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MONEY DEMAND IN A DOLLARIZED ECONOMY: THE CASE OF UKRAINE[⊥]

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Abstract:

After 2000 Ukraine entered a phase of economic development and macroeconomic stability. Owing to moderate price growth and stable exchange rate, the subsequent years were marked by growing public confidence in national money as can be inferred from the increasing share of national currency deposits in the banking system. At the same time, dynamics of money supply and inflation diverted from the conventional parallel path indicating some substantial changes in the demand for money.

This paper is devoted to the econometric study of dollarization effect on the money demand function in Ukraine. Following the general money-as-an-asset approach, the paper concentrates on the demand for broad money, measured by the monetary aggregate M2 less foreign currency deposits. By means of the error correction model (ECM) both long-run equilibrium and short-run dynamics of the function are explored. To test importance of dollarization factor for money demand dynamics various versions of the model (with and without different proxies for the opportunity costs of holding national instead of foreign currency) are estimated and then tested for stability. By investigating influence of wide-spread for transition economies phenomenon of dollarization on money demand this paper will contribute to insipient scientific literature on money demand in transition economies, specifically in Ukraine.

JEL classification: E41, F31, P24

Keywords: money demand, dollarization, currency substitution, transition

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1. Introduction

Dollarization - the holding by residents significant share of foreign assets - is a common feature of many transition economies.[1] Presence of dollarization influences choice of exchange rate regime and monetary target, as well as the overall conduct of monetary policy. If foreign currency is an easy substitute for domestic money, the dynamics of money demand is also likely to be determined by dollarization and de-dollarization trends. In this paper we explore development of the real money demand function in Ukraine - one of the most dollarized transition economy.

The high level of dollarization in Ukraine emanates from rather tough monetary and banking history since independence in 1991. Roughly speaking, one can divide the time since independence into four periods.

The *first* period (1991-1995) was marked by a sharp economic decline, hyperinflation and growth of shadow economy, which resulted in rapid impoverishment of population. In addition, people's confidence in the banking system and other intermediary financial institutions was strongly undermined, since most Ukrainians lost their savings deposited at the successor of the Soviet savings bank Sberbank. [2]

The *second* period (1996 - first half of 1998) started with the introduction of a new national currency, the hryvnia. The output reduction became less severe than before and inflation came down to modest two-digit figures. Hryvnia was pegged to US dollar through the "exchange rate corridor", which allowed exchange rate fluctuations within the established band. Yet, these achievements were outweighed by fallacious fiscal policy. To cover the persistent fiscal deficit Ukrainian government started to borrow heavily by issuing government bonds. The stability of the exchange rate encouraged significant capital inflow, directed primarily to domestic government bonds market (IMF 1999). However, in 1997 Asian crisis negatively influenced foreign investors perception of emerging market economies and non-residents started to withdraw their capital from risky market segment, including Ukraine. As a result, the National Bank of Ukraine (the NBU) lost much of its international reserves and became the primary source of credit to Ukrainian government. The government, in turn, continued borrowing in an unsustainable manner and ended up with a kind of a financial pyramid. The difficulties to service state debt in combination with continuous capital outflow and the spill-over effect of the Russian crisis in August 1998 resulted in a collapse of secondary market for government bonds and to a crisis in Ukraine.

The *third* period (end of 1998 - first half of 2000) started with the reaction to the 1998 - crisis. Notwithstanding the attempts of the NBU aiming at suppressing the demand for foreign currency through available monetary policy tools and through introduction of strict regulations on a foreign exchange market[3], hryvnia lost much of its value against the US dollar. Furthermore, in 1998 – 1999 the NBU almost fully financed budget expenses by purchasing government bonds in the primary market, which inevitably led to the rapid money supply growth and inflation (see Figure 1). Striving to protect value of their wealth from growing prices and devaluation economic agents turned to foreign assets. However, due to restrictions imposed by the NBU on operations with foreign currency, even legal purchase of cash dollars at that time was a difficult task, not to mention investing in financial assets abroad. This only reinforced people's desire to get rid of hryvnia encouraging creation of illegal market for foreign currency, mainly US dollars. In addition to shadow trade of foreign cash, whenever possible market transaction were made in US dollars without regard to strict prohibition. Dollarization of the banking system also increased sharply as reflected by the growing share of foreign

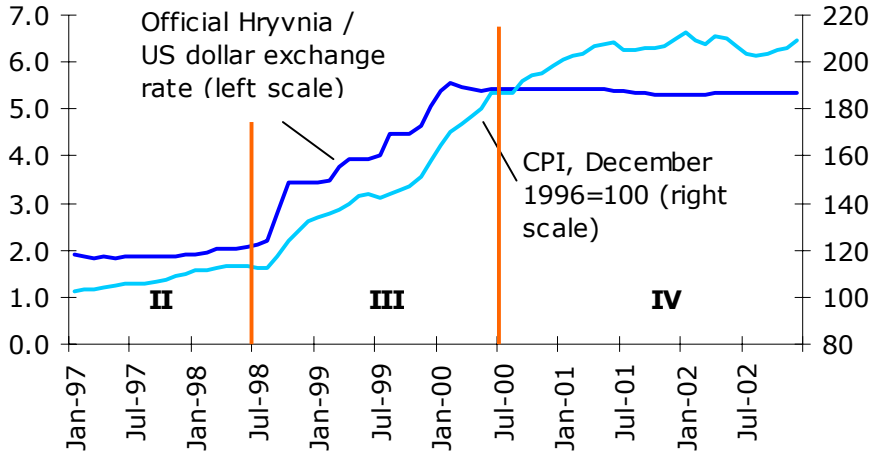
[1] In this paper terms "dollarization" and "currency substitution" are used interchangeably.

[2] See Yushchenko (2000) for detailed analysis of economic development during this period.

[3] The instruments of monetary policy used by the NBU in 1998-2001 are described by Bilan (2002); for a list of most severe foreign exchange market restrictions refer to IMF (1999).

currency deposits shown in Figure 2. The situation was hardly improved by the second half of 1999, when rise in international oil and gasoline prices shook the Ukrainian economy again (Yushchenko 2000). Hryvnia was strongly devalued one more time evoking new upsurge of inflation (see Figure 1). Only in the second half of 2000 foreign exchange market was eventually stabilized.

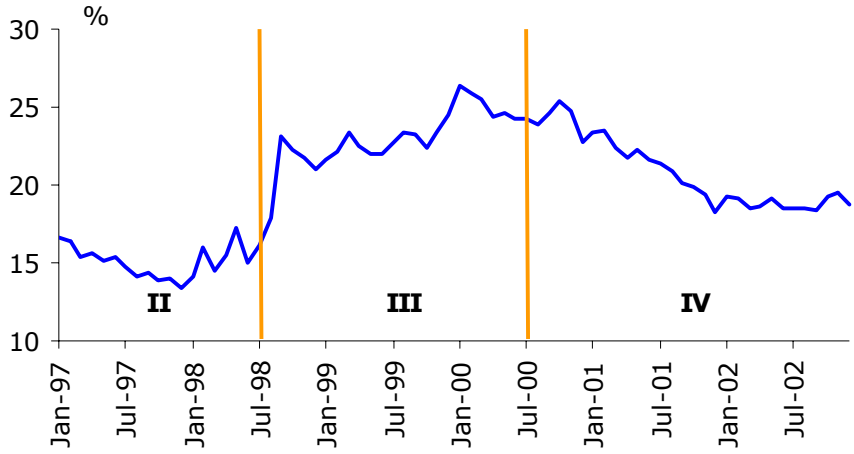
Figure 1. Dynamics of official exchange rate and consumer prices in 1997-2002



Note: vertical lines separate the discussed periods

Source: the National Bank of Ukraine, the State Statistics Committee of Ukraine

Figure 2. Dollarization of the Ukrainian banking sector measured by share of foreign currency deposits in total deposits

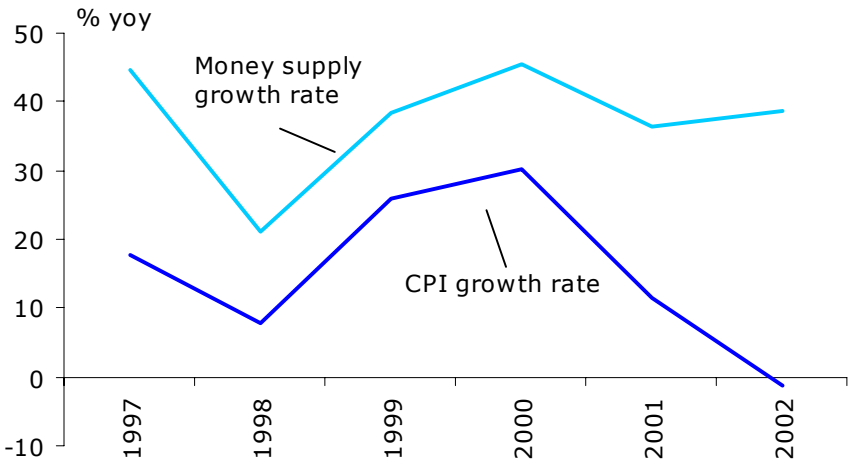


Source: the National Bank of Ukraine, own calculations

Thus, Ukrainian economy entered the *fourth* period (second half of 2000 – 2002) with stable exchange rate. Although in 2000 the NBU formally announced introduction of a free floating exchange rate regime, in fact, it has heavily intervened at the foreign exchange market since then with the aim of keeping the exchange rate to the US dollar stable or even constant. Several restriction on the foreign exchange market were abolished. Nevertheless, regulation and control over foreign currency operations remained tough.

