Introduction

Malgorzata Jakubiak[1]

Background

The collection of papers published here was written in 2004 within a project, which aimed to broaden the knowledge about sources of inflation in Ukraine and indicate policies that can support low inflation in the future. While working on analyses of monetary policies and inflation, the authors used the experience of other transitional countries, Polish in particular.

This volume presents the effects of work of the team of Ukrainian and Polish economists from three research institutes: Center for Social and Economic Research CASE, CASE Ukraine and the Institute for Reforms.[2] The project entitled "Sustaining Low Inflation in Ukraine in the Context of Financial Stabilization Policies" was supported by Polish-American-Ukrainian Cooperation Initiative PAUCI.

Value of low inflation

Stabilizing inflation has proved to be one of the most crucial conditions for continuous economic growth. The perception of macroeconomic stability, influenced by steady and low, one-digit level inflation has had particular meaning for emerging or transitional economies. It increases the confidence to domestic currency, macroeconomic policies and boosts financial intermediation. At the same time, low and predictable price changes reduce transaction costs.

The issue of stabilizing inflation is of special importance in Ukraine. The economy has been growing at high rates, and the post-1998 crisis recovery brought many positive changes that helped to increase confidence to domestic policies. First of all, balanced budgets substantially decreased inflationary pressure on monetary policy. The implicit exchange rate peg to the US dollar worked and the exchange rate has remained broadly unchanged from 2000. As we can see from the chapter on price changes in Ukraine in 1992-2004, post-1998 period resulted in sharp re-monetization of the economy, which helped in bringing CPI changes to 1-digit levels in 2001, and even to deflation in the following year. However, after 1.5 years inflation rebounded and – being on the upward path – was already above 10% in annual terms at the end of 2004.

As the central bank of Ukraine has been considering turning to inflation-based stabilization policy, the project team decided to review Polish disinflation experience. The National Bank of Poland switched from "eclectic monetary policy" to direct inflation targeting in 1998. The exchange rate regime was significantly relaxed that year, although formally it continued to be under the control of the central bank until 2000. Chapter by Przemyslaw Wozniak lists reasons for which Polish monetary policy has focused solely on the CPI inflation from this time. Among others, the clarity of the monetary policy goal has allowed to anchor inflation expectations in an effective way, thus facilitating disinflation. Also, direct inflation targeting allowed to improve transparency of decision making and to better communicate with the market. The author concludes that although none of the short-term targets have been met in

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the five-year history of direct inflation targeting, the overall experience should be considered positive. The mid-term goal of reducing inflation below 4% by 2003 was achieved.

Przemyslaw Wozniak, in his text on Polish disinflation experience, presents also data on relative price changes, indicating the supply- and demand-side sources of inflation. Besides, there is an account of evolution of consumption structure in Poland through 1990-2003. The description of inflation target as one and only goal of monetary policy is complemented by the discussion of instruments used by the National Bank of Poland, explaining the bank's focus on interest rates.

Inflation measurement

Sustaining low inflation requires not only that suitable policies are introduced but also that appropriate methods of measurement and forecasting inflation are developed. When monetary policy is focused on longer-time inflation trends, it becomes necessary to know underlying trends, i.e. to filter conventional CPI series, eliminating the influence of short-term noise. Mykyta Mykhaylyczenko and Przemyslaw Wozniak present statistical analysis of core inflation indicators in Ukraine in the subsequent chapter of this volume. Up to date, it is the first such complex approach to the subject of core inflation in Ukraine.

The uniqueness of this approach lies in the fact the choice is made for an optimal core inflation indicator for Ukraine using various theoretical criteria.. The authors – for the first time when estimating core inflation in Ukraine – make use of annual inflation rates which became the standard measure of inflation worldwide.

The following core inflation measures are calculated by Przemyslaw Wozniak and Mykyta Mykhalychenko: ordinary trimmed means, means trimmed according to the distance from the center of the distribution, means trimmed according to price stability, variance-weighted means, and exclusion-based means. Such diversified approach to the core inflation indicators, together with the detailed account of criteria chosen to determine the best measure – made on both statistical and practical grounds – undoubtedly contributes to the understanding of inflationary processes in Ukraine.

Monetary transmission in Ukraine

In order to conduct wise monetary policy it is also necessary to be aware of how the economy is affected by policy actions and how quickly it responds to them. In other words, monetary authorities need to know transmission mechanisms of monetary policy. Based on this knowledge they can adjust policy instruments so as to achieve desired inflation and output outcomes in a most timely and efficient manner.

However, getting to know transmission mechanisms of monetary policy is not an easy task, especially in transition economies that still undergo substantial structural, institutional and political changes. The most important impediments to interpret the results of the monetary transmission for countries of Central and Eastern Europe seem to be short time series and exchange rate regime changes. Nevertheless, Wojciech Paczynski reviewed the empirical research on transmission mechanisms of monetary policy in some Central and East European countries (new EU member states), reporting that in comparison to the euro-zone, there are no clearly distinguishable differences in output responses in reaction to interest rate changes. If some difference occurs, it relates to the lag in the response of prices. It takes longer for prices in the CEE to adjust. However, its reaction is larger in the longer run.

The project team decided to follow the Bank of England classification of stages in which the monetary policy operates (as reported in the text by Wojciech Paczynski), in order to structure

the research on these mechanisms in Ukraine. The first step is from the change in central bank's rates to the market rates, and the second is from financial market to spending behavior of firms and households.

Yet, before moving to constructing VAR and cointegrating equations, Ukrainian money market was analyzed by Oksana Novoseletska. The author reported the instruments at the NBU disposal, evaluating the importance of different interest rates for the money market. Increased banking efficiency during the recent years was underlined. However, Oksana Novoseletska writes that the research on monetary transmission in Ukraine is under certain limitations, as competition between banks remains weak, banks differ very much in soundness indicators, assets quality and other characteristics. Moreover, the credit channel of monetary transmission should be limited to bigger and most efficient banks only. The author also reviewed the relationships existing between the discount (actual NBU discount and overnight), inter-bank (credit and deposit) and retail banks' (credit and deposit) interest rates.

Both Oksana Novoseletska and Wojciech Paczynski point on factors that limit the interpretation of estimates of the monetary transmission in Ukraine. The most important are: de facto peg to the US dollar, making the control of the money emission with the use of interest rates difficult or even impossible, specific features of the Ukrainian financial market (banking sector functioning not according to the efficiency principle), and short time series.

The empirical approach of testing the "first stage" of monetary transmission in Ukraine – from the central bank's refinancing rate to market rates was undertook by Victor Maziarchuk and applied to period 1996-2004. Then, Mykyta Mykhaylychenko, Volodymyr Hryniv and Wojciech Paczynski constructed a VAR model and tested variance decomposition and the model robustness when different interest rates and different inflation measures (including core inflation indicators) are used. The authors conclude that interest rates increases have tended to dampen inflation in Ukraine in 1999-2004, but the transmission from the interest rates to output has not yet been observed. Generally, the transmission to the model variables in Ukraine takes in some cases a year and a half to materialize, a lag which is in the range found for many European economies.

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Polish Disinflation Experience: 1990-2004

Przemysław Woźniak[1]

1. Introduction

Poland's disinflation experience represents an interesting case for studying various disinflation strategies. Polish monetary authorities used many different stabilization strategies to mixed results, but the overall effect has to be considered positive. Within several months after launching the stabilization program, the near-hyperinflation of early 1990 has been brought under control, albeit single-digit inflation rates were not registered on a consistent basis before 2000. Thus, while the initial stabilization success is unquestionable, many economists view the period of high and moderate inflation that prevailed during most of the 1990s as markedly too long and protracted. Likewise, the recent experience of direct inflation targeting is also ambiguous: although inflation has been brought down to satisfactorily low levels, no single short-term inflation target has been met since adopting the strategy in 1999.

This paper divides the 15-year period of Polish disinflation into 3 natural periods: the initial stabilization programs of the early 1990s, the period of controlling money supply with the use of market instruments and finally the period of Direct Inflation Targeting. It has to be mentioned that it is not a trivial task to determine when the initial stabilization efforts have been completed and hence when the second 'free-market' episode of the Polish disinflation started. In this paper the author follows Kokoszczynski (2004) in applying the criteria of the use of free market instruments of monetary policy to determine the completion of the initial stabilization period. Consequently the first stabilization period is assumed to finish in 1993. The following period of a largely eclectic monetary policy of controlling the money supply and exchange rate is thus assumed to begin in 1993 and end in 1998 when the Monetary Policy Council officially announced adopting the Direct Inflation Strategy that is in place until present. For each of the three periods the main features of the disinflation strategy are described: goals and instruments of the monetary policy as well as the success of the disinflation process. Special focus has been placed on the exchange rate policy that was an important component of the disinflation strategy during the decade of the 1990s.

The last section of the paper includes a brief review of the structure of Polish disinflation and the underlying relative prices changes. It also investigates the evolution of the structure of the Polish consumption basket and compares it to the structure of the basket in the Euro-zone.

2. The Initial Stabilization 1990-1992

2.1. The Shock Therapy

Poland started its systemic and economic transition in the environment of high macroeconomic imbalances and rapidly rising prices. The process of price liberalization was initiated in late 1980s and intensified in 1989 resulting in monthly inflation rates of 10, 40, 34, 55, 22 and 18% in the respective months of the second half of 1989 (see Figure1). Thus, the stabilization program known as the *Balcerowicz Plan* introduced on January 1st 1990 was

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as much a political choice as a pure necessity if the country was to avoid entering the hyperinflation path. The program was designed using the guidelines of the IMF and its approval by the Fund enabled Poland to take advantage of the stand-by facility in 1990 and several consecutive years. It called for a rapid and economy-wide price liberalization, reduction of subsidies, internal convertibility and exchange rate unification as well as a comprehensive package of systemic and institutional changes[2].

The goal of the program was to reduce inflation quickly down to the level of 1% per month. There were two principal elements of the program that pertained to the monetary policy, i.e. the policy of a stable exchange rate and the policy of maintaining positive real interest rates. The dynamics of the most important components of money supply was agreed on with the IMF and written into quarterly executive criteria of the program. These criteria set the maximum growth of net credit to the Government and net domestic assets as well as the minimum growth of foreign reserves (Kokoszczynski 2004).

The Balcerowicz Plan went much further than just inflation stabilization. Taking into account the challenges of the Polish economy in late 1980s, the program included a very comprehensive package of systemic, institutional and administrative changes. To ensure achievement of the Plan's short term goals, very decisive fiscal measures were implemented. They included radical expenditure cuts mainly in the area of subsidies and state investments along with eliminating most tax exemptions and relieves. A particular role was given to the restrictive income policy which involved an introduction of a tax on excessive wage increases (the so-called *popiwek*)[3], abolishing automatic wage indexation and lowering some tax brackets. Restrictive domestic monetary and fiscal policies were accompanied by the liberalization of the foreign trade. Practically all quantitative restrictions on imports were lifted and the newly introduced uniform customs tariffs were set within a moderate range of 10-20% (Dabrowski, 1992).

The monetary authorities in early 1990 possessed a very limited set of market instruments to achieve the goals of the stabilization program. The two-tier banking system introduced in 1989[4] created the background for the development of the financial market but in 1990-1991 one cannot yet speak of a functioning market for securities enabling the central bank carrying out conventional open market operations. Thus the main instruments used by the central bank in early 1990s were setting the interest rates of the refinancing credit, imposing credit ceiling on banks as well as actively using the reserve requirement ratio to control the banks' liquidity. Figure 2 presents the monthly rates of inflation and domestic money growth as well as the ratio of required reserves and the monthly rate of the refinancing credit.

Although some prices were freed in late 1980s, the prices liberalization culminated in January 1990. In this month alone, prices of bread rose by 147%, electrical energy – by 370% while those of furnace fuel, central heating and hot water – by almost 400%. The effect of these hikes was exacerbated by the fact that the monetary overhang that has been building up during years of shortages and rationing in the form of forced savings, has now made its way

[2] For details see Balcerowicz (1997)

[3] In excess of a certain percentage of the price growth.

[4] Prior to 1989 the National Bank of Poland together with 3 banks and a network of cooperative banks were formally a part of the Ministry of Finance. The new NBP Law and banking law accepted in January 1989 extracted the banking sector from the framework of the Ministry of Finance and gave the NBP the conventional central role of the *bank of banks* with the right to hold required reserved from the banks, set credit limits and grant refinancing credit on the market basis. The rest of the banking sector, i.e. specific banks were meant to become fully commercial and self-financing market entities subject to supervision of the NBP (see Topinski, 1995 and Kokoszczynski, 2004).

to the goods' market. The resulting aggregate inflation in January was 80% and significantly exceeded the expectations (see Figure 1). Inflation came down quickly from the record high January to 24% in February and to 2-7% in the rest of the year. However the goal of 1% monthly inflation seemed out of reach as the average inflation in the second half of 1990 amounted to 4.4% and 5.7% and 2.4% in the first and second half of 1991.

The goal of the positive interest rate was achieved only partially (see Figure 2). To increase its control over credit in the economy the NBP moved to setting the refinancing rate on a monthly basis in the first half of 1990. Although refinancing rates were set at markedly higher levels than in 1989 (36% and 20% in January and February, respectively, compared with 7% in late 1989), the unexpectedly high inflation in January and February resulted in negative refinancing rate in real terms. However, for most remaining months of 1990 the positive real interest was achieved[5].

Another key feature of the stabilization program, the fix of the Polish currency, was maintained much longer than originally planned. The exchange rate was officially tied to the USD in January 1990 at the level of 9500 zl/$ with the commitment to keep it there for 3 months, but the arrangement remained in effect for 15 months. The credibility of this commitment was significantly boosted by the establishment of USD 1 billion stabilization fund which could be drawn upon to support zloty in case of a speculative attack. The rate at which the exchange rate was fixed was slightly below the black market rate and well below the official exchange rate (5600z zl/$) in December 1989. The apparent overshooting was motivated partly by the wish to accommodate the upcoming radical liberalization as well as the pressures of the industrial lobby and many other factors. It has to be noted, however, that given the impossibility to gauge the equilibrium exchange rate in the specific situation of Poland in 1989[6], the choice of 9500zl was viewed as a conservative guess at what would be a relatively conducive rate for the real economy while at the same time leaving room for defending the currency in case of speculative attacks. Undoubtedly, fixing the exchange rate at a rather undervalued level, contributed to the early 1990 inflation outburst, along with the aforementioned price liberalization and monetary overhang.

Table 1. **Deviations of official targets of the CPI and the money supply from their execution.**

	Broad Money Supply (M2)* Growth, Dec-on-Dec; in billion zl.			**CPI inflation, Dec-on-Dec**			
	Target	Actual	in %	Target	Actual	Deviation (in %)	Deviation (in percent. points)
1990	4.1	10.3	151.2	95	249.3	162.4	154.3
1991	8.5	9.0	5.9	32	60.4	88.8	28.4
1992	12.7	15.0	18.1	36.9	44.3	20.1	7.4
1993	15.0	14.8	-1.3	32.2	37.6	16.8	5.4
1994	15.5-16.9	21.4	26.6	23.0	29.5	28.3	6.5
1995	17.1	26.9	57.3	17.0	21.6	27.1	4.6
1996	23.0	30.6	32.6	17.0	18.5	8.8	1.5

[5] The NBP set the refinancing rate on a monthly basis between January and June 1990 to subsequently return to conventional setting of annual rates. The monthly rates for the period July 1990-December 1992 are thus calculated from the annual rates set by the bank using the usual compounding formula. In view of the consistent disinflation and falling interest rates the rates calculated in this way may thus overstate the actual cost of the refinancing credit in this period.

[6] Putting aside the problems with estimating it even in developed market economies.

1997	27.4-28.6	39.8	39.2	13.0	13.2	1.5	0.2
1998	28.2-35.5	44.4	25.6	9.5	8.6	-9.5	-0.9

Source: Kokoszczynski (2004) and various NBP materials.

Fixing of the exchange rate, besides initially injecting some extra inflation, provided a fairly efficient anchor of expectations even though the fix apparently lacked credibility[7]. The stable exchange rate also made the monetary authorities lose considerable part of autonomy in the area of foreign reserves inflows. As table 2 suggests foreign reserves have accumulated rapidly during initial months of the stabilization program and became the second most dominant source of money creation in 1990 (Bauc et al, 1995). The most important component of the broad money supply throughout 1990 were credits to households and enterprises. Altogether, the target for the broad money supply was exceeded by 162% in 1990 (see table 1). There are several reasons for such a significant deviation in 1990 as well as several subsequent years. Because of the undeveloped financial market, the NBP could only hope to control the credit for the non-financial sector (one of the three sources of money growth – see table 2). With the fixed exchange rate and due to the impossibility to sterilize the foreign capital inflows by open market operations, foreign reserves were directly reflected in the money supply. Net credit to the Government was also under limited control of the central bank, due to the fact that the magnitude of the direct financing of the budget deficit was decided in the Parliament (Kokoszczynski, 2004, s. 228). In fact, these limitations were in effect until the central bank was fully able to use conventional, market instruments, including open market operations i.e. until 1993-95.

2.2. "Second Stabilization": mid-1990 – 1992

After the initial success of the shock therapy evidenced in a radical fall of inflation in the first quarter of 1990, the restrictive macroeconomic policies began to loosen mostly in reaction to the severe recession in the real sector. Interest rates were radically decreased: the monthly refinancing rate set at 36%, 20% and 10% in the months of the first quarter, respectively, was lowered to 4% in June and 2.5% in July 1990. This triggered a dynamic credit rise in the economy in the economy (see table 2) which coupled with a fast growth of foreign reserves led to a sizeable expansion of money supply in the second and third quarter of 1990. In parallel, several important components of the restrictive income policy were softened as well (Dabrowski, 1992).

Table 2. **Origins of money creation 1990-1996**

	M2 In million zloty	Net foreign assest	Net domestic assets	Due from				Net General Govern. Debt	Other items (net)
					Households	Enterprises	Other		
	A	B	C	D	E	F	G	H	I

[7] Wellisz (1997) argues that in fact this commitment lacked credibility. If dollar funds were converted into zlotys in January 1990, earned the interest granted by the Polish banks in zloty accounts and were then switched back into dollars after the 3-month period, 70% of return in USD could be earned. However, the commitment apparently lacked credibility and very little switching between currencies took place in this period.

90						
91						
92		25.9	25.8	2.3		48.3
93		17.5	35.4	4.5		47.1
94		32.9	29.9	3.9		37.2
95		58.7	37.9	5.9		3.7
96	134796	29.9	57.3	14.6		12.8

Source: NBP

Without the expected effects in the real sector, the loosening of the stabilization package brought rising inflation (beginning in September) and a worsening in the balance of payments. The macroeconomic situation called for a new stabilization program which was introduced in late 1990. This time the program focused primarily on monetary measures. The reserve requirement ratio was raised substantially in July 1990. The rate of the refinancing credit was increased several times: from 34% in July 1990 to 72% in February 1991 on an annual basis. To augment these changes, restrictive credit policy (credit ceilings) was pursed (Topinski 1995).

The money supply growth was reduced significantly in 4Q90 and 1Q91 (see table 2). However, the profitability of enterprises started to deteriorate rapidly and recessionary tendencies set in again. Additionally the currency fix coupled with high inflation caused dramatic real appreciation (see Figure 3) which was gradually leading to problems with the balance of payments. In early 1991 all these trends have brought about serious budgetary deficits which were to become a persistent problem for Polish governments throughout 1990s.

The tightening policies have helped bring inflation down on the steady disinflation trend but the budgetary problems have forced the NBP to participate in financing the deficit. Consequently, net credit for the Government became a significant source of money creation. While in 1990 net foreign assets and credit for the non-financial sector were dominant factors in M2 creation, the year 1991 brought a significant rise in importance of net credit for the Government (see table 2).

Overall, the first year of transition was marked by extremely high deviations of both money supply and inflation from their targeted values. The domestic money growth exceeded the planned level by 162%, while inflation was higher than the planned value by no less than 151 percentage points (see table 1).

The sharp real appreciation of the currency as well as mounting balance of payments and budgetary deficits have prompted the NBP to devalue zloty by 17% in May 1991. Along with the devaluation, the anchor currency – US dollar was substituted by the basket of 5 currencies including the US dollar (45%), the German mark (35%), the British pound (10%), the French and Swiss francs (5% each). The official fix of the currency was abandoned in October 1991 and replaced with the crawling peg with the rate of crawl set initially to 1.8% per month[8]. Shortly afterwards the NBP allowed for transactions deviating +-2% from the central parity (Szpunar, 2000). The central parity exchange rate was devalued once in February 1992 (this time by 12%). These regime changes and one-off devaluations have helped to decelerate the rate of appreciation of the exchange rate in late 1991 and 1992 (see Figure 3).

[8] In fact the central exchange rate was devalued every day at a rate that yielded 1.8% a month, with a daily compound.

In line with the relaxation of the exchange rate regime, after the temporary tightening in late 1990, the monetary policy has been loosened as well in 1991 and 1992. Between February 1991 and July 1992 the refinancing, rediscount and lombard rate of the central bank have been cut by 34, 35 and 28 percentage points (or almost by half) while reserve requirements have been lowered twice (Figure 2). Consequently the lax monetary policy combined with increased crediting of the budget (1991 and 1992) as well as massive increase in foreign assets (1992) led to the overshooting of the monetary targets both in 1991 and 1992 by 89% and 20%, respectively (see Table 1). Likewise, inflation rates have also exceeded the targets: by 28.4 and 7.4 percentage points, respectively.

Summing up, the stabilization efforts undertaken during the first 3 years of transition in Poland should be evaluated as successful, even if inflation turned out more persistent than originally planned. The best single indicator of the success is the size of reduction of inflation which came down from well above 1000% in early 1990 down to 45% in late 1992. This happened despite the unfavorable environment for the monetary policy, e.g. a virtually nonexistent market for securities which made the monetary transmission very difficult as well as growing credit needs of the Government.

3. Eclectic Monetary Policy 1993-1998

In the period of 3 initial years of transition in Poland, monetary authorities have conducted their policy with the help of direct administrative instruments (such as credit ceilings) and found themselves incapable of effectively controlling the market interest rates and money supply. The period of Polish stabilization between 1993 and 1998 under investigation in this chapter was singled out based on the increasing role of typical free-market instruments used by the NBP in the disinflation policy. Naturally, this process has been gradual but unlike the initial stabilization where the monetary policy has been fully subordinated to the comprehensive package of economic and systemic reforms, the period 1993-1998 has more features of a typical (albeit eclectic) monetary policy where targeting money supply is conducted in the framework of a controlled exchange rate regime (Kokoszczynski, 2004).

The most important factor determining the character of the monetary policy was the increased use of open market regulations. In 1991-1992 the NBP was forcing changes that would facilitate the transactions in the interbank money market as well as regulate legally and technically the process of open market operations. These operations have become an important part of the central bank's policy in early 1993. Initially the OMOs were mainly carried out to control the quantitative targets (e.g. liquid reserves of commercial banks) but after 1994 they played an increasing role in shaping the interest rates in the money market. (Szpunar, 2000).

In spite of the use of these modern instruments, controlling money supply in this period can hardly be considered successful. The broad money supply deviated from the target by 27% and 57% in 1994 and 1995, respectively (see Table 1). As table 2 suggests the period 1993-1995 has seen an increasing importance of net foreign assets in the aggregate money growth coupled with the decreasing role of the budget deficit financing. The rapidly growing net foreign assets component was related to the surplus in the current account largely due to cross-border trade and tourism (1994 and 1995) as well as massive capital inflows in the form

of foreign direct and portfolio investments. These phenomena have led to the increase in official reserves by 41% in 1994 and 148% in 1995 (Kokoszczynski, 2004).

In order to neutralize the money supply effects of these inflows, the NBP was trying to absorb the liquidity by carrying out sterilized open market operations on a wide scale. At the same time, in order to accommodate the apparent appreciation trend the monthly rate of crawl was lowered to 1.6% in August 1993, and then again in September 1994 (to 1.5%), in November 1994 (to 1.4%) and February 1995 (to 1.2%). To increase the currency risk the NBP increased the permitted deviation band around the central parity from +-2% to +- 7% in May 1995. These changes in the currency regime are depicted in figures 5 and 6 and described in annex I.

However, these modifications did little to discourage capital inflows. The actual central parity exchange rate was very close to the lower band and was kept within the band only thanks to sizeable interventions of the NBP in the forex market. Further steps of the NBP were radical interest rate cuts in 1995. The main central bank rates during this period, the rediscount and lombard rate have been lowered 3 times between February 1995 and January 1996 by the total amount of 8 percentage points (see Figure 7).

In 1996 for the first time, the monetary policy of the NBP was presented as a classical triad of targets: the official final target (inflation), the intermediate target (broad money supply) and the operational target (reserve money). Such a framework was in effect also in 1997. However, while inflation deviated from the target by a mere 1.5 and 0.2 percentage points in 1996 and 1997, respectively, the money supply again turned out beyond the control of the central bank exceeding the target by 33% and 39%, respectively (see Table 1).

Table 3. **Origins of money growth 1997-2004**

	M3									
			Net foreign assest	Net domestic assets	Due from				Net General Govern. Debt	Other items (net)
						House holds	Enterp rises	Other		
		A	B	C	D	E	F	G	H	I
	mn zloty	%	%	%	%	%	%	%	%	%
97	39 173.5	100	54.4	45,6	71,5	27,3	38,5	5,7	15,3	-41,3
98	44 311.1	100	29,4	70,6	70,2	18,3	44,6	7,4	12,3	-12,0
99	44 954.4	100	32,6	67,4	90,0	35,6	38,3	16,2	7,3	-29,9
00	31 889.4	100	66,5	33,5	96,4	46,2	41,3	9,0	-38,0	-24,9
01	27 676.6	100	2,9	97,1	71,6	38,3	16,6	16,7	47,4	-22,0
02	-6 472.7	100	6,9	93,1	-188,0	-109,1	-29,3	-49,6	50,3	230,7
03	18 149.7	100	18,9	81,1	108,6	67,3	15,0	26,3	23,0	-50,5
04 *	4 601.4	100	395.9	-295.9	66.4	140.5	-31.2	-42.9	-212.8	-149.4

Source: NBP

**- Growth May 2004 - December 2003*

The year 1996 marks the period of important changes in the monetary policy in Poland. After several years of sound economic growth[9], the economy started to exhibit many symptoms of overheating. The rapidly growing domestic demand prompted a sharp increase in net credit for the economy (see tables 2 and 3). In parallel, the current account began to deteriorate which coupled with many instances of financial crises in 1997 and 1998 has triggered worries about the sustainability of the macroeconomic situation in Poland. The NBP reacted by raising the reserve requirement in February 1997 (first such hike after 1990) and interest rates in August 1997 (by 2 percentage points).

However, these changes had a very limited effect on the market. The emergence of foreign investments in the Polish T-bills and bonds market as well as foreign direct investments on a significant scale in 1995 substantially reduced the effectiveness of monetary authorities. As mentioned before, massive capital inflows generated excess liquidity, which the central bank tried to absorb by engaging in sterilizing open market operations. The problem was exacerbated during periods when the intention of the NBP was to tighten the monetary policy through increasing real interest rates. Such increases encouraged even higher capital inflows and called for further sterilizations. Simultaneously, the banks that invested an ever increasing portion of their assets in the short term open market operations, became more immune to the NBP interest rate policy (Szpunar, 2000). Therefore, the tightening of monetary policy in 1997 did little to limit the money supply which exceeded the target by almost 40%, largely due to the high dynamics of credits for households and enterprises.

