VOLATILITY OF VELOCITY IN TRANSITIONAL ECONOMIES: CASE OF UKRAINE

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Abstract

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Money demand is a very important indicator of country performance. Almost all economists' works concerning money demand or inflation assume that velocity of money is stable in a long run and has only tiny seasonal or cyclical variation that is quite small in comparison with the level of velocity. However, in reality velocity varies greatly, especially in countries whose economies suffer from structural shifts due to change of economical system, as for example, Ukraine. The velocity of money in circulation (M0 monetary aggregate) in 1989 was equal to 2.3 and after hyperinflation, velocity peaked in 1993 when it reached 41 (May, 1993; M0 velocity), i.e. it had almost twenty fold increase. Thus, estimates of , for example, inflation on the basis of change in money aggregates can be biased because of omitted variables.

My paper aims to detect whether there is a long time trend in velocity changes in transitional economies or not; and asks whether it is possible to develop a definition of money or output, such that it would render velocity

stable. I do it by analyzing the behavior of inflation, real money balances and interest rate in Ukraine. Econometric analysis was performed and results suggest that inflation is an important determinant of velocity and that there is a linkage between financial and real economy. Results also imply that changes in institutions can as well be an important factor that determines a performance of velocity. Broader definition, on the other hand, does not significantly improves both econometric results and stability of velocity.

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Chapter 1

INTRODUCTION

Preface.

Velocity matters.

The velocity of currency in circulation is one of the crucial parameters of the performance of nominal (monetary) economy as well as the real one. However, the absolute majority of works that concerns the influence of shocks in the nominal variables (e.g. price shocks) on the real economy assumes that velocity is too vague parameter to be used it in the theoretical analysis. As a primary example I can propose the 'x-rate money growth' approach by Milton Friedman (1959), where money should grow at the same rhythm as output does, so the absolute price level remains the same. This approach is actively used by both economists and government officials for measuring the adequacy of monetary policy. Nevertheless, with unstable velocity, all these careful calculations become imprecise. As a result, I think that (a) velocity has not been investigated enough to make any conclusions of its stability or perhaps some people have tried to down-play the existence of instability of it and (b) research should be done in order to give more accurate explanations of economics situation and more reliable estimations of possible changes.

During the last several decades there were endeavors to explain why velocity changes both in developed and developing countries (e.g. Bordo and Jonung). The main reason for such attempts is a fact that with unstable velocity monetary economists cannot make correct predictions of effect of change of money supply in the economy. This, of course, leads to the problems with implementation of monetary policy. For example, Mankiw in his textbook says that:

> "The deep recession that the United States experienced in 1982 is partly attributable to a large, unexpected, and still mostly unexplained decline in velocity"(Mankiw 1997, p. 241).

In developing economies of Latin America shifts were much more volatile than in OECD, causing serious problems for proper prediction of inflation and therefore producing huge swings in the level of real interest rate, causing shrinkage of long-term investments.

All former Soviet Republics suffered from a drastic fall of output at the beginning of transformation. It was caused by a number of factors, but one of the most important was a huge increase in price level that sharply squeezed demand. One of the consequences of price liberalization without adequate structural changes especially in the system of government expenditures was an increase in prices as well as in amounts of money issued. Some countries managed to stop this dangerous self-feeding process, while others, like Ukraine, failed.

Soft budget constraint and financing of deficit through expansionary monetary policy of the Ukrainian government led to hyperinflation in the year 1993. In some months prices doubled in a month[1] (December, 1993 90% monthly inflation, equivalent of 23300% in annual terms!!). At that time up to 64 percent (December, 1992; in December 1993 deficit was 15%) of the state budget were financed via emission (as no bond market existed in 1992, as well as foreign grants or credits, all deficit was financed by issuing money). Unstable money and spurious methods of fighting inflation led to several consequences that are now assumed as the main puzzles of transitional economies. These include dollarization, high real interest rates, inter-firm arrears, barter and a huge drop in production.

From the beginning of 1994, the National Bank of Ukraine adopted very tight monetary policy in order to defeat unprecedented price level increases. as economic theory predicts, real interest rates skyrocketed, during the several months of 1996 they were above 60% (April, 1996 60.8%, May 78.1%, June 72%) thus making investment almost impossible. This led to sharp decline in money demand, as well as to substitution of the official currency with other means of payment, especially foreign currency and barter.

Money demand is one of the classical representatives of 'intangible' fundamentals upon which much of the modern mainstream macroeconomics is based. We cannot measure money demand without additional microeconomic assumptions about the behavior of all the agents in the economy. However, we can calculate the velocity of

[1] All data and its sources are given in appendix.

money. The velocity is commonly described as the ratio of nominal transaction held in economy through the given period of time to the amount of stock of means of payments that exist in economy. This comparison of two items of different nature is often criticized, because it describes relation between flow and stock. Despite this, the velocity of money is the one of the most common proxies that depicts money demand; moreover, other measures of intangible money demand make explicit or implicit assumptions about stability of the velocity.

Despite the existence of a huge number of works on money demand and the theory of money, the general theory of velocity has not been written yet. Maybe it is due to the somehow ambiguous nature of subject, namely that we can find it only as a ratio of other variables. This argument belies the importance of velocity, as the following example shows:

Assume an economy, where 30n persons live ($n \in N_+$). Everyone gets a wage payment (w –monthly wage payment) once per month and spends this money in equal proportion every day, such that at the last day she spends last cent. On the first day she spends $\frac{w}{30}$ and thus $\frac{29w}{30}$ of her money balances are laid idle[2]. So does everyone else in this economy, so together they spend $30n\frac{w}{30} = wn$ during a single day. The **n** persons do not spend the rest of the money at the first day, but hold it (assume that investing money in any short-term project demands too high transaction costs or something similar). Such economy needs **wn** dollars to operate properly. However, if one assumes that all **30n** persons get their monthly payment (**w** –monthly wage) at the beginning of the month (generally at any one point of time, but only at a specific day and (as in the previous case) once per month) then economy needs **30wn** dollars in order to operate properly (monthly wage is w and number of persons that get money is **30n** versus only **n** persons in the previous case).

The third case is when assumption about the same spending across time is violated. If person spends either **0** or $\frac{w}{30}$ or $\frac{2w}{30} = \frac{w}{15}$ each possibility with probability 1/3 then the economy needs **2wn** money to operate properly in the continuous payments (the first case)

[2] Spending is rather continuous over time or discrete, but in any case it does not change between two different days.

or **30wn** in the single payment (the second case). Note that no assumptions about output, or prices were made, but we achieve up to thirty-fold difference in results. If for the second economy one makes a model that is appropriate only for the first one and on basis of this implements monetary policy then he/she will probably go awry and achieve harmful results. I hope that this simple example suggests the importance of velocity as a separate important variable even for not monetary economics oriented economists.

The classical assumption about velocity is that it changes in a stable and predictable manner over long periods of time. However, as twentieth century economic history has shown, predictions about long run behavior of velocity have almost always been wrong. For example Clark (1949) wrote an expressive analysis of 150 years of the US velocity behavior and argued that velocity would continue its soft decline during the next at least 10 years while in fact we can observe 1.3 times growth in the USA velocity during the 1945-1960. Velocity in the most OECD countries showed almost steady decrease in the 50s and 60s, but then it increased sharply in the 70s and 80s. Trends in the developing world were even more volatile, and they are heading in directions that contradict theory, i.e. declining during growth and rising during recessions. This shows the need in wider theory that will account for additional factors that were not included previously because of their negligible importance in the developed economies.

Due to kinship between velocity and money demand, both should be affected by the same variables. The existing literature proposes the following determinants (only several articles mentioned as examples):

1. interest rate, either on credits or deposits; nominal or real, short or long term (Friedman, 1959)
2. inflation, measured by CPI, PPI, deflator or the like (Hanson & Vogel, 1973)
3. exchange rate nominal or real; based on purchasing power parity (PPP) (De Broeck *et al.,* 1997; Brittain, 1981)
4. disposable income or demand for goods and services (Driscoll & Lahiri, 1983; Mayor & Pearl, 1984)

5. group of general descriptors of situation with population, namely median age, urbanization and education levels (Driscoll & Lahiri, 1983; Brodo, 1987).

It is very challenging to try to say anything concrete about behavior of velocity in transition economies, possible trends and determinants of these trends. For Ukraine this topic is especially interesting, because I assume that nominal economy measures like velocity can be interdependent with such transitional phenomena as hyperinflation, high levels of dollarization, huge budget deficits, inter-firms arrears.

Therefore, some of the main questions of this area are:

Why does velocity vary so greatly in transitional economies? Does it exhibit common trend for all countries? Does government policy affect velocity? Can currency (asset) substitution affect velocity? Does a 'broad' definition of money (inclusion of barter, dollarization, inter-firm arrears) or/and output (income) give stable velocity? Does exclusion of velocity trend from inflation prediction gives biased results?

I think that monetary policy greatly affects real economy, thus policy-makers should be extremely careful whether they act or remain passive. One of the underlying assumptions of proponents of softening monetary policy and increasing emission are stable velocity and rigid prices. As a result, in order to accept or deny such policy one should first test whether assumptions are valid. If velocity increases faster than money supply then Ukraine can get another hyperinflation that probably is not a desired outcome.

Structure

In this chapter, I describe by motivation for doing this very topic. *Main idea: velocity matters,* thus it should be investigated more closely, as I attempt to do in this work.

Alas, there is no single theory about velocity. Thus, in the second chapter I survey the previous works and try to figure out what are the problems with standard view and how I can attempt to overcome these problems. This should be a theory chapter, but there is no real theory that describes foundations of velocity behavior. There you can find a separation of hypotheses and models on several cases. Literature survey presents an attempt to classify methods of working with velocity that can be found in economic literature, published for the last 400 years. The main conclusion of this review is that there

is a lot of literature on this topic, but the questions raised greatly outnumber the questions answered.

In the third chapter, I present my empirical work. This begins with the description of data and econometric models of interdependence of velocity and other economic variables (like inflation) based on data. As a separate part, I present the list of problems related with empirical analysis, mainly issues of misspecification, co-integration of series, possible measurement errors, endogeneity and non-linearity. Regressions made suggest that there are strong relationships between velocity and inflation, exchange rate, interest rate, real output. Partially due to the noisiness of data results should be taken with a grain of salt.

The last chapter deals with "widened" data and presents an attempt to run same regressions as in the third chapter, but measuring output as a combination of official and estimated shadow GDP, monetary aggregate including foreign currency and arrears.

Conclusions make a short summary of facts revealed by this work.

Chapter 2

SURVEY.

There are two main views on velocity, associated with monetarism and Keynesianism. The distinction is rather illusory, because some authors (e.g. Ritter, 1959) will say that they are true monetarists, but in reality share the view of the opposite camp. One of the most important problems is that both schools use different definitions of the same parameters. The monetarists' quantity theory (for detailed description see a basic monetary economics textbook, e.g. Mishkin, 2001, p.535-563) assumes that changes in the amount of money in circulation do not alter velocity or, more precisely, that they do not influence the long run growth trend of velocity, cleared of business cycle (Friedman, 1959). Trend is assumed to depend on some institutional factors, like existence of sophisticated banking system. The opposite point that emerged during the Keynesian Revolution in the 1930s attacked the assumption that velocity was independent of the level of money stock. Rather a new assumption became standard, that changes in money supply tended to be offset by changes in velocity. Thus if money increased by 10%, velocity would tend to decline, and as a result the change in income would be less than 10%, and could even be zero (details can be found in Keynes, 1936; Tobin, 1945).

The reason for the position that money stock and velocity should be negatively correlated involves the interest rate. Cash does not pay any interest (or at least pays less than deposits), so an increase in the interest rate paid on non-monetary assets should make holding idle money balances more expensive. When people hold their assets in the form of money, they forgo the opportunity to earn the interest they could earn if they held assets in the form of bonds or other assets. Since people are assumed to be nearly rational utility maximizes, they should take into account costs and benefits when determining their real money balances and hold smaller money balances in times of high real interest rates (opportunity costs). In the world of perfect information agents hold money just enough to satisfy desired consumption.

Further, when money stock drops, interest rates should rise. A fall in money stock happens when the amount of bank lending decreases (either the central bank explicit or

implicit lending to commercial banks or banking system lending to real economy). Money stock is most commonly measured as M2 monetary aggregate, i.e. currency in circulation plus time and demand deposits. Decrease of supply of funds leads to increase in a rate of interest. Demand of funds assumed unchanged. Cash does not reproduce itself as deposits do, so stock of money necessary becomes smaller. The rise in interest rates should cause rational people to reduce their idle balances, or to increase the velocity of money. The opposite should happen in the case of a rise in the stock of money (following Schenk, 1997-8).

Theory assumes that there are three main monetary and financial factors that determine behavior of velocity in the USA for the last 50 years. Of course these factors are universal, but because most of the authors are the graduates of the US PhD programs, the main focus is on the American economy.

First factor is that during the last half of the century both inflation and real interest rates rose (especially during the 1970s-80s), thus pushing down demand for real money balances. Among the main works in this framework are Friedman & Schwartz (1982) and Goldfeld (1976).