At the same time, due to strong after-crisis devaluation, which resulted in a quick improvement in the trade and current account balances, as well as due to structural reforms of new government, Ukraine entered a phase of economic growth.[4] Consequently, in order to keep nominal exchange rate stable the NBU had to purchase foreign currency on the foreign exchange market accumulating international reserves and increasing money supply. As before, the expansionary monetary policy was accompanied by relatively high inflation, but only during 2000. Since then inflation came down to the single-digit level in spite of high money supply growth (see Figure 3). This development indicates noticeable increase in the demand for real balances.

Figure 3. Year-over-year growth rates of money supply and inflation



Note: Average over year figures of monetary aggregate M2 and CPI are used for growth rates calculation

Source: the National Bank of Ukraine, the State Statistics Committee of Ukraine, own calculations

The expansion of real money demand could be partially explained by economic growth and concomitant increase in real income. However, in our view, the de-dollarization process has contributed much to increase in the demand for real balances. Stability of the exchange rate to the US dollar since 2000 and the low rate of inflation since 2001 have increased the attractiveness of the national currency vis-a-vis the US dollar. Consequently, a significant substitution of US dollars (both cash and bank deposits) by national currency might have taken place. The decreasing share of foreign currency deposits in the banking system in 2001- 2002 (see Figure 2) can serve as an indication of de-dollarization process. However, since large amount of foreign currency circulated outside commercial banks, data on foreign cash holdings is unavailable or unreliable. Thus, it is not obvious whether shift from foreign to national currency was an economy-wide process.

In such circumstances, one can investigate this substitution process only indirectly. In this paper we try to do it by modelling money demand function that includes different measures of opportunity cost of holding national currency as opposed to foreign currency. Since holdings of foreign cash by Ukrainians were induced by both transaction and precautionary motives, the demand for money should be considered in the framework of a portfolio choice problem. Exactly this approach is employed in our paper. The structure of the paper is as follows. In Chapter 2 a survey of the studies devoted to money demand in a dollarized economy is presented. In Chapter 3 the choice of data and variables is discussed. Chapter 4 contains the econometric analysis and Chapter 5 concludes.

[4] For an econometric study of the determinants of economic growth in Ukraine since 1999 see Movchan and Giucci (2003).

2. Review of Empirical Literature

The number of empirical studies devoted to estimation of money demand function for different countries is innumerable. To be concise, here we focus on research that employ the closed economy model of money demand.[5] The majority of studies from this category deals with developing countries. Among others, Domowitz and Elbadawi (1987) emphasise that in the presence of currency substitution, i.e. when foreign currency is desirable and feasible alternative to domestic money holdings, omission of variable approximating the return on foreign currency may lead to overstating influence of inflation. Choudhry (1995) also states that in countries with high inflation both rate of inflation and rate of currency depreciation may be required in the money demand function. Indeed, according to Choudhry's results, stationary money demand function in Argentina, Israel and Mexico is ensured only when currency depreciation variable is included in the regression in addition to real income and inflation. According to Choudhry's findings, although exchange rate movement is important determinant of money demand function, the long-run currency depreciation semi-elasticity of money demand is much smaller than semi-elasticity of inflation rate.

Arize, Malindretos and Shwiff (1999) estimate money demand function in 12 developing countries[6] and test whether exchange rates (as well as foreign interest rates and volatility of real exchange rate) influence demand for real balances. The estimates are performed for narrow and broad definition of money measured by monetary aggregates M1 and M2 respectively. They find that exchange rate is statistically significant in all except one cointegrating equations, but has different sign depending on a particular country and monetary aggregate. Specifically, when broad money stock is employed the exchange rate coefficient is predominantly positive, and it is negative in the majority of narrow money demand functions.[7]

As noted by Mizen and Pentecost (1996), in contrast to developing countries, the phenomenon of currency substitution in transition economies, like Ukraine, is interesting from another perspective due to drastic change of institutional environment that underlined further macroeconomic development of these countries. However, desire of economic agents to protect real value of their wealth remains a driving force of currency substitution whatever the case. Thus, the approach for assessing money demand in the presence of currency substitution and is basically the same either in developing or transition economies.

To the best of our knowledge, there are few works devoted to demand for real balances in transition countries. Banerji (2002) investigates determinants of the demand for national currency in Russian Federation – an economy, which is very similar to Ukraine in terms of institutional settings and macroeconomic development and is known to be one of the most dollarized economies among former Soviet Union Republics. Three specifications are estimated

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[5] The general idea behind the closed-economy model is as follows: if economy can not be classified as an open one due to strict capital control, but foreign assets (in the form of cash or foreign currency deposits within domestic banks) is an attractive and feasible substitute for domestic money, expected exchange rate is likely to be an important determinant of money demand dynamics. The alternative is an open-economy model. In this case return on foreign assets is measured by foreign interest rate corrected for exchange rate expectations. As shown in the previous chapter, Ukraine is an example of a country, characterized by strict capital control, high desirability (due periods of high inflation) and accessibility of foreign currency. Thus, the closed-economy models seems to fit money demand study in Ukraine best.

[6] These countries are India, Korea, Malaysia, The Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Ghana, Morocco, South Africa and Tunisia.

[7] Such discrepancy can be attributed to the fact that foreign currency deposits are usually included in the definition of monetary aggregates. Devaluation of domestic currency forces economic agents to shift from domestic currency holdings to foreign currency. Thus, if foreign currency component of employed monetary aggregate is large the exchange rate variable tends to enter money demand equation with positive sign. As a result, the sign of the coefficient will be inconclusive for determining effect of exchange rate on domestic money holdings unless monetary aggregate is purified from foreign currency component. Unfortunately, researchers often do not point out clearly whether foreign currency component of monetary aggregate is considerably large and whether it was included in the money stock definition.

in this study. The first one is a model without external variables, the other two specifications differ by the variable used to capture return on foreign currency holdings. Namely, two proxies are employed: level of exchange rate and rate of depreciation of Russian ruble with respect to US dollar. The results appear to be inconclusive as to the effect of these proxies on the real demand for national currency, since respective coefficients depend crucially on the seasonal adjustment factor applied to the series. In addition, there is evidence of structural break in the money demand function, which cannot be investigated further due to unavailability of data.

Concerning Ukraine some evidence on the link between demand for national money and currency substitution can be found only in two unpublished papers. Volkov (2000) estimates money demand in Ukraine by means of open-economy partial adjustment model with (i) official exchange rate of hryvnia to US dollar lagged by one period and (ii) LIBOR (London InterBank Offer Rate). The first variable is intended to approximate opportunity costs of holding hryvnia as opposed to foreign cash and foreign currency bank deposits, the second one is used to capture opportunity costs of holding domestic money versus investing abroad. Investigation is performed for the period from 1994 to 1998. The model is estimated on the whole sample, and on two sub-samples that represent periods of high and moderate inflation. Volkov finds that exchange rate proxy is negative and significant during the period of high inflation, but becomes insignificant afterwards. In contrast, LIBOR variable is significant only during the second period, but has " wrong" positive sign. Results of Volkov's study should be interpreted with caution, since properties of the estimated model have not been tested properly and choice of variables is not fully justified, For example, as can be inferred from Chapter 1 it is highly unlikely that Ukrainian residents had an opportunity to invest abroad, thus LIBOR rate seems to be inappropriate variable. In addition, some measure of return on real assets is not considered even in the high inflation period, which could invalidate results because of omitted variables problem.

Piontkivsky (2002) provides much deeper analysis of money demand determinants in Ukraine including the influence of dollarization on the dynamics of real balances. The data used in his error-correction model are quarterly spanning 1996-2001. In the framework of the money-as-an-asset approach the broad monetary aggregate (less foreign currency component) is used to construct real money stock. The set of explanatory variables includes index of real GDP, official hryvnia/US dollar exchange rate, consumer price index[8] and time trend. Piontkivsky finds that long-run elasticity of money demand with respect to exchange rate is negative and equals to –0.35. This allows the author to conclude that dollarization significantly influences the dynamics of real balances in Ukraine. However, behaviour of residuals as well as stability properties of the estimated long-run relationship remain unclear from this study.

Thus, works by Volkov (2000) and Piontkivsky (2002) provide some insight as to the dynamics and determinants of money demand function in Ukraine, however, the issue is not investigated in full. By undertaking thorough examination of variables in question and providing econometric study of money demand dynamics this research will contribute to the scant empirical literature on money demand in transition economies, in general, and in Ukraine, in particular.

[8] All variables are in logs.

3. Data and Variables

3.1. A note on definitions

As was mentioned in the footnote to Chapter 2, researchers often pay little attention to the definition of term money and clear distinction between foreign and national currencies is rarely made. To avoid confusion, hereafter we refer to the *demand for national money (*or shortly *money demand)* as demand for national cash and national currency deposits. Foreign money is defined in a similar way - as foreign cash in circulating inside the domestic economy plus foreign currency deposits within domestic banking system.

3.2. General comments about data

The common problem with time series analysis in transition countries is poor quality of most data sets reported by local statistics authorities. The reliability of data is seriously weakened by frequent revisions of previously reported figures, substantial and sometimes undisclosed changes in methodology, irregular publication of data, etc.