Faced with the low effectiveness of its standard instruments, the NBP resorted to the direct collection of deposits from households in late 1997. The main goal of this unconventional instrument was to decelerate the surging dynamics of consumption credits and increase domestic savings. This operation did not have a significant impact on the money supply but led to a noticeable decline in domestic demand (Kokoszczynski, 2004, p. 236).

In parallel to cooling down the overheated economy, the central bank tried to prevent the further worsening of the current account by maintaining the competitiveness of the Polish zloty. Even though inflation was going down consistently by several percentage points each year (see Figure 4), the devaluation of the central parity did not follow suit. As figure 5 suggests, in 1997 the authorities have kept devaluing the central parity at a rate very close to or even exceeding the average inflation. This was a significant change in the policy adhered to so far which relied on the use of the exchange rate as an important disinflation tool through maintaining the pace of central devaluation much below the rate of inflation. Faced with the growing threat of a currency crisis, the monetary authorities decided to minimize this risk by stabilizing the real exchange rate. As figure 3 shows, this policy was successful in preventing appreciation of a real effective exchange rate and has even led to its temporary depreciation (between February and August 1997 and in the third quarter of 1998).

In spite of attempts to limit credit expansion, broad money grew in 1997 and 1998 largely as a result of the rising credit for enterprises while the importance of both net foreign assets and net credit for the Government declined significantly (see tables 2 and 3). The monetary target has been missed in 1998 by a considerable 26% but inflation was actually lower than the target by almost 1 percentage point (see table 1).

Summing up, the period of an eclectic policy of monetary targeting in the environment of a crawling exchange rate regime was successful in terms of the reduction of inflation from about 40% in late 1992 to about 10% in late 1998. On the other hand, during the entire period

[9] Between 1992 and 1997 the Polish GDP grew by 1/3 – the highest such growth in transition economies in this period.

broad money (the official intermediate target) has remained largely beyond the control of the central bank deviating from the targeted value by up to 60%. With respect to the structure of money supply growth some significant changes took place in the analyzed episode. While the period 1992-1994 was marked by the dominance of the deficit of the budgetary sector, the year 1995 saw the net foreign assets take on the leading role in money creation. On the other hand during years 1996-1999 net credit for the non-financial sector became increasingly important.

The changing structure of the money supply and particularly its unexpected character was undoubtedly one of the reasons of the failure to meet monetary targets year by year. Inflation turned out much easier to control as evidenced by visibly lower deviations of the actual values from the targets (Table 1). Meeting the inflation targets more successfully than the monetary ones has been often explained by the difficulties with estimating the demand for money, the prevalence of non-monetary determinants of inflation during longer periods as well as the heterogeneity of the targeted aggregate of money supply with respect to the pro-inflationary character of its components (Szpunar, 2000). In any event, in the second half of the 1990s it became increasingly clear that the link between money and inflation is extremely difficult to estimate and cannot be relied on in designing the credible disinflation policy at the central bank. Hence, the change in the framework of monetary policy that took place in 1998 was well motivated and justified.

4. Direct Inflation Targeting

4.1. The Monetary Policy Council and the New Strategy

In accordance with the adoption of the new Constitution in April 1997 and the Law on the National Bank of Poland in August 1997, the monetary policy became the responsibility of the new organ of the central bank, e.g. the Monetary Policy Council. The Council was formed in early 1998 with 9 members chosen by the President, the Parliament and the Government (in equal proportions) and the Governor of the central bank as a head of the new body. In October 1998 the MPC published the 'Medium-Term Strategy of Monetary Policy' which formally introduced the Direct Inflation Targeting as an official strategy of monetary policy in Poland.

The MPC has acknowledged that in view of the dynamic development of the financial market in Poland as well as the prospective integration with the EU and later with the Euro-zone, replacing the eclectic strategy hitherto adhered to with the direct inflation targeting would be beneficial for the mid- and long-term perspectives of price stability in Poland. In accordance with the DIT, the Council rejected pursuing any intermediate targets and instead decided to focus solely on the final goal, i.e. the rate of inflation defined as an annual growth of the CPI index in December. Within the strategy a special role was given to inflation forecasts which play the role of an intermediate target (albeit no formal intermediate targets are announced). The strategy necessitates greater transparency of the decision-making process and better communication with the financial sector, firms and households alike.

The MPC motivated the switch to the DIT by the fact that the strategy allows to set the goal of the monetary policy in a most direct and transparent manner as well as to use instruments more flexibly in reaction to changes in the demand for money and in the case of unexpected shocks. The clarity of the final target makes the monetary authorities highly accountable and at the same time allows to effectively anchor inflation expectations which facilitates the disinflation policy.

By adopting the DIT strategy the NBP committed itself to improving the transparency of decision-making and to better communication of its views on current and future inflation. To facilitate this, the bank decided to publish more[10] detailed and systematic Inflation Reports on a quarterly basis. These reports contain the analysis of demand and supply side developments in the economy, external factors, current inflation developments and projections as well as a section on monetary policy and perspectives of meeting the inflation target.

The inflation reports also contain various indicators of core inflation which the NBP started to calculate shortly following the official regime change. Core inflation is used by the MPC to determine the inflation trend without the influence of short term noise and forecast the perspectives of this trend. Core series are calculated and announced officially by the NBP every month several days after the publication of the CPI figures. Although the official target is expressed in terms of the conventional CPI, core inflation indicators are very important in the policy-making process in which the MPC often refers to their dynamics justifying its decisions. The group of specific core inflation indicators used by the NBP has changed several times since 1998 and now encompasses:

- Core inflation excluding food and energy (the so-called 'net inflation')
- Core inflation excluding administratively controlled goods and services
- 15% trimmed mean (calculated as a weighted average of the distribution of individual inflation rates from which 15% extreme hikes and 15% extreme falls were eliminated)
- Core inflation excluding most volatile items (volatility based on variance)
- Core inflation excluding most volatile items and fuel (volatility based on variance)

Figure 9 presents the first 3 indicators along with the CPI inflation.

4.2. Exchange rate policy

In regard to the exchange rate policy the MPC announced that it will gradually introduce more flexibility to the regime to finally allow for a free float (NBP 1998). This was motivated by both the systemic impossibility to control the exchange rate in the strategy of the DIT as well as the wish to introduce higher currency risk. No wonder then, that one of the first decisions of the MPC was to widen the deviation band of the central parity exchange rate (to +- 7.5%) and to decrease the rate of crawl to 0.8% monthly (in February 1998). The band was then widened once again in October 1998 (to +-12%). January 1999 saw replacing the 5-currency composite central parity currency by the weighted average of just 2 major currencies: the euro with the weight of 55% and the USD with the weight of 45%. The band was widened once more in March 1999 to +-15% along with reducing the rate of crawl to 0.3% monthly. The MPC decided to float zloty in April 2000 (see Figures 5 and 6).

It has to be noted that during the period 1998-2000 the NBP did not intervene in the forex market. Hence, although moving within a predetermined band, the exchange rate did not find any barriers and was de facto floating.

The real effective exchange rate was appreciating until mid 2001 after which it entered a stable depreciating trend in place until present. Undoubtedly, the depreciation of the real

[10] Until 1998 the NBP published inflation reports but their structure often changed from one issue to another and contained on average considerably less information and analyses.

exchange rate has been one of the factors of extraordinary high export dynamics in 2002-2004 and the related improvements in the current account.

4.3. Focus on interest rates

Relaxing the exchange rate regime was accompanied by strengthening the role of the interest rates as instruments of monetary policy. The Council identified 3 interest rates crucial for the monetary market that are to be adjusted during its monthly meetings: the lombard rate, the rediscount rate and the reference rate (the rate of the short term OMOs). These rates were very actively used throughout the period 1998-2004 as evidenced in figure 10. During this period, the MPC have changed the interest rates nearly 30 times and lowered the reserve requirement ratio 3 times.

The structure of the money supply growth has evolved during the period of the DIT (see Table 3). During 1998-2000 the growth of net foreign assets was becoming increasingly important while net government debt lowered its share in the money growth. The period 2001-2003 saw the reversal of these trends: while net foreign assets accounted for the declining part of the total money growth, the budgetary needs became important again. Credit for the non-financial sector was growing until 2000, following by a sharp slump in 2001 and recovery in 2003-2004.

4.4.Targeted inflation rates

In the Medium Term Strategy 1999-2003 the MPC announced that its medium-term inflation target will be the reduction of the CPI inflation below 4% by the year 2003. Short term targets for a given year are announced by the MPC in the Monetary Policy Guidelines usually published several months before the end of the preceding year. However, every time the MPC announced the short-term target, it reminded the public that it is the medium-term target for 2003 that is of key importance. The short-term targets and their execution are presented in table 4.

Table 4. **Short term inflation targets and actual inflation (in %, Dec-on-Dec)**

	Official inflation target	**Actual inflation**
1999	8-8.5 (in Sep 98) changed to 6.6-7.8 (Mar 99)	9.8
2000	5.4-6.8	8.5
2001	6-8	3.6
2002	4-6 (in Sep 2001) changed to 2-4 (June 2002)	0.8
2003	2-4	1.7
2004 and after	1.5 – 3.5	

Source: NBP

Although in a 5-year history of the DIT in Poland none of the short term targets was met, the mid-term goal of reducing inflation to below 4% by the year 2003 was accomplished. Also, it is subject to discussion whether achieving an inflation rate below the targeted range should be treated as an equal failure as overshooting the range. If achieving inflation lower than the target is not considered a failure of monetary policy, the MPC has done relatively well since 2001.

The overall experience of inflation targeting in Poland during 1999-2004 has to be considered positive. In this period inflation was brought down from moderate levels

(exceeding 10% in 2000) to well below 1% in 2003 which is less than in most free-market western economies. Although inflation has been rising since mid 2003 it is mostly due to supply side factors (high energy prices and EU-accession effect) which are likely to wear off in the near future. Hence, it seems that the ultimate goal of monetary policy in Poland, i.e. low and stable inflation has finally been achieved after a dozen years of efforts.

5. Changes in relative prices and inflation structure

The disinflation process in Poland during 1990-2004 has not been uniform across all markets. Inflation processes have evolved in time: in initial years it reflected the transition from the post-socialist price structure to a free-market one while later on a bigger role was assumed pure supply-side factors world price movements.

Initial years of transition were marked by radical administrative adjustments of controlled prices. Staple foods, municipal services and electricity have all been substantially under-priced (well below cost recovery) during the socialist era, therefore the initial price liberalization implied much higher increases in their case (Wozniak 1998). Figure 11 illustrates relative price indices of 4 basic CPI aggregates calculated as a ratio of a price index of a particular CPI aggregate to total CPI. Rising values of this index indicate that prices in the sector concerned register on average, price growth rates exceeding those of the CPI.

Figure 11 makes clear that prices of food, alcohol and tobacco have been partly adjusted in the second half of 1989. On the other hand, prices of services (mostly municipal) have undergone radical adjustments in early 1990. The period 1991-2004 has seen a steady increase of relative prices of services accompanied by a continuous decline of food prices and a slight decline of non-food goods.

Figures 12-13 present the process on a more disaggregated level after the initial liberalization shock of 1990 has worn off. Figures suggest that prices of controlled services have outpaced inflation the most. This group includes electricity, gas, central heating and hot water supply as well as rents, some transportation services (railway, local busses), telecommunication services. The rising trend of relative prices in this category has been stable and uninterrupted in Poland during the entire period. Some prices are still kept administratively undervalued (rents, railway tickets) so the upward trend in this category is very likely to prevail in future.

Services with unregulated prices (free-market services) have registered a steady growth of relative prices after a slight fall in 1994-1995. These prices account for about half of the services in the consumer basket. Their moderate relative price growth suggests that the frequently mentioned[11] relative surge of services prices in Poland (and in other transition economies) has been mainly the result of hikes in the sector of administratively controlled services.

Relative prices of food have been falling consistently throughout this period. While relative prices of processed food have stabilized in recent years, those of unprocessed food continue to decline. Relative prices of alcohol and tobacco have been on the rise for the most part of this period although in recent years they have been fairly stable.

Finally, non-food goods have registered a steady decline of relative prices. This has been undoubtedly due to the fact that the majority of these goods are perfectly tradable and their prices are shaped abroad. As the competitive pressure of imports works via the exchange rate, the significant real appreciation of the Polish currency (see Figure 3) has also contributed to the fall of relative prices of non-food goods.

[11] E.g. in the context of the Harrod-Balassa-Samuleson effect.

Along with changes in the relative prices of various goods and services, the structure of Polish households' expenditures has been undergoing substantial changes as well. Figure 14 presents shares of expenditures divided into 4 basic aggregates: food, alcohol and tobacco, non-food goods and services for Poland during 1990-2003 as well as for the Eurozone for 2002 for comparative purposes. The figure makes clear that during this period the consumption structure of Polish households was converging to the one prevailing in the Eurozone. The trends present in the consumption data include a continuous increase in expenditures on services coupled with a steady decline of expenditures on food (especially unprocessed food). The share of services in households' expenditures has gone up from 17% in 1990 to 37% in 2003, while the share of food has declined from 46% in 1990 to 27% in 2003. The shares of expenditures on alcohol and tobacco as well as non-food goods have remained fairly stable at 6-6.5% and 30%, respectively, for most years in the 14-year sample.

Comparing to the most recent Polish data, the structure of expenditures in the Eurozone is characterized by higher shares of expenditures on non-food goods and services and lower for the remaining 2 categories. However, the differences are much smaller now than they used to be in early 1990s and with the prevailing trend we should expect the Polish structure to converge to the Eurozone structure within several years.

To summarize the investigation of inflation structure, it is worthwhile to see the contribution of each of the 4 basic CPI aggregates to inflation. Figure 15 presents the extent to which food, alcohol and tobacco, non-food goods and services contributed to annual inflation rates during 1991-2004. It is worthwhile to notice that the contribution of the food aggregate has been very volatile in recent years with longer periods of deflation in 1999, 2002 and 2003. Non-food goods, in line with their slightly falling relative prices (figure 11 and 13), have seen their contribution fall in recent years, while services continue, to have the highest contribution to total inflation, on average.

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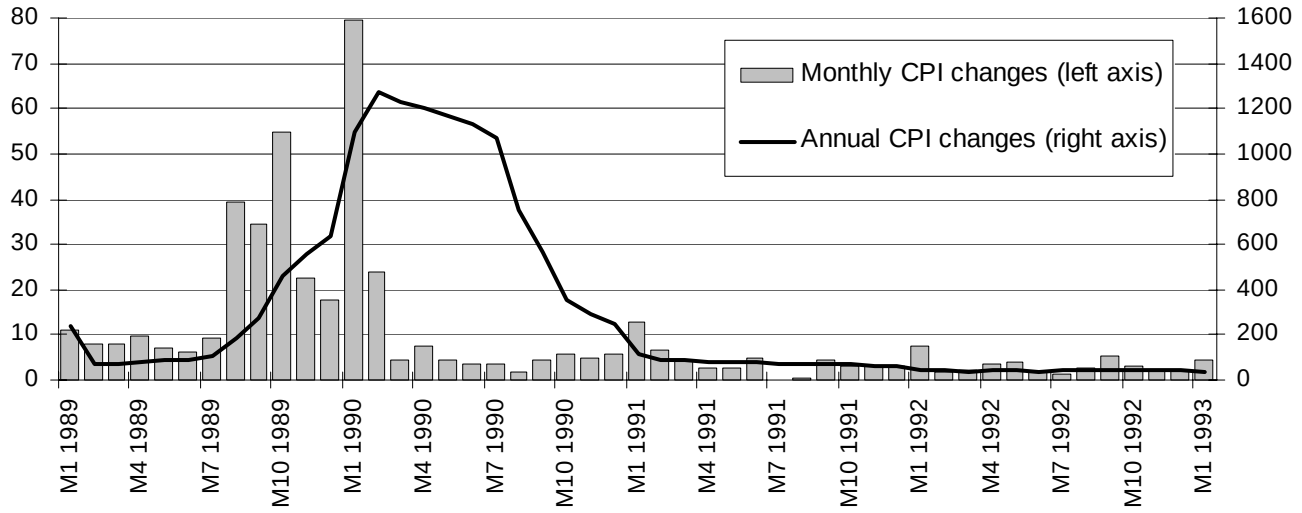
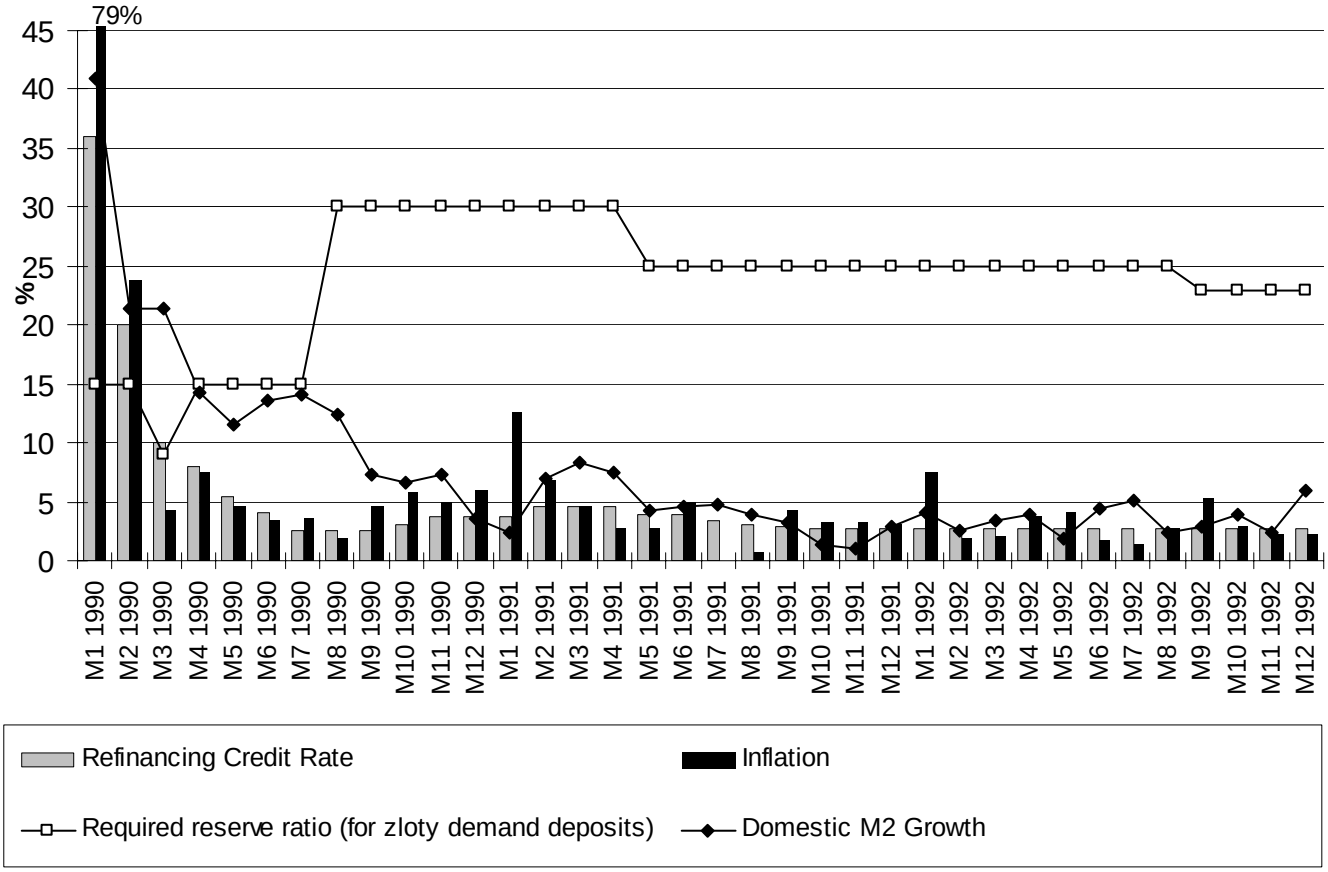
Figure 1. Monthly and annual inflation rates 1989-1992 (in %)



Source: GUS (Polish Main Statistical Office)

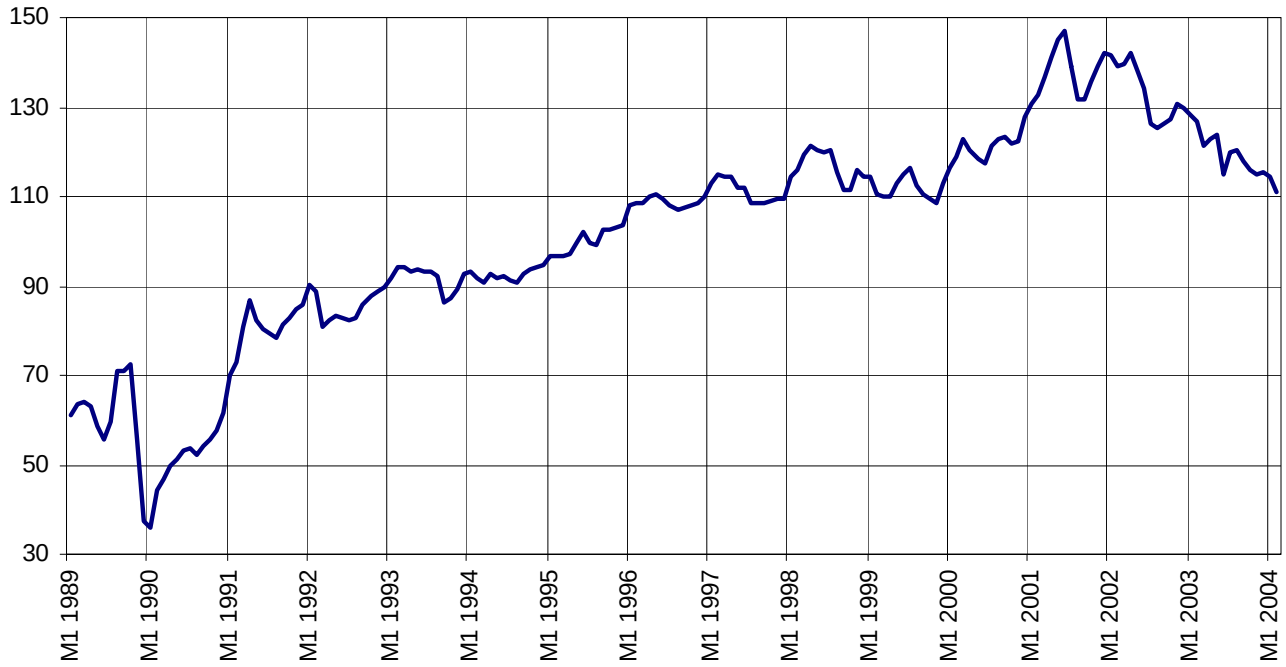
Figure 2: Monthly Inflation and Domestic M2 Growth and Main Central Bank Instruments in 1990-1992 (refinancing credit interest rate* – percent per month)



Source: NBP

** The refinancing credit rate was announced on a monthly basis between January and June 1990 and on an annual basis afterwards. Monthly rates for the period July 1990-December 1992 presented in the figure have been calculated using the compound interest formula.*

Figure 3. Real Effective Exchange Rate of the Zloty (1995=100)



Source: International Financial Statistics
Note: Increase points to appreciation

Figure 4. Monthly and annual inflation rates 1993-1998 (in %)

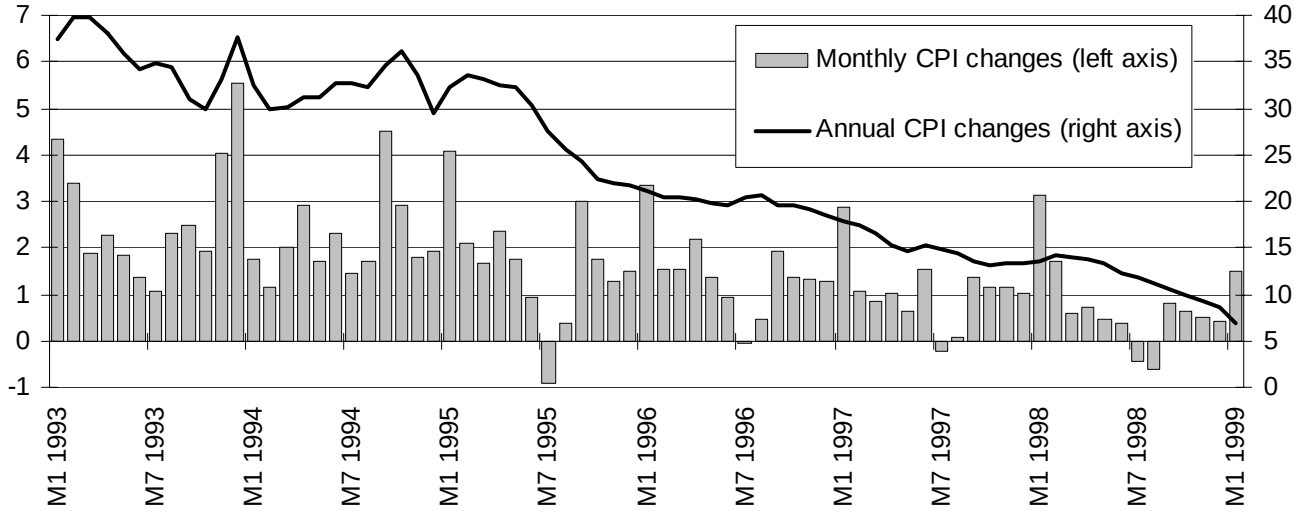
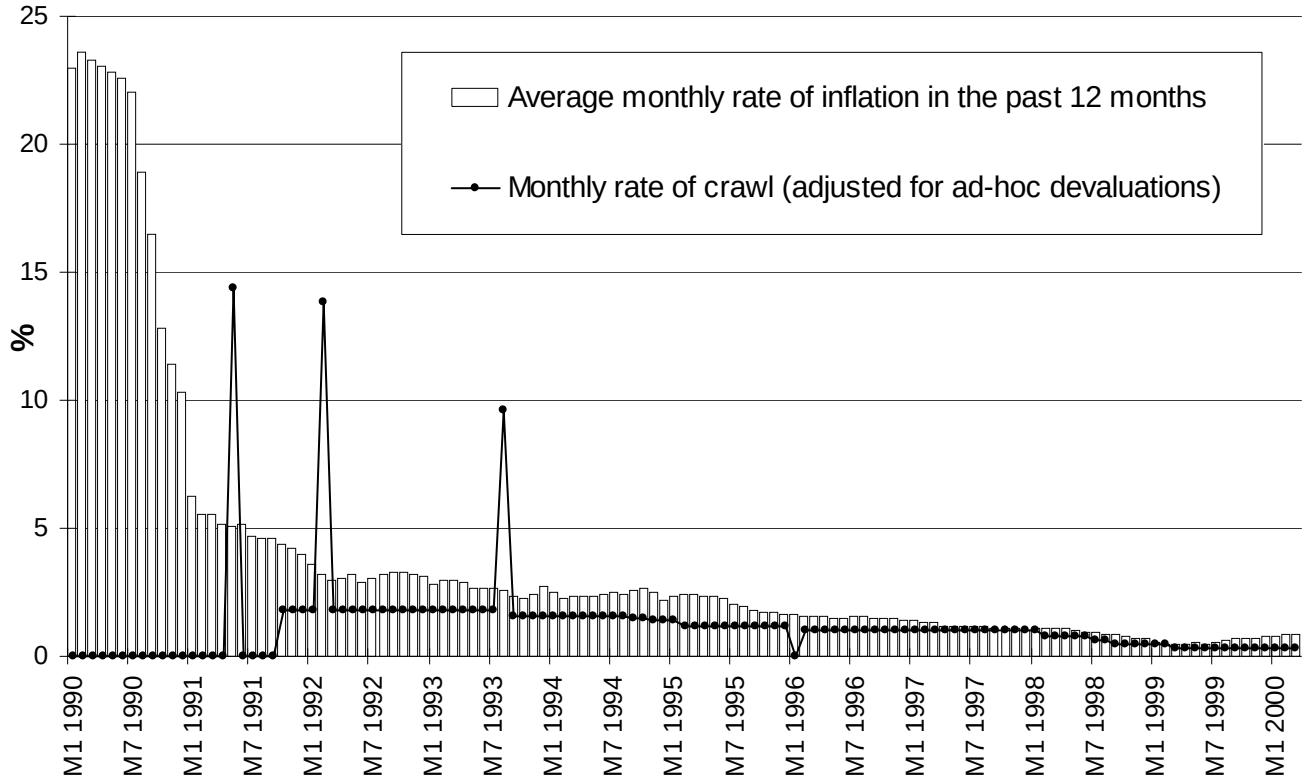


Figure 5. Average monthly inflation during past 12 months and a monthly rate of crawl adjusted for one-off devaluations.