The second factor that influences velocity is an increase in speed of asset market transactions and a decrease of a single transaction cost, due to development and maturing of financial markets, as it is especially fulminated in works of Brodo (e.g. Brodo and Lars, 1987.). In Ukraine in the 1994 there was introduced totally new interbank transactional service (TOPAZ system) that highly reduced the amount of time that is necessary for one money transaction inside the country. Of course, such system increased velocity, but it is almost impossible to extract this particular impact from the broader set of policy actions that were implemented during the stabilization period. However, it is worth to mention that now one Ukrainian transaction takes around 30 minutes, while in the neighboring Russia such a transfer takes up to 2 days. Now banking transactions in Ukraine are going faster than even in 'banking Mecca' Switzerland. I assume that the change in technology was entirely demand driven, i.e. during hyperinflation it too costly even to wait for two days, because money lose up to several percent points of its purchasing power (in yearly terms in can be hundreds or thousands percent).

Third factor that is usually mentioned in the literature is a decline in the use of money either as medium of exchange or as store of value. In the developed countries alternative

means of payment were introduced during the post-war period, the most important being credit cards or other credit arrangements. I think that definition of money should be changed in order to include this means in monetary aggregates, but as I understand it is quite hard to do because VISA can be treated as a credit line, not a one-moment credit, so its amount is undetermined. This last factor is of minor importance in determination of velocity in central and eastern European countries, because financial system is underdeveloped (assets of Ukrainian bank system is only 20% of GDP in 1999) and credit card usage is insignificant. Moreover, up to 85% of those who have electronic cards use them only to withdraw money, ever if they later on spend this money for purchasing goods. The main substitution source in the transitional economies is foreign currency, mainly US dollars and DM. The issue of dollarization is very important, because up to a half of transactions are made in hard currency. This decreases the power of monetary policy.

Literature review.

The literature on monetary theory has discussed a velocity of money for a very long time. The first works on velocity dated back to the seventieth century (e.g. William Petty and D. Hume). Shortly after the formal definition of velocity (usually attributed to Irving Fisher) at the beginning of the century (Fisher, 1911; 1913) as MV≡PY (referred later on as Fisherian equation or equivalence) revival of interest in velocity was observed. Before the twentieth century no reliable time series were available, so no one tried to estimate it (I mean statistically). It is very important to note that described an equivalence, i.e. both parts equalize by definition. Today's mainstream economists treat two works as main masterpieces in defining velocity and its behavior. The first is Fisher (1911) and the second is Milton Friedman (1956). It is quite unusual, but both of these works are centered not on velocity but on other questions. Other works were much less influential, but they took a much closer look on velocity. As a result, I'll present a short overview of such works.

During the 1930s several works that concerned problems of definition and relationship of velocity with other parameters, e.g. interest rate and money demand were published. Among them particular interest is in large articles by Angell (1937) and Howard Ellis (1938). They give general rhetoric set of concepts related with velocity, its determinants and its effect on other economic factors, like inflation. Under rhetoric I mean that no models were created, but the simple behavioral attributes described, like importance of

developed baking system that can decrease the transaction costs of trade-off between liquidity and interest.

Keynes first proposed the relative stability of transactions velocity and instability of total velocity due to changes of demand on property titles that does not go on consumption but rather on savings. In his famous *The General Theory of Employment, Interest and Money* (1935-36) he states that transaction velocity is the representative of demand for money for consumption and when demand, guided by animal spirits, decreases, stable velocity leads to decrease in prices (deflation) and output (directly through lower investment and indirectly via liquidity preference). As it is suggested by econometric tests velocity can be a nice indicator of future recession (see e.g. NBER indicators[3]). However, references to velocity imply that changes in it are an accurate guide to shifts in the aggregate expenditures, but they are hardly the causes of these shifts (see e.g. Oliver, 1949). Keynes distinguishes between *circuit* velocity that is highly volatile and depends on interest rates and *real'* velocity that is constant. Circuit velocity is the speed of turnover of idle balances, i.e. the balances that could be withdrawn without negative impact on output.

After the Second World War, in the economic journals was a little wrestle between the future Nobel Prize winner James Tobin (see Tobin, 1945; 1948; 1950) and Clark Warburton (Warburton, 1948; 1949; 1950). Tobin was the defender of Keynesian point of view on velocity, he states that variability in short run is mainly due to idle money balances, or money that are not spent (because liquidity premium is low but cash balances are already satisfied) and long run trend is due to behavioral changes in consumption (e.g. Tobin, 1948). Warburton argues that liquidity function presented by Tobin is rather ambiguous and proposed to return to pre-Keynesian theory where "velocity was assumed to vary sequentially and directly with changes in the quantity of money except those accordant with the increase in output at full use of resources"(Warburton, 1948). One of the ideas is that the relation between quantity of money and circuit velocity under Keynesian assumptions has opposite sign if compared with classic approach. To make easier understanding, let me present an analogy. Under the Keynesian model, providing more food (money supply increase) makes people more lethargic, while under classics they became more productive. Of course, both theories are wrong in their extremes, because as it usually shown in the microeconomics basic course as wages rise, value of leisure as a

[3] www.nber.org

good consumed also increases and researcher should simply distinguish between income and substitution effects. What effect is dominant is crucially depends of functional form and points of comparison. Later on Milton Friedman (1959) proposed to call these effects cyclical (dependent on business cycle) and secular (dependent on growth path of economy). At the end of the discussion Warburton published excessive study about velocity trends in the US economy from 1799 to 1945 and showed that circuit velocity had a downward trend nearly 1% per year and variations in this type of velocity are much smaller than Keynesians argued. However, conclusions of his work where he puts the predictions about future decrease in velocity are dreadfully wrong. In the year 1946 velocity started its increase that was followed by much slighter decline during the 70s, but level at the end of decrease was still above the 1945 level, so velocity had an upward trend for the 30 years. This also show that it is hard to predict the behavior of velocity, even if for prediction use long run data.

Changes in direction of trend and speed of change leaded to creation of new papers on velocity in the late 1970s and 1980s. Most of the papers concerned primary developed countries, e.g. Germany and the US (Brittain, 1981) where impact of policies of one country on another is quite high, financial markets are huge, well developed and safe. However, I am more interested in researches that are based on developing countries, because they are much closer in parameters to transitional economies with which I am going to work in my research. However, number of such papers is rather small. One of these papers, written by Hanson & Vogel (1973) investigates the problem of anticipation of inflation in Latin America with income velocity as proxy for expectation. They found that inflation has a significant impact on the income velocity of money using pooled regression on 12 countries. Another paper (Driscoll & Lahiri, 1983) concerns more about changes in income velocity due to changes in structure of employment and output in Asian countries. Both papers give quite a good base for my own investigation of these problem using data on CIS countries. Their main pluses are the investigation of changes in velocity due to inflation and change in institutions (economic system that affects behavior of economic agents).

At the present stage of development, **models describing properties and dependences of velocity can be divided in three main categories**:

The first class of models is microeconomic in nature and describes behavior of consumers that choose appropriate amount of cash balances to maximize utility. In these models variation in velocity arises if money paid cannot be spent immediately (Lucas 1981) or because part of goods consumed can be bought only for cash that doesn't, however, brings any interest, or future demand for cash is unknown and there exist costs for transformation interest-bearing assets into cash. Most of the models assume infinite-living atomistic individuals with some kind of risk-aversion function and infinite horizon of planning. Specific assumptions differ from model to model, usually including some uncertainty (Barnett & Xu, 1998), differentiation of goods on the basis of payment procedures (Pardini 1996), difference in individual's knowledge about true state of the world and so on. The main drawback of these models is too harsh assumptions. Alas, in Ukraine banking market is underdeveloped for the period used in econometrical sample, the individuals have rather vague and misty forecast of their future in one year, to say nothing of more. As a result, despite the fact that these models have nice mathematical derivation and are probably an adequate descriptors of world in the very long run, I think that they are of little use for the current research.

The second class of models is much smaller and concerns primarily macroeconomic impact of variable velocity on the results of government policy. One of the most complete models is probably made by Gordon, Leeper and Zha (1997). It includes governmental policy impacts on economy as a whole that is taken from mainstream macroeconomics. As an example, it is assumed that increase in budget deficit leads to increase in aggregate demand and output, but it should be financed by some instrument, that usually contracts investment, thus affecting aggregate expenditures. According to authors, the result of all these movements should be captured by their model. I am going to use somehow changed specification of their model in my work. However, the model has limitations, mainly it was created for countries with developed capital markets, thus they never ever try to use massive emission as one of the instruments. Model does not give much space for inflation, so it is not a fully applicable for the transitional economies.

The third important class consists of models that might be called 'structural'. One of the models of Mayor & Pearl (1984) is mainly econometric approach that proposes another treatment of trend in velocity. Authors argue that neither interest rate nor improvements in productivity lead to increase in velocity, but changes in urban population and average age. The model can be tested with Ukrainian data but I'm not sure that one can clearly

distinguish changes between systems and changes within them. This is really long run model, so I cannot use it with the short dataset I have. Second paper in this group is by Flavio Pardini (1996) and concerned primary institutions that simplify payments, arguing that financial intermediates can improve even real sector performance if they increase fraction of income that is available for current consumption. In ten years these models should be calculated for economies in transition, but now the number of observations is too small to any serious regression analysis.

The Theory of velocity.

Alas, up to this moment, no general theory that describes nature of velocity and its interrelationship with other economic parameters was made. Therefore, I will try to summarize some of the existing ideas about velocity. But before I start, I want to note some important facts about velocity and its definition.

First, velocity relates *stock* of money (in any aggregate measure: MB, M0, MZM, M2 or M3) with *flow* of production/consumption (measured as GDP, GNP, industrial production, etc.). Thus, time measure became critical in determining level of velocity and its volatility. Even the most developed economies have seasonal changes in production due to number of factors, like agricultural sector harvesting time or a lot of holidays during January. As a result, if one uses monthly data on e.g. GDP for calculation of velocity, she very probably finds out that velocity is very volatile. There are two main nostrums for this problem. One method is to use yearly data (assuming all seasonal effects are of less than annual longitude). Drawback of such method is that for Ukraine, I can use only ten observations, and this is not enough for econometric analysis. The other method is to use some seasonal smoothing in order to use at least quarterly data series. Problems with this method is difficultness of determining what adjustment to use and possibility of determining fall in GDP due to crisis or recession as seasonal; in the latter case adjusted series can inherit measurement error that will affect regression.

Second, it is important to note that different authors have different interpretations of money stock, particularly its determination, whether it is supply, demand or equilibrium. There is no difference if one can reasonably assume that market for money always clears, i.e. supply always equals demand for given interest rate. This can be a very strong assumption for transitional economies, because financial markets in such countries are usually underdeveloped. With interest rate controlled legally by the central bank increase in demand can lead to credit rationing and queuing. Note such important behavioral attitude

of money: as demand for money decreases (lower real money balances needed), ceretis paribus, supply of money increases and vice versa. This means that change in supply inversely proportional to change in demand. This leads to necessity of assumption about market clearing. Many monetarists, continuing Friedman tradition insert M^D in velocity equation in theoretical model, but use money aggregate (i.e. money supply) in empirical studies. It can be a very nice assumption for economies with developed financial markets, but in transitional economies with such abnormal events as credit queuing and assets/currency substitution, it is not always the case. Thus, one can have relatively stable velocity with respect to money demand, but highly volatile if money supply used for determination of velocity.

Theoretical background of econometric models with velocity.

Now I want to summarize several approaches used by economists for description of velocity behavior.

First approach: one variable.

The variable is usually price level or money supply. Main idea: as one of the parameters that determine velocity changes, ceretis paribus, this leads to change in velocity. The most often used parameter is price level, maybe because of the idea that increase in prices is very likely to happen in economy and this change is unpredictable. With abnormally high increases in prices of all other factors will have lesser magnitude than they would have had otherwise, so they can be dropped from the analysis. Note however, that classical version of the quantity theory assumes that the value of velocity in equilibrium is not dependent on either the amount of money or on the price level[4]. Changes in velocity are possible, however, due to factors such as changes in transaction costs, financial institutions, or other exogenous factors (see e.g. Schenk, 1997). During the 1970s in the economic journals were published two works on the behavior of velocity in high inflationary economies of Latin America. It is very interesting that both works used similar samples, but get quite different results. The first, Melitz and Correa (1970) had shown that behavior of velocity is not determined by inflation or/and GDP. Several regressions ran by authors did not give statistically significant results. However, Hanson and Vogel (1973) using slightly different specifications, test pooled regressions on eight countries and their results were quite

[4] Care must be taken here, because this does **not** mean that velocity is unaffected by **changes** in price level. However, if price level is changing, the system cannot be in equilibrium.

significant. One important thing is that in both cases researchers used several additional variables, because velocity also affected by institutional change and the like.

Second approach: two variables relationship.

The idea of this method is an assumption that some of the variables each of which is important in influencing on velocity are also highly correlated between themselves. Real money balances are the most striking example. Alas, as far as I know there were no attempts to find an empirical dependence between velocity and real money balances. This happens possibly due to the fact that one can achieve spurious regression, where velocity and real money balances are correlated simply because the definition of the letter can be included in the former, i.e. $RMB = \frac{M}{P}; MV \equiv PY \Rightarrow V = \frac{PY}{M} = \frac{Y}{RMB}$. Under such dependence and with relatively stable real output (denoted by Y) a econometric specification is like

$$\ln V_t = \ln \frac{Y_t}{RMB_t} = \ln Y_t - \ln RMB_t = \alpha + \beta \ln RMB_t + \varepsilon_t$$

that regression will give a nice fit but in reality is totally useless. Because of such considerations, economists instead of making regression directly on velocity, try to determine the dependence between real money balances and some variables, and then use the results for analyzing the behavior of velocity. One of such studies was made recently by the Word Bank economists (De Broeck et al., 1997). They suggest an econometric specification of real money balances function, that interrelates real money balances (as supply side) with real output and interest rate (as demand side). Despite the fact that this study tries to determine the sources of volatile movements of velocity in transitional economies, authors omitted Ukraine and Georgia from econometric analysis. In my work, I will try to improve their techniques in order to include these two countries. They are of special interest, because in these countries velocity had the highest increase both relative and absolute. Theoretical background of such work was made by Friedman and Schwartz (1970).