In Ukraine the rare exception to the rule is monetary statistics gathered by the local central bank and data on prices (CPI and PPI) reported by the State Statistics Committee of Ukraine (the SSC). These series appear to be trustworthy enough for econometric study without any special corrections. Using mostly this relatively good monetary and price statistics, we hope to secure (at least to some extent) reliability of the obtained results. Nevertheless, we are not released from problems with some variables. And as any time series econometrician, who works with data in transition economies, we face a trade-off between using short samples which undermines power of econometric test and reduces reliability of results, or expanding sample size at the expense of deteriorating quality of data. In such cases, we incline to put more weight to data quality.

Thus, our sample is restricted to 5-year period spanning January 1998 to December 2002. All necessary series are reported monthly, which implies in given circumstances quite reasonable sample size of 60 observations. Summary statistics of all series is provided in Table A1 in Appendix. Below we substantiate choice of particular variables used in this research.

3.3. Choice of variables

As economic theory predicts the demand for money is positively related to the real income (scale variable) and negatively to the opportunity costs of holding money instead of other assets. However, there is no theoretical grounds as to the exact definition of each variable to be used in the applied research. The choice of a particular indicator representing money stock, scale variable or opportunity costs depends on the purposes of each separate study and justification of variables choice is a matter of diligence of a researcher conducting the study.

Money stock

Sticking to the theoretical money-as-an-asset approach, we use "broad" definition of money. According to the central bank of Ukraine, broad monetary aggregate M2 includes national currency in circulation plus all types of bank deposits in hryvnia and in foreign currency. Since we are interested in estimating demand for national currency only, the foreign currency component was subtracted from the monetary aggregate. The resulting series was then transformed in real terms by the means of specially designed price index calculated as

average of producer and consumer price indices (0.5*PPI+0.5*CPI). The necessity to use special price index was evoked by absence of trustworthy monthly data on GDP deflator in Ukraine and inability of other reported indices to account of changes in price level in the *whole* economy. The averaging scheme for money stock deflator was chosen for the sake of consistency with inflation expectations variable, which will be explained below.

Scale variable

As was mentioned in Chapter 1, in the framework of money-as-an-asset approach, money demand is viewed as a part of wealth allocating problem. Therefore, the most appropriate scale variable here would be some measure of wealth. However, wealth is often difficult to evaluate and proper data are rarely available even in countries with well-developed statistics gathering institutions (Sriram 1999).

Given quality of Ukrainian statistics, it could be risky even to follow a wide-spread practice in international economic literature and take GDP as a scale variable[9] and the need for more trustworthy scale variable is evident. A promising candidate would be volume of industrial output, which is collected more accurately and is used as a basis for monthly GDP estimation. Or, as an alternative, volume of sales of industrial products could be employed.

Table 1. Structure of output and value added by economic sectors, %

	1998	1999	2000	2001	2002*
Output					
Goods	63.6	65.4	66.6	63.8	63.2
Industrial production	***43.3***	***46.5***	***47.0***	***46.2***	***46.7***
Agriculture	14.8	13.6	14.5	13.6	12.8
Other	5.5	5.5	5.1	4.0	3.7
Services	36.4	34.6	33.4	36.2	36.8
Value added					
Goods	50.4	52.8	53.4	45.1	47.3
Industrial production	***29.8***	***32.8***	***31.4***	***27.1***	***30.5***
Agriculture	13.7	13.5	16.3	14.4	13.4
Other	6.9	6.5	5.7	3.6	3.4
Services	49.6	47.2	46.6	54.9	52.7

Source: the State Statistics Committee of Ukraine

**Note: preliminary figures are reported for 2002*

As can be seen from annual data presented in Table 1, the share of industrial production in total output and creation of value added is fairly stable over the period of investigation. Therefore, in this respect use of industrial production is valid. However, both indicators, volumes of industrial production and volumes of industrial product sales, are reported in nominal terms as *cumulative* figures from the beginning of the respective year. Disaggregating cumulative numbers is not entirely correct procedure, which is likely to bring inaccurate monthly figures. Nevertheless, we are inclined to believe that these errors in data will be of less

[9] The problem with measuring GDP lies in the procedure of monthly data collection. Short-term GDP figures (monthly and quarterly) are reported by the State Statistics Committee in order to provide general information about macroeconomic development in the country. The precision of monthly figures are very doubtful, since they are calculated solely by the means of production method and grounding on statistics of industrial enterprises output adjusted for estimated trend coefficients and expert's opinions. Furthermore, while annual GDP figure is calculated accurately and revised several times afterwards, monthly GDP data are never corrected, even if discrepancy between sum of rough monthly figures and accurately computed annual number is huge.

magnitude than monthly estimations of GDP reported by the SSC. Thus, either of the disaggregated indicators of industrial sector development could become a passable proxy for a scale variable.

Both variables are available since the end of 1997; therefore, the only possible start-date for our data sample is January 1998. In the process of econometric exercises it appeared that regressions with *volumes of industrial products sales* (*indp*) exhibited slightly better properties; consequently, exactly this variable was eventually chosen to represent the scale variable.

Opportunity costs

To find the appropriate measure for opportunity costs we should first define a set of assets available for Ukrainians as an alternative to national currency holdings. From Chapter 1 it follows that starting from 1998 there was little chance for an Ukrainian resident to invest abroad because of strict administrative restrictions imposed on operations with foreign financial assets. Due to underdevelopment of bond and stock markets in Ukraine the opportunities to allocate wealth inside the country were also restricted.

In general, portfolio allocating decisions of economic agents in Ukraine were strongly affected by quickly changing economic environment. During the period of investigation, Ukraine experienced sharp depreciation of national currency, which started after 1998 Russian crisis and was followed by accelerating inflation rates. As a result, risk averse economic agents were looking for assets that could secure them from growing prices and loss of national currency value. It is very likely, that in Ukraine the set of assets alternative to national currency holdings was confined to (i) foreign currency (both cash and bank deposits) and (ii) real assets.

The opportunity costs of holding national money instead of other assets is represented by return on these assets. The return on real assets is usually measured by expected inflation, whereas return on foreign currency holdings is gauged by expected depreciation of domestic currency. Choice of expectation proxies is given below.

- **Expected inflation**

People's expectation towards inflation is a powerful factor that has strong influence not only on the demand for money, but on the development of other macroeconomic indicators. Properly measured expectations would give important signals to policy-makers and would greatly facilitate conduct of monetary policy, not to mention their importance for economic research like this. However, assessing peoples behaviour is rather complicated task and survey data are rarely available. As a result, for money demand studies researchers have to adopt (more or less arbitrarily) some behaviour assumption and to chose inflation expectation proxy basing on the assumption.

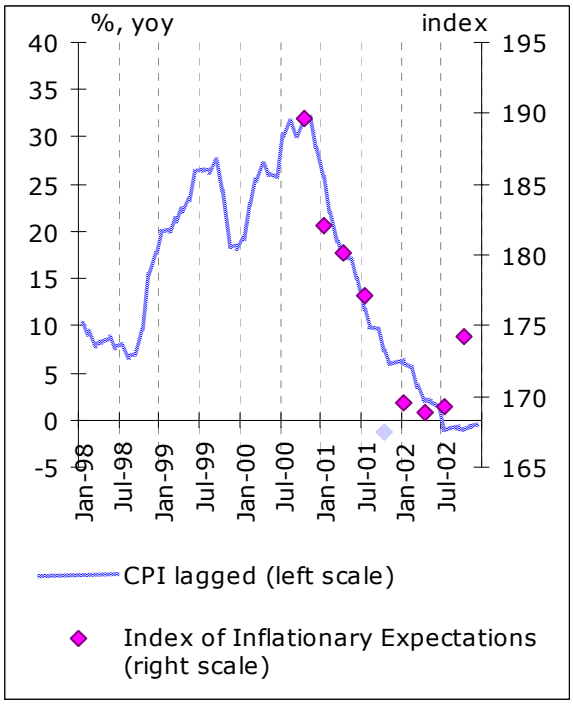
We assume that expectations of economic agents follow adaptive mechanism, thus anticipated inflation can be approximated by lagged values of inflation rate[10]. However, the questions of the very price index (CPI, PPI, or some composite) as well as representation of inflation figures (year-over-year, month-over-month, etc.) remain unanswered. The problem can be solved by the means of a recently initiated survey of Ukrainian households[11] that includes question about people's perception of future price changes. Though the survey started at the end of 2000 and covers less than half of our sample, it still could be very helpful in choosing the price index and its representation, which approximates inflation expectations best.

[10] The same is done, for example, by Asilis, Honohan, and McNelis (1993). For other inflation expectation proxies used in money demand studies refer to Sriram (1999).