Source: NBP.

Figure 6. The evolution of the central parity exchange rate (prior to January 1999, based on the basket of 5 currencies, after January 1999 based on the basket composed of 55% euro and 45% dollar)

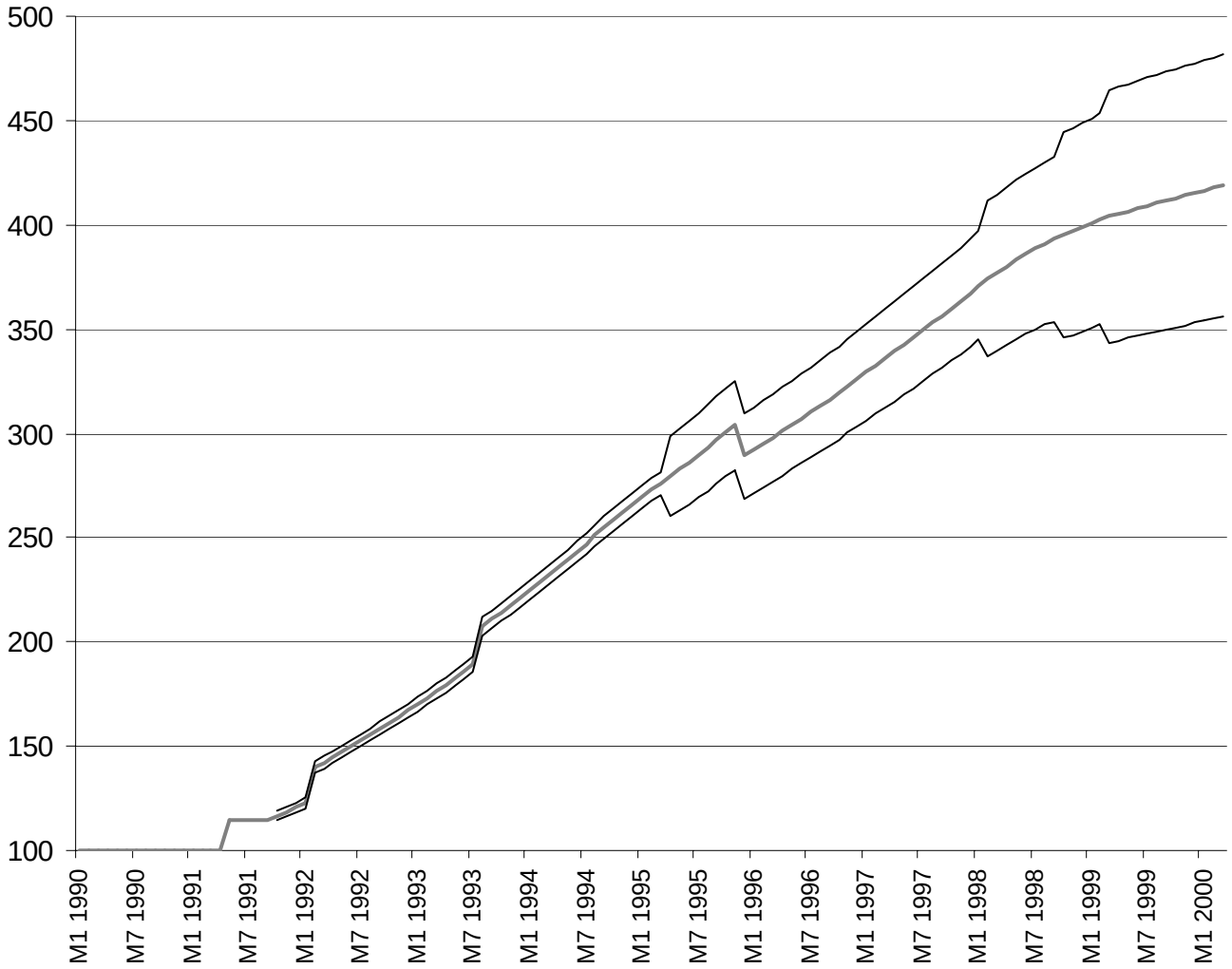


Figure 7. Inflation and central bank instruments 1993-1998.

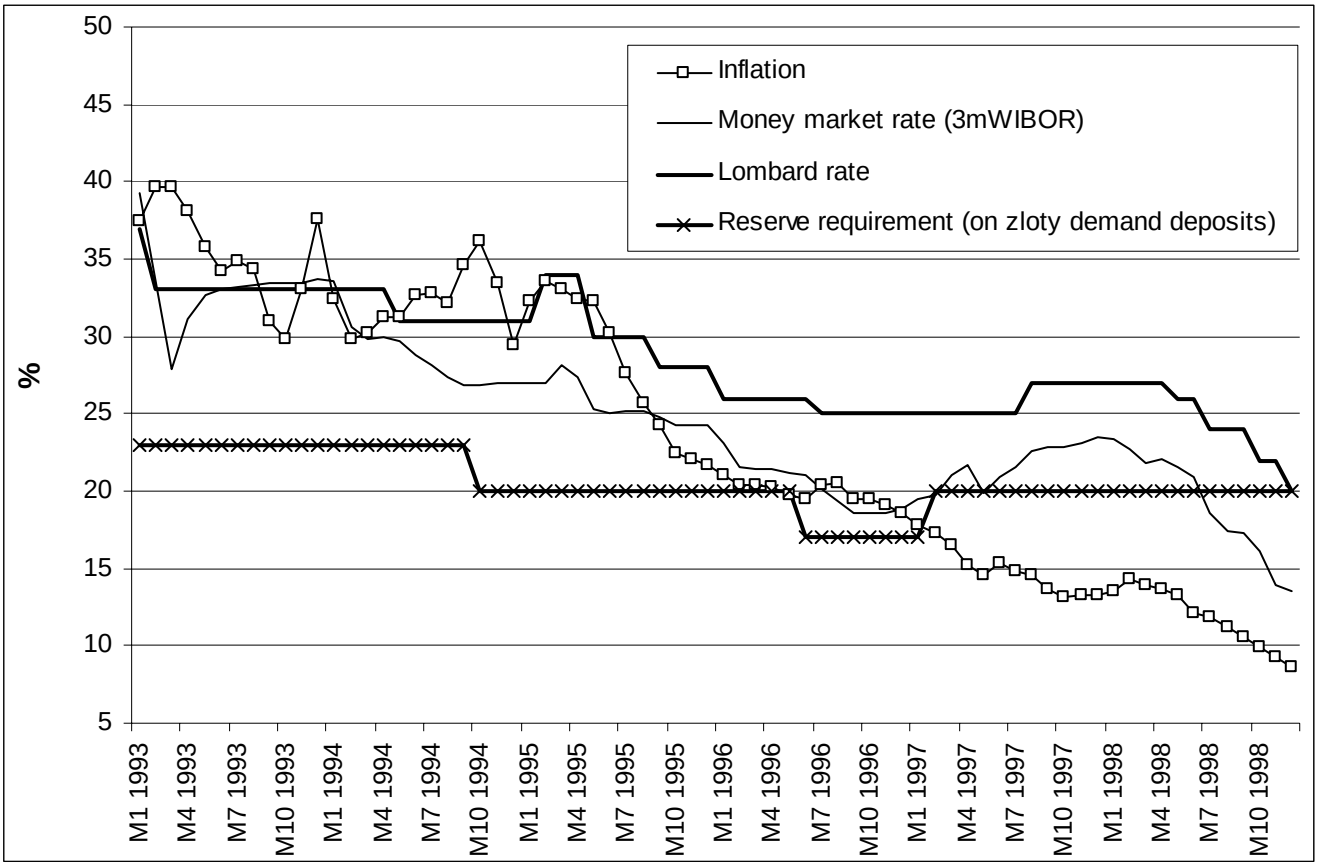


Figure 8. Monthly and annual inflation rates 1999-2004 (in %)

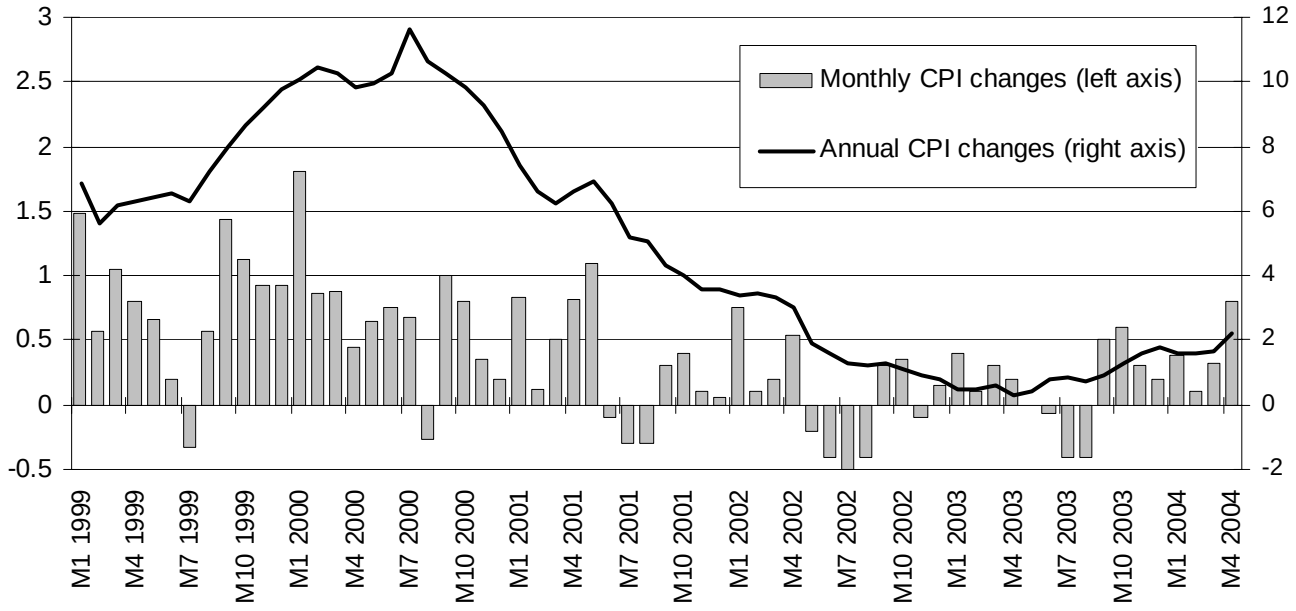
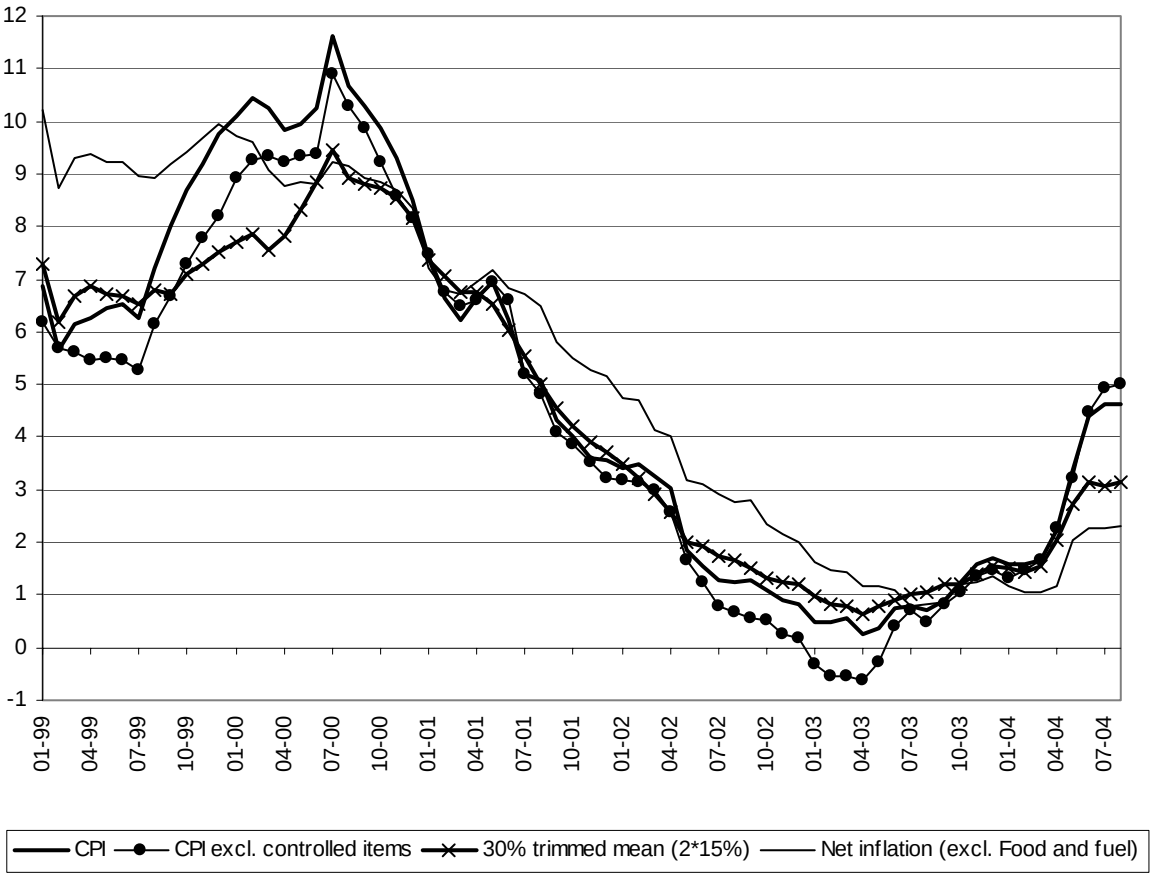


Figure 9. Core inflation indicators of the NBP 1999-2004



Source: NBP

Figure 10. Inflation and central bank instruments 1998-2004

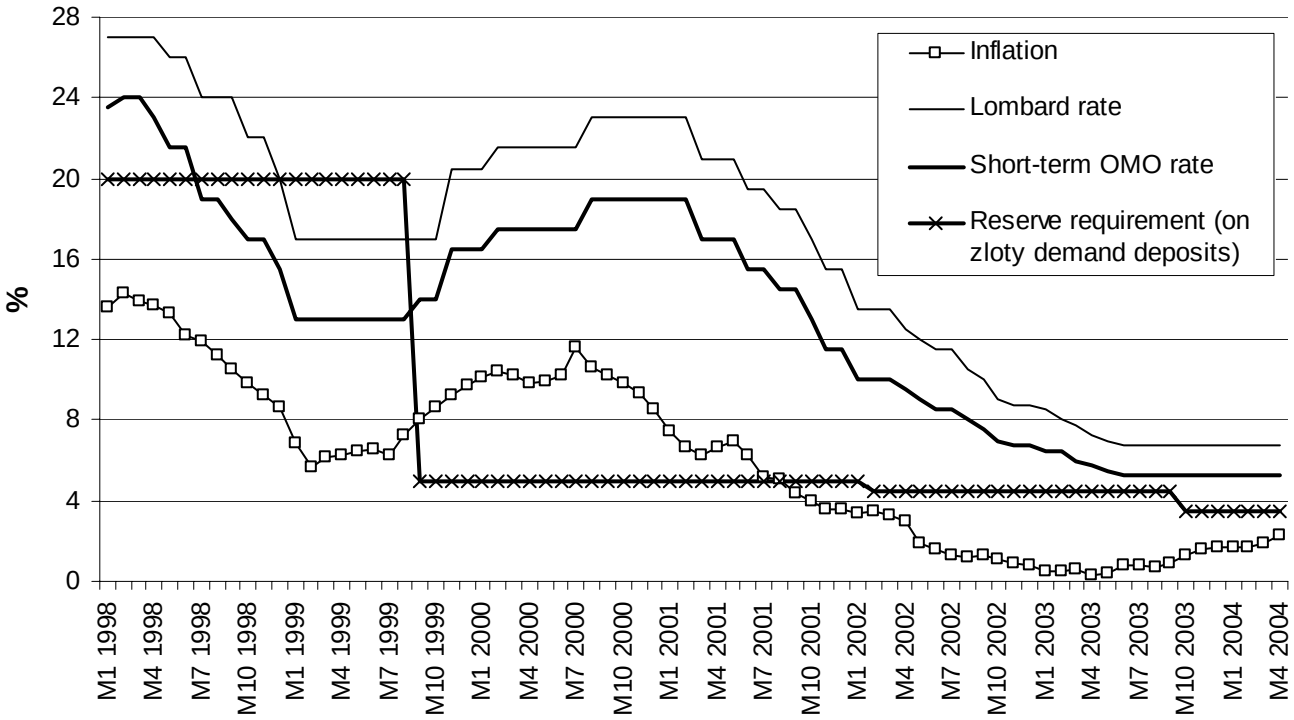
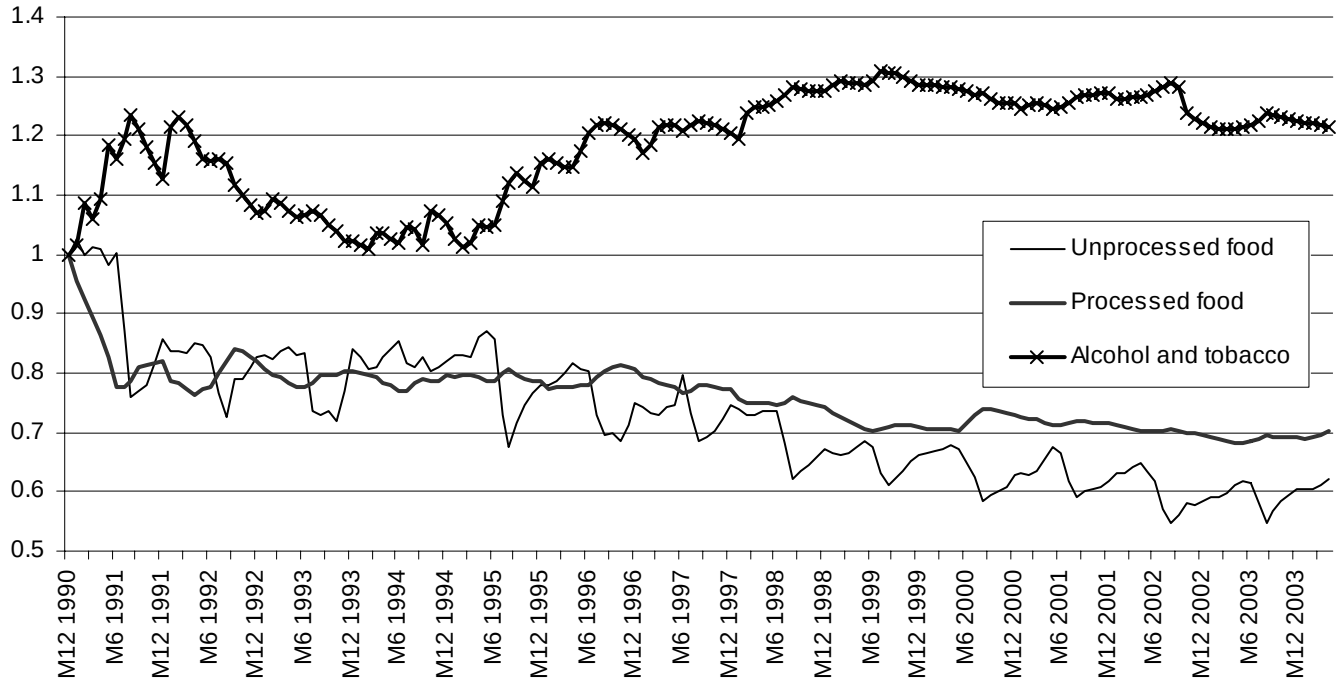


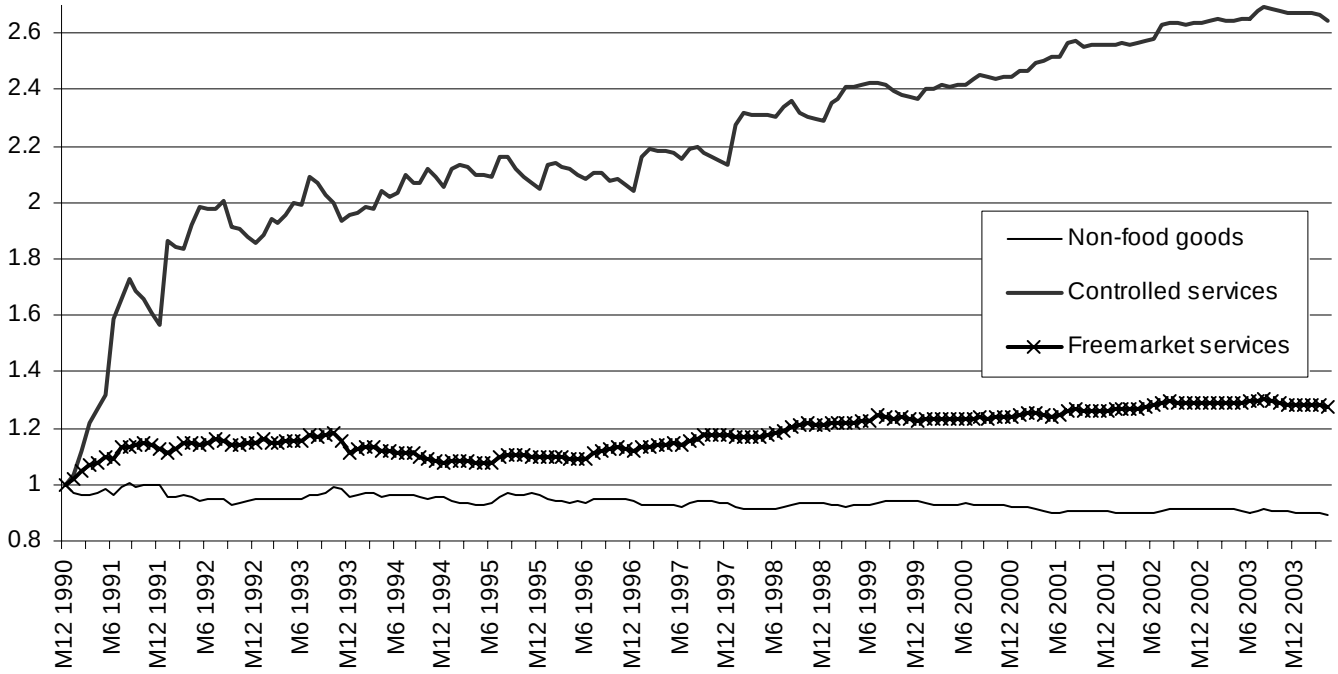
Figure 11. Relative price indices of 4 basic aggregates of the CPI (Dec 1988=1)

Figure 12. Relative price indices of main groups of the consumer basket: alcohol and tobacco, processed and unprocessed food (Dec 1990=1)



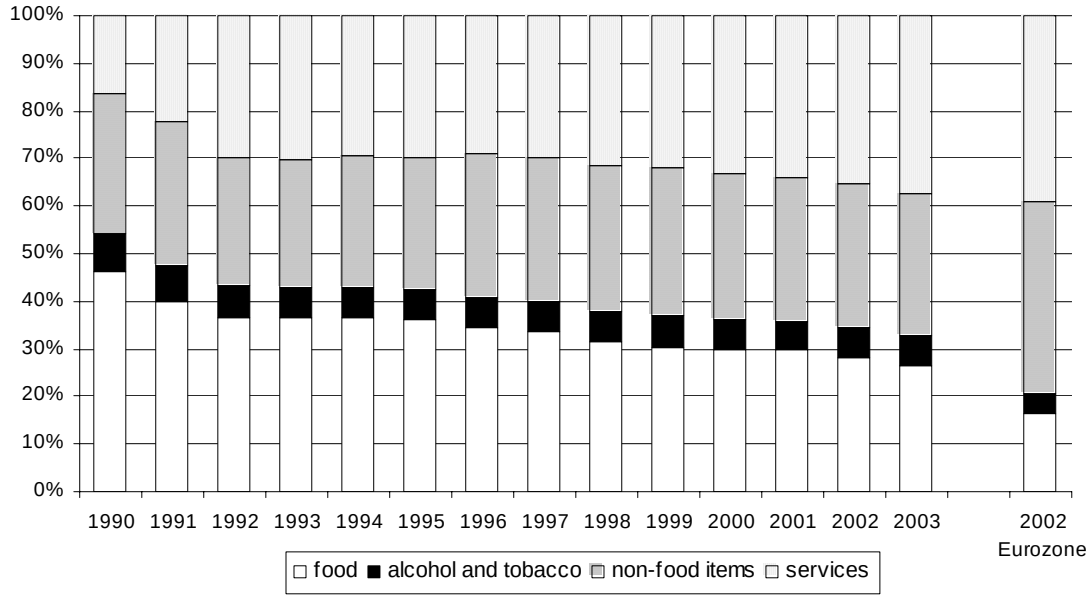
Source: Main Statistical Office (GUS)

Figure 13. Relative prices of main groups of the consumer basket: nonfood goods and services (Dec 1990=1)



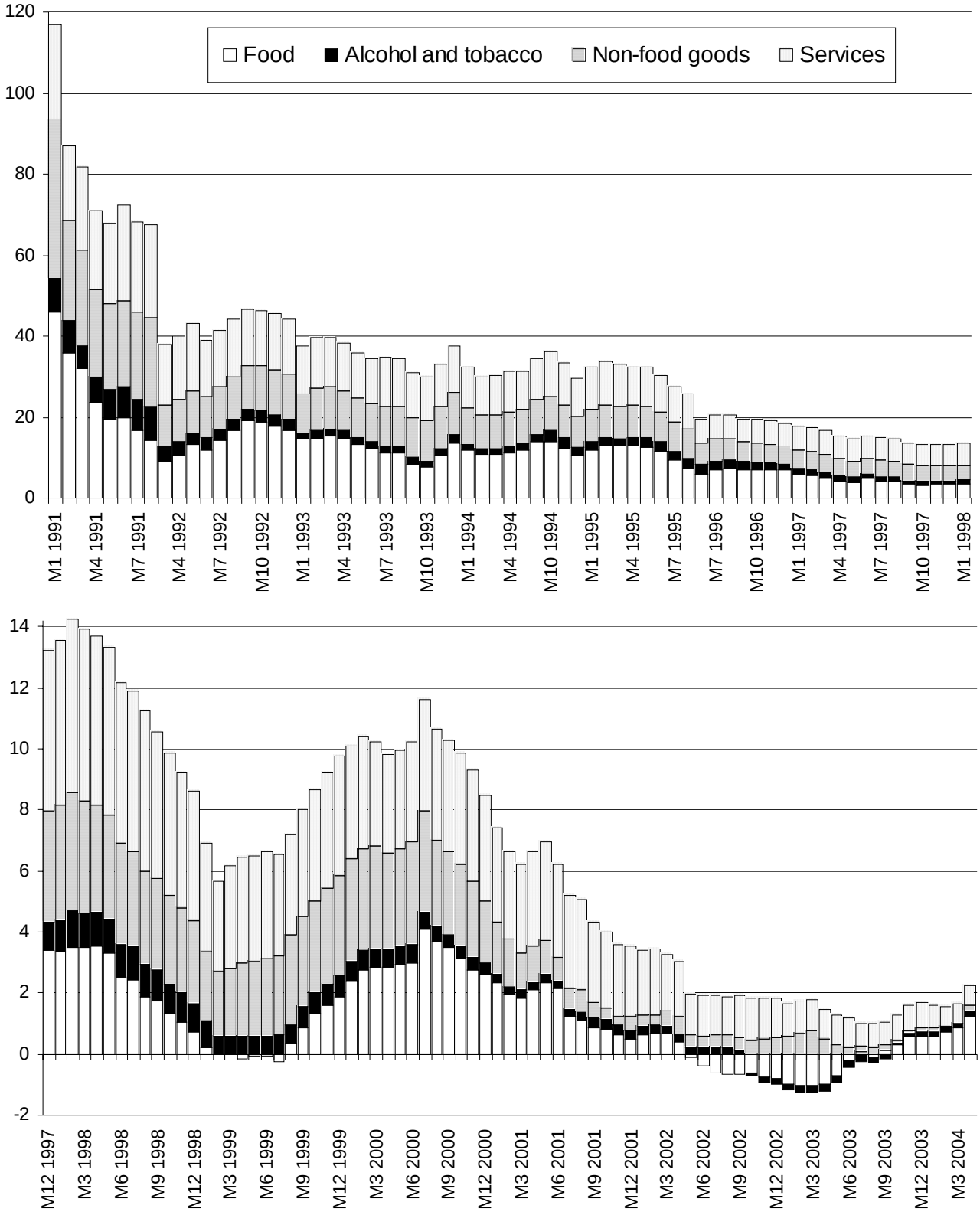
Source: Own calculations based on the data from the Main Statistical Office (GUS)

Figure 14. Evolution of consumption structure of Polish households 1990-2003 and the consumption structure in the Eurozone in 2002.