Example: Velocity and real money balances.

There is a direct connection between velocity of money and real money balances. This is very important to understand that these two variables sometimes may be used

interchangeably. Some theoretical background should be added in order to clarify some predicted movements of velocity with changes in real money balances. From the classical framework that was firstly graphically presented by Hicks (1937) there is equivalence $M^S = M^D$. Money supply is given by real money balances while demand for money depends on interest rate and output (income, demand for commodities), so equivalence can be rewritten as $\frac{M}{P} = f(Y,r)$. This function has the following properties: (a) $\frac{\partial f}{\partial Y} \geq 0$ i.e. to satisfy increasing demand one needs an increase in the real money balances; (b) $\frac{\partial f}{\partial r} \leq 0$ i.e. as interest rate increases, opportunity cost of holding money also rises and consequently demand for real money balances decreases. Now one can insert achieved result in velocity function that is defined as $V = \frac{Y}{M/P} = \frac{Y}{f(Y,r)}$.

In order to find the marginal influence of change in real output one can show that:

$$\frac{\partial V}{\partial Y} = \frac{f(Y,r) - Y\frac{\partial f}{\partial Y}}{(f(Y,r))^2}$$

As long as output is always positive (it is possible to have negative value added in a sector, but not in a whole economy), as well as real money balances (price level is zero only if all prices are zero and money supply is positive if it exist at all), it is easy to show that $Y\frac{\partial f}{\partial Y} > 0; f - f^2$ should have any sign, otherwise the will be a limit, e.g. if $f - f^2 \geq 0 \Rightarrow f \geq f^2 \Rightarrow f \leq 1$ or $M \leq P$ and this cannot be true for all cases (generally it is like a comparison what is bigger: liter or meter). As a result of such constraints one can say that $\frac{\partial V}{\partial Y} \leq 0$ i.e. increase in output leads to decrease in velocity. From mathematical point of view it is true, but empirical studies show that increase in demand during the upward part of business cycle coincide with increase in inflation compared with average inflation during the cycle as well as a rise in velocity.

Another used combination of factors that determine velocity is a real output of goods and services multiplied by price level, or more widely used term for this combination is a

nominal output. Rationale for usage of this factor is relative simplicity of obtaining the data and calculation of model. Theoretical background is in fact that small changes in GDP in stable economy usually represent changes in demand for commodities, so as well the demand for means of payments and velocity is proxy for money demand. However, for the case of transitional economies, usage of nominal GDP can be not a worth wise thing to do, because main changes in it are usually due to price changes called either by money supply increases or cost changes or demand shifts. It is impossible to determine what exactly called for such a change without usage of additional information about other factors performance.

Third Approach: Multi-variable relationship.

The main idea is that all variables, which are the determinants of velocity are important. For example, emission (ΔM) that is made for financing government deficit that affects aggregate demand (ΔG➔ ΔY) also leads to increase in prices (ΔP) due to desire to hold previous level of real money balances. Increase in price level leads to possible drawbacks like decline in the real tax revenue or general instability. The main method of creation of such models is to make a decomposition of demand/output on fractions, i.e. consumption, investment (savings) and government spendings (Keynesian framework). Then some microeconomics applied, in order to describe agents behavior (something like game theory is used). The main idea is that agents maximize their lifetime consumption and divide income on consumption and savings on the basis of number of constraints that differs across models. I will not describe such models extensively because classical market system for which such models were made is much more predictable, shocks are much weaker, so marginal analysis can be applied and micro-level data are much more available and reliable. Despite possible importance of such models I cannot use them for Ukraine because with our quite unreliable future it is too hard to assume that agents are able to maximize their life-time discounted utility. Problem of prediction of even the nearest future is very hard in transitional economies.

<u>To the question of an endogenous nature of velocity in the economy.</u>

As many may argue, velocity that one can find only via Fischer equivalence namely $V_t \equiv \frac{Y_t P_t}{M_t}$ is dependant, for example, on price level by its very definition. As a result, it is possible to achieve highly statistically significant results by running a regression of velocity

on price level. However, they forget two quite important things: (a) if function is not a linear combination of factors then it cannot be considered spurious. For example, when one tries to find minimal average costs as function of output, she runs a regression like $AC(Q) = \frac{TC(Q)}{Q} = \alpha + \beta Q + \tau Q^2 + \varepsilon$ despite the fact that she uses quantities in RHS as well as LHS. (b) Partial derivative is not a full derivative and what I am going to find by regressing velocity on prices is $V(P) = \frac{Y(P)P}{M(P)}$. It is very hard to argue that demand for money does not depends on velocity. On the contrary, real money balances are usually taken as a representative of money demand. In some works, authors argue that they omit velocity from a regression because it is only a combination of other factors and can be treated as a mere residual. For example:

> "The model I am going to investigate is based on the equation of exchange, which is an identity relating the volume of output at current prices to the stock of money times the turnover rate of the average unit of currency.
>
> **M*V= P*Y**
>
> From this identity, we could infer that price level depends on the supply of money and the level of real GDP:
>
> **P = f(M, Y)**
>
> I do not include velocity as an explanatory variable at the right-hand side of the equation because velocity can be treated as a residual (it is a variable that is completely determined by the other three variables: P, Y, and M.)" (Dekhtiarchuk, 1998)

I think that all can agree that despite the fully endogenous nature of Solow's 'technology' residual it is a very important parameter that is a proxy for some changes that cannot be subscribed to either capital or labor. Economists can argue whether the residual shows mainly technological advance or it is the measure o something like human capital, but no one being in own right mind would argue that economists cannot use an Arrow's residual simply because it is a combination of other weighted factors. The same logic applies to velocity as well: it is a proxy for some changes that cannot be captured fully by other observable parameters.

Chapter 3.

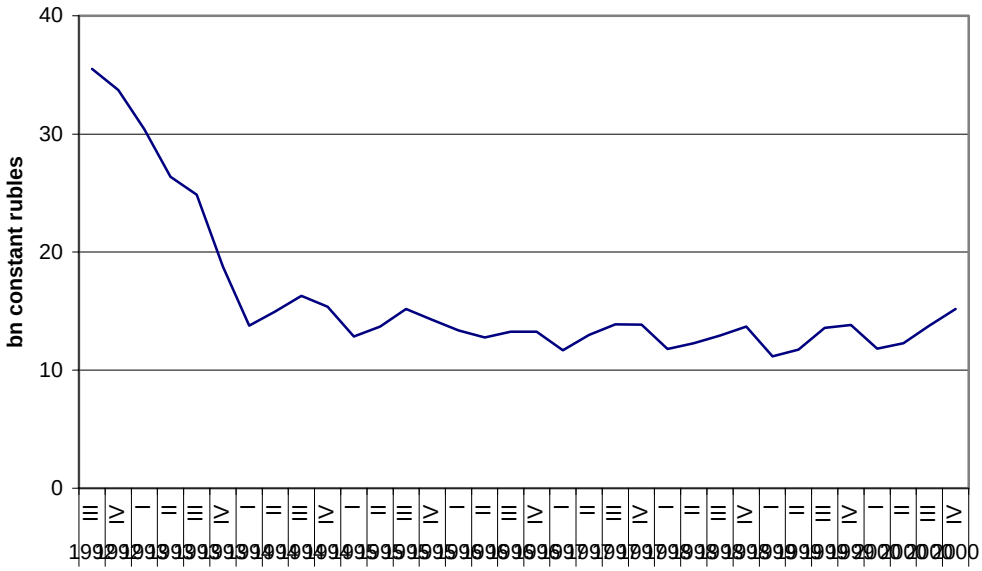
EMPIRICAL STUDIES ABOUT THE BEHAVIOUR OF VELOCITY

Country description.

This chapter presents the attempt to investigate empirically the behavior of velocity in Ukraine. In order to describe country velocity time series, one should firstly describe movements in country's GDP, monetary aggregate and price level.

As the following graph shows, real GDP started to decline at the beginning of the 90s, and this was caused by some disorganization and breakage of links between plants situated in different republics (Blanchard & Kremer, 1997). However a really sharp drop in the middle of transition, was caused in Ukraine by hyperinflation and extensive financing by emission of large budget deficit.

Graph #1: real GDP non-smoothed quarterly data, bn constant 1990 rules



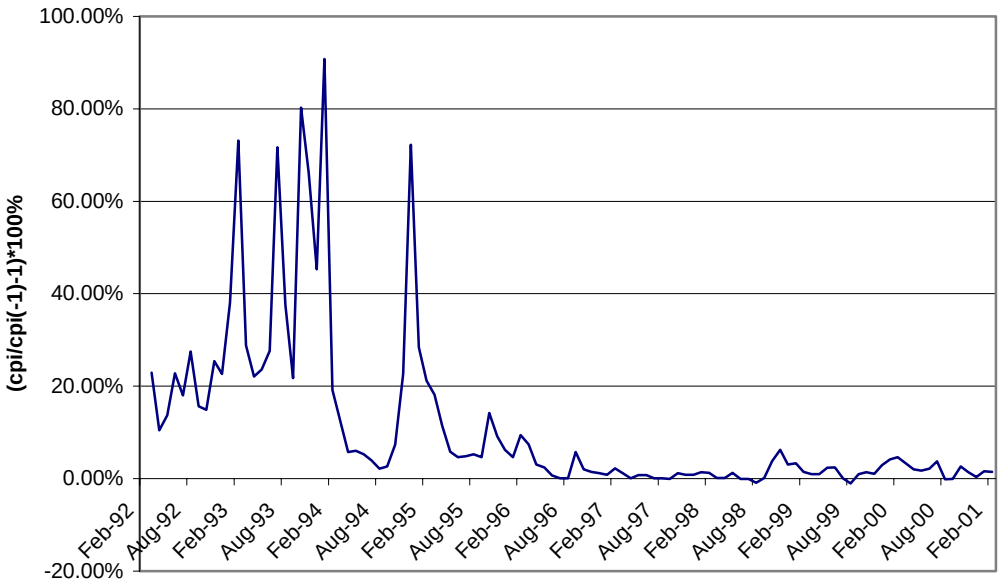
source: UEPLAC UET data

Uncontrolled increase in prices led to lack of confidence in domestic currency, problems with investment and depreciation, thus creating both long and sort run downward pressure on output. Since 1995 to 1997 fall in real GDP was slowed down, not due to the better economic policy of the government but mostly because when one already lies on the floor, it is hard to fall further. In 1998, there was a possibility to start economic growth, banking

sector seemed to be stable, and real interest rates fell to levels that made investment in real economy possible. However, unwise policy of financing substantial budget deficit with government bonds (OVDP) instead of trying to decrease deficit, together with Russian crisis 1998 led to further shrinking of GDP that continued up to 1999. From the march 2000, Ukrainian economy slowly and diffidently started to recover. Growth, however, is based on extensive development, increase in export of metals that became highly profitable after 44% depreciation of hryvnya in 1998. any fall of demand for Ukrainian production abroad can reverse the growth trend. Ukraine is in a great need of structural economic reform. Total fall in GDP from 1990 to 1999 is almost 70% (UEPLAC, Trends... October, 2000, p.8). Problems with economic performance and tax burden led to sharp increase in shadow economy. Shadow economy is almost impossible to measure, but some experts estimated that its accounts from 50 to 170% of official GDP.

Inflation in Ukraine deserves a special book to be written about it. Usual measure of inflation that is used by economists is CPI. This index is not perfect and misses some aspects of changes in bundle as well as other things. General behavior of CPI presented on the following graphs.

Graph #2. inflation in Ukraine, 1992-2001, monthly data on basis of CPI.



source: DerzhKomStat data, author's calculations.

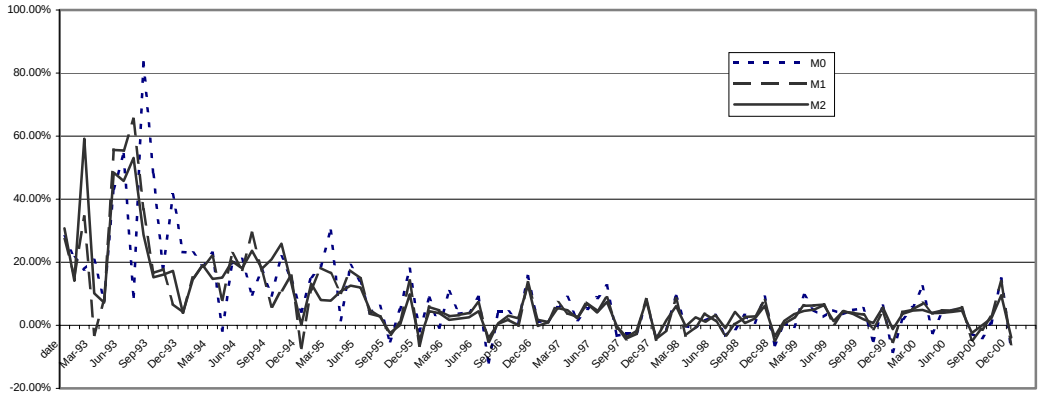
Graphs represent monthly changes in levels and in percent of CPI. As can be seen, first shock was in first quarter 1992 due to price liberalization. In reality, firms were allowed to

increase prices on some percent and all received this signal as a 'must' and increase prices accordingly. Then in years 1992-1993, government tried to 'compensate' increase in prices by different subsidies, but this policy led to ever-bigger price increases. After shock of hyperinflation, people didn't want to hold money, so they actively substituted 'coupon-karbovanets' with dollars, firms stopped to give any credits, other bad things happened. From 1994 to first half 1998 inflation became less volatile and unpredictable, its levels were quite moderate, population started to return to national currency as a store of value and even real sector was likely to begin economic growth. However, Russian crisis 1998 killed it all in one shot. NBU managed to keep inflation in borders with austere monetary policy.