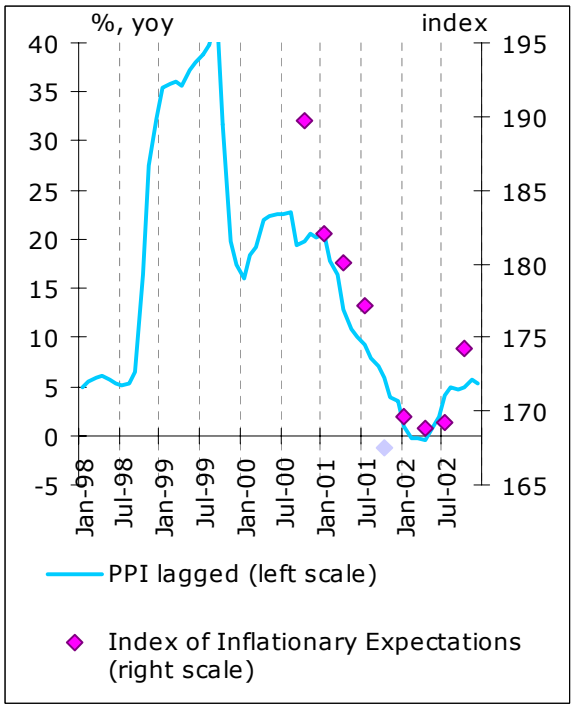
[11] The survey is conducted quarterly by the GfK-USM company and the International Centre for Policy Studies, Kyiv, Ukraine, and is representative in region, gender, and age. An important caveat is that the interviewed people are chosen randomly, which sometimes leads to unexplainable outliers. Nevertheless, omitting outlying points the survey gives good picture of people's perception towards future economic development.

Figure 4. Alternative measures of inflation expectations

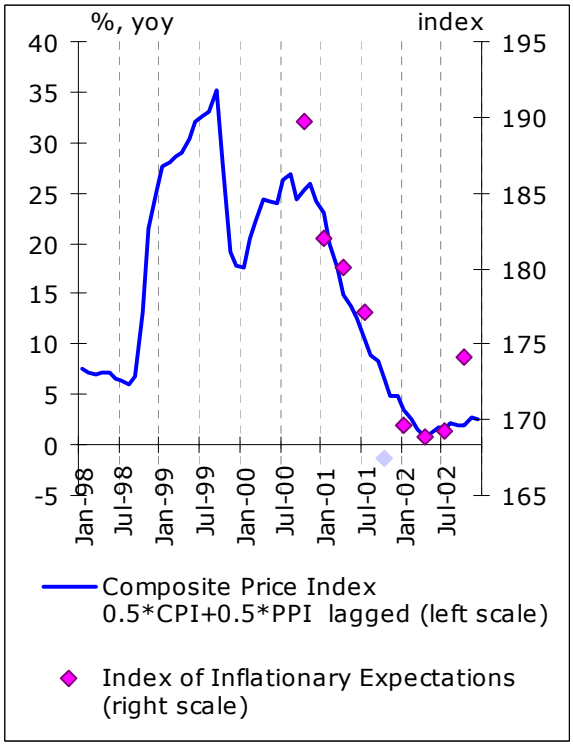
a)



b)



c)



Note: Obvious survey outlier at the end of 2001 was not taken into considerations

The visual inspection of the survey based Index of Inflationary Expectations clearly evidence that year-over-year representation of price indices' dynamics fits best. As can be seen from Panels a) and b) of Figure 4, both CPI or PPI individually reflect inflation expectations quite well but during the different time periods: reflected by the survey anticipated increase in prices at the end of our sample is not captured by CPI development, whereas actual PPI dynamics at the end of 2000 is slower than people's projections. It appeared that averaging of two series (shown on Panel c) of the Figure) extenuates these shortfalls better than other combinations of indices. Thus, we use lagged average between PPI and CPI, denoted as π^{exp}, to approximate inflation expectation. For the sake of consistency, the same index is employed as a deflator for money stock variable.

- **Expected depreciation**

Expected depreciation is a key variable in this research; therefore, accurate measure of expected depreciation is of extreme importance for us. Similar to the situation with measuring inflation expectations, there is no conformity among economists as to the best variable that reflects people's expectations towards future exchange rate. Usually, exchange rate expectations are derived from the forward market for foreign exchange. The dynamics of forward rate allows researchers to get at least a rough idea about expectations towards future movements of exchange rate. However, since forward operations with foreign currency are not developed in Ukraine, we have only one way out: try various proxies that intuitively could be plausible measure of expected depreciation.

In constructing expected depreciation proxies we will follow our assumption of adaptive mechanism. It would be reasonable to assume also, that under conditions of frequently changing economic environment the prior time horizon that people take into account is rather short and period of three months length seems to be reasonable for expectation formation[12].

Among all constructed variables we first of all eliminated those that could potentially produce problems with statistical properties of our regression, e.g. due to strong correlation with other regressors.

Other options were excluded because of absence of cointegration with the regressand and the rest of regressors. In such a way, following Banerji (2002) we tried to use actual depreciation. Many researchers also use level of exchange rate (in logs) as a measure of expected depreciation[13] (Arize, Malinderos and Shwiff 1999, Banerji 2002, Domowitz and Elbadawi 1987, Piontkivsky 2002, etc.). Thus, logarithm of current level of hryvnia/dollar exchange rate was also included in the list of possible proxies. In addition, we considered dollarization of Ukrainian banking sector (ratio of foreign currency deposits within banks to total deposits) as an indicator of peoples projections of future depreciation of national currency. However, we failed to find any cointegration vector in all three cases and excluded these variables from the set of expected depreciation proxies.

As argued by Ortiz (1983) the spread between official exchange rate and the rate determined in the cash exchange market could provide valuable information about expected changes in the exchange rate. Intuitively, the wider the spread the stronger people's believe that national currency will devalue in the nearest future. The hardly solvable problem with this variable in Ukraine is that during the period of investigation various restrictions on foreign cash market were sporadically set and changed by the NBU. To avoid incorporating distorted information we abstain from using unadjusted exchange rate spread.

Thus, the eventual set of expected depreciation proxies consists of three variables:

[12] We tried to incorporate longer periods, but results were much poorer.

[13] Sriram (1999) and Black, Cristofides, and Moumouras (2001) provided arguments why the level of exchange rate may bear important information about people's expectations

1) *wa3m* - weighted average depreciation of Ukrainian hryvnia to US dollar over past 3 months with weight diminishing backward, i.e. the lowest weight is attributed to the most distant months.[14]

2) *stdev3m* – moving-sample standard deviation of hryvnia/dollar official exchange rate over past 3 months. This variable is intended to capture volatility of the exchange rate.

3) *cash_np* - volumes of net purchase of foreign cash by population. Intuitevely, the stronger people' believe that hryvnia will devalue in the future, the more foreign cash they will purchase. Despite the fact that majority of operations with foreign cash in Ukraine service shadow economic activity, this variable could be helpful in tracking dynamics of demand for national currency.

[14] Regression with simple average depreciation produces very similar results.

4. Econometrics

4.1. Preliminary notes

The choice of econometric technique does not evoke many doubts. From the extensive survey of economic literature conducted by Sriram (1999) it follows that error-correction models (ECM) have proven to be the most successful tool for money demand estimations. The ECM is superior to other econometric techniques in one important feature. It gives a possibility for a researcher to explore theory-based long-run relationship between money demand and explanatory variables as well as to analyse dynamics of short-run deviations drawn from the data.

The prior step before applying ECM is to check stationarity of the series. The Pillips-Perron test for unit root[15] applied to levels does not reject hypothesis of unit root implying that all series used in this research are non-stationary. Further testing indicates stationarity in first differences, which means that variables are integrated of order one and could potentially be linked by a common long-run relationship.

Two approaches to estimation of cointegrating equation are widely used in economic literature. The technique of Engle and Granger (1987) includes two steps. Application of OLS procedure to variables expressed in level results in consistent estimate of long-run coefficients. The derived residuals series is then used as an error-correction term in the general ADL specification estimated in first differences. The other approach developed by Johansen (1988) and Johansen and Juselius (1990) allows for multiple cointegrating equations and is known to be more efficient.

According to Sriram (1999), there is a tendency in recent money demand studies to derive benefits from more efficient multivariate procedure of Johansen and Johansen-Juselius, whereas univariate two-step procedure of Engle-Granger is more often applied in earlier works. Charemza and Deadman (1999), however, suggest that for a single-equation modelling Johansen method is used as an auxiliary tool. We will follow this advice and concentrate on the Engle-Granger procedure.

4.2. Long-run relationship

The estimated long-run equation can be expressed in a general form as:

$$\log(m) = \gamma + \alpha * \log(indp) + \beta_1 * \pi^{\exp} + \beta_2 * depr^{\exp}$$

where m – money stock in real terms defined in Chapter 3;

$indp$ – scale variable represented by volume of industrial product sales (deflated by PPI);

π^{exp} – expected inflation, measures opportunity costs of holding national currency instead of real assets;

$depr^{exp}$ – proxy for expected depreciation, intended to measure opportunity costs of holding national currency as opposed to foreign currency.

Coefficient on the scale variable represents elasticity of money demand with respect to income, whereas opportunity costs coefficients represent corresponding semi-elasticities. Expected signs of estimated coefficients are $\alpha>0$, $\beta_1<0$, and $\beta_2<0$.

[15] Test results are presented in Table A1 in Appendix.

Our econometric specifications differ by the proxy used to measure the opportunity costs of holding national money instead of foreign currency. Since the question of interest is size of individual effect of each expected depreciation proxy on the money demand function, we should run a regression which includes as many proxies as possible. However, incorporating all three proxies in one specification could yield problems, because two variables, *wa3m* and *stdev3m*, are strongly correlated. This is not surprising, considering that stronger depreciation implies higher volatility of the exchange rate. To avoid multicollinearity problem we will refrain from regressions, which include strongly correlated variables.

Thus, two specifications (S1 and S2) are estimated. S1 includes *wa3m* and *cash_np* as proxies for expected depreciation, whereas S2 includes *stdev3m* and *cash_np.* Coefficients obtained from applying OLS procedure to the whole sample are presented in Table 2.