Source: Own calculations based on the data from the Main Statistical Office (GUS) and Eurostat

Figure 15. Structure of annual inflation by main CPI aggregates: 1991:2004



Source: Own calculations based on the data from the Main Statistical Office (GUS)

Analysis of Core Inflation Indicators in Ukraine

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1 Introduction

Since the end of the 1970s fighting inflation became an issue of highest priority in most countries. Targeting inflation, whether direct (in the form of the Direct Inflation Targeting strategy) or indirect, in the majority of cases implies aiming to achieve a specific rate of annual growth of the Consumer Price Index (CPI), i.e. the index that measures the percentage change in the cost of a variety of goods and services comprising the consumers' basket. As such, it is publicized and well known and the target itself is therefore transparent and well understood. However, it is also widely acknowledged that the CPI is a rather deficient indicator of the "trend" inflation especially if measured at high frequencies such as quarters or months. Monthly or quarterly series are usually highly volatile, seasonal and contain a lot of noise. Given the insufficient knowledge of the nature of transmission processes, monetary authorities need some firm guidelines that would help shape their policy to produce the targeted rate of inflation. Most importantly, they need to distinguish between movements in inflation that are transitory and those that are symptoms of the persistent drift of prices. Roger (1995) notes that as long as perceived CPI changes reflect one-time shocks to the general price level (such as for example, a change in the tax rate), or one-off shifts in relative prices, they should not provoke any action on the part of monetary authorities[3].

Therefore, the ideal measure of core inflation should account for the long-term trend movements in prices that reflect the state of demand in the economy and discard various one-off shocks coming from the supply side. This idea of excluding all shocks with no demand-side provenience stems essentially from the mainstream economics view that "monetary policy works primarily through its influence over demand pressures in the economy" (Roger 1995). Therefore one can only hold monetary authorities accountable for inflation that arises from those pressures, i.e. inflation whose elements lie within their direct influence. To see why this is a reasonable setup, one might think of a frequently exploited example of bad harvest caused by unfavorable weather. High prices of agricultural products due to a smaller-than-usual supply would certainly drive raise foodstuffs' prices up and the entire CPI would pick up temporarily. If monetary authorities followed the CPI movements closely this would prompt a "tightening" action on their part as the targeted variable moved out of the band. But this can hardly be considered a right policy to pursue as the registered rise in inflation is not a symptom of the new permanent trend or but rather reflects a temporary shift in relative prices.

This simple example provides intuition for what is not at all a trivial problem. How to filter out transitory noise out of price data and construct a measure that can serve as an appropriate guideline for monetary authorities? This paper aims to shed some light on the answer to this complex question in the context of Ukrainian inflation data. Inflation developments in Ukraine have been highly unpredictable in recent years: annual deflation prevailed in the second

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[3] *Unless monetary authorities target price level*

half of 2002, after which inflation was on a steady rise in 2003 and is now back to moderate levels at 7-8% on an annual basis. High volatility of the CPI inflation makes it more difficult for Ukrainian policymakers to filter out transitory short-term fluctuations and correctly predict the inflation trend. Core inflation constitutes a potential solution to this problem. It provides the authorities with a more stable and reliable measure of inflation and is thus a highly desirable policy tool in Ukraine.

In view of the absence of one widely accepted theoretical definition of core inflation, methods of calculating core inflation have proliferated in last 2 decades. Each of them renders itself further to parameterization and owing to numerous values for these parameters, the resulting population of core inflation estimates is virtually infinite. To the extent that all series differ in the way they filter the data, it is necessary to find a statistical method that reflects core price movements in a relatively most efficient and robust way. In this paper we suggest a complete and methodologically coherent technique of comparing and choosing between various core inflation indicators and then apply it to the Ukrainian inflation data.

The paper is composed as follows. Chapter 2 reviews the most important conceptual issues related to core inflation as well as introduces 5 statistical methods of estimating core inflation indicators. Chapter 3 presents and analyzes descriptive statistics of empirical distributions of disaggregated CPI in Ukraine and provides further rationale for using statistical techniques of estimating core inflation. Chapter 4 introduces the 3 criteria used in evaluating core inflation indicators and applies them to the population of empirical series of Ukrainian core inflation indicators. These criteria provide a tool for singling out optimal core inflation series for each method separately as well as for indicating the series that can be considered the optimal indicator within the entire population of core inflation series. Finally, chapter 5 concludes with summary and recommendations.

2 Core inflation – theory and practice

2.1 General considerations

Literature suggests two general broad categories of problems that arise when one deals with typically collected price data. Using the terminology borrowed from econometrics they will be labeled *noise* and *bias*.

Noise refers to all transitory shocks that are assumed to add up to zero in the long run, but exert temporary and noticeable influence on prices in the short run (especially when data is reported at high frequencies such as month or quarter). This category encompasses all kinds of shocks that originate in the supply side of the economy, such as seasonal phenomena, broadly defined resource shocks as well as shocks related to exchange or tax rate changes or any other shocks inducing shifts in relative prices. As indicated earlier all these shocks cancel out when one looks at a longer horizon but introduce undesirable fluctuations at high frequencies. Eliminating *noise* will be the primary focus of this study.

Bias in the context of price data is usually thought of as being either *weighting bias* or *measurement bias.* The former is rather unlikely to play a substantial role in the Ukrainian data since it is essentially related to infrequent adjustment of consumption weights. The Ukrainian Statistical Office belongs to a group of statistical agencies that carry out expenditure surveys every year and adjust the weights accordingly. Therefore, the bias that arises as constant weights do not account for relative price shifts, may be harmlessly neglected. *Measurement bias* refers to

actual errors in measuring individual prices[4]. It is the subject of numerous studies done mostly in the context of US price data[5] and since it is essentially different in nature than *noise* it will not be elaborated upon in this paper.

Cecchetti (1996) gives a simple formalized accounting framework wrapping up the preceding discussion in formulas. Following his notation, we define:

(1) $\dot{p}_{it} = \dot{P}_t + \dot{x}_{it}$ is the rate of change in the price of an individual CPI item – *i*

According to the formula it is composed of

$\dot{P}_t$ -the trend movement and the best approximation of the underlying inflation and

$\dot{x}_{it}$ -relative price inflation that represents one-time movements inherent in an individual item and not representative of the core trend.

Now, the regular "headline" CPI is just the weighted average of all the items:

(2) $\pi_t \equiv \sum_i w_{it} \dot{p}_{it}$ where w_{it}'s represent expenditure basket weights and add up to unity for each t.

or, combining (1) and (2)

(3) $\pi_t = \dot{P}_t + \sum_i w_{it} \dot{x}_{it}$

The second term in (3) is of most interest from the point of view of measuring core inflation. It represents the cluster of noise (n_t) and bias (b_t) that is attached to the "real" inflation period by period for all t's. Writing more explicitly:

(4) $\pi_t - \dot{P}_t = \sum_i w_{it} \dot{x}_{it} = n_t + b_t$

where noise or n_t has zero mean and is stationary and bias b_t can be further decomposed into a constant (μ_b) and a zero-mean transitory component (ω_t):

(5) $b_t = \mu_b + \omega_t$

If we define inflation of an individual item *i* over k periods as

(6) $\dot{p}_{it}^k = \frac{p_{it+k} - p_{it}}{p_{it}}$

this yields the following definition of the aggregate price inflation:

(7) $\pi_t^k = \dot{P}_t^k + \mu_b + \sum_{j=1}^k \left(\omega_{t+j} + n_{t+j}\right)$

In line with the earlier discussion, the assumption is being made that the weighting bias - ω_t is rather insignificant in the Ukrainian price data. As for the measurement bias represented by the constant term - μ_t, it might very well be present in the data, however, it will not be discussed in this paper[6]. It follows from the definition of the noise (in particular from zero mean assumption) that when the number of elements (k) in the right-hand side sum in (7) is sufficiently large, n_t*'s* cancel each other out and the whole summation collapses to zero. In the context of

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[4] *Cecchetti [1996] gives quality and new goods bias as examples of measurement bias.*

[5] *See Wynne and Sigalla[1993] and Shapiro and Wilcox[1996] for detailed discussion and actual bias estimates for the US.*

[6] *The measurement bias should not weaken the conceptual framework of the analysis presented in this paper since as a constant it does not interact with the time-variable noise.*

inflation rates this means that with the change of frequency from monthly to 12-monthly, π_t should get closer to $\dot{P}_t^k$ which represents the core inflation.

From (7) it is also clear that taking averages of inflation over longer periods will do the job too as high-frequency noise averaged over longer time horizon is likely to move closer to zero. However, averaging inflation rates in order to approximate trend price movements is not a good option for policy makers who need timely measures, that is, indicators available for use in the first instance.[7]

Ideal estimators of core inflation should also be robust, i.e. relatively insensitive to particular cases (or, in the context of this study, individual price distributions). Robust estimators may not be optimal for every single situation, but their useful feature is good and reliable performance even in extreme settings.

Another desirable characteristic of a good estimator is unbiasedness. It is clear that any good measure of core inflation must hit the "real" core inflation on average. Otherwise, it will tend to mislead us and either over- or understate the core price movements.

2.2 Core inflation: econometric vs. statistical approach

To come up with a measure of inflation that comprises all these characteristics and ends up being a transparent and coherent measure, is not an easy task. Econometric methods (e.g. Eckstein, 1981 and Quah and Vahey, 1995) offer a rigorous model-based approach to core inflation calculation.

Eckstein who is considered the father of the term itself[8] defined core inflation in the following way:

> *"The core rate of inflation can be viewed as the rate that would occur on the economy's long-term growth path, provided the path were free of shocks, and the state of demand were neutral in the sense that markets were in long-run equilibrium. The core rate reflects those price increases made necessary by increases in the trend costs of the inputs to production (Eckstein, 1981, p.8)."*

To accompany this theory, Eckstein presented a multi-equation model that produced a core inflation series for the US during the 1960 and 1970s. A more rigorous approach was taken by Quah and Vahey (1995) who defined core inflation as

> *"the component of headline inflation that has no effect on output in medium and long run (Quah and Vahey, 1995, p. 1130)"*

Core inflation is thus interpreted as an "output-neutral" inflation and extracted from the bivariate output-inflation VAR as the inflation component with no mediun and long-run effect.

Both methods imply the necessity to use econometrics in order to produce an estimate of core inflation series. This triggers all the well-known consequences such as extreme sensitivity of results to the length of the sample, in particular to its first and last observation as well as pervasive revisions of history (changing of core inflation series) every time the system is re-estimated. Moreover, econometric methods rely on complex[9] models with the use of many other macroeconomic variables (such as GDP or industrial output) which protracts the process of

[7] *It is obvious that averages will fail as timely measures as one needs some "future" (t>0) observations in order to calculate a contemporaneous (i.e. t=0) measure.*

[8] *Eckstein (1981) first used the term "core inflation" in a coherently defined and elaborated way.*

[9] *Particularly in the case of the Eckstein's model.*

producing core estimates and leaves to entire modeling process open to revisions (every time the GDP estimates are revised).

To be useful for monetary policy, core inflation indicators must be final and available in a timely manner (ideally together with conventional CPI). Therefore, it is not surprising that no central banks use the econometrically generated core inflation series as their official core inflation indicator. When it comes to the active use of core inflation in communicating with the market and setting the parameters of monetary policy the focus is on statistical methods. In spite of the many drawbacks they suffer from (see, for example Wozniak, 2002 or Wynne, 2002), they offer the best techniques of generating core inflation in a reliable and timely manner, with no revisions of historical observations and are relatively easy to communicate to the general public.

The statistical methods of calculating core inflation refer directly to the concept of extracting the trend through noise reduction (see 2.1). Most commonly applied techniques typically fall into 3 broad categories:

1) Exclusion- based methods

This method relies on the idea of removing certain categories of goods or services from the index. These categories typically include portions or entirety of food and energy aggregates in the consumer basket. The rationale for excluding these items in the process of calculating core inflation stems from the fact that historically movements in these prices have had much more to do with supply-side transitory shocks (often reversible) rather than the fundamental state of demand in the economy. Additionally, their high volatility obscures the general picture of inflation and hence may trigger inappropriate policy actions.

2) Trimmed means

Trimming involves calculating the core series as a weighted average with extreme price movements given reduced of zero weights. However, unlike exclusion (where zero-weighing is applied to specific aggregates), statistical methods are "component-blind", in that they modify the weights regardless of the CPI category that the affected CPI component belongs to. The resulting core inflation indicator is calculated as the weighted average of the inner, stable core of the distribution.

Ordinary trimmed means

The most common category within this group are *ordinary trimmed means*. Calculating simple trimmed means involves discarding (or zero-weighing) a certain percentage of CPI components (based on their share in the basket) from both ends of the distribution of individual inflation rates and computing the weighted average of the rest. Symmetric trims zero-weigh the same percentage at both ends so that k% trimmed mean eliminates k/2 %[10] highest and k/2% lowest price movements during the period concerned and takes the weighted mean of the middle (100-k)%. Asymmetric means distribute the trim asymmetrically. A special case of a trimmed mean is the usual CPI (0% trimmed mean) and percentiles that are 100% trimmed means (specifically, median is a symmetric 100% trimmed mean). Thus, ordinary trimmed means are characterized by 2 parameters: total trim (t) and the asymmetry of trimming (a).

Means trimmed according to the distance from the center of the distribution

[10] *Where percentages refer to basket weights rather than the number of categories.*

In the case of this type of trimmed means, the criterion for trimming is the distance from the center of the distribution of cross-sectional price changes. In simple terms, this method eliminates all the components whose prices changed much more or much less than the average.

The new weight system changes every month and can be written as follows:

$$(7)\ \tilde{w}_i = \begin{cases} w_i \text{ for } \forall_i \pi_t^i \le \mu_t + \tau V_t \\ 0 \text{ for } \forall_i \pi_t^i > \mu_t + \tau V_t \end{cases} \text{ where}$$

μ_t is the center of the price change distribution during a particular month t defined for example as the weighted mean,

τ is a non-negative number,

V_t is the volatility measure of individual inflation indices during time t, for example, variance of the cross-section distribution.

In the re-weighting process items with unrepresentative price changes are zero-weighted and items with price changes close to the average are left with the original weight.

Means trimmed according to price stability

The trimming criterion used here refers to volatility. This method aims at reducing noise by eliminating those components whose variance ratio (to the variance of the CPI) is higher than some cut-off threshold. The implied new weight structure is as follows:

$$(8)\ w_i^{***} = \begin{cases} w_i \text{ for } \forall_i \dfrac{\sigma_i^2}{\sigma_\pi^2} < \gamma \\ 0 \text{ for } \forall_i \dfrac{\sigma_i^2}{\sigma_i^2} > \gamma \end{cases} \text{ where}$$

γ is a non-negative number

σ^2 stands for the variance of individual items of the basket (in numerator) or the aggregate CPI (in denominator).

3) Variance-weighted means

The main principle of calculating variance-weighted means is to reduce noise by substituting completely or augmenting consumption-related weights with weights proportional to volatility. The system of re-weighting implies that no items are zero-weighted (which was the case in all 4 preceding methods), but instead, basket elements are given weights inversely proportional to their volatility. Four different types of variance weighted means will be calculated in this paper with the following modified weight systems[11]:

Type I: Complete substitution with reciprocal of individual variances $w_i^1 = \dfrac{1/\sigma_i^2}{\sum_{i=1}^{N} 1/\sigma_i^2}$ (9)

[11] *All weight structures presented below are scaled to unity.*

Type II: Partial substitution in which consumption weights remain but are augmented (multiplied) by reciprocal of individual variances $w_i^2 = \frac{\frac{w_i}{\sigma_i^2}}{\sum_{i=1}^{N} \frac{w_i}{\sigma_i^2}}$ (10)

Type III: Partial substitution with reciprocal of variances of relative price changes: π_i - π^{CPI}

$$w_i^3 = \frac{w_i \frac{1}{\sigma_{(\pi_i - \pi),i}}}{\sum_{i=1}^{N} \frac{w_i}{\sigma_{(\pi_i - \pi),i}}} \qquad (11)$$

Applying such alternative weighting systems ensures that each CPI component gets a weight proportional to the quality and strength of the inflation signal it carries. The contribution of volatile items to the index is reduced while that of stable items is magnified. The end result is a core inflation indicator that indicates the trend inflation movement to a much bigger extent than does the CPI which contains a lot of noise coming from volatile items.

Methods based on crude exclusion (method 1) are very good in that they are concise, simple, and offer a very appealing alternative to the conventional CPI. Their widespread use as indicators of trend inflation does, however, raise of couple of important objections. To the extent that the ideal measure of core inflation should make use of all available price information about long-run inflation trends, is permanent exclusion of food and energy prices always justified? In other words, is it always the case that those price movements convey no such information? Certainly not, and it seems logical to try to construct a measure of underlying inflation that would make use of valuable price information in a more flexible way without automatically discarding specific CPI categories like the first two methods described above. Trimmed means and variance weighted means (methods 2 and 3) seem to fulfill the conditions of an efficient use of available price information and are based to a smaller extent on ad-hoc judgment and discretion.

Throughout the paper several terms will be used interchangeably. Core inflation will be sometimes called underlying or trend inflation. CPI inflation will be referred to as "headline" rate inflation or simply, conventional rate of inflation.

3 Empirical distributions of disaggregated CPI

3.1 Description of the data

To date, core inflation for Ukraine has been estimated by Petrik and Polovnyov (2002, 2003). However, their analysis concerns only monthly inflation rates which, due to seasonality, are a much less important measure of inflationary pressures than annual rates. In their 2002 paper Petrik and Polovnyov calculated one exclusion-based indicator for the period 1999:1-2002:5 while their 2003 study includes 3 basic indicators (exclusion, trimmed mean and a median) as well as a moving average and covers the period of 1999:1-2003:4.

Our study is fundamentally different in that we make use of annual inflation rates and apply various theoretical criteria to make a choice of an optimal core inflation indicator for

Ukraine. Our analysis also covers the extended sample: we made use of a monthly inflation series for the period 1997:1-2004:9 which yielded 82 annual inflation observations covering the period 1997:12-2004:9.

We decided to work with annual data since annual changes of the CPI became the standard measure of inflation worldwide. Inflation targets are also expressed in annual terms and the annual inflation rate is the primary focus of the financial market. It is somewhat surprising that the Ukrainian Statistical Office and the National Bank of Ukraine do not publish annual inflation rates on a regular basis and instead use some other indices with base periods in a preceding month or as in December of the preceding year. Due to the pervasive seasonality of such indices and in line with clear trend among central banks, we will make use of the annual inflation data and calculate core inflation on an annual basis.

Before calculating core inflation series it is worthwhile to check descriptive statistics of the Ukrainian inflation data. Our dataset is composed of 85 CPI categories (accounting for the entire CPI basket) and 93 monthly observations from January 1997 until May 2004. Out of the 85 categories, 84 were original series from the Statistical Office and the 85th was the residual category introduced to ensure that the weighted average of all the components sums up to the CPI. All descriptive statistics were calculated at an annual frequency (k=12). Annual observations on price changes have been obtained by cumulating monthly observations over 12 months at overlapping intervals, so that the resulting data set contains 82 monthly observations: from December 1997 through May 2004.

Following most studies in the field we use the standard definitions of the weighted moments.[12]
If

$$\Pi_t^k = \sum w_{it}\pi_{it}^k$$

defines aggregate CPI inflation over the period of k = 12 months calculated as the weighted sum of all components using time-variable weights w_{it} , then the r^{th} weighted moment around the mean (the CPI inflation) is defined as:
and coefficients of skewness and kurtosis which are scaled third and fourth central moments,

$$m_{r\,t}^k = \sum_i w_{it}\left(\pi_{it}^k - \Pi_t^k\right)^r$$

respectively:

skewness[13] and kurtosis[14]

$$S_t^k = \frac{m_{3t}^k}{\left[m_{2t}^k\right]^{3/2}} \qquad K_t^k = \frac{m_{4t}^k}{\left[m_{2t}^k\right]^2}$$

[12] *Conventional moments implicitly put equal weights on all observations and therefore give a distorted view of the distribution of price changes. When weighted moments are calculated, the standard CPI becomes just the first central moment.*

[13] *Skewness characterizes the degree of asymmetry of a distribution around its mean. Positive skewness indicates a distribution with an asymmetric tail extending toward more positive values. Negative skewness indicates a distribution with an asymmetric tail extending toward more negative values.*

[14] *Kurtosis characterizes the relative peakedness or flatness of a distribution compared with the normal distribution. Positive kurtosis indicates a relatively peaked distribution while negative kurtosis a relatively flat distribution.*

Figure 1 shows weighted (defined above) and unweighted (conventional) descriptive statistics of distributions of annual individual inflation rates. The average and median empirical skewness amounts to 1.5 and 1.2, respectively. In the case of weighted skewness the values are: 1.04 and 0.69. In all cases the empirical skewness exceeds the value of 0 characteristic of the Normal distribution.

The situation looks similar with kurtosis. The average and median unweighted kurtosis are 15.17 and 13.94, while the respective values of the weighted kurtosis are 9.06 and 7.11. It is much more than 3 which characterizes the Normal distribution.

The departure of empirical distributions from the Normal is further confirmed if the normalized observations on individual components are pooled into a population of 6970 elements (85 components x 82 observations). The pooled empirical distribution is presented in Figure 2 (for this and some other figures see appendix) and contrasted with the Normal distribution[15]. The figure makes clear that the empirical distribution has higher kurtosis (as evidenced by much fatter tails) and is skewed to the right (as evidenced by more observations in the right far-end of the tail compared with the left one). Positive skewness suggests that during most periods few unusually large price jumps dominated the inflation process. On the other hand, the presence of fat distribution tails as detected by high kurtosis implies that random draws from such a distribution are likely to yield "unrepresentative" values.

Similar studies for other countries confirm the presence of both positive skewness and high kurtosis in inflation data. For monthly U.S. CPI data Bryan and Cecchetti (1996) report with a very slight positive average skewness (0.25), and a kurtosis of 11.44 over the 1970-97 period. Using quarterly data for New Zealand, Roger (1997) finds that the average skewness is 0.7 and kurtosis 7.2. Wozniak (2002) estimated the descriptive statistics on the monthly sample 1991:2001:12 of the 78-element-dataset and obtained empirical values of 2.21 (unweighted skewness) and 16.53 (unweighted kurtosis)[16].

3.2 Additional rationale for using the statistical approach

If we think of the distribution of individual inflation rates of all CPI components as being a draw from the underlying population of all inflation rates during that period, we can redefine our search for core inflation. It then becomes an issue of finding the most efficient estimator of the underlying mean. A thorough discussion of the statistical rationale of that approach can be found in, among many, Roger (1997) and Wozniak (2002). For the purpose of this study we provide only a brief intuitive explanation.

Since we treat the observed individual inflation rates as a sample from the underlying population that is of interest to us, we should condition our estimate on the type of population we are drawing from. Basic statistics tells us that in the case of the Normal distribution, the best and the most efficient estimator of the population mean is the sample mean. However, if we are not sure about the shape of the distribution or if we know it is not Normal, then a sample average may not be the most efficient in the family of all estimators[17]. Specifically, if the underlying

[15] *The distribution is truncated at -4 and 4..*

[16] *Respective values were higher for more disaggregated datasets*

[17] *Nonetheless, it still remains unbiased.*

distribution is skewed and leptokurtic, one is more likely to get a sample distribution that contains observations that are unrepresentative of the central tendency. Therefore, a simple average which weighs all the observations equally will tend to give a distorted image of the underlying distribution.

Figures 1 and 2 clearly show that the distribution of individual inflation rates in Ukraine is very far from the Normal. It is persistently skewed to the right and has fat tails. Hence, it is easy to see that sample means (be it weighted or unweighted) will be frequently pulled away from the "true" central tendency by extreme observations.

