic model of seignorage is based on quarterly data, which cover periods of I.1994 – IV.1999 for Belarus, I.1992 – I.2000 for Russia and I.1993 – III.2000 for Ukraine. These data were obtained from *Belarus Economic Trends, Russia Economic Trends* and *Ukrainian Economic Trends*.

Unit root tests show that all time series are non-stationary (they are stationary of the order 1). Thus, the OLS procedure can be applied for estimation of the money demand function (12) only in case of existence of long-run relationships between the regressand and regressors. Unfortunately, the relatively short data series for countries[*] do not allow to run Johansen cointegration test (the minimal required amount of observations for a reliable test should be at least 40); therefore, the OLS procedure can be used only after taking first differences of money demand function (12).

The Granger causality test confirms the existence of a relationship between one of the regressors (inflation) and the regressand (real money balances). 2SLS is used to overcome the problem of endogeneity. Twice lagged values of inflation are applied as instrumental variables for expected inflation.

The money demand function is estimated in first difference form to control for autocorrelation. The results are summarized in table 2[**].

[*] There are 18 observations for Belarus, 28 observations for Russia and 23 observations for Ukraine.

[**] The detailed results are in Appendix B.

Table 2. Money Demand Functions: Partial Adjustment Model

	Belarus (I.94 – IV.99)	**Russia** (I.92 – I.00)	**Ukraine** (I.93 – III.00)
α_1 *(trend)*	-0.02 *(0.02)*	0.01 *(0.01)*	0.04 *(0.02)*
α_2 $(m_{t-1}-p_{t-1})$	0.24 *(0.13)*	0.31 *(0.07)*	0.44 *(0.12)*
α_3 (π^e_t)	-1.55 *(0.52)*	-0.65 *(0.17)*	-0.72 *(0.35)*
α_4 (y_t)	1.10 *(0.30)*	0.79 *(0.09)*	0.79 *(0.20)*
α_5 *(dummy*π^e_t)*	- -	- -	-2.89 *(1.17)*
α_6 *(dummy)*	- -	-0.09 *(0.03)*	-0.24 *(0.15)*
R^2	0.63	0.94	0.86
SER	0.13	0.07	0.11
Breusch-Godfrey test	3.65	0.58	3.5
Note: standard errors are presented in parentheses.			

For Russia, all coefficients, except for time trend (α_1), have the expected signs and are significant at 5% level. The same is true for Ukraine, except for dummy coefficient that is significant at 10% level. For Belarus, coefficients for expected inflation and real income are significant at 5% level, whereas coefficient for lagged real money balances is significant at 10% level; coefficient for time trend is insignificant. The analysis fails to detect the statistically significant influence of financial improvements on money demand.

The dummy variables are used in order to take into account possible differences between periods of high and low inflation. In particular, for Belarus and Ukraine, dummy equals 1 in quaters with the rate of inflation in excess of 30% (III-IV.1994 and I-II.1995 for Belarus; I-IV.1994 and IV.1995 for Ukraine). In the case of Russia, the dummy is 1 for quarters with the rate of inflation in excess of 20% (I-II.,IV.1992 and I.1993). The coefficients for dummy variables are significant for Russia and Ukrain. Introduction of dummies into model leads to interesting results. In particular, in Ukraine the elasticity of demand for real money balances with respect to inflation is much higher (in absolute value) than 1 in the period of high inflation (the sum of α_3 and α_5 is about –3.5). In other words, in 1994 Ukraine was on the downward-sloping side of the Laffer curve and the amount of seignorage was lower than the maximum one. Individuals were very sensitive to the rate of inflation and an increase in the rate of money growth resulted in significant decrease in the amount of seignorage. If a 1% increase in the rate of money growth led to 1% increase in the price level, this inflation would have stimulated a decrease in the demand for real money balances by about 3-5%.