At first glance, regressions look very promising – all estimated coefficients are of expected sign, although income elasticity is greater than unity, which is quite unusual. However, when Augmented Dickey-Fuller test is applied to account of serial correlation, stationarity of residuals is not detected: in both cases second augmentation lag is significant and corresponding ADF test statistics (shown in the last column of Table 2) is lower (in absolute terms) than MacKinnon critical values.

Table 2. Long-run relationship estimated on the *whole sample*

			$depr^{exp}$					
	indp	π^{exp}	*wa3m*	*stdev3m*	*cash_np*	*c*	$\overline{R}^2$	*Augmented DF test (augmentation lag 2)*
S1	1.351	-0.009	-0.008	--	-0.021	-0.562	0.86	-2.572
	(0.133)	(0.002)	(0.005)		(0.011)	(0.562)		
S2	1.352	-0.009	--	-0.195	-0.025	-0.563	0.85	-2.557
	(0.134)	(0.001)		(0.137)	(0.009)	(0.569)		

Standard errors are in parenthesis[16]
Asymptotic McKinnon critical value for cointegration test at 10% significance level is –3.81

As becomes evident from graphical representation of recursively estimated coefficients (shown in Figure A1 in Appendix), the long-run money demand function is quite unstable. Especially sharp change is observed in coefficient on expected inflation variable: it starts to reduce quickly at the end of 2000. In addition, the Ramsey RESET test has P-values close to zero, strongly indicating some specification error. Thus, it seems that the estimated long-run money demand function is subject to structural change somewhere at the end of 2000. Indeed, the Chow breakpoint test applied sequentially to the several data points at the end of 2000 - beginning of 2001 also does not reject hypothesis of structural break.

In this respect it is important to recall behaviour of exchange rate during the period of investigation. As was already discussed in Chapter 1, from 1998 till the end of 2000 hryvnia was depreciating constantly despite all efforts of the National Bank of Ukraine directed to retain value of national currency. Only at the end of 2000 the exchange rate was eventually stabilized and its further development was marked only by small fluctuations. Thus, presence of structural change in the money demand function exactly after first signs of exchange rate stability designates that actions of economic agents under the circumstance of high uncertainty and depreciation risk differ from their behaviour in times of stable exchange rate. The nature of this difference may become apparent when we compare money demand determinants in two sub-periods.

[16] Since the estimated standard errors obtained from applying OLS procedure to non-stationary series are not consistent, conclusions regarding significance of coefficients could be misleading.

Since it is difficult to find out the exact month of change in model parameters, for the sake of simplicity, we break our sample exactly between two years. Thus, new long-run relationships are estimated on two sub-samples: 1) Jan-98 -- Dec-00 and 2) Jan-01 -- Dec-02.

Properties of the OLS regression estimated on the *first* sub-sample are much better. Application of ADF test to residuals indicates that no augmentation for autocorrelation is required. As can be inferred from the DF test statistics reported in the last column of Table 3a), residuals of specification S1 and S2 are stationary. Ramsey RESET test does not reject hypothesis of correct specification and recursive coefficients are pretty stable (see Figure A2 in Appendix).

It should be emphasised that stability of coefficients is ensured only when expected depreciation proxies are added to the equations.

Table 3. Long-run relationship estimated on the *first* sub-sample, Jan-98 -- Dec-00

a) initial specifications

			$depr^{exp}$					
	indp	π^{exp}	*wa3m*	*stdev3m*	*cash_np*	*c*	$\overline{R}^2$	*DF test for residuals*
S1	**0.489**	**0.000**	**-0.005**	**--**	**-0.020**	**2.554**	**0.75**	**-3.826**
	(0.088)	**(0.001)**	**(0.002)**		**(0.005)**	**(0.356)**		
S2	**0.499**	**0.000**	**--**	**-0.130**	**-0.024**	**2.654**	**0.75**	**-4.132**
	(0.089)	**(0.001)**		**(0.057)**	**(0.005)**	**(0.361)**		

b) modified specifications

			$depr^{exp}$					
	indp	π^{exp}	*wa3m*	*stdev3m*	*cash_np*	*c*	$\overline{R}^2$	*DF test for residuals*
S1a	0.482	--	-0.005	--	-0.019	2.734	0.75	-3.758
	(0.086)		(0.002)		(0.004)	(0.352)		
S2a	0.476	--	--	-0.146	-0.023	2.762	0.75	-4.022
	(0.087)			(0.055)	(0.004)	(0.355)		

Standard errors are in parenthesis
Asymptotic McKinnon critical value for cointegration test at 10% significance level is –3.81 for S1 and S2, and -3.45 for S1a and S2a.

Comparing Tables 2 and 3a, it is evident that coefficients obtained from regressing money demand function on first sub-sample are considerably different from the whole-sample estimates. Coefficient on *indp* is less than one, which conforms to the international empirical evidence[17]. As anticipated, expected depreciation enters long-run money demand function with negative sign regardless of a particular proxy. In contrast to the whole-sample estimates, expected inflation measuring return on real assets seems to have no explanatory power for long-run dynamics of money demand, since its semi-elasticity is very close zero. This finding may suggest that during the period of continuous depreciation of national currency economic agents did not perceive real assets as a attractive component of their asset portfolios. Wealth was allocated basically between national money (both cash and bank deposits) and foreign currency (cash and deposits as well).

Since inflation appeared to be unimportant, we tried to exclude inflation variable from the cointegrating equation. As shown in Table 3b, this exercise resulted in similar coefficients of other variables, but lower values of the DF test statistic Thus, in our short-run analysis of money demand behaviour in the first sub-period we will use initial equations S1 and S2.

[17] Feige and Pearce (1977) provide list of elasticities obtained by other researches.

Cointegration between the examined variables is also revealed on the *second* sub-sample. However, properties of long-run relationship estimated on the second sub-sample are not so promising. As can bee seen from Table 4 coefficients of income and inflation are sensitive to the proxy used for expected depreciation and coefficient of *wa3m* has a "wrong" sign. Stability of coefficients is not preserved (see Figure A3) and some specification error is detected by the Ramsey RESET test.[18]

All these problems could be readily attributed to the insufficient number of data-points in the second sub-sample. However, the following explanations also seems to be reasonable in this respect. We have already ascertained that there was a shift in people's attitude towards national currency, evoked most probably by stabilization of the exchange rate. Yet economic agents cannot shift from one state to another immediately. Confidence in national currency is restored very slowly and movement from the old steady state to the new one can take a long time. In other words, our findings demonstrate that coefficients of the cointegrating relationship between money, income, inflation and exchange rate were undergoing changes during the period of 2001 – 2002, and it seems that new steady state has not been reached yet. If so, the nature of new long-run relationship could be assesses only as time passes and new data become available. So far, only first difference equations could be estimated on the second sub-sample to explore the short-run dynamics of money demand.

Table 4. Long-run relationship estimated on the *second* sub-sample, Jan-01 -- Dec-02

			$depr^{exp}$					
	indp	π^{exp}	*wa3m*	*stdev3m*	*cash_np*	*C*	$\overline{R}^2$	*DF test for residuals*
S1	0.838	-0.021	0.147	--	-0.006	1.772	0.94	-3.833
	(0.122)	(0.002)	(0.063)		(0.011)	(0.529)		
S2	0.660	-0.025	--	-4.211	-0.003	2.582	0.96	-4.074
	(0.132)	(0.002)		(1.392)	(0.009)	(0.584)		

Standard errors are in parenthesis
Asymptotic McKinnon critical value for cointegration test at 10% significance level is –3.81

4.3. Short-run dynamics

Since long-run relationship is prone to substantial changes, it is highly likely that short-run dynamics was also different in two sub-periods. Thus, the short-run equations are estimated separately on two sub-samples (the error correction models (ECM) on the first one and first deference equations on the second one) by means of general to specific approach. Due to small sample size we cannot afford including more than two lags of each variable in general equations. The reduced forms of short-run ECM specifications are presented in Table 5a. Removal of insignificant terms from the first difference equations resulted in identical reduced forms, reported in Table 5b.[19]

The reduced short-run equations are subject to several principal tests. The zero autocorrelation in residuals is not rejected by the Breusch-Godfrey serial correlation LM test (P-values of the test statistics are above 0.3). There is no significant evidence of misspecification, since P-values of the Ramsey RESET test for specification error lie in range from 0.1 to 0.25, which is quite good given the sample size. Recursive coefficients of short-run equations exhibit stable dynamics. Residuals are always normal as suggested by the P-values of Jarque-Bera normality test lying above 0.4 figure.

[18] We tried many specifications in addition to S1 and S2, but none of them survived the specification tests.

[19] The coefficients of initial (general) equations are presented in Tables A2 – A5 in Appendix. The step-by-step procedure of elimination of unnecessary components is also described there.