Conventional headline inflation (CPI) takes account of many shocks and disturbances that are unrepresentative of the long run trend. In calculating the CPI (as with any simple weighted mean), equal importance (albeit no equal weight) is given to each observation. While this is the right method of calculating the central tendency of the sample drawn from the Normally distributed population, it may not always be optimal if the distribution departs from the Normal. Statistical methods of calculating core inflation presented in the chapter 2 constitute the response to these problems. Calculation of exclusion-based methods, trimmed mean as well as variance-weighted means implies re-weighting the CPI basket so that volatile items (that are most likely to be found in the tails of the distributions) are downplayed and stable components are given relatively higher weights. Hence, estimates of core inflation with the use of statistical techniques embody not only the postulates of the theory of core inflation (provide a clear inflation trend) but solve some statistical deficiencies of the conventional CPI, as well.

4 Evaluation of core inflation indicators

4.1 Criteria used for evaluating core inflation indicators

The process of evaluation of various competing core inflation indicators will be carried out with help of 3 criteria most frequently used in the literature:

- Unbiasedness, "attraction" and exogenity - the UAE criterion
- Deviation from the trend - the DT criterion
- Stability – the ST criterion

4.1.1 Unbiasedness, "attraction" and exogenity (UAE)

This complex criterion was first proposed by Freeman (1998) and then augmented by a group of economists from the Central Bank of Portugal[18]. The conditions that constitute this criterion refer to 3 properties that any good core inflation estimate should posses if it is to be helpful for monetary authorities:

- Core inflation series should be unbiased with respect to the CPI.
- CPI should fluctuate around core inflation, i.e. core inflation should "attract" the CPI.
- Core inflation should be (strongly) exogenous with respect to the CPI.

These properties have been formalized in a set of 3 conditions (see for example Marques, P. D. Neves and da Silva, 2000). In the notation below π^c refers to core inflation and π to CPI inflation:

Condition 1) Unbiasedness

[18] *See for example Marques, Neves and da Silva (2000) and Marques, Neves and Sarmento (2000)*

π^c and π are cointegrated with unitary coefficient, i.e. (π^c - π) is stationary and the coefficient α in the regression

$\pi_t = \alpha + \beta * \pi^c{}_t + u_t$ (13)

is insignificant

Condition 2) "Attraction"

There exists an error correction representation for π given by ($\pi^c{}_{t-1}$ - π_{t-1}), i.e. $\gamma \neq 0$ in the equation:

$$\Delta\pi_t = \sum_{j=1}^{n} \alpha_j \Delta\pi_{t-j} + \sum_{j=1}^{m} \beta_j \Delta\pi^c_{t-j} + \gamma(\pi_{t-1} - \pi^c_{t-1}) + \varepsilon_t \qquad (14)$$

Condition 3) Exogeneity

π^c should be weakly (strongly) exogenous with respect to π, i.e. λ (as well as all thetas -θ_j) should be equal to zero in the following equation:

$$\Delta\pi^c_t = \sum_{j=1}^{r} \delta_j \Delta\pi^c_{t-j} + \sum_{j=1}^{s} \theta_j \Delta\pi_{t-j} + \lambda(\pi^c_{t-1} - \pi_{t-1}) + \eta_t \qquad (15)$$

We consider 2 variations of this criterion in our paper. They differ with respect to treating each of the 3 conditions. The basic version of the criterion is in line with Marques et al (2000) and considers that a core inflation series fulfills this criterion if it satisfies all the 3 conditions. Thus, the criterion has a discreet, zero-one character: the series either fulfills it (1) or does not (0). This version is denoted as a standard version of the UAE criterion (UAEs)

An alternative version of this criterion treats each of the 3 conditions as separate criteria. Then, the evaluation takes the form of assigning 1 if the series fulfils a particular condition or 0 if it does not. The final assignment takes the form of the average of the 3 values. This version of the UAE criterion is denoted as the alternative version of the UAE criterion (UAEa).

4.1.2 Deviation from the trend (DT)

This criterion was first formalized by Cecchetti (1996) and applied most extensively in the core inflation literature. It refers to *minimizing deviations from trend inflation.* Cecchetti points out that what central bankers are looking for in inflation figures are timely estimates of a long-term trend in general price level. Therefore, core inflation series that tracks this trend closely should also be considered a good inflation measure for monetary policymakers.

Two assumptions are crucial in order to evaluate core inflation series using this criterion. First, one needs to define the trend series and the function to be minimized. The trend series has been conventionally defined as a centered moving average of the CPI inflation while the deviation function is commonly taken to be the root mean squared error (RMSE) or mean absolute deviation (MAD).

where x_i is the deviation of core inflation from the benchmark trend.

Unlike the UAE criterion, the DT criterion is continuous in that the core series can exhibit

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i)^2} \qquad (16) \qquad\qquad MAD = \frac{1}{N}\sum_{i=1}^{N}\left|(x_i)\right| \qquad (17)$$

the feature of trend tracking to varying degrees. By means of monotonic transformation, the series with minimum deviation is assigned 1 while all the other series are assigned values from the range (0, 1).

4.1.3 The stability criterion (ST)

This criterion follows from the basic postulate that a core rate of inflation should be characterized by lower volatility than the CPI. Within the population of competing core inflation indicators, those that are most stable, are also the ones that are potentially the most attractive for policy makers (provided of course, they fulfill the previous 2 criteria).

In our study we will use two most intuitive measures of stability: standard deviation of levels and first differences of core inflation series. As was the case with the DT criterion, the stability criterion is also continuous. The highest value of 1 is assigned to the most stable series, while all the remaining indicators are assigned values from the range of (0,1)

4.1.4 The final evaluation

Each of the 3 criteria evaluates the population of core inflation indicators in an independent way by assigning values from the range [0;1] in the case of the UAE criterion or (0;1] in the case of the DT and ST criteria. We base the final selection on the sum of the 3 criteria, which assigns each indicator a value from the range (0;3] and orders the entire population accordingly.

4.2 Ordinary Trimmed Means

As explained in section 2.2, ordinary trimmed means are weighted averages of the inner "core" of the distribution. Each month the cross-section distribution of individual price changes is trimmed of a certain percentage of the basket from the left and right tail of the distribution. The sum of the trimmed share of the basket is the total trim parameter (t), while the percentage of the total trim that is trimmed from the left tail constitutes the asymmetry parameter (a). If only integers are considered for both parameters (1 to 100), the population of trimmed means equals 10,000 (100 x 100). Within this population one can single out special cases. All the trimmed means with the parameter t set to 100 are percentiles and specifically the one with a=50 is the median. In addition all the trimmed means with a=50 are symmetric trimmed means which eliminate the same percentage of the basket weight for both tails of the distribution.

4.2.1 UAE criterion applied to ordinary trimmed means

Applying the UAE criterion to the population of 10,000 trimmed means, involves checking the unbiasedness of the core inflation indicators. In line with 4.1 this requires testing whether the deviation of core inflation from the CPI is stationary and zero-mean. This is done by testing the $(\pi^c - \pi)$ for the presence of a unit root and then testing the significance of α in equation (13). The results are presented in Figure 3 which depicts the unbiased trimmed means as dots on a plane of all trims (x-axis) and all asymmetries (y-axis). Out of 10,000 analyzed trimmed means only a small fraction turned out to satisfy the UAE criterion. They form a wave running across all trims and centered around the 50^{th} percentile. Generally for smaller trims, the unbiased means are characterized by a relatively wide range of asymmetry parameters (30%-65%). The range narrows as trims increase and for trims higher than 70%, the asymmetry parameter falls within a range of 47%-54%.

"Attraction" property is tested by testing the null hypothesis of the insignificance of the error correction mechanism (ECM) in equation (14). This test is only applied to the unbiased indicators, i.e. those that passed the "unbiasedness" test. In figure 3 the means that posses this property are marked as circles around the dots. These means constitute only a small fraction of all unbiased means - they comprise 3 asymmetry parameters: 49, 48 and 47 and trims of 98-100, 85-

100 and 92-100, respectively. Most of those trims are very close to the weighted median of the distribution (whose parameters are t=100, a=50).

The third stage of application of the UAE criterion involves testing whether core inflation is exogenous with respect to headline inflation. This is done by testing the joint significance of the CPI terms in the Granger causality-type equation (15). This test is only applied to the unbiased core inflation series that possess the "attraction" property as evidenced by the ECM term. The set of means satisfying this condition is identical to that satisfying the attraction condition. In other words, all trimmed means that are unbiased and have the "attraction" property, turn out exogenous with respect to CPI, as well.

Thus, the set of trimmed means satisfying all three conditions of the UAE criterion contains 28 series: 3 means with asymmetry parameter=49 and trims of 98-100, 16 means with asymmetry parameter equal to 48 and trims 85-100 as well as means with asymmetry parameter equal to 47 and trims 92-100.

4.2.2 DT criterion applied to ordinary trimmed means

As noted in section 4.1 the DT criterion requires setting the form of the deviation function as well as the series which is to serve as a benchmark trend. We check the sensitivity of results by assuming two alternative forms of the deviation function: root mean squared error (RMSE) and the mean average deviation (MAD), i.e. equation (16) and (17) in 4.1, respectively.

The selection of the benchmark trend is a problematic issue. As some studies show that the results are sensitive to the specific form of the benchmark trend (e.g. Wozniak 1999, Kearns 1998, Meyler, 1999), we take a rigorous approach to choosing it. We assume the best benchmark to be centered moving averages of a headline inflation. Out of the many variants of the averaging horizons we choose 25 means: from a 12-month moving average to a 36-month moving average. We select the optimal moving average by applying the UAE criterion to all the 25 moving averages. It turns out that only one moving average fulfills of the 3 conditions of this criterion. It is the 35-month centered moving average. This series will serve as a benchmark trend in all subsequent applications of the DT criterion.

In order to better interpret the results, we transform the deviation function so that it assigns higher values to the series that exhibit lower deviation and all values are contained in the range (0;1]. This is done by a simple monotonic transformation (shown here for the MAD function):

where MAD(t,a) is the value of the MAD function (equation 17) of a particular trimmed mean with parameters (t,a). The values of the p function (transformed deviation function) for all the analyzed ordinary trimmed means is presented in figure 4.

$$p(MAD(t,a)) = \frac{\left(MAD(t,a)\right)^{-1}}{\max\left(\left(MAD(1 \le t \le 100, 1 \le a \le 100)\right)^{-1}\right)} = \left(MAD(t,a)\right)^{-1} \min\left(MAD(1 \le t \le 100, 1 \le a \le 100)\right)$$

Quite surprisingly the means that exhibit the lowest deviation from the trend are concentrated around the small trims and small values of the asymmetry parameter. We can also notice a band going through all symmetric trims (a=50), however, the value of the deviation function for trimmed means with lowest asymmetry parameters exceeds that of the symmetric trims. The single trimmed mean that deviates from the trend the least is the trimmed mean with parameters (1,1), marked with a white dot in the figure.

4.2.3 ST criterion applied to ordinary trimmed means

In this paper we assume two alternative forms of the stability criterion: one that uses the standard deviation of the inflation rates and another one, that uses the standard deviation of first differences of inflation rates, i.e. the month-to-month changes in annual dynamics.

Analogously to the DT criterion, the continuous character of the ST criterion requires transforming the volatility function so that the resulting function assigns higher values to more stable series and all values are contained in the range (0;1].

If V(t,a) is the value of the volatility function (e.g. standard deviation) for a particular trimmed mean with the parameters *(t,a)*, the transformation function *p* has the following form

$$p(V(t,a)) = \frac{\left(V(t,a)\right)^{-1}}{\max\left(V\left(1 \le t \le 100, 1 \le a \le 100\right)^{-1}\right)} = \left(V(t,a)\right)^{-1} \min\left(V\left(1 \le t \le 100, 1 \le a \le 100\right)\right)$$

The function is monotonic and assigns the value of 1 to the trimmed mean with the lowest volatility of all and values close to 0 to the most volatile trimmed means.

Figure 5 presents the values of the *p* function applied to standard deviation of both levels and first differences of inflation rates (stability function I and II, respectively). Changing the argument of the stability function changes the results somewhat. In the case of levels, the group of optimal trimmed means forms a 'cloud' with trims ranging from 60 to 80% and asymmetries ranging from 5-20%. In the case of first differences the cloud is 'blurred' somewhat and spreads to higher trims and asymmetries (trims up to 100% and asymmetries between 0 and 30%). The optimal means are tm(65,8) and tm(100,21) - a 21st percentile, for stability functions defined on levels and first differences, respectively.

4.2.4 Final evaluation of ordinary trimmed means

To come up with a final evaluation of the population of trimmed means, we summed up the values assigned by each of the 3 analyzed criteria for all 10,000 trimmed means. Simple summation is naturally subject to criticism, as it implies that the properties checked for by each of the 3 criteria (i.e. unbiasedness-attraction-exogenity, tracking the trend and low volatility) are equally important. This might not always be the case, but seems the most natural assumption to be made when neither theory nor practice indicates clearly the prioritized features of a core inflation indicator. Hence, the final evaluation of the core series will be made based upon the sum of the values assigned by each of the 3 criteria.

As noted earlier, the UAE criterion enters the final evaluation in 2 different forms:

- The standard form, denoted as **UAEs**, where a series is assigned '1' only if it satisfies all the 3 conditions of the UAE criterion. Thus only 2 values are possible in this case: 0 and 1.
- The alternative form, denoted as **UAEa**, where a series is assigned an average of values assigned by applying each of the 3 conditions. Thus 4 values are possible in this case: 0 (no condition is satisfied), 1/3 (unbiasedness condition), 2/3 (unbiasedness + attraction) and 1 (all 3 conditions).

If we take into account that both deviation-from-trend criterion and volatility criterion each have 2 alternative versions, the final evaluation yields 8 different optimizations (2 x 2 x 2). Since the value assigned by each criterion ranges from 0 to 1, the final evaluation ranges from 0 to 3.

The results for all possible cases are presented in the upper panel of Table 1. Because final evaluation results were identical for both versions of the UAE criterion[19] we only present those for UAEs. Figure 6 presents the results in 2 out of 8 combinations: the upper panel presents evaluation based on the standard version of the UAE criterin, MAD function and Stability type I (levels), whereas the lower panel depicts results calculated for the alternative version of the UAE criterion, MAD function and stability function calculated with the use of first differences.

Clearly, due to the fact that only relatively few trimmed means fulfilled the UAE criterion, scores on this criterion turned out decisive. The optimal trimmed mean was thus chosen from the subgroup of the series fulfilling the UAE criterion and the final choice depended on the sum of the values assigned by the two latter criteria. The results turned out robust with respect to the form of the UAE criterion, however both the form of the deviation and stability function mattered. The final set of optimal trimmed means encompasses 3 series with the following parameters: (92,47), (88,48), (100,49). The latter 2 series are presented in figure 7 along with the CPI. Both core series move very closely together and perform well in smoothing out the short term volatility of the CPI. In particular, none of them falls below 0 in the second half of 2002, when convention CPI indicated annual deflation.

4.3 Means trimmed according to the distance from the center of the distribution

As follows from the description in 2.2, means trimmed according to the distance from center of the distribution, are characterized by 2 parameters. The first one refers to the exact definition of the center of the price change distribution and the second one sets the threshold for zero-weighting the elements of the distribution. In terms of the definition of modified weights (equation 7), we need to define μ which is going to be our benchmark inflation rate and τ which determines the width of the band around the center within which price changes are considered moderate and are given its full consumption weight in the new weighting system. The permitted deviation band is defined in terms of the unweighted standard deviation of the distribution in a particular month.

The main difference between this type of trimming and the ordinary trimming presented in 4.2 is that trimming need not occur at all here when the distribution is relatively condensed and there are no dispersed observations, while in the case of ordinary trimmed means, the distribution is always trimmed regardless of its shape.

In our study we considered 4 alternative definitions of the center of the distribution: weighted mean (equivalent to the CPI), unweighted mean as well as weighted and unweighted median. For the parameter τ, we investigated 1000 possible values[20] equally spaced between 0 and 1: 0.001, 0.002, 0.003, …, 0.999, 1. These values correspond to eliminating all the components whose distance from the center is larger than 1/1000 of a standard deviation up to eliminating all the components further away from the center than 1 standard deviation.

[19] *Final results were identical, however, for intermediate results and the ranking of series within each method, the form of the UAE criterion did matter.*

[20] *We also checked values higher than 1, but they yielded series with worse characteristics*

Accordingly, the population of means trimmed according to this method is 4000 (4 definitions of μ times 1000 values for τ)

The analysis will proceed analogously to that in the preceding subsection. Unlike in the previous case, however, we will not present all the intermediate results and instead we will focus on the final evaluation. Table 1 presents full results of the evaluation procedure for possible combinations of alternative criteria, while figure 8 presents the evaluation score of each of the 400 means in 2 chosen cases. As table 1 suggests, in all cases, the optimal series are centered around the weighted mean, i.e. the CPI ($\mu 1$), means calculated with the use of other definitions of the center of the distribution scored visibly worse. Furthermore, the results turned out robust with respect to the deviation function (criterion DT) and the form of the UAE criterion. However, as was the case with ordinary trimmed means, the form of the stability function determines the specific final result. When we evaluate means according to stability function calculated on levels, the optimal series is the mean with paramter τ=0.1 while, if the function's arguments are first difference, the optimal mean is characterized by parameter τ=0.25.

The figure graphs four lines (each for an alternative definition of the distribution center) as a function of the τ parameter. Because the form of the stability function used mattered for results, figure 8 contains two graphs: the upper one for the evaluation with the use of the stability function calculated on levels (Stab I) and the lower one plotting the results obtained with the use of the stability function calculated on first differences (Stab II). In both cases the optimal indicator was estimated by trimming around the weighted mean, i.e. the conventional CPI. The optimal mean eliminates all components whose price changes deviated more than 1/10 or 1/4 of a standard deviation from the CPI (for Stab II and Stab I, respectively).

Figure 9 presents both series along with the CPI.

4.4 Means trimmed according to price stability

Rationale for calculating this type of trimmed means stems from acknowledging that individual CPI components are characterized by a different strength of the "inflation signal" and this strength is not directly related to consumption weights. Stable CPI components, i.e. those whose price change variations are moderate, contain much more information about the trend than those whose price changes are very dispersed. Therefore, if a core inflation indicator is to reflect an inflation trend, it is advisable to eliminate the influence of volatile, "noisy" items. However, unlike in the case of previous methods, where only the cross-section properties of the data were exploited, this technique makes use of the time-series dimension of the data as well. In particular, it assigns new weights based on the volatility of the time series of CPI components: components whose variance has been high are excluded from the new basket, while those that were stable become part of the basket.

In our study, we define volatility in terms of the ratio of a variance of an individual component to the variance of the CPI inflation during a particular period of time (equation 8). If this ratio exceeds a parameter value - γ, the item is zero-weighted. We investigate 30 possible values for this parameter equally spaced between from γ=1.05 and γ=2.5[21]. The first one corresponds to the situation in which all items with variance higher than the variance of the aggregate CPI get discarded from the basket. The last one sets the threshold much higher: only those items that are 2.5 times more volatile than the CPI are assigned a zero weight.

[21] *We also checked values higher than 2.5, but they yielded series with worse characteristics.*

In addition to the threshold parameter γ, we consider 2 alternative ways of defining volatility: one based on levels of price changes, another one based on first differences of price changes. Horizon of measuring variance in our study ranges from 12 to 36 months. Thus, the total population of means trimmed according to the price stability criterion is 1500 (2 volatility definitions x 30 values for parameter γ x 25 different time horizons).

Table 1 presents results for all possible criteria combinations. This time results are robust to alternative formulations of all 3 criteria. In all cases the optimal series is the mean that discards all components whose first-difference variance calculated in a 35-month moving window exceeds the analogously defined variance of the CPI by more than 115%.

Figure 10 presents the graphical results for the standard version of the UEA criterion and with the use of MAD and Stab I functions. The figure contains only means estimated with the use of variance on first differences of inflation since this definition yielded visibly better results than those estimated with the use of variance on levels of inflation. The series that scored highest were the ones calculated with the value of γ=1.15 and the second longest variance horizon: 35 months.

Figure 11 presents the optimal trimmed mean in this category along with the CPI.

4.5 Variance-weighted means

Variance weighted means exploit the signal-noise properties of the disaggregated CPI components to an even higher extent than do means trimmed according to price stability. While the trimmed means implied a rigid system of either discarding or including the components based on analysis of their volatility, variance weighted means offer a more gradual and sophisticated approach. The weighting system is modified in a continuous manner allowing for weights of more stable components to be expanded and weights of more volatile components to be reduced. Instead of assigning zero or full weights, this method implies adjusting weights by factors inversely proportional to individual variances.

In our study we will investigate 3 systems of weights' re-adjustments described by equations 9, 10 and 11. Furthermore, analogously to means trimmed according to price stability, we will use two alternative arguments of the volatility function (variance), namely: levels and first differences of price changes of individual components. The width of the variance horizon will vary from 12 to 36 months. This parameterization produces 150 different variance weighted means (2 volatility definitions x 3 weight adjustment systems x 25 time horizons).

Table 1 presents the full results. It has to be mentioned that none of the 150 variance weighted means fulfilled any condition of the UAE criterion in an analyzed sample. Hence the evaluation was done based on sums of respective scores from the DT and ST criteria and, naturally, combinations with 2 alternative versions of UAE criteria give identical results (See table 1). Changing alternative definitions of the DT and ST criteria changed the results only marginally. All of the "optimal" series are calculated by complete substitution of weights (equation 9) and make use of the volatility function defined on levels of inflation. The only parameter sensitive to changing the stability and deviation functions was the averaging horizon. Optimal series are characterized by 3 different (albeit relatively close) values of this parameter: 30, 34 or 36. Thus, even though results are not robust to changing specific criteria combination they are all very close to one another and the resulting series are very similar.

Figure 12 presents the graphical results of the evaluation for the selected combination of the criteria: RMSE and Stab I. Graph depicts values of final evaluation (the sum of RMSE and Stab I) for 6 different re-weighting systems as a function of the averaging horizon. It is clear that

type I variance weighted means implying complete substitution of consumption weights with reciprocal variances, take the lead for almost all horizon lengths.

Figure 13 presents these the 2 optimal variance weighted means along with the CPI. Out of all analyzed core inflation series, variance weighted means seem to be the most smooth and stable.

4.6 Exclusion-based means

This is the single most frequently applied method of calculating core inflation among central banks. In fact, when most people think of core inflation they mean some indicator that is calculated by permanent exclusion of specific broad aggregates, like food, energy or fuel. Exclusion-based means imply a zero-one re-adjustment system and exploit only a cross-section dimension of data on price changes: components that are considered volatile and "noisy" are eliminated from the basket while the rest retains their original consumption weight. The crucial issue in estimating the core inflation indicator according to this method concerns the selection of components to be excluded. Traditionally they included food and energy due to the fact that their short term movements in the past reflected supply-side transitory shocks rather than fundamental state of the demand in the economy. However, the exclusion-based method does not formalize the selection process (there are no formal criteria to guide the researcher) and hence the decision is rather arbitrary and relies on subjective judgment. The excluded goods or services typically fall into 3 categories:

- Administratively controlled items; prices are controlled directly by the Government or indirectly through the Government agencies or local authorities and are adjusted upwards in a discreet (one-off) manner (e.g. electricity in most countries)
- Items whose price contains a high share of indirect taxes (e.g excise); movements of such prices are typically triggered by tax changes and are not demand-driven (e.g. alcohol, tobacco)
- Items whose price changes contain a significant seasonal component or prices are shaped by other clearly observable supply-side effects. (e.g. fuel, unprocessed food).

For the purpose of calculating exclusion-based means we singled out the following "candidate" CPI categories (consumption weight used in 2003/04 in brackets):

1. All food (63.5%);
2. Raw food: meat, eggs, butter, sugar, flour, bread, potatoes, vegetables, berries (28.7%)
3. Fuel (0.5%);
4. Tobacco (1.3%);
5. Alcohol (2.0%);
6. Public utilities (9.3%);
7. Communications (1.5%);
8. Transport (2.7%);

Components so defined were excluded from the CPI basket in different 56 combinations. Consequently, we calculated 56 series of exclusion-based means in which the total weight of excluded components ranged from several to over 80%. The process of evaluation of these

indicators revealed that while none of them fulfilled all three conditions of the UAE criterion, several were found to be unbiased. However, optimal series are robust to the choice of the specific UAE criterion. The results are also robust with respect to the form of the deviation function, but not to the form of the stability function (criterion ST). Thus, 2 different series can be considered optimal in this category. When stability function was calculated on levels, the best evaluation score was registered for the mean excluding raw food (2) and utilities (6) (the total weight of excluded elements: 38%). However, when the arguments of the stability function were first differences, the optimal indicator turned out to be the mean calculated without raw food(2), public utilities(6), communications (7) and transport (8). (total weight of excluded components amounts to 42.2%). Thus, both series are fairly similar – they exclude raw food and public utilities (conventionally the most volatile CPI components) while the latter also eliminates transport and telecommunications.

Both series are presented in Figure 14.

4.7 Aggregate evaluation

So far we have applied the UAE, DT and ST criteria to each method separately in order to identify the parameters that characterize the optimal series within each of the 5 methods. Each evaluation procedure resulted in selecting 1, 2 or 3 series that outperform the remaining series within each method. In order to single out the best of all of them, it does not suffice to compare the scores of each of the "within-method" optimal series. This would be incorrect because both DT and ST criteria have been transformed (divided by the maximum value) so that they yield a set of values within a range (0;1] (see 4.2.2 and 4.2.3 for details). Therefore, in order to compare all of the series across methods, we have to apply the criteria to a full dataset with series representing all methods pooled together.

The full dataset contains 15706 elements and is composed by stacking up core inflation series in the following order:

- Ordinary trimmed means (quantity 10000; no. 1-10000)
- Means trimmed according to the distance from the center of the distribution (quantity 4000; no. 10001-14000)
- Means trimmed according to price stability (quantity 1500; no. 14001-15500)
- Variance-weighted means (quantity 150; no. 15501-15650)
- Exclusion-based means (quantity 56, no. 15650-15706)

When we form the population of 15706 core inflation series and apply standard criteria, the optimal series are robust to the version of the UAE and DT criterion. As in many cases before, the stability function arguments matter. Table 1 lists the final results in the lower rows. If the stability function is defined on levels, the optimal series is a mean trimming all elements of the distribution that are further away from the weighted mean of the distribution (CPI) than 1/10 of a standard deviation (or, precisely, 10/97 of a standard deviation). If the argument of the stability function are first differences, the optimal series is a mean that eliminates all components of the CPI whose variance (measured for first differences) exceeds that of the aggregate CPI by more than 15%.

Figure 15 presents scores of the entire population on the DT criterion (RMSE), the ST criterion (Stab I), the alternative version of the UAE criterion as well as the sum of these criteria

(in the lower panel). The following figure, figure 16 presents analogous results for Stab II function. Each of the 4 graphs in the figures depict criteria values (y-axis) for the entire population of core series (x-axis) pooled together in the sequence described above and repeated below the figures. Although one cannot read off the specific parameters of a series from these figures, their purpose is to visually inspect the performance of each of the 5 methods, and in particular, the relative scores of top-ranking series for each method.