In Belarus the elasticity of demand for real money balances with respect to expected inflation (in absolute terms) is greater than 1. That means that during all period of 1994-1999 Belarus was on the downward sloping side of the Laffer curve.*

The elasticity of real money demand with respect to inflation (a_3) is the lowest for Russia and equals to – 0.65. It can be explained by the fact that during the period under consideration Russia suffered less from inflation than the two other countries. There were only three jumps of price levels in Russia during the seven year period, namely in January 1992, September and December 1998. In the period of high inflation in Russia (1992 - 1993), the monthly rate of inflation was about 20%, which is lower than the similar figures for Belarus and Ukraine.** This may have led to individuals having more trust in the value of money and

* For a more detailed analysis it necessary to calculate the revenue –maximizing rates of money growth and compare not only the actual rates of money growth with revenue-maximizing one but also the actual rates of inflation with ones that are stimulated by this revenue-maximizing rates of money growth.

holding money longer. That may be why the reaction of people on inflation is less sensitive in Russia than in Belarus and Ukraine.

The revenue-maximizing rates of money growth for three countries, calculated according to formulas (25) and (31), are shown in table 3:

Table 3. Revenue-Maximizing Rates of Money Growth in percent per quarter

	Belarus (I.94 – IV.99)	**Russia** (I.92 – I.00)	**Ukraine** (I.93 – III.00)
$\mathbf{g^{LR}}$	32.9%	51.3%	43.9%
$\mathbf{g^{SR}}$	-55.0%	34.7%	28.1%

It can be seen from table 3 that the short-run revenue-maximizing rate of money growths is smaller than the long-run one. This result was obtained by Aschauer (1997) as well. He explains this by the existence of the "overshooting" effect. A permanent increase in the rate of money growth by X percent leads, in the short run, to the increase in the rate of inflation by more than X percent. Therefore, in the short-run money demand will decrease more than in the long-run and thus, in the short-run, the lower rate of money growth will bring the maximum value of seignorage.

The revenue-maximizing rates of money growth presented in table 3 are the rates of growth with respect to the amount of money supply in the end of the period (g). In order to make the further analysis more convenient it is necessary to transform these rates into the revenue-maximizing rates of money growth with respect to the amount of money supply at the beginning of the period (m). Using formula (16) the results of transformation are presented in table 4.

[**] For example, in 1993-1994 the monthly inflation in Belarus was more than 30% with peaks in January, November, and December 1994 (40%) and August 1994 (53%); in Ukraine monthly rate of inflation was more than 25 % with peaks in January, June, September 1993 (70%) and December 1993 (90%).

Table 4. Revenue-maximizing rates of money growth as a percentage change with respect to the initial amounts of money supply

	Belarus (I.94 – IV.99)		**Russia** (I.92 – I.00)		**Ukraine** (I.93 – III.00)	
	in % per quarter	*in % per year*	*in % per quarter*	*in % per year*	*in % per quarter*	*in % per year*
$\mathbf{m}^{LR}$	49.1%	393.9%	105.2%	1674.1%	78.3%	911.2%
$\mathbf{m}^{SR}$	-35.5%	-82.7%	53.1%	49.9%	39.2%	275.0%

For Ukraine, the results of analysis do not reject the hypothesis that the actual rate of money growth exceeded the revenue-maximizing one in the period of high inflation but was lower after introduction of stabilization policy by the end of 1994.

Table 5. Annual Rates of Money Growth and Inflation, Seignorage and Seignorage Loss: Ukraine

	Rate of Money Growth		Rate of Inflation		Seignorage	Seignorage Loss**	
	actual	revenue max. in LR (m^{LR})	actual	at revenue max. rate of money growth		in LR	in SR
	in percent per year				*as percent of GDP*		
1993*	705.7	467.1	2790.7	467.1	17.3	2.3	2.4
1994	440.1	911.2	493.1	911.2	10.3	3.6	3.9
1995	132.4	911.2	260.6	911.2	3.7	5.1	5.6
1996	37.9	911.2	45.3	911.2	1.6	10.8	11.5
1997	44.6	911.2	9.9	911.2	2.3	12.5	13.3

1998	21.9	911.2	17.7	911.2	1.5	15.0	15.9
1999	39.3	911.2	18.7	911.2	2.7	15.8	16.9
2000*	34.5	467.1	31.1	467.1	2.4	20.4	21.7