Table 5. Short-run reduced equations

a) ECM estimated on the *first* sub-sample, Jan-98 -- Dec-00

S1

Dependent Variable: Δm
Method: Least Squares
Sample(adjusted): 1998:03 2000:12
Included observations: 34 after adjusting endpoints

Variable	Coef	Std. Error	t-Stat	Prob.
Δm(-1)	0.41713	0.129382	3.22404	0.0030
Δindp	0.18610	0.058262	3.19429	0.0033
Δcash_np	-0.00991	0.003697	-2.68120	0.0118
EC(-1)*	-0.30820	0.123252	-2.50062	0.0181

R-squared	0.660455	Mean dep var	0.0055
Adjusted R-sq	0.599822	S.D. dep var	0.0357
Regression S.E.	0.022631	Akaike info criter	-4.588
Sum sq resid	0.021588	Schwarz criterion	-4.310
Log likelihood	76.90934	F-statistic	9.563
DW stat	1.858781	Prob(F-statistic)	0.000

**Note: EC stands for error correction term.*

S2

Dependent Variable: Δm
Method: Least Squares
Sample(adjusted): 1998:03 2000:12
Included observations: 34 after adjusting endpoints

Variable	Coef	Std. Error	t-Stat	Prob.
Δm(-1)	0.421175	0.128118	3.2873	0.0026
Δindp	0.190699	0.057973	3.2894	0.0026
Δcash_np	-0.010748	0.003591	-2.9932	0.0055
EC(-1)*	-0.313072	0.118416	-2.6438	0.0129

R-squared	0.543692	Mean dep var	0.005
Adjusted R-sq	0.537742	S.D. dep var	0.035
Regression S.E.	0.021558	Akaike info criter	-4.308
Sum sq resid	0.021159	Schwarz criterion	-4.129
Log likelihood	77.25135	F-statistic	9.961
DW stat	1.826071	Prob(F-statistic)	0.000

b) First difference equation estimated on the *second* sub-sample, Jan-00 -- Dec-02

S1 and S2

Dependent Variable: Δm
Method: Least Squares
Sample(adjusted): 2001:01 2002:12
Included observations: 24 after adjusting endpoints

Variable	Coef	Std. Error	t-Stat	Prob.
Δindp	0.105336	0.045661	2.3069	0.0325
Δindp(-1)	-0.146796	0.050421	-2.9114	0.0090
Δindp(-2)	-0.110022	0.044924	-2.4490	0.0242
Δcash_np(-2)	-0.008679	0.003077	-2.8203	0.0109
const	0.031503	0.002992	10.529	0.0000

R-squared	0.560465	Mean dep var	0.0300
Adjusted R-sq	0.497932	S.D. dep var	0.0186
Regression S.E.	0.013374	Akaike info criter	-5.5782
Sum sq resid	0.003501	Schwarz criterion	-5.3328
Log likelihood	71.93910	F-statistic	6.0568
DW stat	2.004240	Prob(F-statistic)	0.0025

Coefficient on error correction term reported in Table 5a shows that during 1998-2000 some 30% of the disequilibrium was corrected in the subsequent month. The dynamics of real income affects short-run adjustment of the demand for money in both periods. However, inflation appears to be unimportant determinant throughout the whole period of investigation. Among examined proxies for expected exchange rate net purchase of foreign cash affects adjustment process. Thus, there is evidence that dollarization affects short-run dynamics of money demand as well.

5. Conclusions

This paper attempts to assess influence of dollarization on the behaviour of demand for national currency in Ukraine. The problem of dollarization, which traces its roots back to periods of hyperinflation just after independence, became especially acute ain the aftermath of 1998 Russian crisis. Only after 2000, when exchange rate was eventually stabilized and Ukraine experienced first sign of economic recovery, the tendency to de-dollarization was observed in the banking sector. At the same time, expansion of money demand took place, as indicated by rapidly growing monetary aggregates and reducing inflation. It is likely that increase in the demand for real balances was to a large extent induced by growing confidence of population to national currency and consequent substitute of foreign currency holdings by domestic money. Since considerable part of foreign assets circulates in Ukraine in the form of cash, for which reliable data do not exist, only indirect assessment of de-dollarization effect on the money demand could be performed. For this purpose money demand function that includes various proxies of return on foreign currency holdings is estimated in this study.

Monthly data are used in the analysis. The paper places high emphasis on the quality of data, which is known to be poor in transition countries. To avoid inclusion of unreliable data the period of investigation is constrained to five years, from 1998 through 2002. Following the general money-as-an-asset approach, the paper concentrates on the demand for broad money, measured by the monetary aggregate M2 less foreign currency deposits. Volumes of industrial product sales is used as a scale variable, whereas the set of opportunity cost variables includes measure of expected inflation and three depreciation proxies. Two specifications, S1 and S2, are estimated with two depreciation proxies in each. The Engle-Granger procedure is applied to estimate the error-correction models. The main findings of this paper are as follows:

1) The structural shift in the long-run demand for money in the end of 2000 – beginning of 2001 is proved empirically. Presence of structural change just after first sign of exchange rate stability may signal that behaviour of economic agents under circumstances of depreciation risk differ from their actions in times of stable exchange rate. To explore the nature of this change both specifications were estimated before and after the break.

2) Stability of the long-run money demand function during the period of continuous depreciation of hryvnia (first sub-period) is proved only when expected depreciation proxies are introduced in the long-run equation. These proxies enter money demand function with anticipated negative sign.

3) From the first sub-sample estimate it follows that coefficient of expected inflation variable is almost zero, thus, inflation is likely to have no influence on the LR money demand function when there is high risk of depreciation. In other words, wealth seems to be allocated between two assets - national and foreign currency (both cash and deposit).

4) Attempts to find stable long-run money demand function on the second sub-period were unsuccessful. This can be attributed to rather small size of second sub-sample or to the sluggish adaptation of economic agents to new stable conditions. If so, effect of exchange rate stabilization and concomitant de-dollarization process can be assessed when new data become available.

5) The short-run dynamics of money demand function is also affected by one of the expected depreciation proxies.

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Appendix

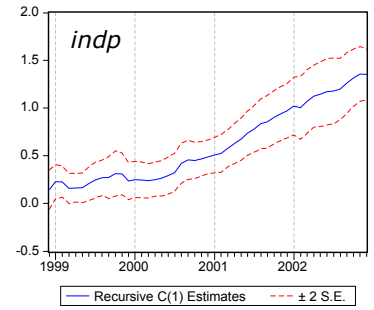
Table A1. Descriptive statistic of variables

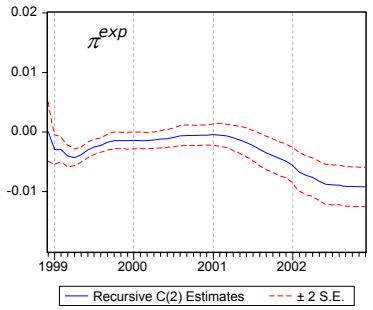
	log (m)	log(indp)	π^{exp}	$depr^{exp}$		
				wa3m	*stdev3m*	*cash_np*
Mean	4.872	4.142	15.318	1.867	0.070	0.311
Median	4.753	4.131	14.359	0.134	0.014	0.050
Maximum	5.515	4.522	35.253	21.255	0.619	7.140
Minimum	4.499	3.849	0.802	-0.673	0.000	-4.300
Std. Dev.	0.310	0.140	10.704	3.922	0.126	1.846
Skewness	0.779	0.438	0.153	3.127	2.359	1.176
Kurtosis	2.298	3.221	1.566	13.762	8.393	5.890
Jarque-Bera	7.299	2.045	5.375	387.432	128.403	34.733
Probability	0.026	0.360	0.068	0.000	0.000	0.000
Observations	60	60	60	60	60	60
Phillips-Perron test statistic for levels*	1.464	-1.428	-1.111	-3.045	-3.332	-2.932
Phillips-Perron test statistic for 1st differences	-4.719	-12.003	-3.867	-4.042	-5.503	-7.929

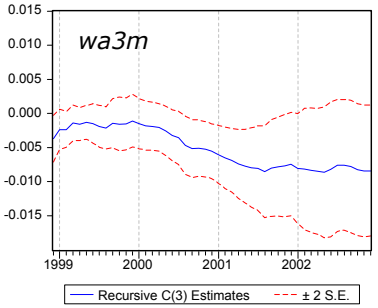
** 1% MacKinnon critical values for rejection of hypothesis of a unit root are –3.544 for levels and –3.546 for first differences.*

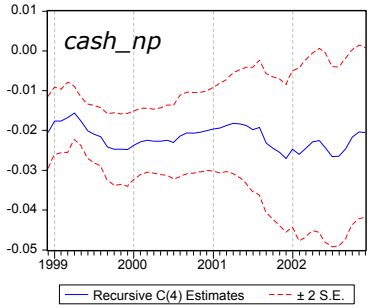
Figure A1. Recursive coefficients of the long-run equation, **whole** sample estimate