Inflation in Ukraine remains quite unpredictable in medium and long run.

Money growth was the main cause of inflation and tight monetary policy led to drop in GDP, so monetary aggregate and its change are very important. Following graph presents changes in M0, M1 and M2 (included foreign currency specification) (Jan.-1992 -Feb.-2001).

Graph #3. changes in M0, M1 and M2, monthly data.



As can be seen very volatile changes during hyperinflation were replaced with moderate temps during 1995-7 and for the last 3 years NBU tries to remonetize economy, thus on average money base growth is about 20% per annum.

Data description.

In my empirical work I used the following data, description of which can be found in Appendix 1:

Nominal GDP (nGDP) –period Jan.-1992 to Feb.-2001, monthly data, billions UAH, UEPLAC estimates of the nominal GDP by the method of incomes. The coverage of its aggregate is the same as the official one (it does not include informal private activities). The official DerzhKomStat data are very similar. Problem is that DerzhKomStat of Ukraine regularly revises quarterly GDP data without revising the constituent monthly figures, thus creating some problems of estimation. As UEPLAC writes in comments to their tables: "The GDP (Gross Domestic Product) is the key indicator of economic activity in the international System of National Accounts. The State Committee for Statistics (DerzhKomStat) began to apply this accounting framework in 1994. However, Ukrainian SNA accounts do not register all transactions, which take place in the economy. UEPLAC calculates its monthly and quarterly GDP figures so that they correspond to the DerzhKomStat data, as closely as possible. Beginning in 1996, DerzhKomStat published cumulative data on monthly GDP. However, the "jumps" which may be observed in December 1996 and December 1997 indicate that methodological adjustments took place unevenly. For instance, accounting of small-scale enterprises' activities occurs after they become available. Since 1997, there is an attempt to anticipate these adjustments in the series in order to avoid further jumps. This, however, renders year-to-year comparisons hazardous. "

Real GDP (rGDP) - period Jan.-1992 to Feb.-2001, monthly data, billions constant 1990 rubles. UEPLAC estimates on the basis of DerzhKomStat data on deflator, CPI and own nominal GDP series.

GDP deflator – period Jan.-1992 to Feb.-2001, monthly data calculated by UEPLAC as a weighted average of CPI. I recalculate it with Dec.-1992=1.

Consumer price index (CPI) - period Jan.-1992 to Feb.-2001, monthly data, DerzhKomStat estimations, Laspeyres index. The CPI is a measure of the actual prices, which consumers have to pay for a given basket of goods and services. The services in this basket include consumer services like housing rents and transport fares. The prices used to build the CPI include taxes. I recalculate it with Dec.-1992=1.

M0 –period Jan.-1992 to Feb.-2001, monthly data, billions UAH, the National Bank of Ukraine calculation. The M0 is currency in circulation (i.e. amount of coins and banknotes issued minus cash reserves in commercial banks).

M1 –period Jan.-1992 to Feb.-2001, monthly data, billions UAH, the National Bank of Ukraine calculation. The M1=M0 + settlement and current accounts in the national currency.

M2D –period Jan.-1992 to Feb.-2001, monthly data, billions UAH, the National Bank of Ukraine calculation. The M2D=M1 + time accounts in the national currency.

M2F –period Jan.-1992 to Feb.-2001, monthly data, billions UAH, the National Bank of Ukraine calculation. The M2F=M1 + time accounts in the national currency + current and time accounts in foreign currency held in Ukrainian banks converted in UAH by official exchange rate.

Models. General notes.

As a contemporary literature suggest almost all macroeconomic time series are non-stationary, or in other words follow a random walk (see e.g. Peter Kennedy, 1999). Usage of non-stationary data can lead to spurious regressions that give inappropriate measures of usual statistics as R1, F-statistics, t-statistics or others. Thus a good econometrician should firstly check, whether regressors she use are stationary or not, and in the latter case she should use nth differences (if series are not exploding). If one needs to perform test for stationarity, she should calculate unit root of time series in question and compare achieved augmented Dickey-Fuller test statistics with critical values. The Results of ADF test are summarized in the following table.

Variable	Order of differentiating	ADF test statistics	Existence of	
			Trend	Intercept
CPI	1	-2.971448**	N	Y
Real GDP	0	-4.392245***	N	Y
M2	2	-5.024949***	N	N
Velocity	1	-7.30827***	N	N

*Comments: CPI -consumer price index, ** -significant at 5%, *** - significant at 1%.*

Absence of trend in all series is due to the fact that transformation of economic system was made. Validity of intercepts in first two cases can be explained as of positive values for both real output and inflation. Real output simply cannot be negative (negative value added in sectors is possible, but economy as a whole cannot be value loosing) and inflation as empirical data about any country is positive in medium to long periods.

Model one: velocity and inflation.

There is a controversy among economists whether inflation affects velocity or not. This is almost impossible to investigate in the stable economy with low and stable levels of inflation, where other, institutional factors have much bigger effect and increase in prices is almost equal to increase in money base, leaving real money balances unchanged. Thus during the 70s several researchers take a closer look on relation between inflation and velocity in developing countries of Latin America which are famous with their persistent problems with price stability. For example, model that describes an anticipation of inflation in Latin America with income velocity as proxy for expectation was made Hanson & Vogel (1973). They found that inflation has a significant impact on the income velocity of money using pooled regression on 12 countries of Latin America. However, others authors, like Melitz & Correa (1970) did not find any dependence between inflation and velocity. With previous works in mind, I created a model that should depict interaction between changes in CPI (proxy for inflation) and velocity (nominal GDP divided by M2 excluding deposits in foreign currency). Data set used covers 7 years, with quarterly partition. All variables that are in model have high degree of seasonal changes, thus I was forced to include some lagged dependent variable to count on seasonal effect. In addition, I assume that dependence is non-linear, and with very high levels of inflation additional factor come on the stage. The asset substitution increases prices and shrinks money base, decreasing power of official currency as a mean of payment. Symbolically it can be presented by such notation:

$$V = \frac{YP(\uparrow)}{M(\downarrow)} \Rightarrow V \uparrow\uparrow$$

i.e. not only inflation directly, but also the change of agents behavior, caused by inflation affects velocity. In terms of mathematical representation:

$$v(p) > 0; v''(p) \geq 0$$

In order to include this into equation I used square of inflation as an additional regressor, thus with agreement with model coefficient should have positive sign. As a result, econometric specification of model is the following:

$$\Delta velocity_t = \alpha * \Delta velocity_{t-4} + \beta \text{inflation}_t + \sigma \text{inflation}_t^{\,2} + MA(2) + \varepsilon_t$$

Summary table of this regression is the following:

Table 3.1 estimation results				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Inflation	-0.853	0.298	-2.862	0.009
velocity(t-4)	0.350	0.172	2.040	0.054
$Inflation^2$	1.282	0.445	2.882	0.009
MA(2)	-0.920	0.048	-18.970	0.000
R-squared	0.65	Mean dependent var		-0.0078
Adj.R-squared	0.61	S.D. dependent var		0.4623
S.E. of regression	0.289916	Akaike info criterion		0.5022
SSR	1.849123	Schwarz criterion		0.6957
Log likelihood	-2.528398	F-statistic		13.855
Durbin-Watson stat	1.88	Prob(F-statistic)		0.00003
source: authors calculation				

As can be seen, coefficients with inflation and inflation squared are highly statistically significant and reasonably far from zero that suggest an economic validity. As it was predicted, high levels of inflation increase velocity of money (positive coefficient with respect to inflation-squared), while low levels decrease it (negative coefficient with inflation). The breakpoint where inflation terms cancel each other is somewhere around 65% of quarterly inflation or around 640% per annum[5]. Such high inflation is rarely observed in economies, thus often non-linearity is omitted. There also can be some additional problems with the behavior of residual and low value of DW-statistics even after usage of moving average. Of course, I cannot use DW-statistics with equation where lagged dependent variable is the one of the regressors. However, correlation LM tests, whether F-statistics, ARCH LM or Breusch-Godfrey statistics clearly accepts the H0: no autocorrelation at 5% significance level. Q-statistics is also insignificant and White heteroscedasticity test cannot be rejected at 5%. But even if there is an autocorrelation, then this is bad for clear predictions, but now I mainly interested in values, and autocorrelation per se gives unbiased results. If uncorrected, serial correlation in the residuals will lead to incorrect estimates of the standard errors, and invalid statistical inference for the coefficients of the equation (E-views 3.1 help reference).

Positive coefficient with lagged velocity suggests that (a) velocity exhibits some inertia and (b) any shock to velocity becomes less significant over time (positive coefficient that is less than one). Null-hypothesis that coefficient is more or equal to one is rejected even at 0.1% significance level.

[5] Lower bound gives 35% per annum and upper 1230%. As a result, take these numbers with a grain of salt.

However, model has several serious drawbacks. First of all it is the issue of simultaneity, namely the fact that:

$$v = f(p) \quad \text{and} \quad p \equiv vm / y$$

If simultaneity is really the case, coefficients are overestimated. From theoretical works on inflation I know that break-point is between 40 and 70 percent per year, not 600%. The problem is that no relevant statistical test for simultaneity cannot exist, so it is depends more on researcher whether to assume simultaneity or not, because it a great number of models, assumptions play critical role.

Second problem is heteroscedasticity. Ultra-high inflation leads to impossibility of prediction of short-run changes. As a result, I expect that with an increase in inflation errors also increased. White heteroscedasticity test does not confirm the existence of heteroscedasticity, but it can be a problem of small sample size.

In order to overcome these problems another specification of the model was estimated.

The main idea is to take out the inflation from the left-hand side. To do this I simply divided both sides on inflation. The resulted model is the following:

$$\frac{\Delta Y_t}{\Delta M_t} = \frac{\alpha_0}{\Delta P_t} + \alpha_1 + \alpha_2 \Delta P_t + \alpha_3 \frac{\Delta Y_{t-12}}{\Delta M_{t-12}} \frac{\Delta P_{t-12}}{\Delta P_t} + \varepsilon_t$$

this model gains also several other advantages in comparison with the previous one, namely it does not have linearly depended auto-regression term and it can be free from heteroscedasticity, because high inflation has less weight in such regression than a low one. The results are presented in the following table:

Table 3.2 estimation results	
Dependent Variable:	$\frac{\Delta Y_t}{\Delta M_t}$
Method: Least Squares	
Sample(adjusted): 1994:01 2001:01	
Included observations: 85 after adjusting endpoints	
Convergence achieved after 10 iterations	

Backcast:1993:12				
Variable	**Coefficient**	**Std.Error**	**t-Statistic**	**Prob.**
1/inflation	1.83	0.531	3.443	0.0009
constant	-1.587	0.849	-1.87	0.0652
inflation	0.749	0.328	2.279	0.0253
v(t-12)/inflation	0.232	0.076	3.054	0.0031
MA(1)	0.44	0.101	4.353	0.0000
R-squared	0.50685	Mean dependent var		0.9546
Adj.R-squared	0.482192	S.D. dependent var		0.075
S.E. of regression	0.053949	Akaike info criterion		-2.9445
SSR	0.232844	Schwarz criterion		-2.8008
Log likelihood	130.1419	F-statistic		20.556
DW stat	1.822666	Prob(F-statistic)		0
Inverted MA Roots	-0.44			
source: authors calculation				

It is easy to see that achieved table is somehow different. First of all, now former intersect term (now divided by inflation) become highly significant. Moreover, a larger sample should also give the results that are assumed to be more adequate. DW-statistics now gives appropriate results, and it shows that one cannot reject the null hypothesis about absence of first order autocorrelation. The behavior of lagged modified velocity does not change: coefficient is still statistically significant and less than one. It is very likely that in stable economies this lagged variable is much closer to one, so together with low inflation, velocity exhibits relative stability that is interpreted as a stable velocity. LM serial correlation test is now not rejected at 5%. White test for heteroscedasticity however, is still somehow vague, namely due to the huge swings during hyperinflation. White heteroscedasticity test gives statistics 0.055436, so it is just enough to not to reject at 5%. The problem is if I will test for them with a dummies then I loose important information about hyperinflation. As long as the intention of this model is to work with inflation and investigate whether results suggest that inflation affects velocity or not, I think the usage of this specification is still applicable.