* include three quarters
** compared to the maximum attainable level
Source: calculations are made using data from *Ukrainian Economic Trends* (UEPLAC)

From table 5, it can be seen that in II-IV.1993 the actual annual rate of money growth exceeded the annual revenue-maximizing rate of money growth and was equal to 705.7% for three quarters. As a result, the actual rate of inflation was 2790%. This value was about five times as much as the rate of inflation at the revenue-maximizing rate of money growth (467.1%). Thus, Ukraine was on the downward sloping side of the Laffer curve. A further increase in the rate of money growth could only stimulate higher inflation with a significant reduction in the value of seignorage. The introduction of stabilization policy in 1994 led to decrease in the rate of printing money (from 440% to 22% per year by 1998) and had the positive effect of stopping inflation. From 1994 the actual annual rate of inflation was lower than the one at the revenue-maximizing money growth and fell significantly (from 493% to about 20% per year). As a result, Ukraine moved to the upward sloping side of the Laffer curve. However, it should be noted that this movement had some negative effect as well. In particular, severe restrictions on money emission led to the shortage of cash for serving economic operations. Therefore, a decrease in the output can be explained partially by restricted monetary policy that is conducted by the NBU. For example, in 1999 the actual rate of money growth was about 25 times less than the revenue-maximizing one, whereas the actual annual rate of inflation was about 50 times as lower as the one at revenue-maximizing rate of money growth (18.7% compared to 911.2%). Nevertheless, it does not mean that stabilization policy was bad and should not be implemented. In order to avoid the collapse of economy the huge inflation should be stopped by, first of all, through slowing down the process of printing money. However, policy makers should take into account the real need of economy in money as well. In other words, the shortage of money also has a negative effect on economy. But in case of Ukraine, stabilization policy should be conducted, because inflation was too high to be ignored.

Unlike Ukraine, from the viewpoint of maximizing seignorage in short run, during 1994-1999 Belarus remained on the downward-sloping side of the Laffer curve. To obtain the maximum seignorage in short run the amount of money supply should decrease by about 35% per quarter or .80% per year. However, from the viewpoint of maximizing seignorage in the long run Belarus did not always stay at the downward-sloping side of the Laffer curve.

In1994-1995 the actual annual rates of money growth exceeded the revenue-maximizing rates (231.3% and 393.9%) and were equal to 639% and 489.2% per year (see the tables 6). It is possible to conclude that in 1994-1995 Belarus reached the downward sloping side of the Laffer curve. More detailed analysis of quarterly data reveals that in 1994 and the first part of 1995 the actual rates

Table 6. Annual Rates of Money Growth and Inflation, Seignorage and Seignorage Loss: Belarus

	Rate of Money Growth		Rate of Inflation		Seignorage	Seignorage Loss**	
	actual	revenue max. in LR (m^{LR})	actual	At revenue max. rate of money growth		in LR	in SR
	in percent per year				*as percent of GDP*		
1994*	639.8	231.3	863.8	231.3	2.7	0.3	59.7
1995	489.2	393.9	331.9	393.9	1.4	0.8	42.2
1996	84.2	393.9	36.1	393.9	1.5	3.1	66.7
1997	88.1	393.9	70.0	393.9	1.5	2.2	58.3
1998	101.3	393.9	137.7	393.9	1.7	2.0	62.4
1999	274.1	393.9	275.6	393.9	2.0	0.7	56.7