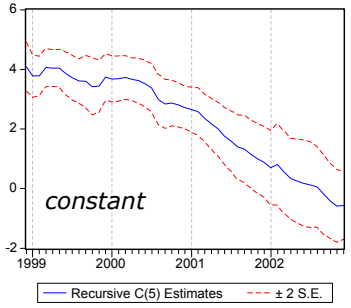
S1



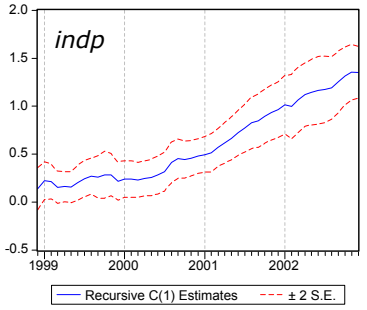


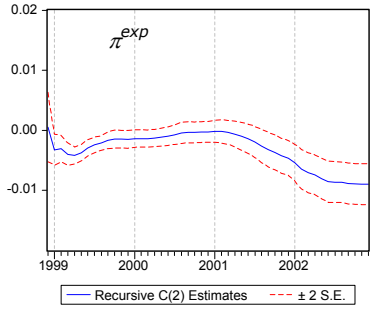


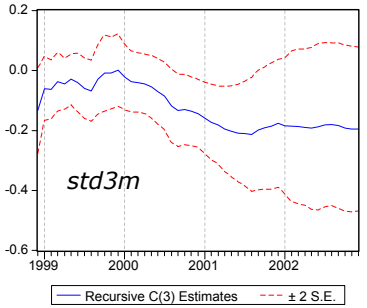


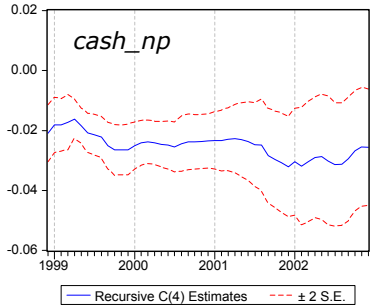


S2









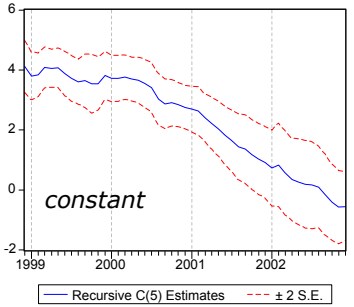
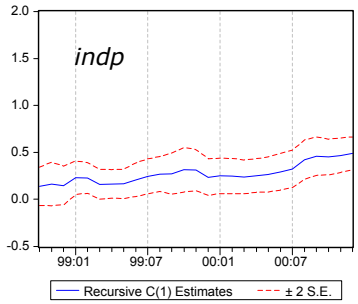
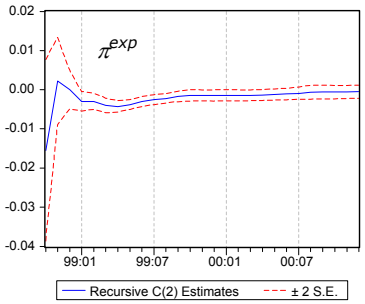
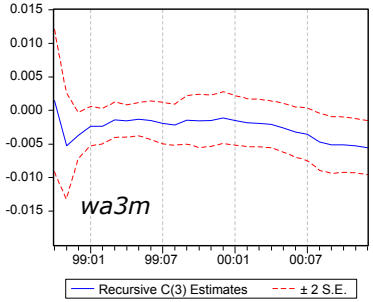


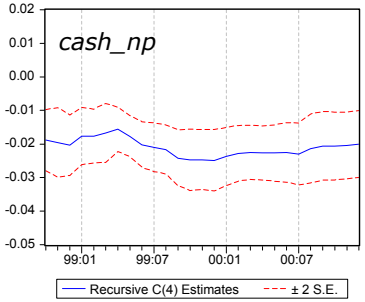
Figure A2. Recursive coefficients of the long-run equation, **first** sub-sample estimate

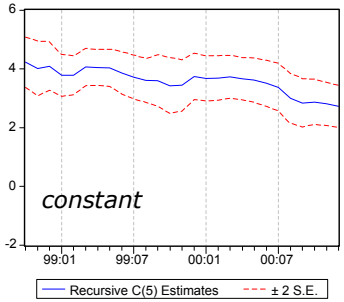
S1



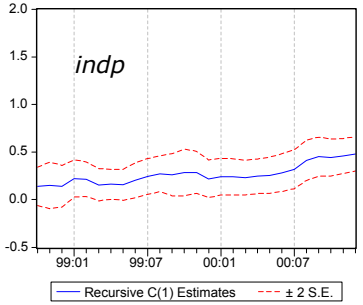


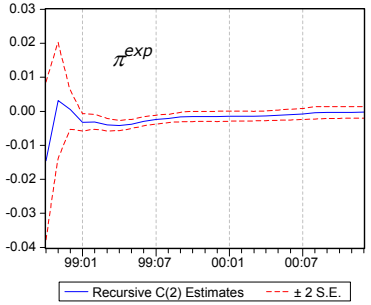


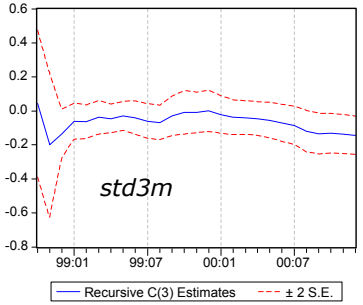


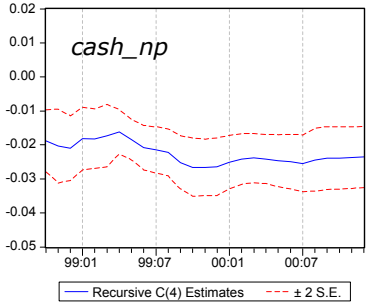


S2









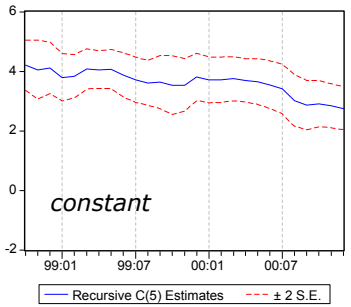
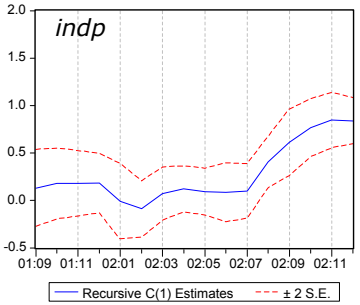
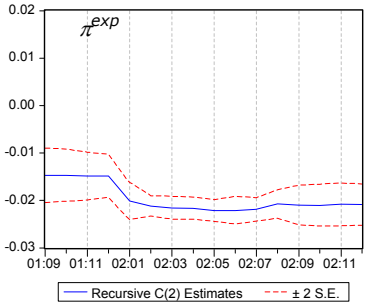
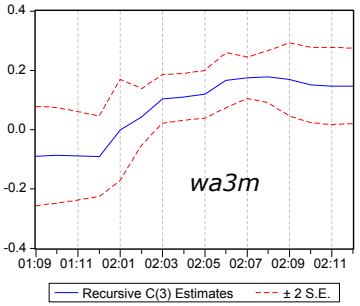


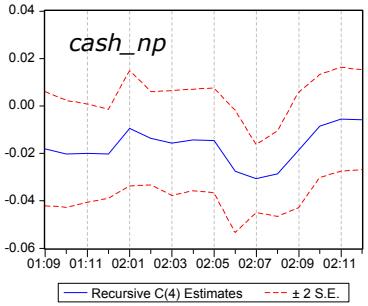
Figure A3. Recursive coefficients of the long-run equation, **second** sub-sample estimate

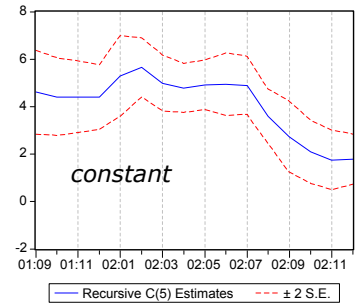
S1



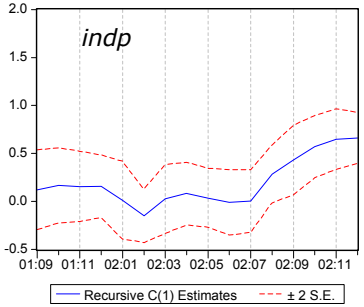


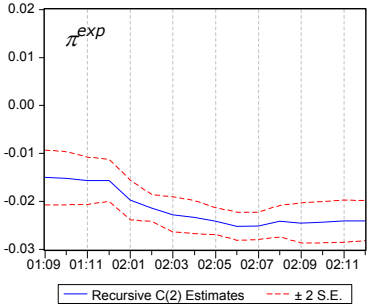


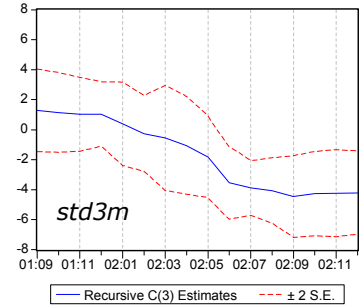


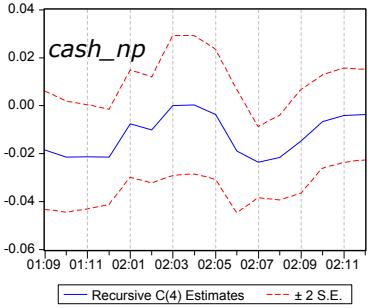


S2









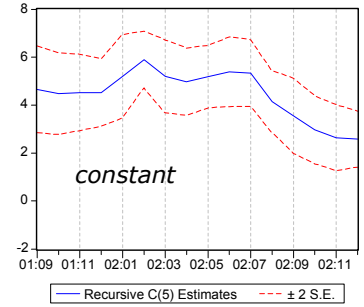


Table A2. Specification **S1**: short-run ECM estimated on the **first** sub-sample

a) general form

Dependent Variable: Δm
Method: Least Squares
Sample(adjusted): 1998:03 2000:12
Included observations: 34 after adjusting endpoints