Minimum for this equation is reached at even higher rate of inflation than in previous case, 1500%! This is probably due to several reasons:

1. Real money balances adjusted using adaptive expectation, so I calculated something like one-time shock and then ex-aggregated it for the whole period.

2. Inflation used in regression is defined as monthly change in CPI, i.e. CPI_t / CPI_{t-1}, so one seasonal shock can be mistakenly interpreted as high inflation. The national bank of Ukraine now knows when such seasonal chocks occurred, and tightens money supply during peaks and raising during the holes, thus trying to make inflation relatively stable over time.

Model two: real money balances.

As it was previously mentioned, the only work that tries to find out the sources of volatile behavior of velocity was written by De Broeck et al. (1997) does not include velocity into regression, but rather works with demand and supply of money, where the latter measured by real money balances and the former is a function of output and interest rate. However, authors do not use Ukraine in their sample of 12 countries because of hyperinflation that gives biased results to their pooled regression. I assume that with the longer sample (they use quarterly data for 1991-1995 while I use monthly data for 1993-2000) I can achieve meaningful results. Theoretical model suggests that $M / P = f(\overset{+}{Y}, \overset{-}{i})$. In order to keep same variables I used nominal GDP deflated by CPI instead of real industrial production used by De Broeck et al. in their work. Because of possible unit root in levels, first differences are used.

Table 2.3 estimation results

Included observations: 98 after adjusting endpoints

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	0.022	0.010356	2.1	0.0386
CHRGDP	0.336	0.078802	4.26	0
CHFOREX	-0.227	0.053007	-4.29	0

R-squared	0.30	Mean dependent var	-0.0005
Adjusted R-squared	0.29	S.D. dependent var	0.1069
S.E. of regression	0.09	Akaike info criterion	-1.941
SSR	0.77	Schwarz criterion	-1.8619
Log likelihood	98.11	F-statistic	20.412
DW stat	1.73	Prob(F-statistic)	0

source: authors calculation

Notation: **CHRGDP** – change in real GDP.

CHFOREX –change in real foreign exchange rate.

Results are highly statistically significant and have predicted signs. However, due to the oscillating move of both GDP and CPI, error term is abnormal. The adjusted R^2 is only

.29, because of omitted variables. Durbin-Watson statistics in on the boundary, so it is useful to add auto regression of error term. Much better regression should take into account other interest rates and output should be divided on groups, due to the fact that in one sector demand for currency can be much higher than in another. Another important factor is a de facto fixation of foreign exchange during 1996-1998 and 2000. Construction of a nice dummy is a very important and challenging issue that is treated below. This regression was made in order to show that regression has the predicted signs and values of coefficients are highly statistically significant.

As an alternative, I used natural logarithms because with logs all variables are stationary in levels at 10%. The introduction of hryvnya is taken as a dummy variable. The way of creation of this dummy is as follows: I assumed that introduction should start from the moment when official public paper became known to general public (i.e. the May 1996) and finished just after the august 1998 crisis. Theoretically, I assume that there should be a positive sign, because with more confidence people hold more money in their real cash balances.

Table 3.3 estimation results

Dependent Variable: D(LNRMB2)
Method: Least Squares
Sample(adjusted): 1995:08 2000:09
Included observations: 62 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.050412	0.016779	-3.00445	0.004
D(LNRGDP)	0.189766	0.046976	4.039672	0.0002
D(LNFOREX)	-0.222258	0.134112	-1.65725	0.1031
D(LNFOREX(-1))	-0.321191	0.133912	-2.39853	0.0198
HR	0.060918	0.018755	3.248087	0.002
MA(1)	0.294898	0.133951	2.201543	0.0318

R-squared	0.491446	Mean dependent var	-0.014
Adj. R-squared	0.446039	S.D. dependent var	0.063
S.E. of regression	0.046765	Akaike info criterion	-3.196
SSR	0.122471	Schwarz criterion	-2.990
Log likelihood	105.0633	F-statistic	10.823
DW stat	1.947191	Prob(F-statistic)	0.000
Inverted MA Roots	-0.29		

source: authors calculation

As can be seen, this dummy is highly significant, but if one takes a closer look on the movements of error term then you can notice that errors are extremely large during 2-3 months before and after dummy takes value of one. This is because confidence rise and fall

much more gradually and thus does not fully captured by dummy. The fact that lagged log of foreign exchange is more statistically significant is because some inertia that real money balances exhibit. This generally not only suggest that balances adjust with some lag, but also proposes the early indicator that can be used for the prediction of the change in real money balances caused by inflation.

Very interesting is the fact that change in log of foreign exchange has significant coefficients that are higher in absolute value than coefficient with respect to real GDP. All these values can be seen as elasticities of demand with respect to positive and negative signals from environment. I say signals, because despite the high dollarization of economy the amount of dollars are a store of wealth that is not hold for speculative purposes but rather for minimization of losses from unpredictable inflation shock.

Very important is the fact that despite higher coefficients for foreign exchange changes, the coefficient for real GDP is much more statistically significant showing the very tight connection between monetary and real economy in Ukraine.

The main results of the third chapter are that:

- there are statistical evidences which suggest that inflation and velocity are non-linearly related.

- Real money balances (one of the determinants of velocity) are tightly statistically linked with real output from on hand and with opportunity cost measured as change in the real exchange rate from the other.

- The real output is the most important determinant of real money balances

- Real money balances adjust with inertia, so previous month change in opportunity costs affects them with one month lag.

Logarithmic model of money demand

In the previous chapter, almost all work was based on ideas borrowed from articles and books that concern velocity. In this chapter I will present an attempt to found out changes in preferences to money holdings and also represent specifications of the last chapter models with wider definition of velocity.

There is a well-known framework where changes in demand for money is a function of output (demand), interest rate (opportunity cost) and lagged real money balances. The idea is that exists some optimal amount of real money balances, but due to uncertainty, *ex ante* and *ex post* values differ. Thus:

$$\left(\frac{M_t}{P_t}\right)^{opt} = a_0 + a_1 Y_t + a_2 r_t$$

$$\frac{M_t}{P_t} - \frac{M_{t-1}}{P_{t-1}} = \lambda\left(\left(\frac{M_t}{P_t}\right)^{opt} - \frac{M_{t-1}}{P_{t-1}}\right)$$

$$\Rightarrow \frac{M_t}{P_t} = a_0 + a_1 Y_t + a_2 r_t + (1-\lambda)\frac{M_{t-1}}{P_{t-1}}$$

I decided that this idea in the model can be used in model that will determine the sources of velocity behavior. Usually, for real money balances econometric form specification is log-log models are used. The important implication of this is that $\ln V = \ln\left(\frac{Y}{M/P}\right) = \ln Y - \ln(M/P)$ and one can calculate two forms of model and choose the best. Two differences between the model of real money balances and model of velocity are present. First is the use of lagged dependent variables and second is that velocity is tied to GDP deflator as a measure of price level.

'velocity' specification gives the following results:

Dependent Variable: LOG(V0)				
Method: Least Squares				
Sample(adjusted): 1994:12 2000:11				
Included observations: 72 after adjusting endpoints				
Convergence achieved after 12 iterations				
Backcast: 1994:11				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**

C	-0.367151	0.115362	-3.1826	0.0022
LOG(RGDP)	0.310916	0.074719	4.161155	0.0001
LOG(RR3)	-0.01823	0.007314	-2.49254	0.0152
LOG(V0(-1))	0.918164	0.016825	54.57007	0
MA(1)	-0.56743	0.106279	-5.33907	0
R-squared	0.938826	Mean dependent var		0.4328
Adjusted R-squared	0.935174	S.D. dependent var		0.3017
S.E. of regression	0.076814	Akaike info criterion		-2.2279
Sum squared resid	0.395329	Schwarz criterion		-2.0698
Log likelihood	85.2057	F-statistic		257.06
Durbin-Watson stat	1.902632	Prob(F-statistic)		0
Inverted MA Roots	0.57			

The model is perfect from statistical point of view: general and specific statistics are high, tests the presence of endogeneity, autocorrelation and heteroscedasticity are rejected at 5% and sometimes even 1% significance level. The coefficients show that major two determinants are real output and lagged dependent variable. This suggests that (a) linkage between nominal and real economy are strong and that adjustment of balances is not momentary but takes time. The coefficient for real interest rate is highly statistically significant but low value suggests that change in real interest rate has very small impact on decision whether to hold additional hryvnya or not.

I performed a test whether log of velocity should be used or it is better to use lagged output and lagged real money balances separately. For this both modifications were calculated. Wald test suggest that coefficients are not the same. From one hand it can imply usage of the latter technique (it also has higher general statistics: adjusted R^2 .96; F-statistics 371.97), but one thing should be remembered: data series has very high seasonality and lagged dependent variable can capture some of this effect. As a confirmation, one can compare the models and notice that moving average in the former case is highly significant but not in the latter. Very important to understand that both models have their economic backgrounds and in order to choose one economist should rhetorically argument for it. Mere statistical significance is not always a clue.

With the logarithmic form however, some estimation problems arise. First of all, in order to have logarithm one needs positive number, so I should assure that no non-positive numbers present in the regressions. It is definitely true for real GDP series as well as real money balances and velocity. However, any definition of opportunity costs (inflation, interest rate, change in foreign exchange rate, etc.) has negative values in monthly series. As a result, three opportunities arise: (a) use quarterly data; (b) elimination of all negative

numbers from series; (c) control for non-positive numbers. First case sharply (four times) decreases the number of observations and still some series consist negative numbers (real interest rate, change in nominal and real foreign exchange rate). Second case leads to possible self-selection bias (results are biased and inconsistent, even under GLS and GMM estimations) as well as destroys continuity of data (impossibility of usage of lags and autocorrelation scheme). As a consequence, only third method is appropriate.

Specification #1: dummy.

Negative real interest rate is impossible in the perfect foresight world, so it is very likely that during the period when negative number is present some adverse shock has happened to economy. To control for this I propose the usage of dummy variable which is 1 if non-positive number is in series and zero otherwise. Then I set all negative numbers to 1, so ln(1)=0 i.e. no impact on velocity/real money balances from negative rate[6]. As a result, all numbers are positive and there is control for negative shocks.

I run the regressions with the following specification:

$$\ln(\frac{M_t}{P_t}) = a_1 + a_2 \ln(rGDP_t) + a_3 \ln(rate_t) + a_4 D_t + a_5 \ln(\frac{M_{t-1}}{P_{t-1}}) + \varepsilon_t$$

the signs expected to be the following:

a_2 -positive, less than one;

a_3 -negative, less than one

a_4 -ambiguous but close to zero

a_5 -positive, significantly less than one.

As for the rate two opportunity costs were considered. The first one is opportunity cost of holding cash dollars and represent the importance of dollarization. The series is calculated as follows:

[6] At first I used .001 (ln(.0001=-9.21)) because minimal positive number is .0009, so negative is lower. Statistically this creates constant if negative numbers are in play. However, results does not differ significantly whether replace with 1 or .0001. Text method is simply more statistically correct.

Series=change in nominal exchange rate-inflation-inflation*change in nominal exchange rate

The second opportunity cost is holding basket of goods (increase proportionally to inflation) vs. real interest rate. The series is calculated as follows:

Series=nominal interest rate-inflation*12-inflation*nominal interest rate*12[7]

For inflation I used three different measures, namely changes in CPI, PPI and GDP deflator. The idea is that these measures increase with different magnitudes over time and they represent different baskets of goods and services, so I should check for all measures. And due to the fact that I described in the previous sentence I also calculated real money balances as nominal M2 stock over CPI, PPI and deflator.

		change in real foreign exchange rate			
			LOG(RGDP)	pos	dummy
rmb2c	rfes1	coef	**0.341904**	**-0.00138**	**-0.02605**
		t-stat	3.519585	-0.08128	-0.25182
	rfes2	coef	**0.336315**	**-0.00399**	**-0.05979**
		t-stat	3.489329	-0.25739	-0.64008
	rfes3	coef	**0.335774**	**-0.01097**	**-0.08316**
		t-stat	3.436684	-0.4019	-0.49146
rmb2p	rfes1	coef	**0.317629**	**-0.00783**	**-0.06129**
		t-stat	3.130493	-0.42022	-0.53762
	rfes2	coef	**0.310939**	**-0.00126**	**-0.04359**
		t-stat	3.088377	-0.07326	-0.42259
	rfes3	coef	**0.311111**	**-0.01754**	**-0.12024**
		t-stat	3.064431	-0.58608	-0.64752
rmb2d	rfes1	coef	**0.231262**	**-0.00313**	**-0.03777**
		t-stat	2.621901	-0.19552	-0.38704
	rfes2	coef	**0.224087**	**0.000562**	**-0.03077**
		t-stat	2.561064	0.038067	-0.34639
	rfes3	coef	**0.22509**	**-0.01273**	**-0.09427**
		t-stat	2.543733	-0.49382	-0.59083

Notation: **rmb2c** –real money balances deflated by CPI.

rmb2c –real money balances deflated by CPI.

rmb2p –real money balances deflated by PPI.

rmb2d –real money balances deflated by GDP deflator.

[7] From the pure mathematical point of view the annualization of monthly inflation should be made in geometrical, not arithmetical progression, i.e. $p_{ann}=(1+p_{mon})^{12}-1$. For the small values of inflation both formulas give similar results, so they can substitute each other. For hyperinflation the results differ widely and this should be controlled for. I used "non-perfect" form because otherwise the values for several hyperinflation months can screw all the picture: for example, Dec.-93 monthly inflation was 90.8% i.e. 232,677% in the annual terms –obviously too high to enter in the real interest rate calculation.