*include three quarters (II-IV) ** compared to the maximum attainable level
Source: calculations are made using data from *Belarus Economic Trends* (TACIS)

of money growth exceeded significantly the revenue-maximizing rates of money growth (about 90% compared to 50% per quarter). A further increase in the rate of money growth could result in further decrease in the amount of seignorage and eventually push economy to the hyperinflation with annual inflation rates more than 13,000% (Cagan, 1956). However, during the stabilization policy in 1995 the exchange rate was set at fixed level (11500BRB = 1$), the real interest rate was set at a positive level and it was forbidden to sell goods and services for dollars. As a result, individuals started to convert national currency into dollars less intensively. Such policy led to a decrease in the money velocity and made it possible to reduce inflation without significant decreasing in the rate of money growth in 1995. For example, in 1995 the rate of money growth exceeded the revenue-maximizing one (489% compared to 393%), nevertheless, the actual rate of inflation was lower than the rate that should be induced by the revenue-maximizing rate of money growth (331% compared to 393%). This happened at the expense of foreign currency reserves of national bank. Eventually, monetary expansion at fixed exchange rate led to depletion of foreign currency reserves of national bank. In 1997 administrative controls on the exchange rate were introduced and foreign currency black market appeared. Individuals speeded up the process of converting of their assets in national currency into dollars in order to avoid a significant devaluation of their wealth and income. This behavior can partially explains why the elasticity of real money demand with respect to inflation is higher than 1 for Belarus during all the period of1994-1999. The existence of inconsistency between currency and monetary policies made individuals so sensitive to a change in the price levels. Nevertheless, some reduction in the rate of money growth during 1996-97 contributed to about 10-

fold decrease in the rate of inflation. From1995 till 1997 the amount of seignorage as percent of GDP decreased from 2.7% to 1.5%. However, a rise in the rate of money growth in 1999, on the one hand, increased the amount of seignorage to about 2% of GDP, but at the same time it led to almost doubling in the rate of inflation (from 137% to 275%).[*]

The results of the estimation for Russia are presented in table 7.

Table 7. Annual Rates of Money Growth and Inflation, Seignorage and Seignorage Loss: Russia

	Rate of Money Growth		Rate of Inflation		Seignorage	Seignorage Loss*	
	actual	revenue max. in LR (m^{LR})	actual	At revenue max. rate of money growth		in LR	in SR
	in percent per year				*as percent of GDP*		
1992	874.5	1674.1	2236.2	1674.1	5.1	6.9	7.2
1993	405.2	1674.1	925.0	1674.1	5.3	3.4	4.7
1994	125.9	1674.1	209.7	1674.1	3.5	2.2	3.5
1995	121.7	1674.1	156.9	1674.1	2.5	2.9	4.0
1996	21.2	1674.1	24.2	1674.1	1.1	9.6	11.0
1997	30.1	1674.1	11.8	1674.1	1.3	9.9	11.4
1998	46.4	1674.1	70.1	1674.1	1.5	11.8	13.6
1999	32.8	1674.1	47.4	1674.1	1.4	10.2	11.8

* compared to the maximum attainable level

Source: calculations are made using data from *Russian Economic Trends* (RECEP) and *Goskomstat*

During 1992-1999 the actual rate of money growth in Russia never exceeded the revenue-maximizing one that was equal to 1674.1% per year. In other words,

[*] Partially, it can be explained by the fact that Belarus used money emission to finance the agriculture (sowing campaign and harvesting).

analysis reveals that in the period of 1992-1999 Russia were on the upward sloping side of the Laffer curve. Though in 1992 the actual rate of money growth was less than the revenue-maximizing one, nevertheless, Russia suffered rather high annual inflation (2236.2%). It can be explained by price in January of 1992. At that time, prices increased by 244.6%. However, it was a "one month" jump in price level, from February till December of 1992 the average monthly inflation rate was about 20%. As Russia was on the upward-sloping side of the Laffer curve, a further increase in the rate of money growth up to the revenue-maximizing level, on the one hand, would increase the amount of seignorage, but, on the other hand, this policy would stimulate further significant rise in price level. As can be seen from the table 7, the rate of inflation stimulated by the revenue-maximizing rate of money growth is equal to 1674.1% per year. Thus, active money emission policy can be very harmful for the economy even before the rate of money growth reaches the revenue-maximizing level and economy get on the downward-sloping side of the Laffer curve.

The main evidence of the analysis is that the revenue-maximizing rate of money growth does not mean the "efficient" rate of money growth. Striving to obtain the maximum value of seignorage, it is possible to induce so high inflation that can demolish the economy. Money emission can provoke deep economic recession even if the economy is on the upward sloping side of the Laffer curve. Thus, it is important to investigate not only the revenue-maximizing rate of money growth, but also the rate of inflation that is stimulated by this rate of money emission.