Variable	Coef	Std. Error	t-Stat	Prob.
Δm(-1)	0.33197	0.259438	1.279591	0.2179
Δm(-2)	0.203919	0.190636	1.069681	0.2997
Δindp	0.151599	0.105504	1.436900	0.1689
Δindp(-1)	-0.048870	0.089930	-0.543418	0.5939
Δindp(-2)	-0.032242	0.094840	-0.339964	0.7380
$\Delta\pi^{exp}$	9.46E-05	0.002731	0.034654	0.9728
$\Delta\pi^{exp}$(-1)	0.005954	0.003917	1.519941	0.1469
$\Delta\pi^{exp}$(-2)	-0.002649	0.002946	-0.899216	0.3811
Δwa3m	-0.000984	0.002393	-0.411238	0.6860
Δwa3m(-1)	0.001014	0.002758	0.367793	0.7176
Δwa3m(-2)	0.000670	0.002044	0.327526	0.7473
Δcash_np	-0.014034	0.004532	-3.096816	0.0065
Δcash_np(-1)	-0.007717	0.006405	-1.204851	0.2448
Δcash_np(-2)	0.002367	0.005927	0.399349	0.6946
EC(-1)	-0.162280	0.195840	-0.828637	0.4188
const	-0.001798	0.004855	-0.370373	0.7157

R-squared	0.713175	Mean dep var	0.003564
Adjusted R-sq	0.460095	S.D. dep var	0.034331
Regression S.E.	0.025226	Akaike info criter	-4.215494
Sum sq resid	0.010818	Schwarz criterion	-3.489915
Log likelihood	85.55565	F-statistic	2.817977
DW stat	1.727252	Prob(F-statistic)	0.021452

b) step-by-step reduction

Step	Redundant variables	P-value of Wald test	S.E. of regression	Adjusted R-squared	SC
0	Δm(-2), Δindp(-2), $\Delta\pi^{exp}$(-2), Δwa3m(-2), Δcash_np(-2)	0.860	0.025	0.494	-3.757
1	Δindp(-1), Δwa3m(-1), const	0.655	0.024	0.536	-4.030
2	$\Delta\pi^{exp}$, $\Delta\pi^{exp}$ (-1), Δwa3m, Δcash_np(-1)	0.592	0.023	0.599	-4.310

Table A3. Specification **S2**: short-run ECM estimated on the **first** sub-sample

a) general form

Dependent Variable: Δm
Method: Least Squares
Sample(adjusted): 1998:03 2000:12
Included observations: 34 after adjusting endpoints

Variable	Coef	Std. Error	t-Stat	Prob.
Δm(-1)	0.291001	0.252171	1.153981	0.2645
Δm(-2)	0.198128	0.189088	1.047805	0.3094
Δindp	0.174726	0.089320	1.956185	0.0671
Δindp(-1)	-0.034875	0.080293	-0.434345	0.6695
Δindp(-2)	-0.003755	0.074861	-0.050155	0.9606
$\Delta\pi^{exp}$	-3.76E-05	0.002819	-0.013353	0.9895
$\Delta\pi^{exp}$(-1)	0.007149	0.003612	1.979483	0.0642
$\Delta\pi^{exp}$(-2)	-0.003735	0.002915	-1.281165	0.2173
Δstd3m	-0.032899	0.078732	-0.417859	0.6813
Δstd3m(-1)	0.007791	0.065641	0.118695	0.9069
Δstd3m(-2)	0.020143	0.063972	0.314878	0.7567
Δcash_np	-0.014187	0.004416	-3.212458	0.0051
Δcash_np(-1)	-0.008129	0.005990	-1.357057	0.1925
Δcash_np(-2)	0.001840	0.006680	0.275453	0.7863
EC(-1)	-0.147126	0.193326	-0.761025	0.4571
const	-0.002027	0.004733	-0.428334	0.6738

R-squared	0.719517	Mean dep var	0.003564
Adjusted R-sq	0.472032	S.D. dep var	0.034331
Regression S.E.	0.024945	Akaike info criter	-4.237852
Sum sq resid	0.010579	Schwarz criterion	-3.512273
Log likelihood	85.92456	F-statistic	2.907316
DW stat	1.712105	Prob(F-statistic)	0.018609

b) step-by-step reduction

Step	Redundant variables	P-value of Wald test	S.E. of regression	Adjusted R-squared	SC
0	Δm(-2), Δindp(-2), $\Delta\pi^{exp}$(-2), Δstd3m(-2), Δcash_np(-2)	0.777	0.024	0.518	-3.802
1	Δindp(-1), Δstd3m(-1), const	0.893	0.023	0.552	-4.001
2	$\Delta\pi^{exp}$, $\Delta\pi^{exp}$(-1), Δstd3m, Δcash_np(-1)	0.295	0.021	0.537	-4.109

Table A4. Specification **S1**: first difference equation estimated on the **first** sub-sample

a) general form

Dependent Variable: Δm
Method: Least Squares
Sample(adjusted): 2001:01 2002:12
Included observations: 24 after adjusting endpoints

Variable	Coef	Std. Error	t-Stat	Prob.
Δm(-1)	0.238445	0.261659	0.911283	0.3859
Δm(-2)	-0.430576	0.318646	-1.351269	0.2096
Δindp	0.031273	0.074797	0.418107	0.6857
Δindp(-1)	-0.181288	0.079682	-2.275135	0.0490
Δindp(-2)	-0.108339	0.069303	-1.563265	0.1524
$\Delta\pi^{exp}$	0.014102	0.006247	2.257610	0.0504
$\Delta\pi^{exp}$(-1)	-0.006990	0.004983	-1.402659	0.1943
$\Delta\pi^{exp}$(-2)	-0.007819	0.003964	-1.972463	0.0800
Δwa3m	-0.025746	0.040169	-0.640933	0.5375
Δwa3m(-1)	0.054757	0.040750	1.343728	0.2119
Δwa3m(-2)	-0.042157	0.040061	-1.052335	0.3201
Δcash_np	0.004253	0.004370	0.973201	0.3559
Δcash_np(-1)	-0.003782	0.003519	-1.074726	0.3105
Δcash_np(-2)	-0.008887	0.003806	-2.334933	0.0444
const	0.037277	0.010530	3.539962	0.0063

R-squared	0.783979	Mean dep var	0.030012
Adjusted R-sq	0.447946	S.D. dep var	0.018609
Regression S.E.	0.013827	Akaike info criter	-5.455265
Sum sq resid	0.001721	Schwarz criterion	-4.718982
Log likelihood	80.46318	F-statistic	2.333041
DW stat	2.257238	Prob(F-statistic)	0.101996

b) step-by-step reduction

Step	Redundant variables	P-value of Wald test	S.E. of regression	Adjusted R-squared	SC
0	Δm(-2), Δwa3m, Δwa3m(-2)	0.471	0.014	0.459	-4.850
1	Δm(-1), $\Delta\pi^{exp}$(-1), Δcash_np	0.938	0.013	0.493	-5.241
2	Δwa3m(-1), Δcash_np(-1)	0.253	0.013	0.501	-5.296
3	$\Delta\pi^{exp}$, $\Delta\pi^{exp}$(-2)	0.149	0.013	0.497	-5.333

Table A5. Specification **S2**: first difference equation estimated on the **second** sub-sample

a) general form

Dependent Variable: Δm
Method: Least Squares
Sample(adjusted): 2001:03 2002:12
Included observations: 22 after adjusting endpoints

Variable	Coef	Std. Error	t-Stat	Prob.
Δm(-1)	0.245499	0.255638	0.960340	0.3620
Δm(-2)	-0.405246	0.317800	-1.275163	0.2342
Δindp	0.029764	0.071641	0.415467	0.6875
Δindp(-1)	-0.210550	0.076116	-2.766165	0.0219
Δindp(-2)	-0.151059	0.073896	-2.044204	0.0713
$\Delta\pi^{exp}$	0.012601	0.006417	1.963739	0.0812
$\Delta\pi^{exp}$(-1)	-0.004751	0.005392	-0.881158	0.4012
$\Delta\pi^{exp}$(-2)	-0.007901	0.004510	-1.751639	0.1137
Δstd3m	0.644994	0.797068	0.809208	0.4393
Δstd3m(-1)	-0.529112	0.673852	-0.785204	0.4525
Δstd3m(-2)	-0.030066	0.722746	-0.041600	0.9677
Δcash_np	0.005852	0.004316	1.355954	0.2082
Δcash_np(-1)	-0.003990	0.003393	-1.175744	0.2699
Δcash_np(-2)	-0.009771	0.003652	-2.675445	0.0254
const	0.037800	0.010404	3.633334	0.0055

R-squared	0.771059	Mean dep var	0.030012
Adjusted R-sq	0.414929	S.D. dep var	0.018609
Regression S.E.	0.014234	Akaike info criter	-5.397179
Sum sq resid	0.001823	Schwarz criterion	-4.660895
Log likelihood	79.76614	F-statistic	2.165106
DW stat	2.252989	Prob(F-statistic)	0.123060

b) step-by-step reduction

Step	Redundant variables	P-value of Wald test	S.E. of regression	Adjusted R-squared	SC
0	Δm(-2), $\Delta\pi^{exp}$(-1), Δstd3m(-2)	0.641	0.014	0.456	-4.881
1	Δm(-1), Δstd3m(-1), Δcash_np(-1)	0.517	0.013	0.476	-5.095
2	Δstd3m, Δcash_np	0.516	0.013	0.495	-5.296
3	$\Delta\pi^{exp}$, $\Delta\pi^{exp}$(-2)	0.145	0.013	0.497	-5.333