Rfes1 –change in real foreign exchange rate deflated by CPI.

Rfes2 –change in real foreign exchange rate deflated by PPI.

Rfes3 –change in real foreign exchange rate deflated by GDP deflator.

Positive –only positive values included.

Dummy –dummy for negative values.

	real interest rate				
			LOG(RGDP)	POS	**DUMMY**
rmb2c	rr1	coef	**0.37383**	**0.016715**	**0.083127**
		t-stat	3.979857	0.578431	0.222976
	rr2	coef	**0.364751**	**0.006642**	**0.002127**
		t-stat	3.814297	0.366996	0.009063
	rr3	coef	**0.366378**	**0.009786**	**0.004352**
		t-stat	3.835504	0.386616	0.013297
rmb2p	rr1	coef	**0.39657**	**0.035688**	**0.311063**
		t-stat	4.061911	1.166347	0.783867
	rr2	coef	**0.363098**	**0.007957**	**-0.00724**
		t-stat	3.668584	0.412875	-0.02908
	rr3	coef	**0.373163**	**0.021575**	**0.132949**
		t-stat	3.836817	0.812813	0.384812
rmb2d	rr1	coef	**0.301558**	**0.018855**	**0.103455**
		t-stat	3.544852	0.697123	0.295668
	rr2	coef	**0.270859**	**0.010208**	**0.037903**
		t-stat	3.128281	0.608193	0.174347
	rr3	coef	**0.281664**	**0.009999**	**0.001832**
		t-stat	3.275653	0.420822	0.005946

Notation: the same as in previous model, except:

Rr1 –real interest rate deflated by CPI.

Rr2 –real interest rate deflated by PPI.

Rr3 –real interest rate deflated by GDP deflator.

The results suggest that the most influential parameter for change in real money balances is real output. The value of coefficient is around .35 and t-statistics is between 2.56 and 4.06. From the other hand all coefficients with positive opportunity cost are statistically insignificant. The insignificance together with very small coefficients can be explained as the small development of the market for idle balances. Very interesting is the fact that while the change in real foreign exchange rate has expected sign while real interest rate is almost always positive. This situation can be explained by the facts that Ukraine is highly dollarized economy (so change in parameter is more important for balance holders) and that people prefer to hold their wealth in foreign currency. The coefficient with respect to real interest rate is positive because real interest rate exist in stable economy where holding

of more real money balances is lees probably decrease in value. As well the care should be taken, because M2 is currency plus deposits in the domestic currency, so stability also can lead to more confidence in domestic banking system and, as a result, increase in the volume of deposits. The dummy is always statistically insignificant at 10% and has the same sign as corresponding positive coefficient. This is very interesting, because one could expect that if with decrease in positive values our dependent variable decreases (positive sign coefficient), then decrease from positive to negative numbers should have negative sign. Unchanged sign suggests that non-linear dependence between real money balances and opportunity cost exist.

The variables omitted in the tables are: constant, lag of real money balances and moved average. The constant is negative and statistically insignificant in all regressions. The real money balances lag is around .70 and highly statistically significant (t-statistics around 12). Test for the fact that coefficient equals one rejected at 5% in any model. This suggests that huge inertia exists and that inertia is not a single determinant of real money balances. Moving average is included for the control of high oscillation that exists in data. The coefficient is positive (around .5) and highly statistically significant (t-statistics around 5.5).

General statistics suggests that regressions are highly significant, namely adjusted R^2 is around .937, with minimum .92; F-statistics has value around 260 (probability of rejection 10^{-6}), suggesting that variables really influence dependent parameter. Tests for heteroscedasticity (White heteroscedasticity) rejected at 10% but not at 5% significance level. Higher error terms during 1993-1995 suggest that maybe inflation is a clue. Test for autocorrelation (LM serial correlation test) cannot be rejected at 10% significance level.

The main results are: (a) real output is very important determinant of real money balances (b) opportunity costs are statistically insignificant at 5% and sometime have the sign opposite to the theoretical predictions (c) real money balances exhibits significant inertia.

Specification #2: absolute values.

The negative side of previous specification is that it controls for the existence of shock but not the magnitude of the shocks, thus some important data can be left. As a result, another specification is proposed: usage of the same dummy, but then all negative numbers are set to 1 and new series created: all positive numbers set to 1 and all negative are taken in their

absolute value. As a result I control for the magnitude. The results of such regressions presented in the following tables:

			change in real foreign exchange rate		
			LOG(RGDP)	pos	neg
rmb2c	rfes1	coef	**0.353697**	**-0.00754**	**-0.01019**
		t-stat	3.622883	-0.66576	-0.97102
	rfes2	coef	**0.351502**	**-0.00357**	**-0.00906**
		t-stat	3.59566	-0.35442	-0.99015
	rfes3	coef	**0.358107**	**-0.0148**	**-0.01771**
		t-stat	3.734937	-1.50727	-1.9057
rmb2p	rfes1	coef	**0.34203**	**-0.01556**	**-0.01726**
		t-stat	3.358479	-1.25959	-1.51084
	rfes2	coef	**0.3239**	**-0.00171**	**-0.00735**
		t-stat	3.155357	-0.15392	-0.7287
	rfes3	coef	**0.335292**	**-0.01423**	**-0.01623**
		t-stat	3.320389	-1.30043	-1.58246
rmb2d	rfes1	coef	**0.254597**	**-0.01258**	**-0.0153**
		t-stat	2.876209	-1.17903	-1.54649
	rfes2	coef	**0.246435**	**-0.00526**	**-0.01065**
		t-stat	2.767187	-0.55159	-1.22726
	rfes3	coef	**0.249462**	**-0.01305**	**-0.01581**
		t-stat	2.84609	-1.3981	-1.79669

Notation: the same as in previous model, except:

Neg –coefficient with absolute value of negative number.

			change in real foreign exchange rate		
			LOG(RGDP)	POS	NEG
rmb2c	Rr1	coef	**0.391591**	**-0.00921**	**-0.01855**
		t-stat	4.232509	-0.57735	-1.27493
	Rr2	coef	**0.371602**	**-0.0017**	**-0.00854**
		t-stat	3.886086	-0.15739	-0.80229
	Rr3	coef	**0.387873**	**-0.00801**	**-0.01687**
		t-stat	4.117269	-0.52338	-1.19151
rmb2p	Rr1	coef	**0.410624**	**-0.00533**	**-0.01605**
		t-stat	4.213104	-0.29717	-0.98132
	Rr2	coef	**0.37365**	**-0.00172**	**-0.01061**
		t-stat	3.791347	-0.15194	-0.9615
	Rr3	coef	**0.390973**	**8.94E-05**	**-0.01089**
		t-stat	4.00591	0.005315	-0.69743
rmb2d	Rr1	coef	**0.330401**	**-0.01615**	**-0.02541**
		t-stat	3.967669	-1.07562	-1.85845
	Rr2	coef	**0.289989**	**-0.00608**	**-0.01395**
		t-stat	3.383966	-0.60844	-1.42374
	Rr3	coef	**0.316645**	**-0.01394**	**-0.02281**
		t-stat	3.732684	-0.96816	-1.71458

Notation: same as in the previous specifications.

As well as in the previous specification, the results suggest that the most influential parameter for change in real money balances is real output. The average value of coefficient is lower than in previous models, while variation of value is higher. The mean is

.3377; minimum is .246 and maximum is .411. The great care should be taken there, because variation exists due to different inflation measures that affect both real money balances and opportunity cost. All indexes are set to 1 for December 1992, but in December 2000 the indexes were: CPI: 4008; PPI: 5403; deflator: 3516. The t-statistics is between 2.76 and 4.23, which is higher than in the previous specification.

Positive opportunity cost in both variants now performs better: the signs are according to the theory and statistical significance is somehow higher, especially for change in real foreign exchange rate. This suggests that second specification can be more appropriate. The values of coefficient with foreign exchange are around .01 for the most significant specifications, however t-statistics is still below the 2.64 that is rule-of-thumb threshold for 1% significance level. The values of coefficient with respect to real interest rate almost all now have expected sign and higher statistical significance than with the dummy case. I checked models with both inclusion of dummy and absolute value of negative cases, but results advocate that due to correlation of this two parameters I achieve more regressors than is econometrically necessary. The adjusted negative values now have more statistical significance than dummy, suggesting usage of the latter specification. It is very interesting that coefficients still have negative sign, signifying that with decrease in opportunity cost on negative part real money balances decrease. The only one meaningful explanation is that during the adverse shocks that lead to negative coefficients (the source is only one – inflation) with respect to opportunity cost, the real money balances also affected by the same shock and due to inertia do not adjust as quickly as expected in the zero transaction perfect foresight world. Another interesting fact that can be extracted from the results is that despite the significance of coefficient with respect to the change in real foreign exchange rate is still higher, the values of coefficients are almost the same, and so both markets move in similar manner. This fact also confirmed by the test that suggests high correlation value (0.86 for CPI as a deflator) between negative values of the change in real foreign exchange rate and real interest rate. To confirm a much less correlation between positive values I checked for this and achieved correlation only 0.016 (for CPI as a deflator) that is definitely much lower.

I omit in the tables the same variables as in the previous specification: constant, lag of real money balances and moved average. The constant is still negative but statistically significant in almost all regressions at 5% significance level (in 2 out of 18 is significant at 1%) with values around –0.3 (antilog(-.3)=.74). The real money balances lag is around .71

and highly statistically significant (t-statistics around 13.5) for the change in real foreign exchange rate and around .79 for the real interest rate (t-statistics around 12.8). in order to check for the probability that either true coefficient for the first case is .79 or .71 for the second I performed Wald test. The results show that I cannot reject the hypothesis that the true coefficient is the same at 10% significance. Test for the fact that coefficient equals to one is still rejected at 5% in any model, and in most models at 1%. This implies that huge inertia exists and that inertia is not a single determinant of real money balances. Second important result is that the change in real foreign exchange rate changes real money balances faster (exhibits less inertia) than the real interest rate. This also suggests the greater importance of dollars as a store of value in Ukraine. Moving average coefficient is positive (around .5 for the change in real foreign exchange rate and around .35 for the real interest rate specifications) and highly statistically significant.

General statistics suggests that regressions are highly significant, namely adjusted R^2 is around .942, with minimum .93; F-statistics has value around 285, telling that variables really influence dependent parameter. Tests for heteroscedasticity (White heteroscedasticity) rejected at 5% for the real interest rate models but not for the change in real foreign exchange rate. This can be explained by the fact that during hyperinflation idle balances moved to dollars and during stabilization back to the domestic currency leading to higher oscillation of exchange rate, while credits where scarce during the whole period of consideration and do not change significantly. Additionally, test for autocorrelation (LM AR test) is also rejected at 1% for the change in real foreign exchange rate but not for the real money balances (note that under LM serial correlation test the null hypothesis is that there is no serial correlation in the residuals, so rejection suggests serial correlation). Existence of autocorrelation can be explained as either some un-accounted residual inertia or omitted variables or wrong specification form. If there first case is a true one then autocorrelation is not too dangerous, because coefficients remain unbiased. If there are omitted variables (most likely some institutional changes) then there can be bias in coefficients, but due to the fact that no good proxies for institutions exist, the model is still the best available.

The main results of second specifications are: (a) real output is still very important determinant of real money balances and its coefficient seems to be a very robust one, because it remains highly significant in any interpretation as well as value is always around .34 (b) opportunity costs are statistically insignificant at 5% but now, with the control for

magnitude of negative values have the theoretically expected signs, (c) the change in real foreign exchange rate has more significant coefficients than the real interest rate, suggesting the greater importance of foreign currency as a store of value in Ukraine, (d) real money balances exhibits significant inertia.

Changes in preferences.

The main purpose of this section is to investigate whether one can capture the changes in preferences to holding money balances during the transition. In order to answer this question I developed an algorithm that should made a de-fragmentation of transition on periods, achieve different proxy coefficients for them and then regress them on possible explanatory variables.

In the long-history stable market economies the periods used in the similar models are connected to business cycle, namely peak-to-peak or through-to-through periods are taken and average of some variable in question is calculated. In Ukraine, however, it is very hard to find even one full business cycle, so this method is inappropriate now. As an alternative I propose to use yearly break-down of monthly series. The pro arguments are: seasonal movements are very similar across the years (like price decrease in July, increase in output in September and so on), so any more or less than annual break-downs can be inapt; less than one year monthly series will have less than 12 observation which fact can lead to micronumerosity problem. The contra arguments are: obviously, the crisis periods can start not only in January and last till December (for example the Ukrainian hyperinflation period usually recommended to be measured from May 1993 to March 1994); the break-down should be on the basis of economic expediency but not on the basis of solar cycle. Despite the all problems and possible misspecifications I still think that the method is the most appropriate under existing constraints.

The method goes through such steps:

1. chooses several regressions with the best statistics from the previous specifications, on the basis of: t-statistics, F-statistics, Akaike information criterion, Schwarz criterion.

2. takes specification and run 8 annual regressions (from year 1992 to 2000) for each.

3. the achieved coefficients for the lagged dependent variable (either velocity or real money balances) give us lambdas for the next regression.

4. regresses calculated lambdas on time trend and inflation. Inflation should have positive sign as well as time. The previous positive coefficient is due to decrease in inertia after experience of inflation. The latter positive sign is expected because I assume that as transition goes people achieve more experience.