From 1992 to 1999 the annual rate of money growth in Russia diminished about 25 times and in 1999 it was equal to 32.8%. The monetary restriction policy contributed to decreasing in the rate of inflation from 2236% to 47% per year. At the same time the amount of seignorage as a percent of GDP declines from 5.1% to 1.4%.

An interesting issue is whether seignorage was actively used to finance the budget deficit. If that is the case, the correlation between the deficit and seignorage would be positive. If, on the other hand, seignorage is unrelated to budget deficit, the correlation would be negative.

The seignorage as a percentage of GDP for the three countries is in table 8 below.

Table 8. Seignorage and Budget Deficit as a Percentage of GDP

	Belarus		Russia		Ukraine	
	Seignorage	Budget Deficit	Seignorage	Budget Deficit	Seignorage	Budget Deficit
1992	-	2.0	5.1	4.1	-	12.2
1993	-	5.6	5.3	7.4	17.3	6.5
1994	2.7	3.6	3.5	9.0	10.3	10.5
1995	1.4	2.8	2.5	5.4	3.7	7.9
1996	1.5	2.0	1.1	7.9	1.6	4.6
1997	1.5	2.1	1.3	7.0	2.3	7.1
1998	1.7	1.5	1.5	5.0	1.5	2.1
1999	2.0	2.9	1.4	1.7	2.7	1.4

Source: calculations are made on the data of Belarus Economic Trends (TACIS), Russian Economic Trends (RECEP), State Treasury of Ukraine and UEPLAC

In the period of 1994-1997, the amount of seignorage in Belarus decreased from 2.7% to 1.5%. In 1998-1999, the rate of money growth in Belarus increased. The result was an increase in seignorage from 1.7% to 2.0% of GDP. The correlation between money growth and deficit is positive and large: the coefficients of correlation are equal to 0.90 with deficit and 0.43 with budget expenditures (see Appendix C, tables C1 and C2). The same is true for seignorage as well (0.71 and 0.79 respectively). This implies that in Belarus the government actively used seignorage to finance part of its budget expenditures and financed budget deficit through monetization. As can be seen from table C1 in Appendix C, from 1997 till 1999, budget expenditures in Belarus increased from 29.5% to 39.4% of GDP. It was accompanied by increasing in the actual rate of money growth from 88% to 274% per year. As a result, seignorage rose from 1.5% to 2.0% of GDP.

The correlation analysis for Ukraine (see Appendix C, tables C5 and C6) also shows that the actual rate of money growth and seignorage are positively correlated with budget deficit and budget expenditures (0.52 and 0.47; 0.47 and 0.42 respectively). However, in the case of Ukraine, it should be noted that during the period 1995-1999, the government not only diminished the actual rate of money growth and received less seignorage, but also it decreased its budget expenditures from 59.7% to 38.4% of GDP. As a result, despite the fact that budget revenues went down during the period under consideration, budget deficit had decreased from 10.5% to 1.4% of GDP. Nevertheless, it is possible to argue that the government considered seignorage as one of the sources for financing budget deficit. In particular, in 1997 budget expenditures rose by 6% (from 43.2% to 49.6% of GDP), which led to an increase in budget deficit by 2.5% (from 4.6% to 7.1%). At the same time, the actual rate of money growth increased from 37% to 45% per year, which led to an increase in seignorage from 1.6% to 2.3% of GDP.

The correlation analysis for Russia (see Appendix C, tables C3 and C4) does not reveal any considerable relationships between actual rate of money growth and budget deficit and budget expenditures (the correlationcoefficients are equal to –0.16 and 0.03 respectively). A possible explanation is based on different levels of development of financial markets in the three countries. The more developed the financial market is, the more possibilities the government has to finance the budget deficit through borrowing from either the public or the private sector by issuing bonds rather than through printing money.