In general, the differences in scores obtained by top-ranking series for all methods are not very large. In particular, the optimal trimmed mean in a criteria setting of figure 15, i.e. tm(88,48)[22] scores 1.68 which is very close to the score of the "winning" series, i.e. 1.75 (see table 1). Similar (albeit somewhat lower) proximity of results is discovered when Stab II is used (see figure 16).

Figures suggest that relative performance of representatives of particular methods in the entire population very much depends on the criterion considered. For example, while variance-weighted means (core 4) score very high on ST and DT, they score nothing on UEA because all of the series proved biased. Thus, the final score of the series calculated using this method (simple sum of scores for 3 criteria), is far for the maximum score that is attained by optimal series in Core2 (Stab I) or Core3 (Stab II) category.

As mentioned in earlier sections, due to the fact that relatively few series fulfill the UAE criterion, scores on this criterion became decisive in choosing the optimal series. This is also a consequence of the particular choice of the final evaluation, i.e. the simple sum of scores on each criterion. One can very well imagine that, if the final choice were based on a weighted average with less weight given to UAE criterion, the end-result would be different. In view of no clear guidelines from theory, the best suggested resolution of this dilemma is to have the researcher (and possibly the policymaker) decide on the specific weights. While this may seem arbitrary, it might be the best solution to the problem of the particular form of the final evaluation index. Since each criterion reflects a specific feature of a core inflation series (see 4.1), individual preferences towards a particular set of characteristics and expectations can easily translate into a specific set of weights. If, for example, stability is what policy makers look for in a measure of core inflation, then the ST criterion should be assigned a weight higher than 1/3. When providing an indication of a long-term trend is a priority, the DT criterion should be in focus. On the other hand, if they want to be sure that the series is unbiased, they might want to give a slightly higher weight to the 'unbiasedness' condition of the UAE criterion.

Nevertheless, without any priors or specific preferences, it seems natural to weigh all of the three criteria equally, i.e. apply simply averaging. This is also motivated by the fact that all of them are in fact very close and reflect similar characteristics. In essence a good measure of core inflation that is unbiased, attracts the CPI and is exogenous with respect to is, should also be stable and should be tracking the trend fairly closely. The series suggested by the simple average of all 3 criteria have all the characteristics of a good core inflation series. Figure 17 presents these 2 series along with the optimal trimmed mean (which came a close second in all criteria combinations).

This result might be viewed as somewhat surprising especially in what concerns the mean trimmed according to the distance from the CPI with τ=0.1. This mean implies that any price changes that differ from the CPI by more than a mere 10% of the standard deviation in the

[22] *See 4.2*

respective month, get eliminated from the index. Because the band is so narrow, what we are left with is several price changes immediately around the CPI. Hence, it comes at no surprise that the resultant series is very close to the CPI.

On the other hand, the mean trimmed according to price stability has a very different shape. It is much more stable and diverges form the CPI for longer periods. Somewhere in between, we have the ordinary trimmed mean that tracks the CPI more closely, yet, smoothes most of its short-term fluctuation in an effective way.

5 Summary and conclusions

In this paper we analyzed a sizeable population of core inflation indicators for Ukraine and evaluated them according to standard criteria postulated in the literature. The investigated population included not only all the statistical methods that are used among central bankers but also some new or modified ones that have not been formalized before, but contain elements of the previously applied approaches (such as means trimmed according to price stability). Due to full parametrization of the methodologies, we obtained a population of 15706 series that can be considered comprehensive and complete when it comes to statistically calculated core series.

The population of core inflation series was evaluated using a set of 3 criteria each of which refers to the desirable properties of a core inflation indicator. Altogether, these criteria ensure that the indicator that will score high in the ranking will

- Be unbiased,
- Have the attraction property, i.e. it will "pull in" the CPI whenever it drifts away from the core inflation indicator
- Be exogenous with respect to the CPI,
- Track the trend inflation well
- Be stable in terms of both levels and first differences.

The final choices made using these criteria are visible in figure 17. The 3 core series are relatively different and hence a problem of recommending a single indicator comes up. It seems that the mean trimmed according to the distance from the center of the distribution is not a very good candidate since it differs only marginally from the CPI and does not offer a particularly good insight into the future developments of the CPI. Not surprisingly, this series scores very low on the stability criterion (see figures 15 and 16).

On the other hand, the mean trimmed according to price stability might be too far away from the actual CPI, to be accepted as a good core inflation indicator. The mean suggests a falling inflation trend during last couple of months while many other credible indicators of inflation processes in Ukraine suggest otherwise.

Undoubtedly the best candidate is the ordinary trimmed mean with parameters very close to the median (or the 47^{th} percentile). It is relatively smooth and seems to have coped very well with reducing short-term volatility and staying relatively close to the CPI.

It has to be mentioned that while ordinary trimmed means are used by many central banks (e.g. Bank of England, National Bank of Poland), the other types of trimmed means, and particularly, the means trimmed according to deviation from the CPI, have not been used officially, to the best of our knowledge, in any central bank. Thus, if the National Bank of Ukraine decides to introduce core inflation to its official indicators, for practical reasons, it might

be easier to start with ordinary trimmed means. Furthermore, all of the trimmed means used at central banks are symmetric means, even though some authors (Marques et al. 2000, Wozniak 2001) suggest that asymmetric trimmed means might be more efficient. For simplicity, we might suggest that the trimmed mean, instead of parameters (92,47), (88, 48) or (100,49) might be also calculated with the simpler parameters to produce a very similar result: asymmetry =50 and the total trim close to 100. The most intuitive choice is the median (100,50) or symmetric trimmed mean [with parameters] (90, 50). The former indicator has been calculated and actively used as a core inflation measure at the Bank of Canada and the National Bank of Poland.

Another core inflation indicator which is widely applied by central banks is exclusion-based mean. Its different modifications are used in USA, Poland, EU and others. Figure 14 presents best choice of this indicator for Ukraine. Although none of them fulfill UAE criterion, they are quite stable and track the inflation trend pretty good (Figures 15, 16). Their visual analysis evidence that they might be useful for the NBU as well.

Summing up we have to conclude, that the somewhat surprising, or even disappointing, results might be due to several factors. The most important, in our opinion is the dataset used for our analysis. As was mentioned in section 3.1, our dataset contains 85 individual components, of which the last is a residual category introduced to ensure that the weighted average of the dataset equals the CPI. Visual inspection of this component indicates that it is one of the most volatile components of the entire basket. Thus, it gets eliminated very often in the processes of applying all the component-blind methods (i.e. all methods except for the exclusion-based method), leaving the basket without the important "stabilizing" element. This might be one of the reasons why the resulting core inflation series seem rather chaotic, volatile or far away from the actual CPI.

Another possible reason is that the length of the analyzed sample is far too short for cointegration analysis to be credible. Since the UAE criterion checks for unbiasedness and the presence of the error correction mechanism, it refers to long-term processes. However, our analysis is based on a mere 58 observations, far too few to justify using such an approach.

Therefore, research on this important issue needs to be continued and refined. Nonetheless, our current results, which we view as a first research-based recommendation in the area of alternative inflation measures in Ukraine, deserve closer attention of the NBU. We think that the core inflation series indicated by the analysis, constitute a very good alternative to conventional inflation measures, and is implemented by the NBU, they will undoubtedly improve understanding of inflationary processes in Ukraine and facilitate their control.

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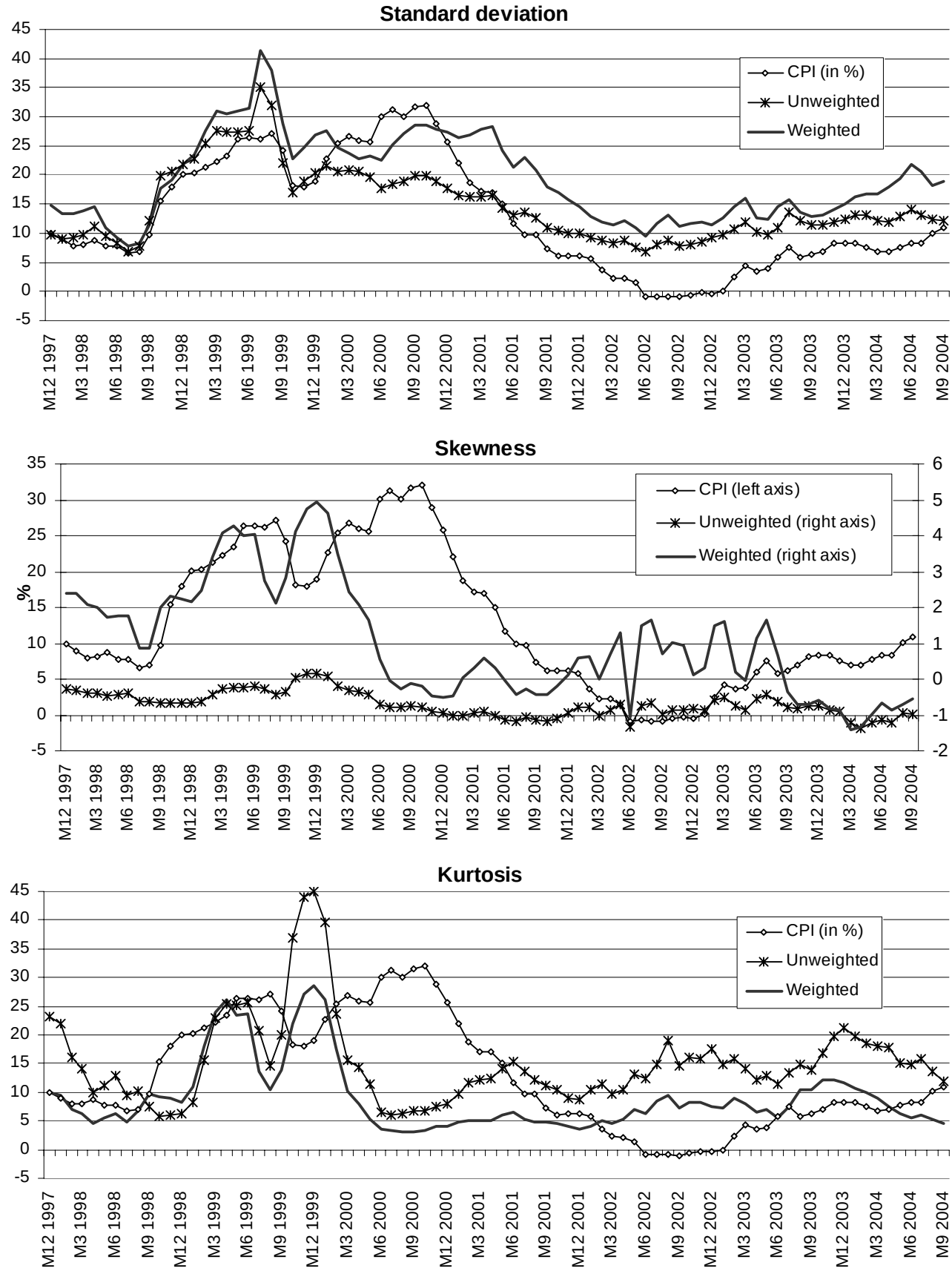
Figure 1. Descriptive statistics of disaggregated distributions of Ukrainian annual CPI data (78 components)



Source: own calculations based on data from the Ukrainian Statistical Office

Figure 7. Optimal ordinary trimmed mean and the CPI

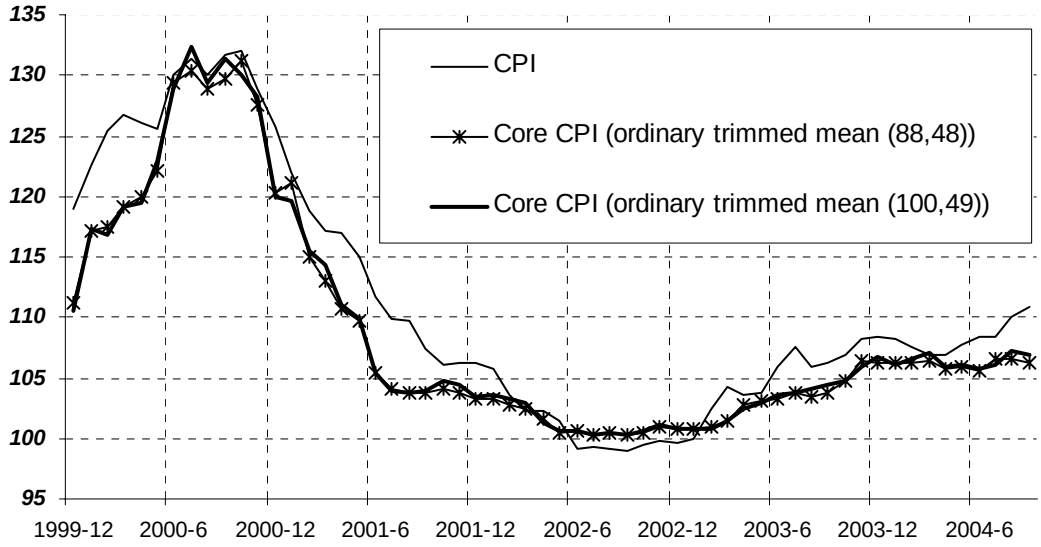
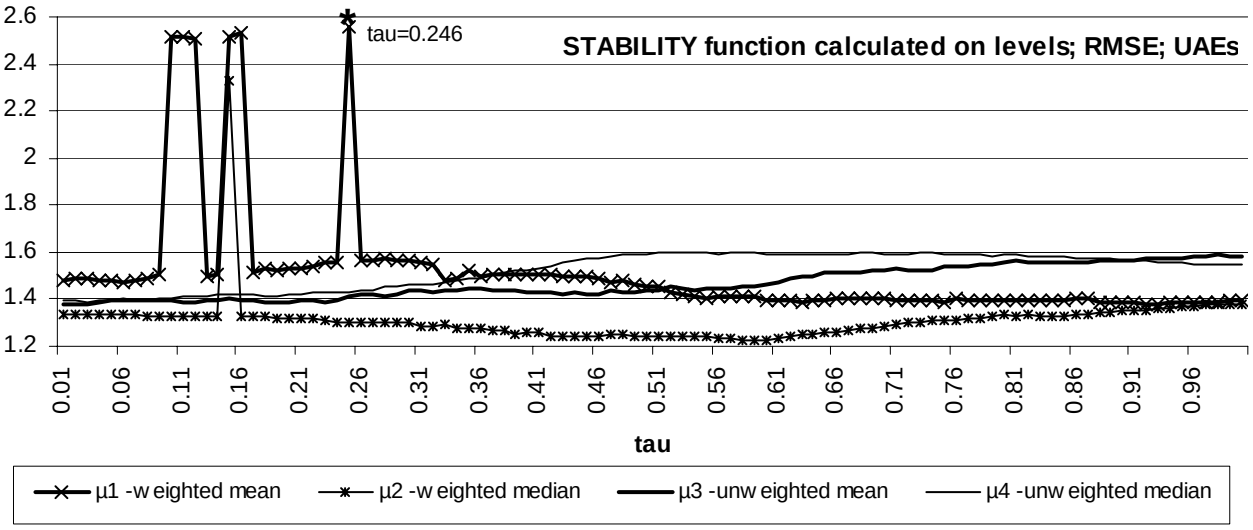


Figure 8. Final evaluation of means trimmed according to the distance from the center of the distribution



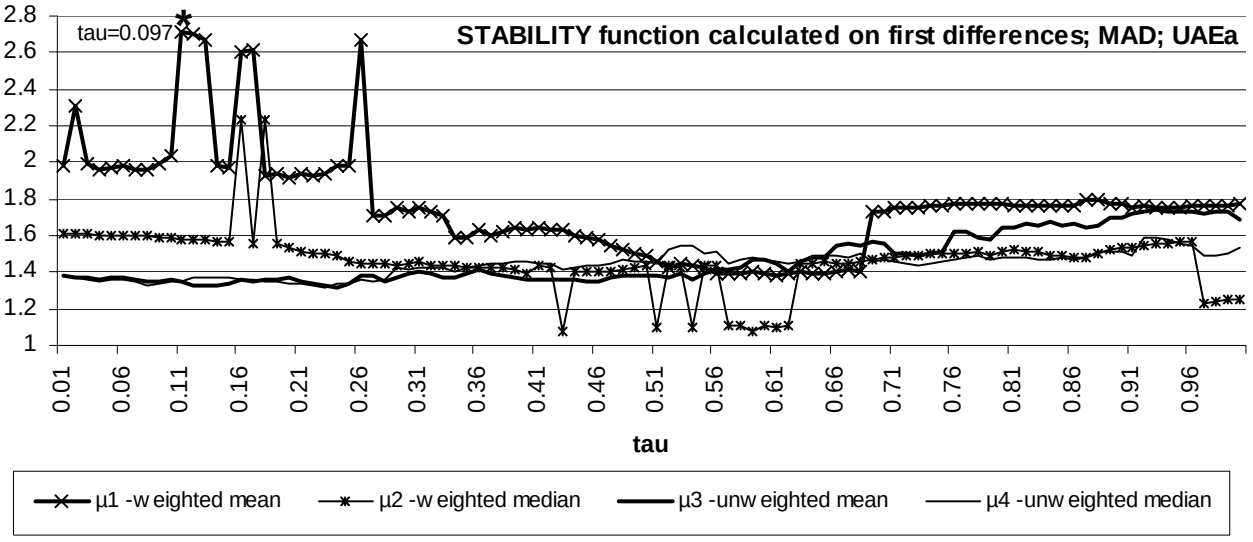


Figure 9. Optimal trimmed means according to the distance from the center of the distribution and the CPI