5. The regressions selected are:

6. real money balances (M2 domestic deposits only) ['RMB(M2D)'] on constant ['c'][8], real GDP positive and absolute negative values of the change in real foreign exchange rate

7. RMB (M0 currency in circulation) ['RMB(M0)'] on the same variables.

8. velocity (M2 domestic deposits only) ['V(M2D)'] on the same variables.

9. V (M0 currency in circulation) ['V(M0)'] on the same variables.

10. from 5 to 8 the same models, but on the values of the real interest rate.

11. RMB (M2 domestic and foreign deposits) ['RMB(M2F)'] on the values of the real interest rate.

The results of these 8x9 regressions give the following numbers for lambdas:

Table #4.5 the change in real foreign exchange rate

	1993	1994	1995	1996	1997	1998	1999	2000
LOG(RMB2D(-1))	1.227	0.577	0.795	0.927	0.315	0.318	0.112	0.190
LOG(RMB0D(-1))	0.699	0.526	0.456	1.100	0.225	0.405	0.356	0.379
LOG(V2D(-1))	0.851	0.243	0.635	0.696	0.361	0.813	0.861	0.662
LOG(V0(-1))	0.808	0.125	0.505	0.475	0.288	0.845	1.111	1.032

Table #4.6 the real interest rate

	1993	1994	1995	1996	1997	1998	1999	2000
LOG(RMB2D(-1))	1.046	-0.576	0.508	0.751	0.364	-0.251	0.263	0.444
LOG(RMB0D(-1))	0.804	0.391	0.326	0.563	0.333	0.246	0.462	0.688
LOG(V2D(-1))	0.91	-0.176	0.636	0.304	0.486	0.86	0.94	1.053
LOG(V0(-1))	0.769	0.098	0.339	0.738	0.293	0.942	0.962	0.924

[8] If constant is insignificant I omit it in order to decrease micronumerosity problem

LOG(RMB2FD(-1))	0.967	0.504	0.304	0.627	0.431	0.855	0.12	0.359

The regressions' results are not quite good from the statistical significance point of view. For example in almost all regressions for 1993-1994 year I achieved moderate R^2 statistics (0.23-.60), as well as F-statistics (12 or less, i.e. rejected at 5%). But my main intention was to achieve lambdas that are unbiased, but not necessary highly statistically significant.

Moreover, as can be seen, during the hyperinflation the value of lambda exceeds one, violating an assumption about the stationary series, but from other hand this coefficient does not statistically differ from zero at 10% significance level, so this value can be zero as well. The high lambda values during 1999-2000 are due to loose monetary policy and to high influence of lagged real GDP growth.

The regression of lambda on time trend and inflation give mixed results. It has high (for 8 observations and 3 regressors) t-statistics with predicted positive signs for 5 out of 9 models. However, two models have negative significant coefficients, which can be explained by non-linear dependence that cannot be fully captured due to the limited number of observations. The rest of the models have t-statistics below one (probability of zero value above 25%), so their signs can hardly be considered.

Very interesting that annual behavior of lambdas for velocity and real money balances for M0 and M2D specifications is very similar to the behavior of yearly M0 velocity, signifying the possibility of using velocity as a proxy not only for money demand changes but for changes in preferences as well.

Results: there is no strong confirmation of the fact that preferences for real money balances holding are changed due to inflation and increase of experience. There is suggestion that there was a change in preferences during transitional period.

CONCLUSIONS.

My work presents an attempt to find out whether velocity is an important indicator for the transitional economies or not. The main outcome that I achieved is that velocity really matters. Evidence suggests that random walk model is not a right so there are some variables that bring an external shock to velocity.

Models show that inflation has a strong non-linear influence on velocity. The signs of econometrical specifications are as predicted, coefficients are statistically greater than zero and reasonably high to imply that real dependence between inflation and velocity exists. However, there are some possible drawbacks that belittle achieved results, mainly problems of heteroscedasticity and simultaneity.

Models with real money balances show that demand shocks have moderate impact on money supply and thus on velocity. This model shows a tight relationship between real economy and financial system. This has an important implication that it is possible to implement active monetary policy in Ukraine, despite the existence of barter and high level of dollarization. Specification of previous model with inclusion of dummies for 'stability' shows that institutional framework also matters.

The experiments with log-log specification reveal that the strongest influence on velocity and real money balances have lag of these values and real output. This suggests an existence of inertia and strong linkage between real and nominal economy. Opportunity costs from other hand are not that influential, and sometimes coefficients have wrong signs. There is some evidence that probably change in real exchange rate has more influence on economic agents than real interest rate. It can be explained by high dollarization of economy and humble development of the banking system.

The broad definitions of velocity, with inclusion of shadow GDP estimates and overdue inter-enterprise payables does not improved the model, but rather made it worse in statistical terms. Sometimes it led to unexpected signs, increasing the probability of mis-specification. As a result, I do not recommend to use wide definition of velocity.

There should be done future research on this topic, namely investigation of effects of government monetary and fiscal policy on velocity, as well as determining some non-

monetary important factors like development of markets, corruption, urbanization and the like. Short time series with quite noisy data however seriously limit the possibilities of conducting such research at the present stage.

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Appendix 1. The description of history of the main determinants of velocity: real GDP, price level and monetary aggregates.

Changes in real output: 1992-2000.

After the first two years of Ukrainian independence real GDP fell around 6% per annum. The more precise data about this period is very hard to find, because old soviet methodology was used that calculated net material product (NMP) that is not directly comparable to GDP. The Ministry of Statistics began to apply the international System of National Accounts accounting framework only in 1994. The main reason of fall was an external shock from the breach of linkages between the plants of the former Soviet Union.

At the end of 1993 and in 1994 another factor became a main determinant of economic downturn. This was an impossibility to create valid prediction of future due to hyperinflation. Weak financial sector and poor governance led to awful fall in investment. In 1993 real output fell by 26.9% and in 1994 by 40%. Ukraine became a classical example of the relation between nominal and real economy.

In 1995 inflation was slowed down, but structural reform was not implemented. Government expenditures remained high and inefficient tax collection led to the fact that 80% of enterprises experienced losses at the end of the year. Changes in industrial gross output do not imply parallel changes in the value added by the sector: insofar as a large part of industrial output still remains non profitable (due to changes in the relative price of energy), a reduction in industrial output can bring a growth of the value added of the whole economy (UEPLAC, trends…, Jan., 1995). In 1995 GDP fell by 7.0%, and if compare with 1990, total fall was 66.5%.

During 1996-7 output fall continued but with ever-decreasing magnitude. The main reason of decline was that several important reforms were not implemented. The share of services in GDP that ought to became a growth area, in reality shrink in comparison with industrial production. However, the business climate was much more favorable than in the previous years, and it is thought that a growing share of the economy just "goes in the shadow", avoiding the tax system (UEPLAC, trends…, Jun., 1997). The general impression was that the GDP is probably on a slowly growing trend, after stabilization has been achieved in 1996. It is worth noting that the official statistics may not fully capture a considerable share of the economy which is just "acting in the shadow" in order to avoid Ukraine's excessive taxation (see e.g. UEPLAC, trends…, Dec., 1998). In 1997 GDP fell by 6.3% and in 1997, when stabilization was achieved, by 0.4%.

In 1998 GDP started to grow but excessive bond financing of government budget led to debt crisis, and this adverse shock once again led to downward movement in GDP. If for the January-July industrial output decreased by 0.12%, during September-November it fell by 4.89%.

After crisis of 1998, there was a huge necessity to harden up budget constraint for central and local government. This increased a tax burden, causing a drop in output. However, devaluation of national currency created possibilities to gain some export advantage. Increase in world demand for ferrous metals led to revival of Ukrainian economy. In the second half of 1999 the Ukrainian economy showed clear signs of improvement of the situation. According to UEPLAC index in 1999 the volume of GDP reached the level 99.6% of the same period of 1998 compare with the 96.8% in 1998 to 1997 (UEPLAC, trends…, Dec., 1999). In 2000 real output started a year long growth for a first time since 1990. the real GDP increased by 6%, the overall industrial output grew by 12,9% and output change in some branches overtook 20%. This is clearly a positive sign, but even now the growth can be easily reversed by fall of demand on Ukrainian metals and pipes that constituted more than 40% of export and around 28% of industrial production.

The development of Ukrainian inflation (1992-2000)

In January 1992 Ukraine introduced new pseudo-currency 'coupon-karbovanets' that was aimed to protect Ukrainian consumers from expansive monetary policy of Russian central bank. Also during this month a lot of consumer goods prices were freed, resulting in 1-month inflation shock, the greatest in Ukrainian modern history – 298%. Price increase was almost entirely demand driven and ought to stop in a month or two. However, in order to keep budget expenditures on high level together with decreasing tax burden, government started massive emission. People were unprepared to sharp change in environment, so in was possible for a short run to rise the supply of money without adequate increase in price level. Average inflation was 21.1% per month. Generally inflation showed a slow upward trend, increasing on 2-5% per quarter. Yearly inflation was 1,292%.

In January 1993 the rest of consumer goods prices were liberalized. Inflation during this month peaked 73.4%. government continued its expansive monetary policy and it triggered ever increasing inflation. Most of the economists determine hyperinflation as rate on price level growth above 50 percent per month. In 1993, average monthly inflation was 49.1%,

and in the last two quarters 57%. Hyperinflation shocked the Ukrainian economy. Price level increased 112 times.

After the hyperinflation period of the second half of 1993, the first half of the year 1994 has seen a decrease in monthly inflation rates which have fallen below 5% in May -August. This relative stabilization was mainly the consequence of the decrease in the growth rate of money. The newly established control of some prices did not play a crucial role in the stabilization process, but contributed to strengthen the distortion of relative prices and to favor a growing misallocation of resources. However, budget credits that were granted for agricultural needs from the end of August and expectations of strong price rises led to re-appear of inflationary tensions. From the beginning of November, prices for bread, rents and communal services, urban transports, were multiplied by a factor of 4 to 10 and most other prices were freed again. Simultaneously, wages and pensions rose significantly. In November the CPI increased by 72%, and the process of price adjustment still took place in December with a 28% growth. Yearly inflation was 510%.

During the following three years inflation steadily decreased and averaged 9 percent per month in 1995, 2.8% in 1996 and 0.8% in 1997. Low inflation rate led to possibility of development of banking system, gave more confidence to population, created conditions for economic growth. However, structural reform was not implemented, budget deficit remained too large and market incentives were weak.

The year 1998 can be separated on two parts: pre- and post-crisis periods. Up to August 1998 inflation remained low, averaged 0.3% per month. After the Russian crisis inflation increased to 3.8% in September and 6.4% in October. The negative output shock and rise in inflation rate led to an increase in distrust to national currency.

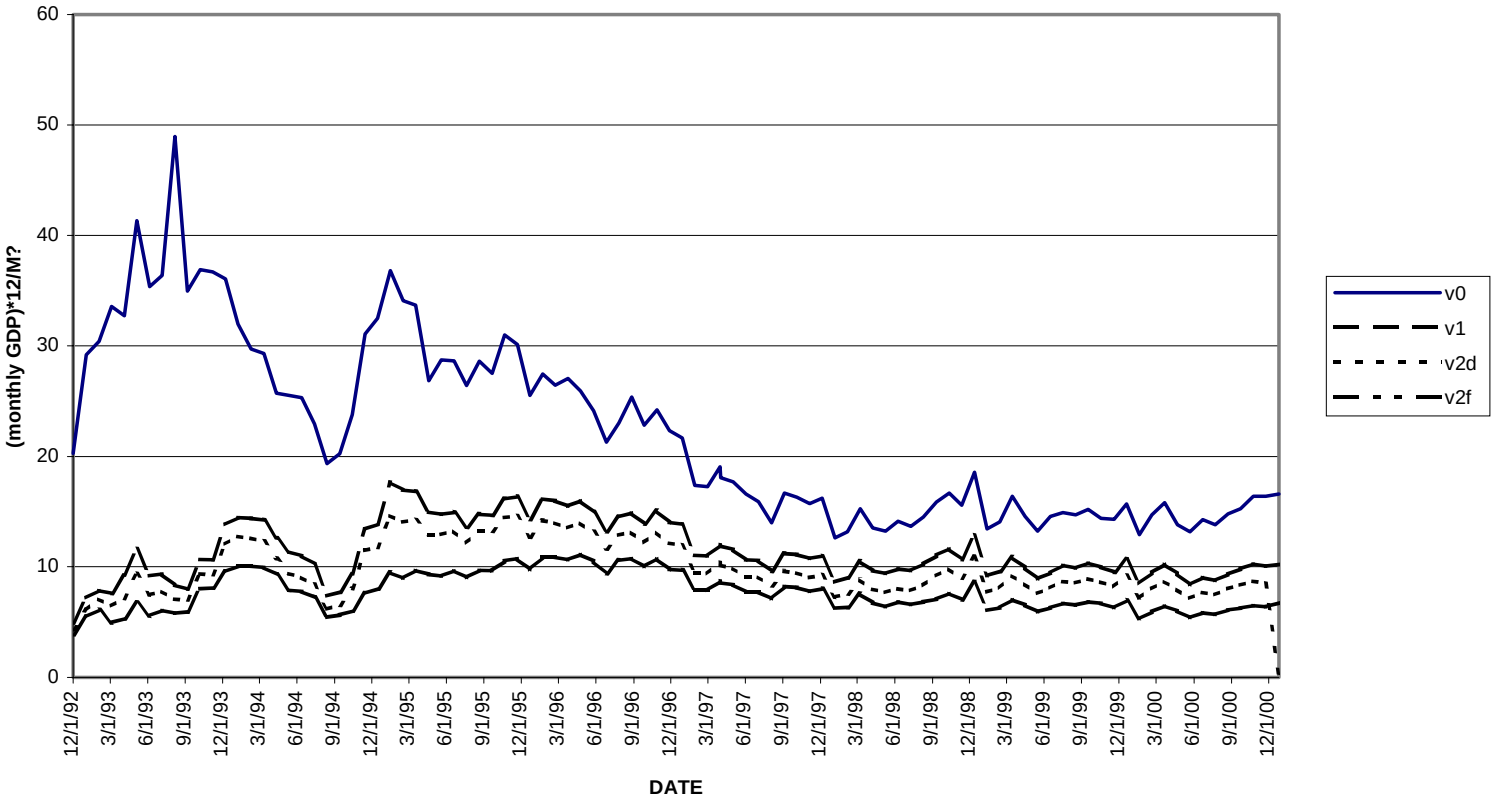
In years 1999 and 2000 inflation was again lowered to 1996-7 level, averaged 1.5% in 1999 and 1.9% in 2000. The main source of increase in inflation rate during 2000 was an increase in supply of money by the central bank.