CONCLUSION

The analysis shows that the Cagan's money demand function is not appropriate to determine the revenue-maximizing rate of money growth for Belarus, Russia and Ukraine. The main reason is that the economic situation in these countries does not meet the requirements for using Cagan's money demand function. The steady-state conditions are not always held during the whole period under consideration in three transition countries. Therefore, the using of partial adjusted model of demand for real money balances is appropriate. This model takes into account that individuals adjust actual money balances to their ideal level with a delay.

In particular, the following results were obtained. In Belarus the elasticity of real money demand function with respect to inflation rate (in absolute value) was more than 1. As a result, from the viewpoint of maximizing seignorage in the short run, during 1994-1999 Belarus remained on the downward-sloping side of the Laffer curve. However, from the viewpoint of maximizing seignorage in long run Belarus did not always stay at the downward-sloping side. Nevertheless, the analysis confirms that in the period of high inflation the rate of money growth exceeded the revenue-maximizing one and this fact can be used as evidence that excessive money emission was one of the main reasons of high inflation. After the introduction of stabilization policy, a decrease in the actual rate of money growth in 1995-1997 contributed to a decrease the rate of inflation and move of the economy to the upward-sloping side of the Laffer curve. However, correlation analysis reveals the existence of strongly positive relation between seignorage, rate of money growth and budget deficit. Thus, government considered seignorage as one of sources of financing budget deficit. However, the policymakers should realize that until money emission is used for financing budget deficit, the economy will always be under threat of high (and hyper) inflation. It is necessary to develop the financial markets to have more possibilities to borrow money in case of budget deficit. Another opinion is to promote economic reforms to increase tax base and raise the budget revenues from tax collection.

In the period of high inflation in 1993 Ukraine also had the elasticity of real money demand with respect to inflation that was more than 1. As a result, the rate of money growth exceeded the revenue-maximizing one (911%) and prices increased tenfold in 199. The seignorage was equal to 17% of GDP. Extensive money emission is one of the main reasons of high inflation in Ukraine in 1993-1994. Stabilization policy that was accompanied by a decrease in the actual rate of money growth (from 705% to 34% per year) led to a reduction in the rate of inflation to 31% per year. After the introduction of stabilization policy the rate of money growth fell below the revenue-maximizing one and as a result, in 1995 Ukraine moved to the upward-sloping side of the Laffer curve. Correlation analysis reveals the existence of positive relation between seignorage, a rate of money growth and budget deficit. However, it is not as strong as in case of Belarus.

Russia never reached the downward-sloping side of Laffer curve. It has the lowest value of the elasticity of real money demand function compared to Belarus and Ukraine. An interesting finding for Russia is that the revenue-maximizing rate of money growth does not mean the “efficient” rate of money growth. The example of Russia demonstrates that striving to obtain the maximum value of seignorage, it is possible to induce so high inflation that it can destroy the economy. Excessive money growth can lead to deep economic recession even if the economy is on the upward sloping side of the Laffer curve. Thus, it is important to investigate not only the revenue-maximizing rate of money growth, but also the rate of inflation that is stimulated by this rate of money emission.

Correlation analysis shows that Russia did not use seignorage as a source of financing budget deficit. The example of Russia demonstrates that money emission should not be considered as the main source for financing budget deficit. Development of financial markets is considered as one of the possible ways to finance budget deficit through borrowing from either the public or the private sector by issuing bonds rather than through printing money. However, the main effort should be directed on the promoting economic reforms that make it possible to finance the budget deficit not trough borrowing or money printing, but through an increase in budget revenues by increasing tax collections.