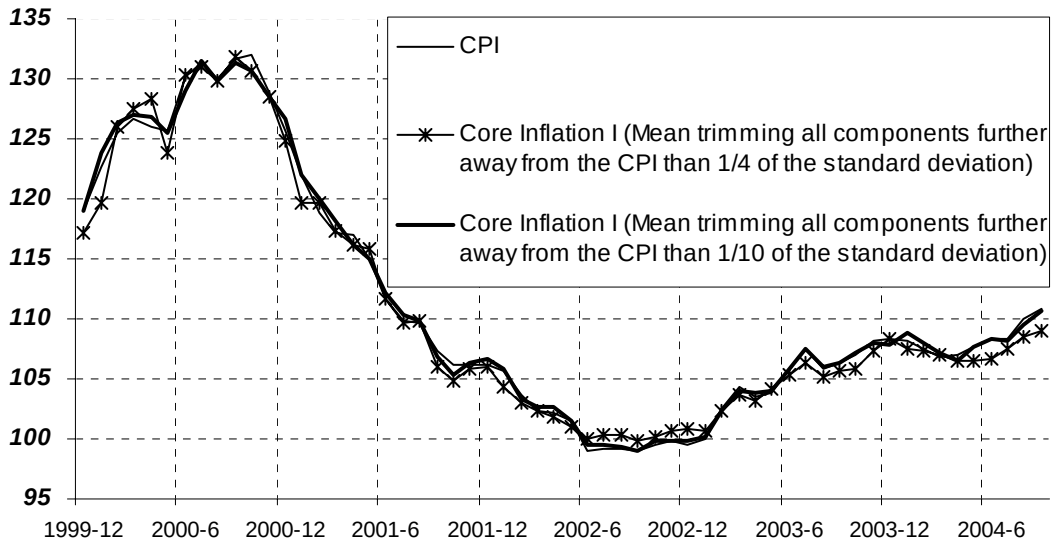


Figure 11. Optimal trimmed mean according to price stability and the CPI

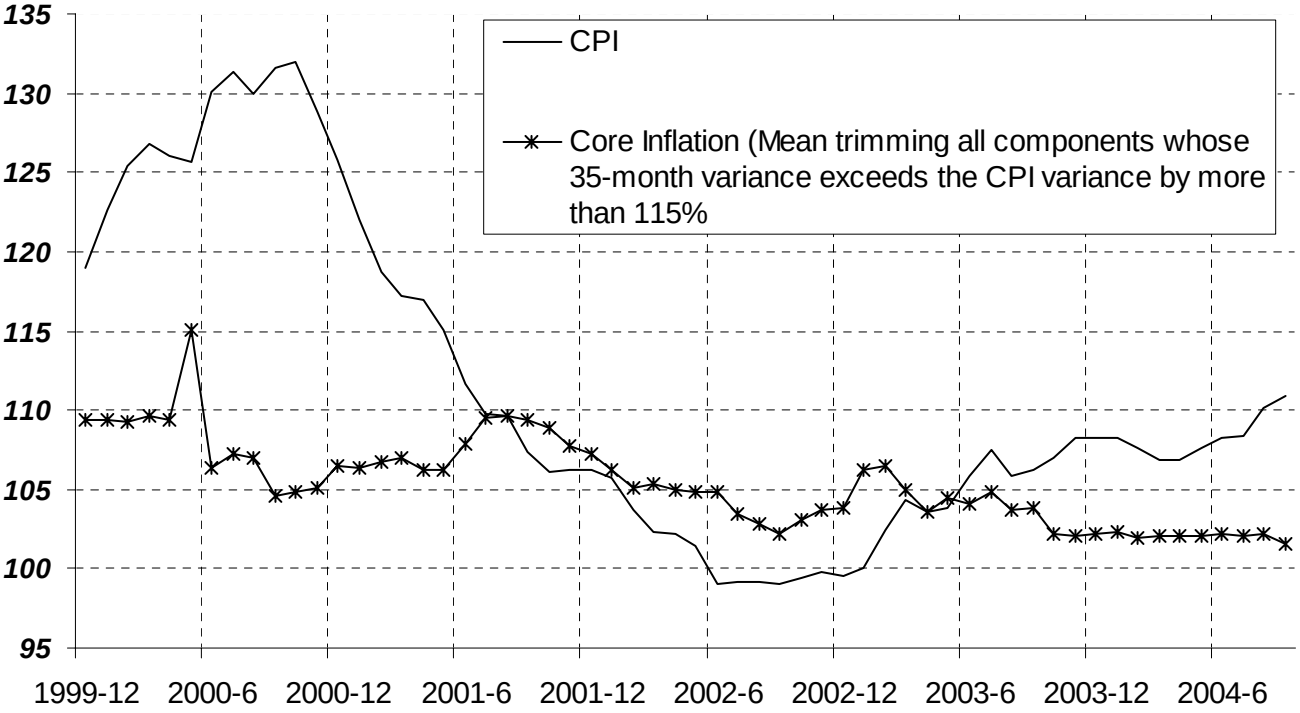


Figure 12. Final evaluation of variance-weighted means

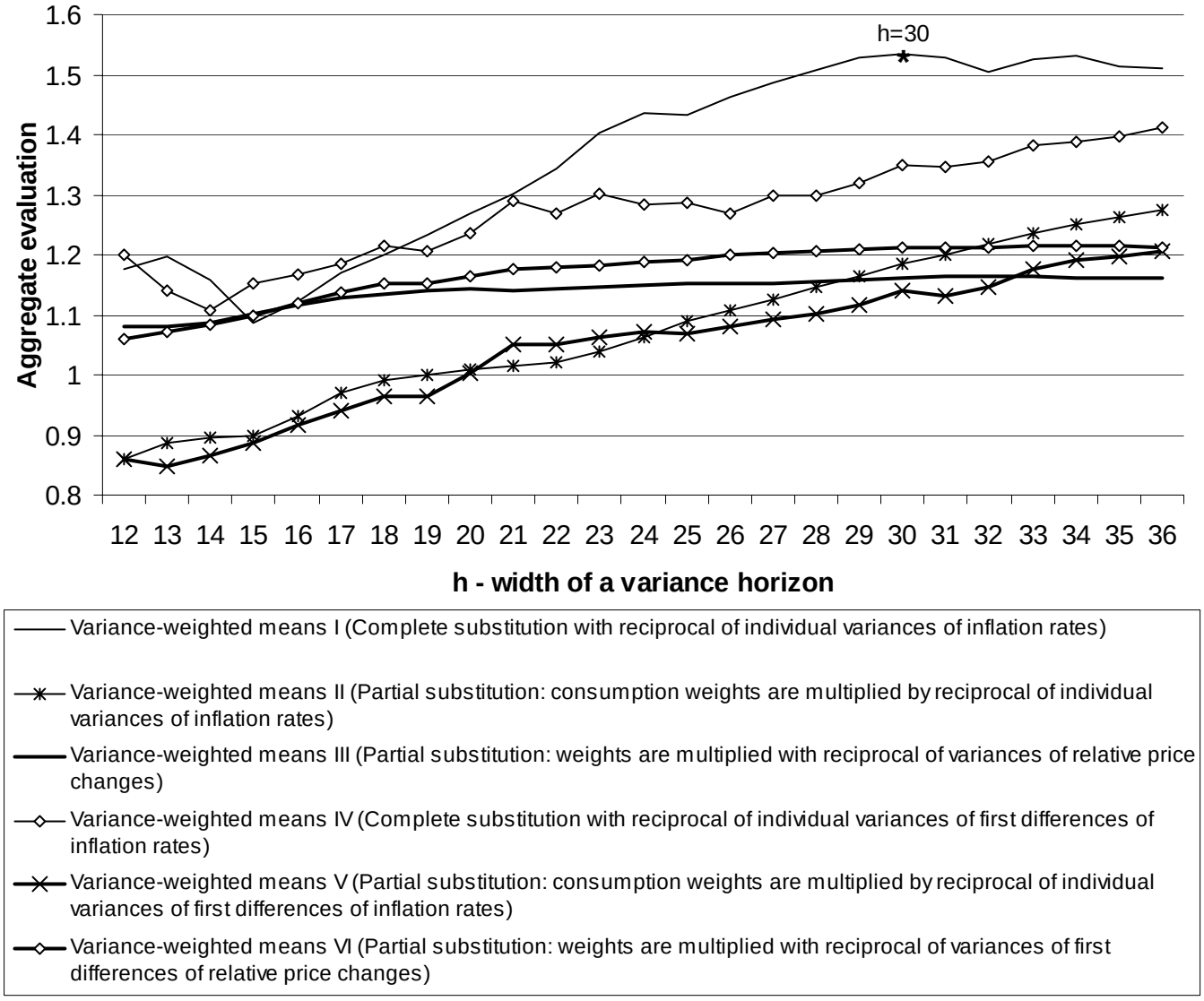


Figure 13. Optimal variance-weighted means and the CPI

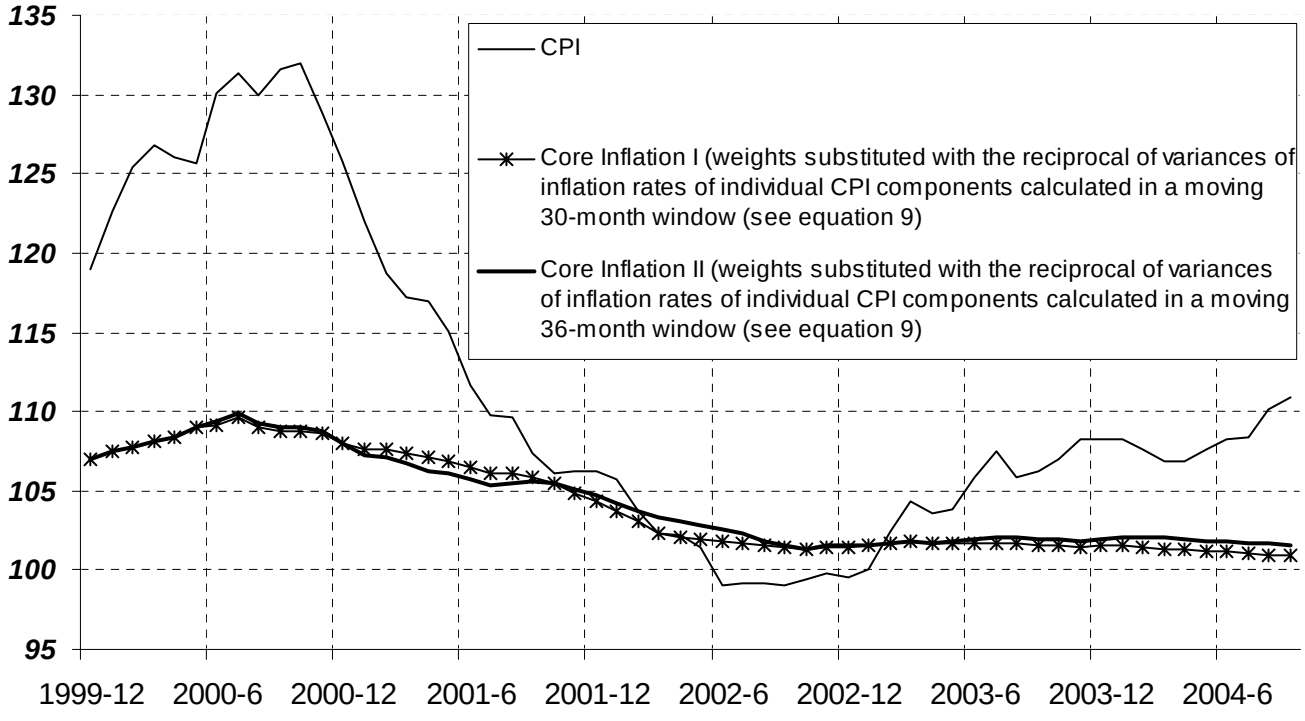


Figure 14. Optimal exclusion-based means and the CPI

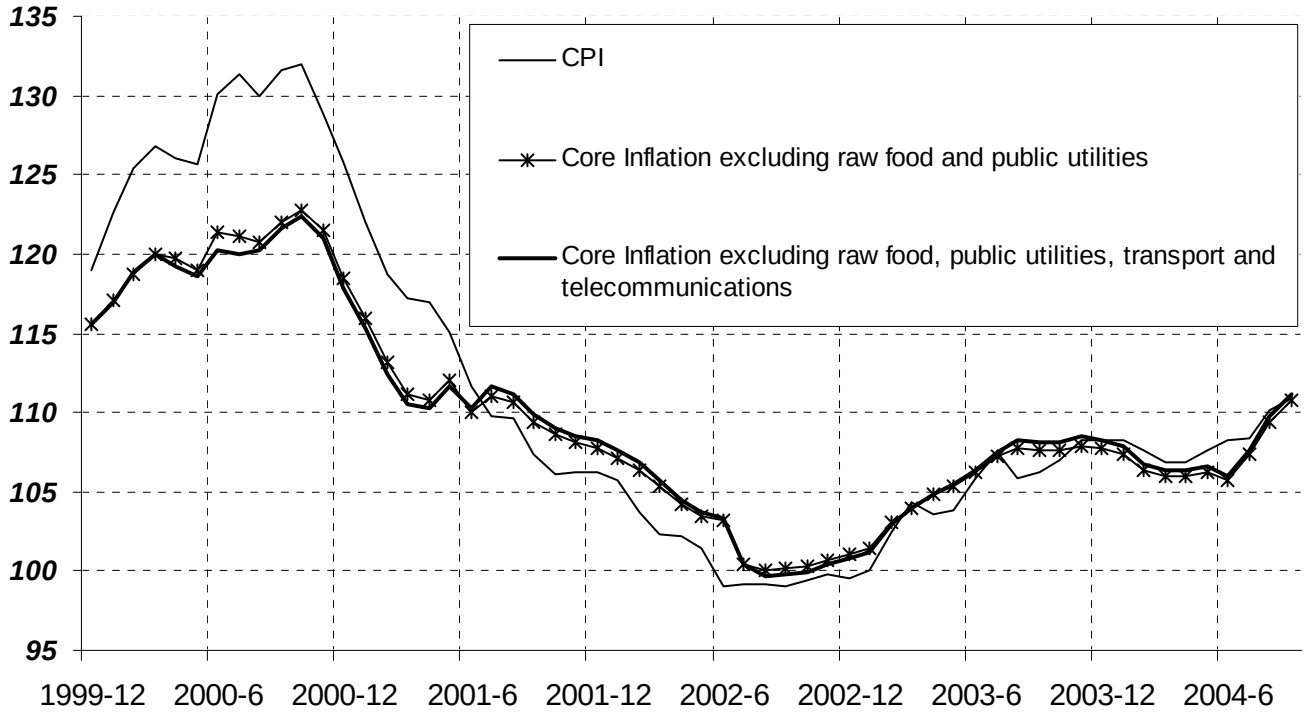
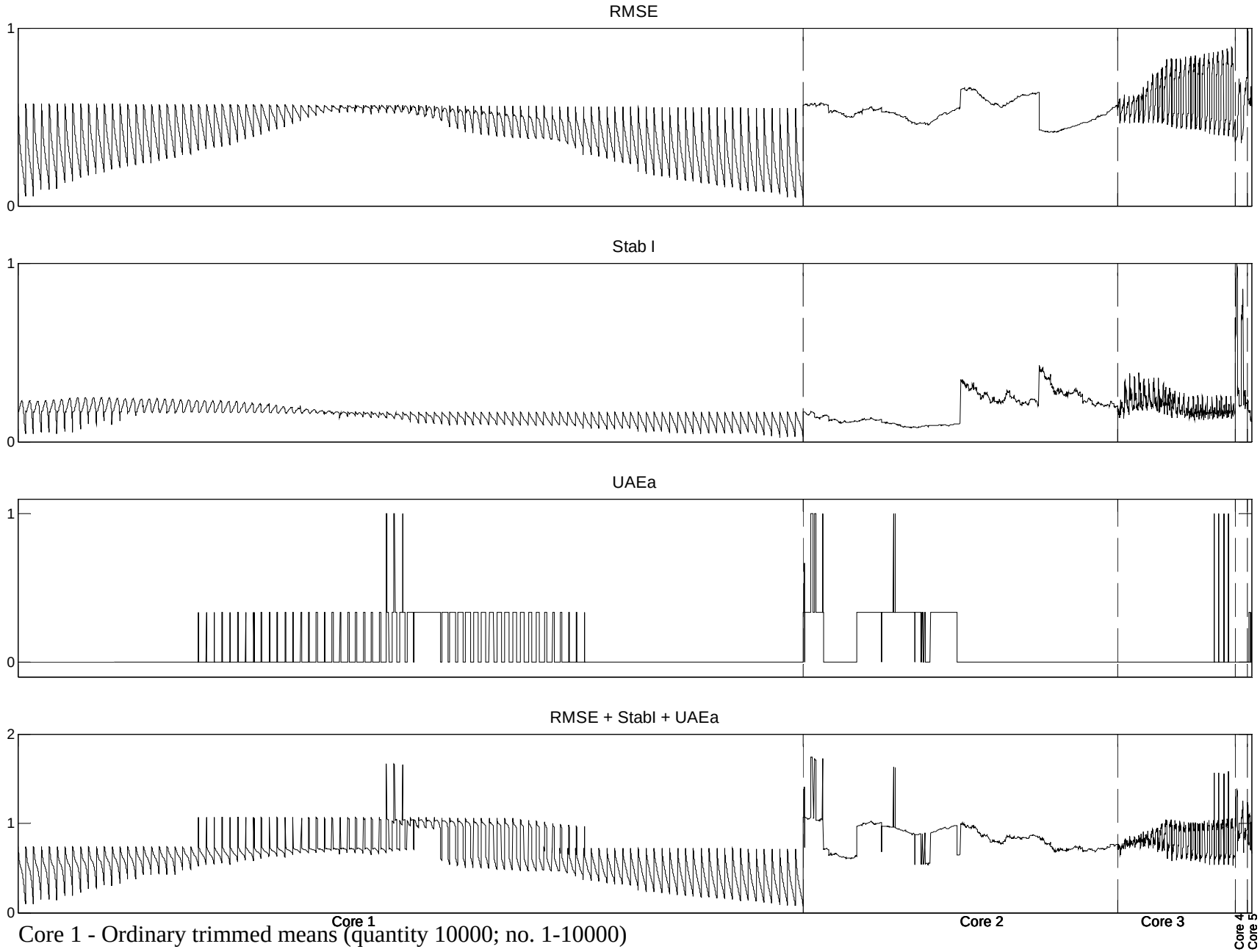
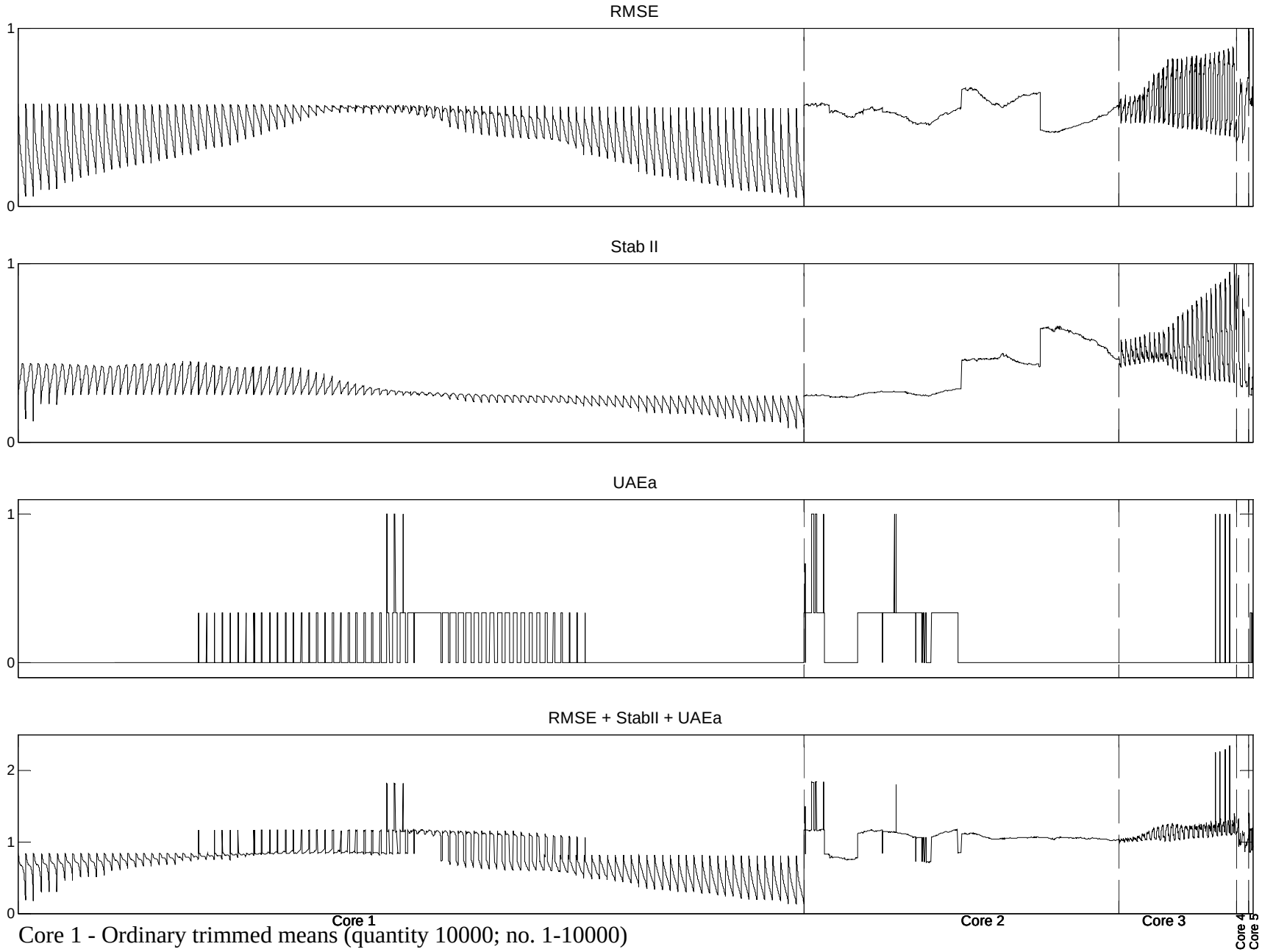


Figure 15. Final evaluation of pooled core inflation indicators using RMSE, Stab I and UAEa



Core 1 - Ordinary trimmed means (quantity 10000; no. 1-10000)
Core 2 - Means trimmed according to the distance from the center of the distribution (quantity 4000; no. 10001-14000)
Core 3 - Means trimmed according to price stability (quantity 1500; no. 14001-15500)
Core 4 - Variance-weighted means (quantity 150; no. 15501-15650)
Core 5 - Exclusion-based means (quantity 56, no. 15650-15706)

Figure 16. Final evaluation of pooled core inflation indicators using RMSE, Stab II and UAEa



Core 1 - Ordinary trimmed means (quantity 10000; no. 1-10000)
Core 2 - Means trimmed according to the distance from the center of the distribution (quantity 4000; no. 10001-14000)
Core 3 - Means trimmed according to price stability (quantity 1500; no. 14001-15500)
Core 4 - Variance-weighted means (quantity 150; no. 15501-15650)
Core 5 - Exclusion-based means (quantity 56, no. 15650-15706)

Figure 17. Optimal Core Inflation Indicators for Ukraine.

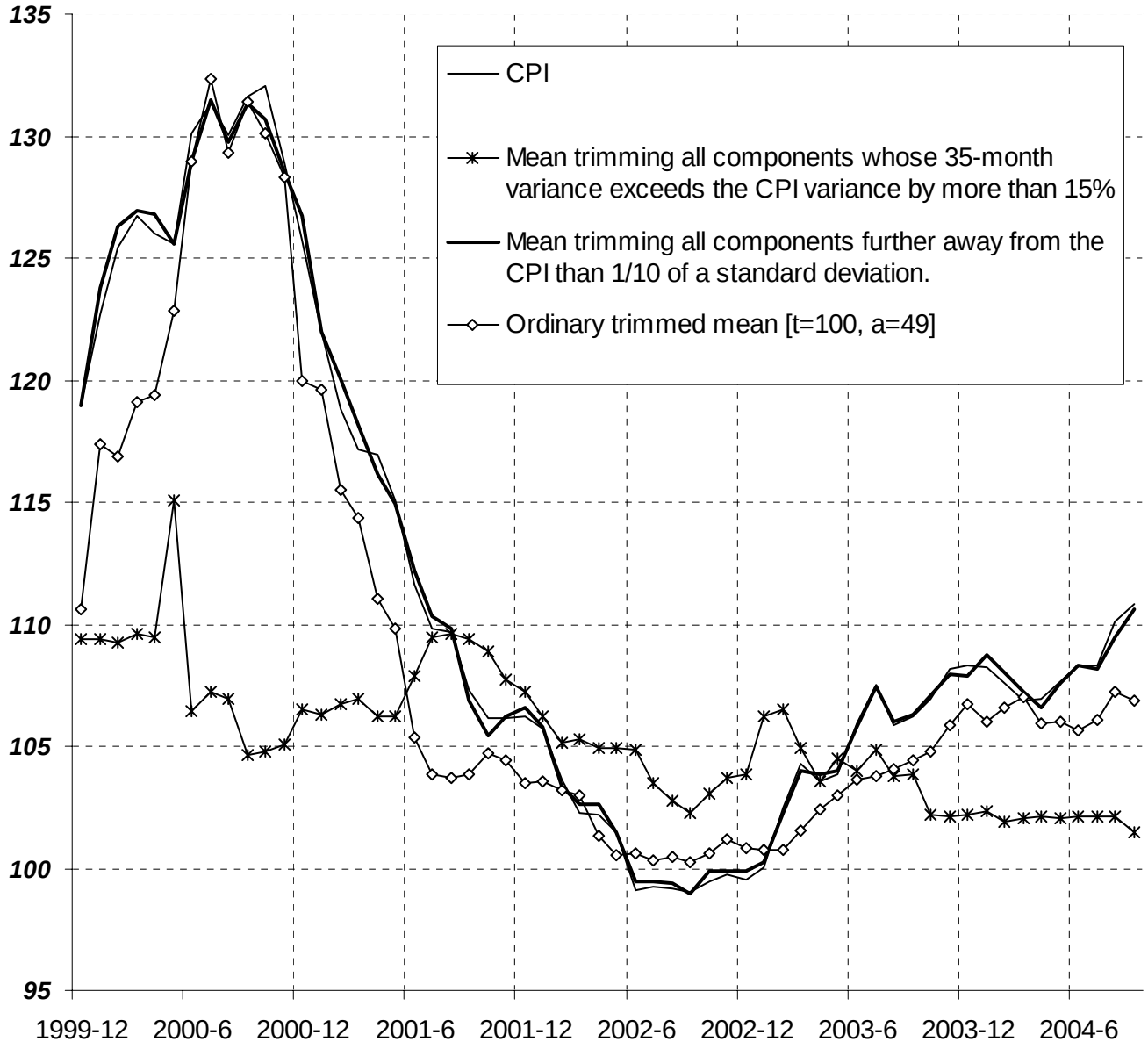


Table 1. Final evaluation of core inflation indicators

Deviation Function	**RMSE**		**MAD**	
Stability Function	Stab I (levels)	Stab II (first diff)	Stab I (levels)	Stab II (first diff)
UAE criterion form	**Standard**			
Ordinary trimmed means (see 4.2)				
Value of the evaluation index	2.47	2.57	2.44	2.54
Total Trim (t)	88	92	88	100
Asymmetry parameter (a)	48	47	48	49
Means trimmed according to deviation from the center of the distribution (see 4.3)				
Value of the evaluation index	2.76	2.57	2.72	2.55
Defintion of the center	Weighted average of the distribution (CPI)			
Parameter *k*	10	25	10	25
Means trimmed according to price stability (see 4.4)				
Value of the evaluation index	1.92	2.40	1.93	2.42
Argument of the stability function	First differences			
Parameter τ	1.15			
Width of the time horizon *t*	35			
Variance-weighted means (see 4.5)				
Value of the evaluation index	1.53	1.54	1.47	1.48
Alternative weighting type	Substitution of consumption weights with reciprocal of variance			
Argument of variance	Levels			
Width of the time horizon *t*	30	36	34	36
Exclusion-based means (see 4.6)				
Value of the evaluation index	2	1.97	2	1.98
Excluded aggregates	raw food, public utilities	raw food, public utilities, transport, telecommunication	raw food, public utilities	raw food, public utilities, transport, telecommunication
CORE INFLATION POOL (see 4.7)				
Value of the evaluation index	1.75	2.35	1.78	2.39
Type	**Mean trimmed according to deviation from the center of the distribution**	**Mean trimmed according to price stability**	**Mean trimmed according to deviation from the center of the distribution**	**Mean trimmed according to price stability**
Description	Eliminates all components that are further away from the weighted mean of the distribution (aggregate CPI) than 1/10 of the standard deviation of that distribution	Eliminates all components whose variance (measured for first differences) exceeds that of the aggregate CPI by more than 15%	Eliminates all components that are further away from the weighted mean of the distribution (aggregate CPI) than 1/10 of the standard deviation of that distribution	Eliminates all components whose variance (measured for first differences) exceeds that of the aggregate CPI by more than 15%

Figure 2. Cumulated empirical distribution of annual price changes of CPI components