Appendix 2. tables with basic data.

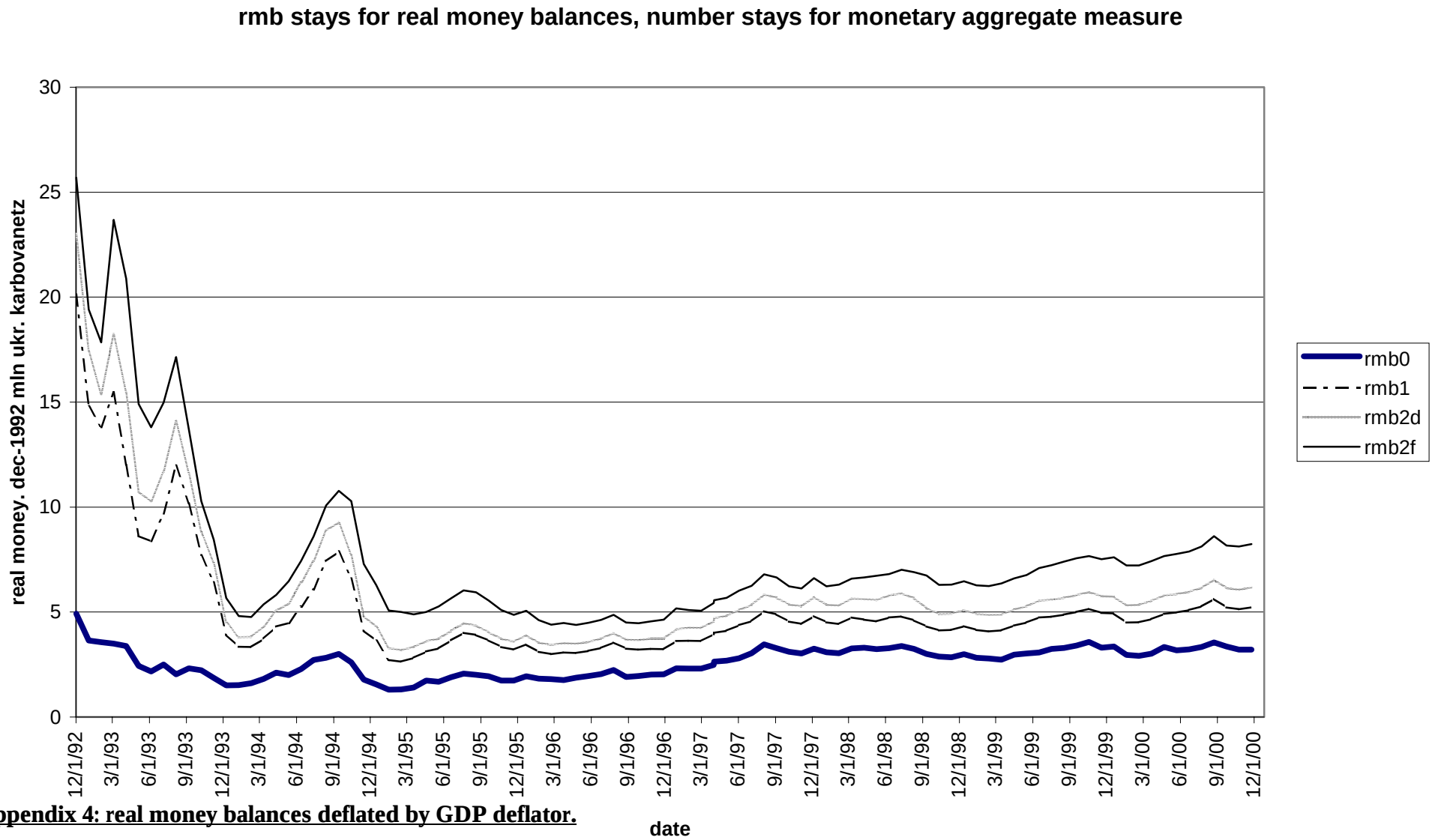
date		M0	M1	M2F	CPI	GDP deflator	PPI	nominal GDP	real GDP	Foreign exchange rate
1992	dec	5	20	26	78	91	111	8	9.13	1050
1993	jan	6	26	34	136	157	243	15	9.74	1480
1993	feb	8	30	38	175	195	294	19	9.93	2000
1993	mar	9	40	61	213	234	328	25	10.76	2200
1993	apr	11	39	67	264	292	387	30	10.14	2950
1993	may	12	42	72	337	439	589	40	9.21	3100
1993	jun	17	65	107	578	703	1119	50	7.04	3350
1993	jul	26	101	155	795	945	1466	79	8.31	3588
1993	aug	28	166	238	968	1263	1950	115	9.14	6440
1993	sep	52	228	307	1745	2035	3442	151	7.42	11058
1993	oct	77	265	353	2898	3126	4619	236	7.54	19297
1993	nov	90	312	410	4210	4420	6148	276	6.25	25413
1993	dec	128	334	481	8033	7718	10876	384	4.97	31650
1994	jan	157	347	499	9576	9440	14585	419	4.44	37450
1994	feb	194	400	572	10782	10915	17691	479	4.39	36904
1994	mar	230	474	681	11397	11536	19159	562	4.92	38597
1994	apr	283	578	781	12081	12214	20194	607	4.97	43627
1994	may	278	624	899	12709	12665	20679	591	4.67	47248
1994	jun	333	766	1082	13205	13243	21299	702	5.30	46149
1994	jul	403	900	1277	13482	13504	22236	770	5.70	43887
1994	aug	442	1163	1579	13832	14266	24882	713	5.00	45766
1994	sep	520	1365	1863	14842	15742	28067	877	5.57	58216
1994	oct	569	1446	2253	18196	19928	33793	1129	5.66	84342
1994	nov	694	1607	2835	31352	35413	70729	1797	5.07	122083
1994	dec	793	1860	3216	40257	46535	95059	2146	4.61	128177
1995	jan	828	1726	3218	48791	57801	122817	2542	4.42	142138
1995	feb	956	1921	3643	57622	66260	136818	2716	4.06	140161
1995	mar	1134	2271	3935	64191	73175	149542	3182	4.37	148026
1995	apr	1474	2646	4245	67914	77162	157169	3301	4.28	148383
1995	may	1498	2916	4703	71038	81257	168327	3584	4.41	152403
1995	jun	1782	3429	5297	74448	85297	182804	4258	5.00	150517
1995	jul	2028	3939	5931	78319	89499	190664	4461	4.98	148484
1995	aug	2107	4085	6217	81922	95176	203057	5027	5.28	165565
1995	sep	2235	4196	6386	93555	104585	223160	5125	4.90	174900
1995	oct	2122	4074	6232	102068	111253	241905	5476	4.92	177500
1995	nov	2226	4104	6235	108397	116542	252066	5587	4.79	180933

1995	dec	2623	4682	6846	113383	122973	258619	5577	4.54	180581
1996	jan	2575	4378	6514	124041	128325	267412	5896	4.59	184935
1996	feb	2799	4635	6805	133220	140715	275167	6168	4.38	188034
1996	mar	2779	4853	7065	137217	143689	283147	6267	4.36	191645
1996	apr	3077	4990	7187	140510	149023	287394	6646	4.46	188500
1996	may	3190	5152	7339	141493	148928	289693	6414	4.31	184000
1996	jun	3324	5358	7522	141635	148018	290852	5904	3.99	179071
1996	jul	3617	5739	7861	141776	146940	292597	6935	4.72	175113
1996	aug	3190	5442	7540	149858	152258	293768	6745	4.43	174867
1996	sep	3330	5459	7592	152855	154678	296705	6326	4.09	171483
1996	oct	3471	5562	7821	155148	155966	297002	6998	4.49	173774
1996	nov	3499	5559	7996	157009	156742	300566	6503	4.15	183267
1996	dec	4041	6315	9024	158423	158849	303271	7297	4.59	184339
1997	jan	4087	6433	9003	161908	160973	304484	5920	3.67	187052
1997	feb	4143	6500	9084	163851	163276	305702	5960	3.66	183020
1997	mar	4376	6967	9585	164015	160629	307536	6948	4.34	181093
1997	apr	4763	7238	10041	165327	164082	310304	7165	4.37	182376
1997	may	4847	7428	10263	166649	164439	311235	7154	4.35	182110
1997	jun	5102	7971	10971	166816	165826	312480	7047	4.25	182948
1997	jul	5549	8336	11413	166983	166063	313730	7359	4.43	182537
1997	aug	6242	9076	12258	166983	164083	313730	7272	4.43	183546
1997	sep	6031	8978	12221	168987	167246	314044	8377	5.01	185484
1997	oct	5865	8589	11759	170507	171839	317498	7971	4.64	186624
1997	nov	5713	8363	11550	172042	171538	316863	7486	4.36	187619
1997	dec	6132	9050	12448	174451	171232	318448	8295	4.84	188506
1998	jan	5896	8639	11919	176718	174167	320995	6196	3.56	189695
1998	feb	5825	8507	12095	177072	174579	323884	6398	3.66	194602
1998	mar	6364	9230	12835	177426	177104	326151	8080	4.56	201467
1998	apr	6354	8928	12793	179733	175050	327782	7173	4.10	202969
1998	may	6294	8893	13116	179733	177368	327782	6955	3.92	203846
1998	jun	6390	9226	13257	179733	177139	328438	7527	4.25	204478
1998	jul	6599	9345	13691	178115	177625	330408	7498	4.22	207467
1998	aug	6384	9049	13569	178471	178977	334373	7727	4.32	216797
1998	sep	6310	9066	14142	185253	190869	365804	8349	4.37	289570
1998	oct	6510	9308	14237	196739	205652	404945	9036	4.39	354964
1998	nov	6566	9574	14538	202641	209951	419118	8512	4.20	346809
1998	dec	7158	10331	15432	209328	217336	431273	11078	5.09	353605
1999	jan	6705	9838	14880	212468	216046	434723	7524	3.48	342700
1999	feb	6747	9872	15090	214593	219998	439505	7912	3.60	347086
1999	mar	6716	10130	15631	216739	223609	441263	9171	4.07	377280

1999	apr	7348	10761	16352	221724	225156	448764	8912	3.94	393368
1999	may	7701	11434	17161	227045	231094	451008	8501	3.67	392352
1999	jun	7915	12192	18258	227272	234081	454616	9601	4.10	394960
1999	jul	8290	12228	18498	224999	232796	460526	10310	4.42	400443
1999	aug	8587	12748	19340	227249	237779	476645	10526	4.42	446050
1999	sep	9008	13255	20019	230431	241018	480458	11420	4.73	445590
1999	oct	9496	13705	20402	232966	242038	483821	11396	4.71	446730
1999	nov	9021	13550	20552	239722	248882	490595	10765	4.32	463060
1999	dec	9583	14094	21714	249550	259664	498935	12545	4.80	506910
2000	jan	8777	13357	21453	261029	270313	514901	9446	3.49	538110
2000	feb	8962	13908	22241	269643	280297	524169	11001	3.92	554310
2000	mar	9465	14605	23275	275036	285304	538321	12490	4.38	546800
2000	apr	10631	15635	24405	279712	289807	549088	12248	4.22	542280
2000	may	10369	16246	25350	285586	296789	552382	11370	3.83	540410
2000	jun	10783	17024	26359	296153	304306	557354	12805	4.21	543600
2000	jul	11295	17813	27483	295856	307697	565157	12997	4.26	543860
2000	aug	11861	18817	28778	295856	303965	569113	14630	4.83	543580
2000	sep	11541	17953	28076	303549	312849	575942	14657	4.68	543900
2000	oct	11088	17711	28035	307798	313946	583429	15147	4.82	543870
2000	nov	11158	18205	28663	309030	316545	589264	15223	4.81	543710
2000	dec	12799	20732	31387	313974	319172	601638	17684	5.54	543580



Appendix 3: velocity of monetary aggregates



Appendix 4: real money balances deflated by GDP deflator.