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APPENDIX A

CAGAN'S MONEY DEMAND FUNCTION: BELARUS

Dependent Variable: dln(M/PY)
Method: Least Squares
Sample(adjusted): 1994:2 1999:4
Included observations: 23 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
di	-0.001654	0.000745	-2.219121	0.0371

R-squared	0.180627	Mean dependent var	-0.006450
Adjusted R-squared	0.180627	S.D. dependent var	0.125034
S.E. of regression	0.113180	Akaike info criterion	-1.477177
Sum squared resid	0.281812	Schwarz criterion	-1.427808
Log likelihood	17.98754	Durbin-Watson stat	1.845992

CAGAN'S MONEY DEMAND FUNCTION: RUSSIA

Dependent Variable: dln(M/PY)
Method: Least Squares
Sample(adjusted): 1995:4 2000:1
Included observations: 18 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
di	-0.000761	0.001887	-0.403166	0.6922

R-squared	0.230078	Mean dependent var	0.005017
Adjusted R-squared	0.181958	S.D. dependent var	0.068886
S.E. of regression	0.062304	Akaike info criterion	-2.609135
Sum squared resid	0.062109	Schwarz criterion	-2.510205
Log likelihood	25.48222	F-statistic	4.781324
Durbin-Watson stat	1.628720	Prob(F-statistic)	0.043971

APPENDIX A (CONTINUED)

CAGAN'S MONEY DEMAND FUNCTION: UKRAINE

Dependent Variable: dln(M/PY)
Method: Least Squares
Sample(adjusted): 1993:2 2000:3
Included observations: 30 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
di	-0.000941	0.000872	-1.079075	0.2894

R-squared	0.038328	Mean dependent var	-0.002777
Adjusted R-squared	0.038328	S.D. dependent var	0.167454
S.E. of regression	0.164214	Akaike info criterion	-0.742528
Sum squared resid	0.782020	Schwarz criterion	-0.695822
Log likelihood	12.13793	Durbin-Watson stat	1.733902

APPENDIX B

MONEY DEMAND FUNCTION (PAM): BELARUS

Dependent Variable: dln(M/P)
Method: Two-Stage Least Squares
Sample(adjusted): 1995:1 1999:4
Included observations: 20 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C (TREND)	-0.019269	0.016197	-1.189686	0.2540
dln(M/P)LAG	0.239117	0.132347	1.806742	0.0929
$dln\pi^e$	-1.550306	0.522856	-2.965074	0.0102
dlnY	1.101028	0.304661	3.613939	0.0028

R-squared	0.635586	Mean dependent var	0.023757
Adjusted R-squared	0.505438	S.D. dependent var	0.179635
S.E. of regression	0.126328	Sum squared resid	0.223423
F-statistic	4.883562	Durbin-Watson stat	1.766303
Prob(F-statistic)	0.008553		

APPENDIX B (CONTINUED)

MONEY DEMAND FUNCTION (PAM): RUSSIA

Dependent Variable: dln(M/P)
Method: Least Squares
Sample(adjusted): 1992:1 2000:1
Included observations: 33 after adjusting endpoints
Convergence achieved after 7 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C (TREND)	0.010222	0.007912	1.292041	0.2073
dln(M/P)LAG	0.312809	0.068904	4.539775	0.0001
dlnπ^e	-0.653028	0.165393	-3.948332	0.0005
dlnY	0.786669	0.088804	8.858530	0.0000
dummy	-0.088915	0.028671	-3.101187	0.0045
AR(2)	-0.754293	0.116430	-6.478487	0.0000

R-squared	0.940094	Mean dependent var	-0.046514
Adjusted R-squared	0.929001	S.D. dependent var	0.249794
S.E. of regression	0.066559	Akaike info criterion	-2.418480
Sum squared resid	0.119614	Schwarz criterion	-2.146387
Log likelihood	45.90492	F-statistic	84.74151
Durbin-Watson stat	2.140516	Prob(F-statistic)	0.000000

APPENDIX B (CONTINUED)

MONEY DEMAND FUNCTION (PAM): UKRAINE

Dependent Variable: dln(M/P)
Method: Least Squares
Sample(adjusted): 1993:3 2000:3
Included observations: 29 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C (TREND)	0.044143	0.021954	2.010753	0.0562
dln(M/P)LAG	0.437134	0.118942	3.675169	0.0013
$dln\pi^e$	-0.718625	0.347745	-2.066531	0.0502
dlnY	0.790053	0.196821	4.014063	0.0005
$dummy*dln\pi^e$	-2.891204	1.173559	-2.463620	0.0217
dummy	-0.243559	0.145319	-1.676027	0.1073
R-squared	0.862071	Mean dependent var		-0.047198
Adjusted R-squared	0.832086	S.D. dependent var		0.260575
S.E. of regression	0.106777	Akaike info criterion		-1.454165
Sum squared resid	0.262228	Schwarz criterion		-1.171276
Log likelihood	27.08539	F-statistic		28.75048
Durbin-Watson stat	1.592512	Prob(F-statistic)		0.000000
Note: dummy is equal to 1 for quarters with the rate of inflation more than 30% per quarter				

APPENDIX C

Table C1. BELARUS

	Actual Rate of Money Growth	as a percent of GDP			
		Actual Seignorage	Budget Revenue	Budget Expenditure	Budget Deficit
1994	639.8	2.7	36.8	40.2	3.6
1995	489.2	1.4	29.9	32.7	2.8
1996	84.2	1.5	27.5	29.5	2.0
1997	88.1	1.5	32.1	34.2	2.1
1998	101.3	1.7	36.2	37.7	1.5
1999	274.1	2.0	36.5	39.4	2.9
Source: calculations are made on the data of Belarus Economic Trends (TACIS)					

Table C2. Correlation: Case of Belarus

	Actual Rate of Money Growth	Actual Seignorage	Budget Revenue	Budget Expenditure	Budget Deficit
Actual Rate of Money Growth	1				
Actual Seignorage	0.643325	1			
Budget Revenue	0.295411	0.722029	1		
Budget Expenditure	0.426571	0.79008	0.986994	1	
Budget Deficit	0.9027	0.71149	0.307093	0.455617	1

APPENDIX C (CONTINUED)

Table C3. RUSSIA

	Actual Rate of Money Growth	as a percent of GDP			
		Actual Seignorage	Budget Revenue	Budget Expenditure	Budget Deficit
1992	874.5	5.1	*NA*	*NA*	4.1
1993	405.2	5.3	*NA*	*NA*	7.4
1994	125.9	3.5	*NA*	*NA*	9.0
1995	121.7	2.5	13.0	18.6	5.4
1996	21.2	1.1	11.8	19.9	7.9
1997	30.1	1.3	12.6	20.0	7.0
1998	46.4	1.5	10.1	15.1	5.0
1999	32.8	1.4	13.3	14.9	1.7
Source: calculations are made on the data of Russian Economic Trends (RECEP)					

Table C4. Correlation: Case of Russia

	Actual Rate of Money Growth	Actual Seignorage	Budget Revenue	Budget Expenditure	Budget Deficit
Actual Rate of Money Growth	1				
Actual Seignorage	0.843327	1			
Budget Revenue	0.237058	0.279396	1		
Budget Expenditure	0.031293	0.029	0.242365	1	
Budget Deficit	-0.16323	0.138745	-0.29418	0.85547	1

APPENDIX C (CONTINUED)

Table C5. UKRAINE

	Actual Rate of Money Growth	as a percent of GDP			
		Actual Seignorage	Budget Revenue	Budget Expenditure	Budget Deficit
1993	705.7	17.3	40.0	46.5	6.5
1994	440.1	10.3	49.1	59.7	10.5
1995	132.4	3.7	40.1	48.0	7.9
1996	37.9	1.6	38.6	43.2	4.6
1997	44.6	2.3	42.4	49.6	7.1
1998	21.9	1.5	39.8	41.9	2.1
1999	39.3	2.7	37.0	38.4	1.4
Source: calculations are made on the data of State Treasury of Ukraine and Ukrainian Economic Trends (UEPLAC)					

Table C6. Correlation: Case of Ukraine

	Actual Rate of Money Growth	Actual Seignorage	Budget Revenue	Budget Expenditure	Budget Deficit
Actual Rate of Money Growth	1				
Actual Seignorage	0.996721	1			
Budget Revenue	0.402607	0.351672	1		
Budget Expenditure	0.476742	0.423558	0.961719	1	
Budget Deficit	0.520836	0.470214	0.81384	0.941908	1