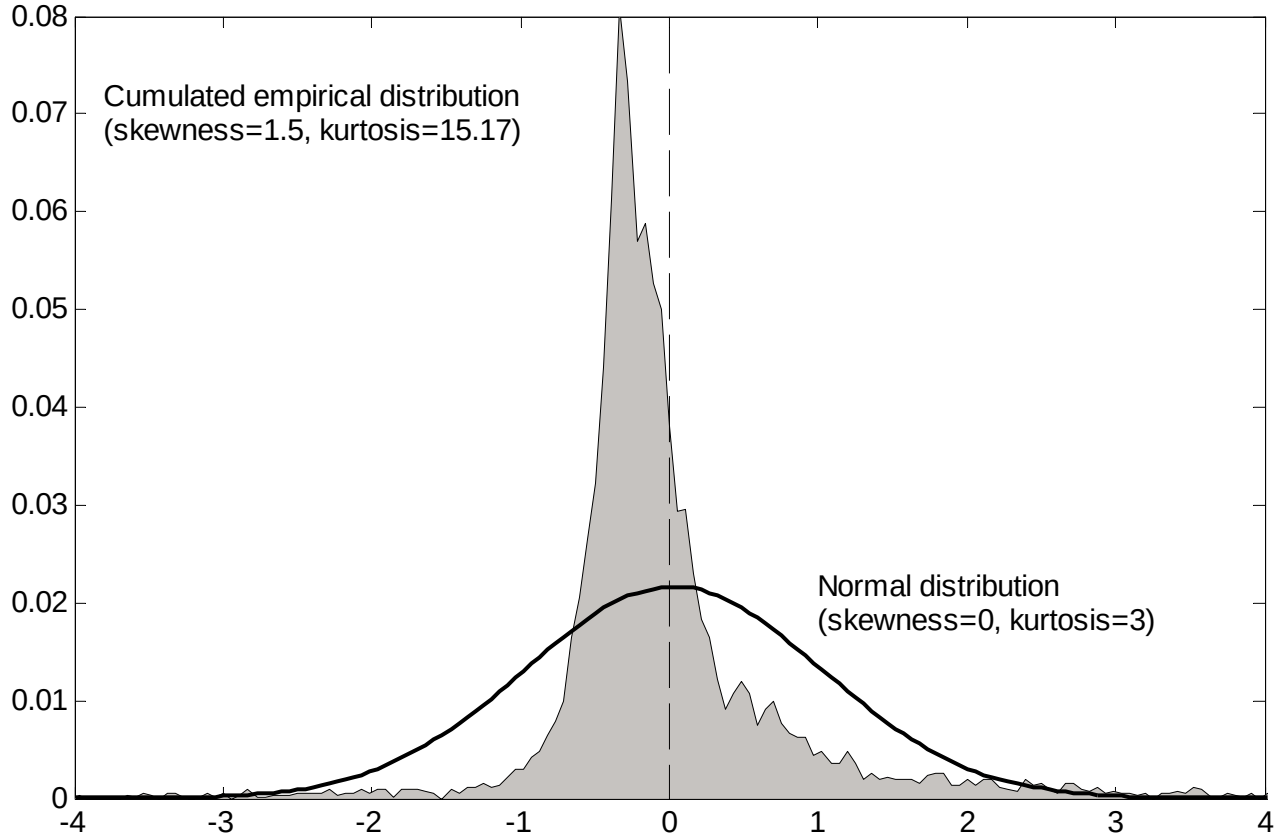


Figure 3. Ordinary trimmed means satisfying the UAE criterion

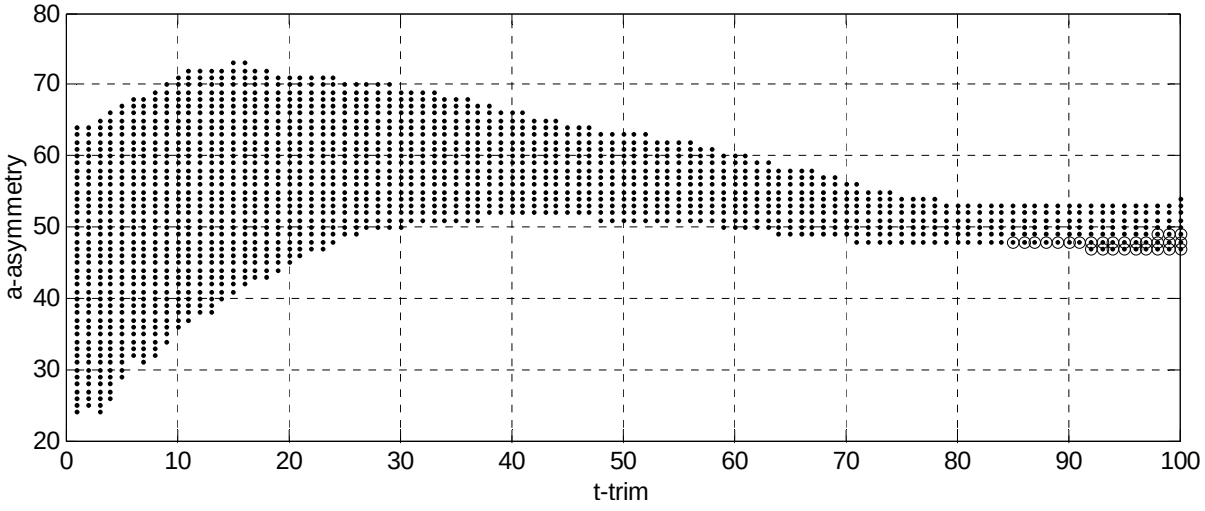


Figure 4. Trimmed means according to the deviation from the trend criterion

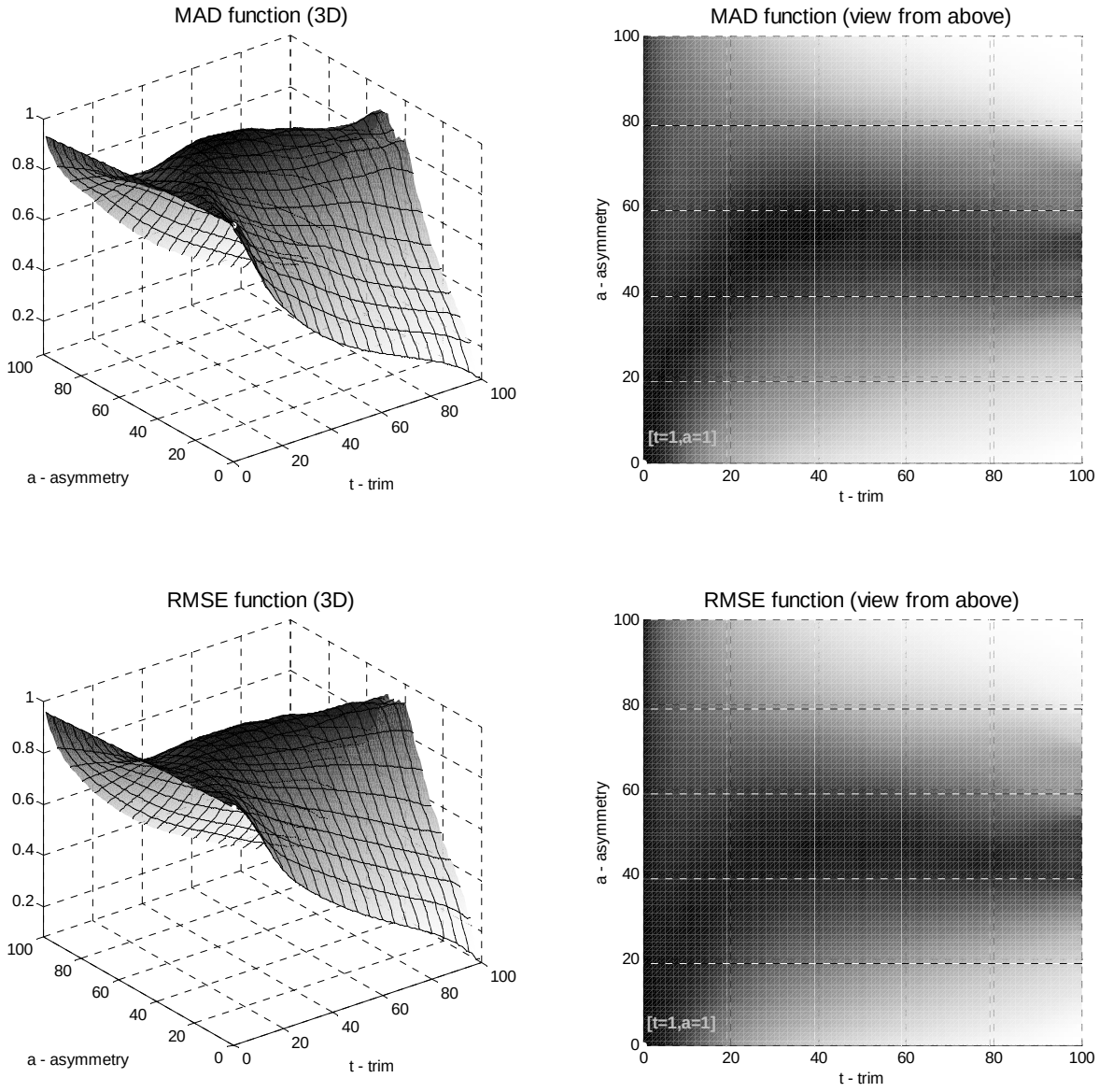
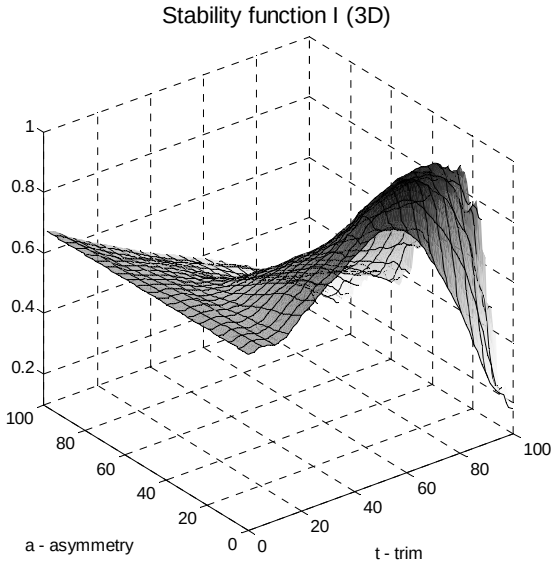
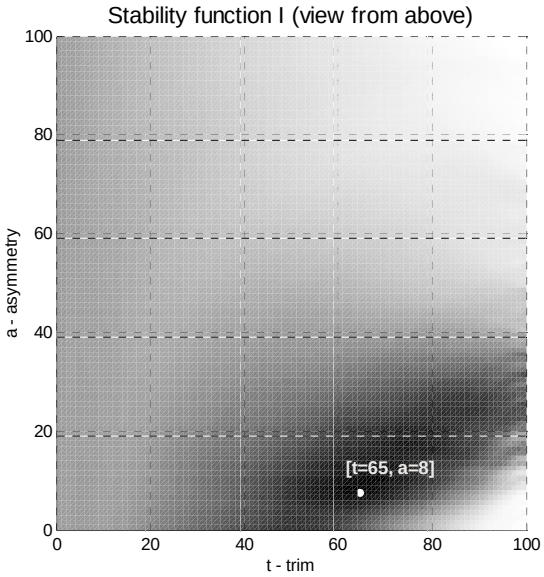
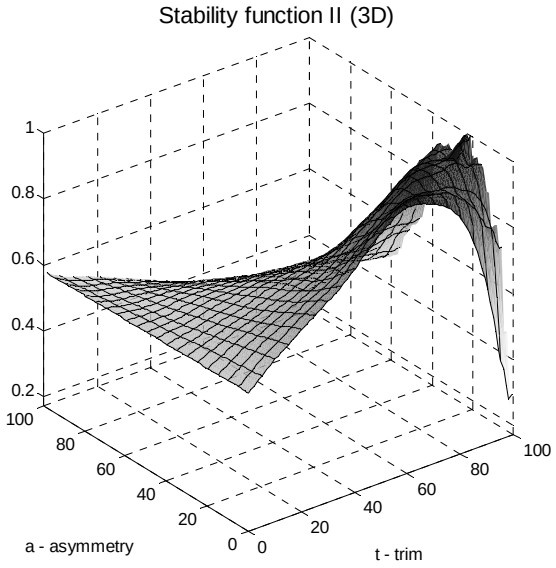


Figure 5. Ordinary trimmed means evaluated according to the stability criterion







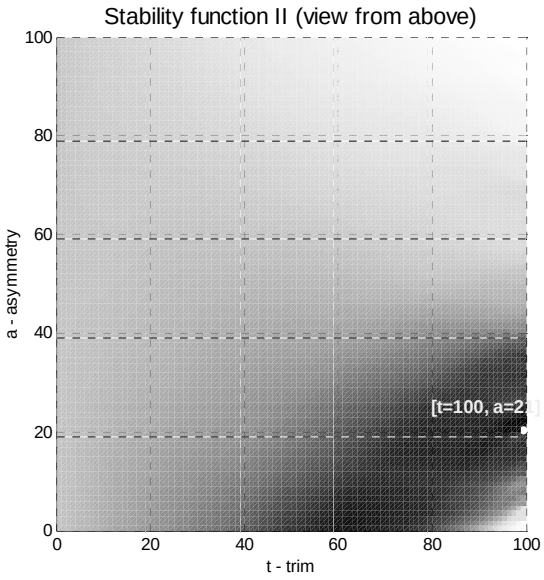
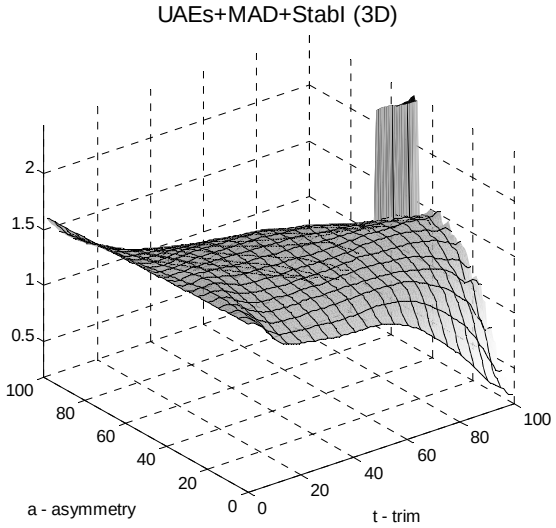
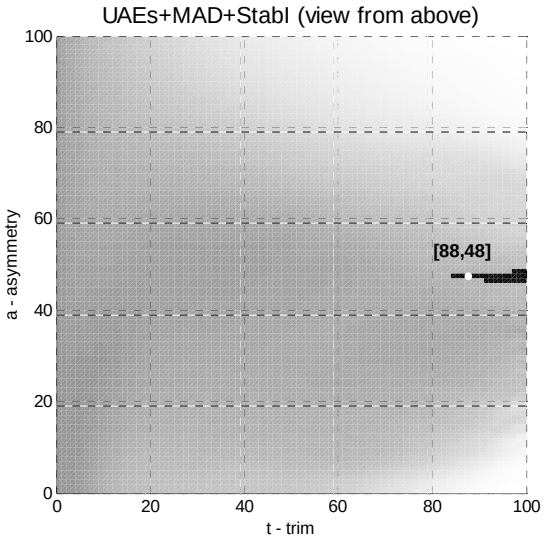
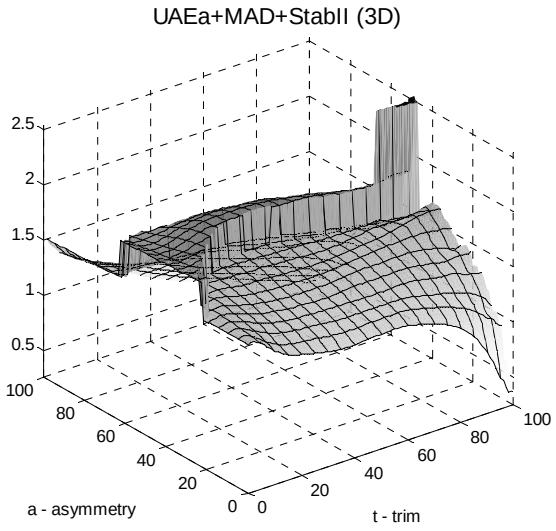


Figure 6. Final evaluation of ordinary trimmed means







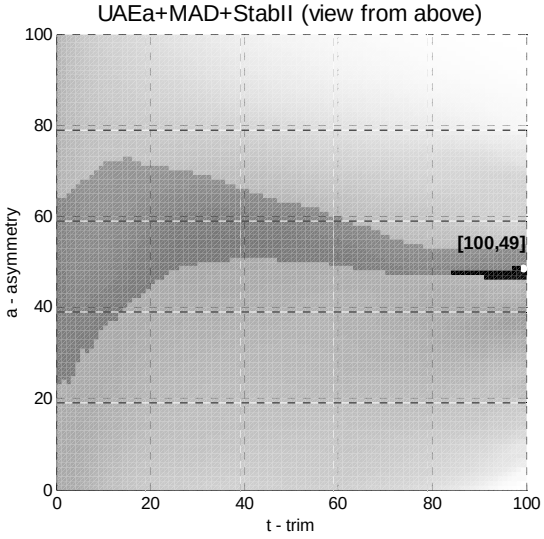
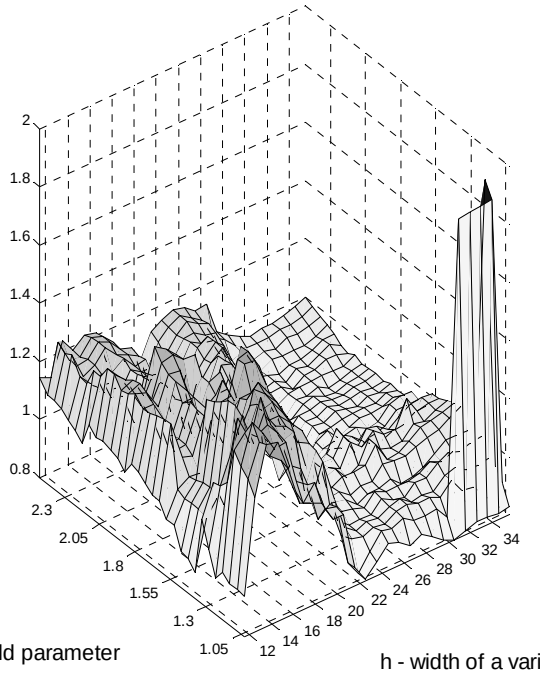


Figure 10. Final evaluation of means trimmed according to price stability

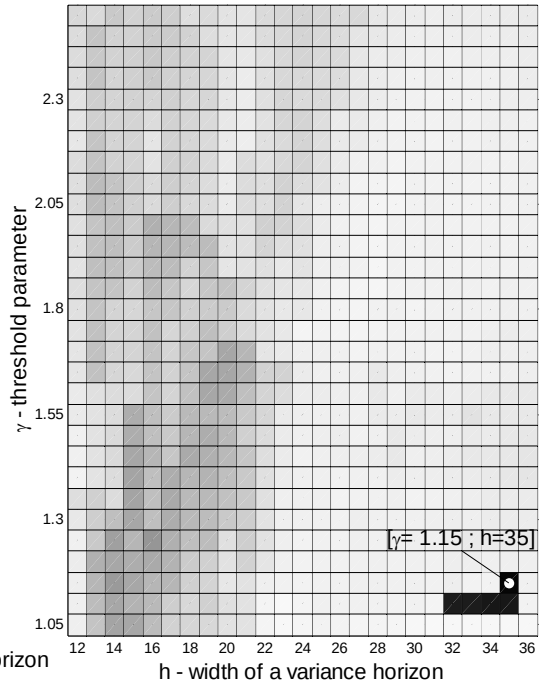
Final evaluation: UAEs;MAD;Stab I (3D)



γ - threshold parameter

h - width of a variance horizon

Final evaluation: UAEs;MAD;Stab I (view from above)



Monetary Transmission Research in Europe: Lessons for Ukraine

Wojciech Paczynski[1*]

Abstract

This paper reviews approaches to thinking about monetary policy transmission and discusses some of the results from empirical work focusing on European countries, in particular those on European transition economies. It then proceeds to formulating suggestions concerning challenges for monetary transmission research in Ukraine. It claims that the monetary policy framework in Ukraine will need to change in view of country's increasing opening to global markets and that proper understanding of the strength and lags of monetary transmission is important for guiding a decision on future monetary policy regime – be it based on some form of fixed exchange rate or based on free floating currency with central bank pursuing the goal of price stability.

1. Introduction

The term 'transmission mechanism of the monetary policy' is applied to the whole process in which central bank's monetary policy actions affect macroeconomic variables such as economic activity and price developments. Given the perceived rising importance of monetary policy in promoting sustainable growth and stability of economies (Mishkin, 1996) the recent years saw an intensification of efforts to understand, describe and draw policy relevant lessons from the nature of monetary transmission processes.

This effort has clearly resulted in better understanding of the broad features of the monetary transmission, though it should be stressed that complexity of the process, differences between countries and instability of the relationships over time all result in there being no unique and undisputed view of all the aspects involved (ECB, 2004).

This paper aims at providing an overview of recent monetary transmission research in Europe that is then used to pose some open questions concerning the future of related work on Ukrainian economy. Section two sketches the analytical framework that is most commonly used in the analysis of monetary transmission process. Next section discusses some institutional features that affect the nature of the transmission process itself and analytical approaches to it. A quick guide to empirical strategies and typical results they produce in other countries can be found in section four. Concluding section offers a view on the research agenda for Ukraine that draws from the experience of work on other European economies and from specific features of the Ukrainian economy.

2. Steps and channels of monetary transmission

Since the interactions between monetary policy decisions and the behaviour of various macroeconomic variables are very complex, it is useful to organise the discussion by introducing some classifications and structure. For simplicity of the exposition we assume

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here that a major tool of the monetary policy is setting the official interest rates (which is true in countries with floating exchange rates; in an environment of the fixed exchange rate regime monetary authorities' ability to impact interest rates is limited; rates are normally determined by the developments in an economy using a currency that serves as an anchor of the peg). One important classification (cf. Bank of England, 1999) distinguishes two steps in which the monetary policy operates:

- from a change in official interest rates to financial and assets markets
- from financial markets to the spending behaviour of firms and households

Another popular classification distinguishes the following mechanisms ('channels') of impact of monetary policy (one should keep in mind that there are obvious interrelationships between them):

- The interest rate channel. The most straightforward effect is that changes of official interest rates directly impact other short-term interest rates and consequently also costs of borrowing along the yield curve. This clearly has an impact on the savings / investment / consumption decisions and thus on short-term output growth rate. Also, changes in the yield curve affect wealth of economic agents (e.g. via stock and real estate prices). Furthermore, these changes in the demand affect the supply demand equilibrium and thus also feed to prices. A standard relationship is that an increase in official interest rates dampens output and (possibly with a longer lag) reduces inflationary pressures.

- The exchange rate channel. Interest rate changes may impact on the nominal and/or real exchange rate, which in turn directly impacts on prices in the economy. Also it may impact on relative demand/supply of domestically produced versus foreign goods and thirdly it may affect the wealth of economic agents.

- The expectations channel. Surprise monetary policy decisions may impact on economic agents' expectations about future price and output developments and thus also on agents' behaviour.

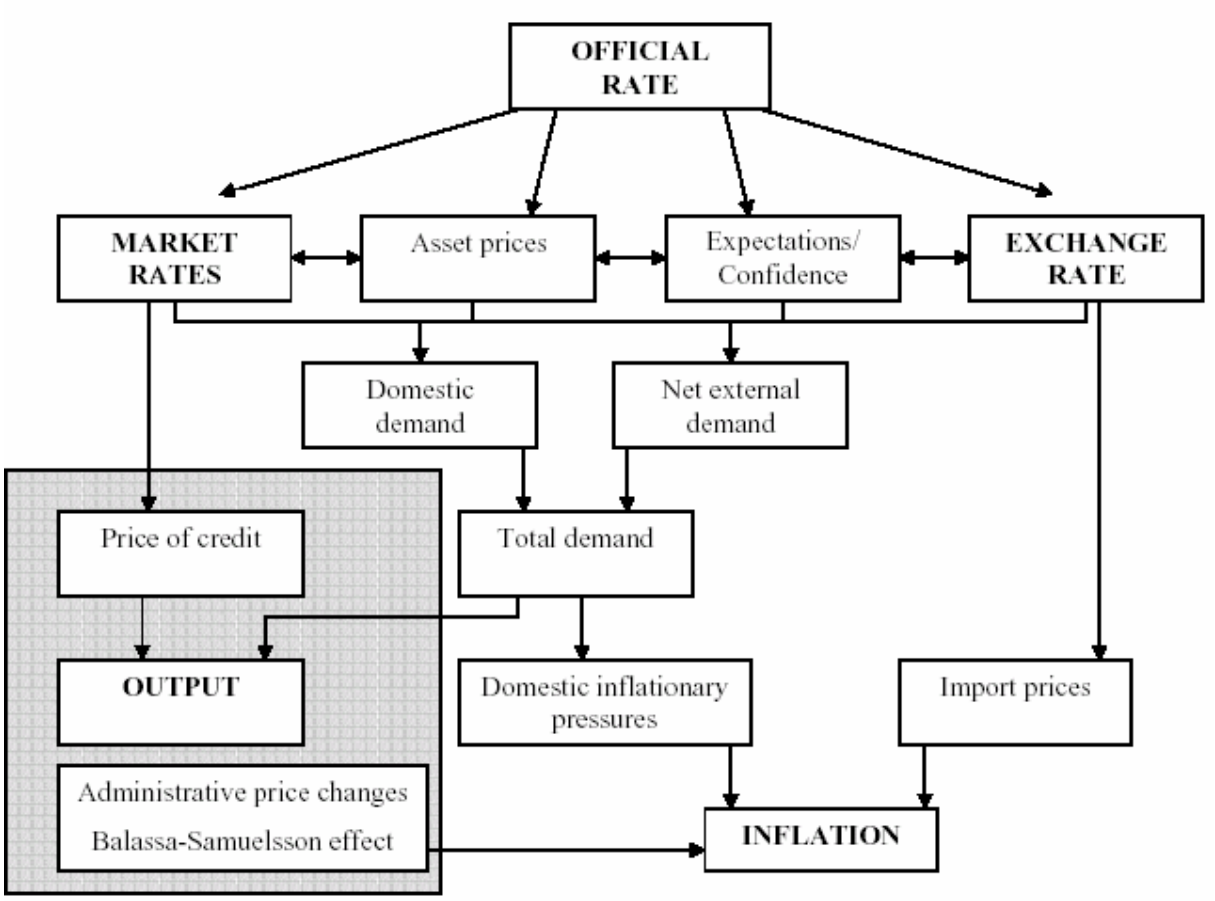
- The credit channel. Banks' propensity to provide capital may be altered by monetary policy decisions beyond the simple augmentation of the interest rates. This is because, in some cases, interest rates moves may not clear the market so that quantity of credit may matter on top of the prices of credit. Monetary tightening may make some banks facing capital constraints thus forcing them to adjust lending more sharply than it would otherwise be needed. On the other hand, some firms may find it harder to obtain credit after monetary tightening due to balance sheet effects – e.g. change in cash flows and changes in prices of assets that can be used as collateral.

While such classifications (the one given above is not unique – e.g. 'expectation channel' is not always treated separately, some authors also distinguish the 'asset prices channel' with regard to assets ranging from currencies to bonds, real estate, stocks, etc.) are useful in organising the discussion, it is often difficult to clearly distinguish between channels and it is usually even more difficult to asses relative importance of channels.

The traditional treatment of the interest rate channel usually abstracts from the effects of interest rate changes on agents' expectations and also on the price on currencies and other assets. The underlying theory is based on the assumptions that central banks have some

influence on the real interest rates and not only nominal rates and secondly, that components of aggregate demand are interest sensitive (Juks, 2004).

Figure 1. **The transmission mechanism of monetary policy – a simplified view**



Note: Only the most important interactions between variables are shown.
Source: Excerpted from Ganev et al (2001). Based on Bank of England (1999). Compare also ECB (2004).

While the manipulation of monetary policy instruments (such as official interest rates) clearly is the major tool of conducting monetary policy and most empirical studies concentrate on the analysis of their impact, there are also other less formalised methods of exerting impact on financial markets and consequently possibly also on investment and consumption decisions. The most important of these is probably control of and manipulation of information, e.g. issuing news to market participants that impact on their expectations of future policy actions. Examples of such news include any central bankers' comments on the expected/intended ERM II accession dates in non-euro EU member states, comments on the possibility of corrections to the whole monetary policy regime, comments on the exchange rate trends (in countries where central banks occasionally intervene in the forex market), comments on inflation forecasts (in countries where central banks are focused on price developments).

3. Monetary policy regimes, institutional arrangements and the scope for monetary policy

Clearly, the nature of the transmission mechanism is crucially affected by the monetary policy regime (Mayes, 2004b). In the world of liberalised capital account central banks can control the price of money (interest rates) or the quantities of money provided or, alternatively, the

exchange rate of the domestic currency, or some combinations thereof. In a (credible) fixed exchange rate regime with full convertibility of the currency the central bank effectively looses the control on interest rates and money creation. Since domestic and anchor currencies are fully exchangeable, domestic interest rates should follow the rates in the anchor currency with some (possibly time varying) risk premium. However, one should keep in mind that even in a floating exchange rate system, the ability of small open economies to set interest rates fully independently is limited by the impact of external factors (Dąbrowski, 2002) and it is not a coincidence that we typically observe co-movements in interest rates in world economies. Indeed, as noted by Mayes (2004a): 'Inside or outside a monetary union small countries simply have to accept the monetary decisions that relate to the needs of the larger countries and work out a strategy for adapting to them with a minimum of real cost to their citizens. The scope for running a divergent monetary policy despite different domestic shocks and requirements is small.' An interesting piece of empirical evidence supporting this view is provided by Frankel et al. (2002). They study the behaviour of interest rates in the large sample of developing and industrialised economies during the last three decades. The conclusion is that in the long run there is almost full transmission of international interest rates to local rates, perhaps with the exception of the largest industrialised economies (US, Japan, Germany) who are thus the only ones able to possibly adopt independent monetary policy. In the short run, exchange rate regimes appear to matter with the intuitive result that countries adopting more flexible regimes have more room of manoeuvre for (temporary) independent monetary policy since local rates adjust slower to movements in international rates. This finding is corroborated by Shambaugh (2004). The situation would look different for countries with efficient capital controls. Still, in the long run efficiency of capital control can be debatable.

The structure of the banking system and institutional arrangements surrounding it are another important elements impacting heavily on the nature of the monetary transmission process. This remains true also for highly developed economies with well developed banking and financial sectors such as EMU countries. In their study on the euro-zone, Ehrmann et al. (2003) list four aspects that could matter for monetary transmission process: the importance of state influences in determining credit flows, the prevalence of relationship lending, the size of deposit insurance guarantees, and the extent of bank networks. It is no surprise that such issues matter even more in countries with less developed financial architecture, where the importance of the 'credit channel' of transmission is usually stronger. Also, institutional arrangements turn out important in influencing the first stage of monetary transmission, i.e. from official interest rates to money market rates. In the context of the euro-zone Moschitz (2004) observes that 'the behaviour of the overnight rate depends on reserve supply, but equally important on the institutional framework for the reserve market'.

Clearly, there are other institutional and other structural characteristics of countries that can potentially crucially affect the strength and speed of transmission of monetary policy to various economic indicators of interest to policy makers. Among the usual suspects one can mention the role of capital markets as proxied e.g. by stock market capitalisation, credibility of central bank policies, and the characteristics of the labour market (nature of wage contracts, etc.). Nevertheless, it is very difficult to formulate generally binding rules as to which combinations of country characteristics affect the transmission in which way, when. For obvious reasons, the scope of heterogeneity in such matters and their impact on divergences in the transmission of monetary policy were studied at length in the run-up to the introduction of the euro (e.g. Dornbusch et al. (1998), Mihov (2001)). Recently, Jarociński (2004) compared the nature of the transmission between Central and Eastern Europe on the one side

and Western Europe on the other side to find some differences and some striking similarities in responses to monetary shocks. The results of Jarociński (2004) appear to empirically support the view that smaller financial sector on CEE countries, as compared to the euro-zone makes the economies in the first region less responsive to the monetary policy in the short-run. However, in medium- to long-term horizons, monetary policy in CEE appears to be quite effective. On a more general level, these findings illustrate the complicated nature of the links between institutional characteristics of countries and the nature of monetary policy transmission.

4. Empirical approaches to monetary transmission

There is a multiplicity of empirical approaches to monetary transmission. One could classify them into the following broad categories:

- less formalised studies using narrative, graphical and comparative arguments to make inference about the factors at play and their relative importance,
- studies using vector autoregressive (VAR) framework with relatively low data requirements and imposing relatively mild theoretical assumptions,
- studies based on small-scale structural macroeconomic models,
- studies based on large-scale structural macroeconomic models,
- studies based on microeconomic evidence on the behaviour of non-financial enterprises,
- studies based on microeconomic evidence on banks' behaviour.

4.1 Brief review of empirical literature

Rather unsurprisingly, there is a vast literature looking at the effects of the monetary policy in the US. These analyses benefit from the availability of long time series. Also, many advances in theoretical models behind monetary transmission analyses as well as empirical approaches were pioneered by researchers based in US universities. Classical references to articles reviewing the large body of monetary transmission research on the US include Leeper, Sims and Zha (1998) and Christiano, Eichenbaum and Evans (2000). Some recent advances in empirical approaches are presented in Uhlig (2001) and Bernanke et al. (2004).

The emergence of the European Central Bank and the introduction of the euro have boosted demand for better understanding of monetary transmission mechanism in the EU12. In 1999, Monetary Transmission Network was created involving ECB and euro-area central banks' economists to comprehensively study the transmission of the monetary policy in the euro-area[2]. The outcome of this work was published in the ECB working paper series (no. 91-114) and subsequently in Angeloni, Kashyap and Mojon (2003). A summary of results can also be found in Angeloni et al. (2003). Elbourne and de Haan (2004) is an example of recent work from outside the ECB.

Ganev et al (2001) contain a fairly extensive survey of papers dealing with monetary transmission in Central and Easter Europe. Some more recent results and references to other interesting work can be found in Garbuza (2003), Schmitz (2004), Jarociński (2004) and EFN (2004). A review of the work on three Baltic States can be found in Bank of Estonia (2004).

[2] For more information on Monetary Transmission Network see http://www.ecb.int/home/html/researcher_mtn.en.html.

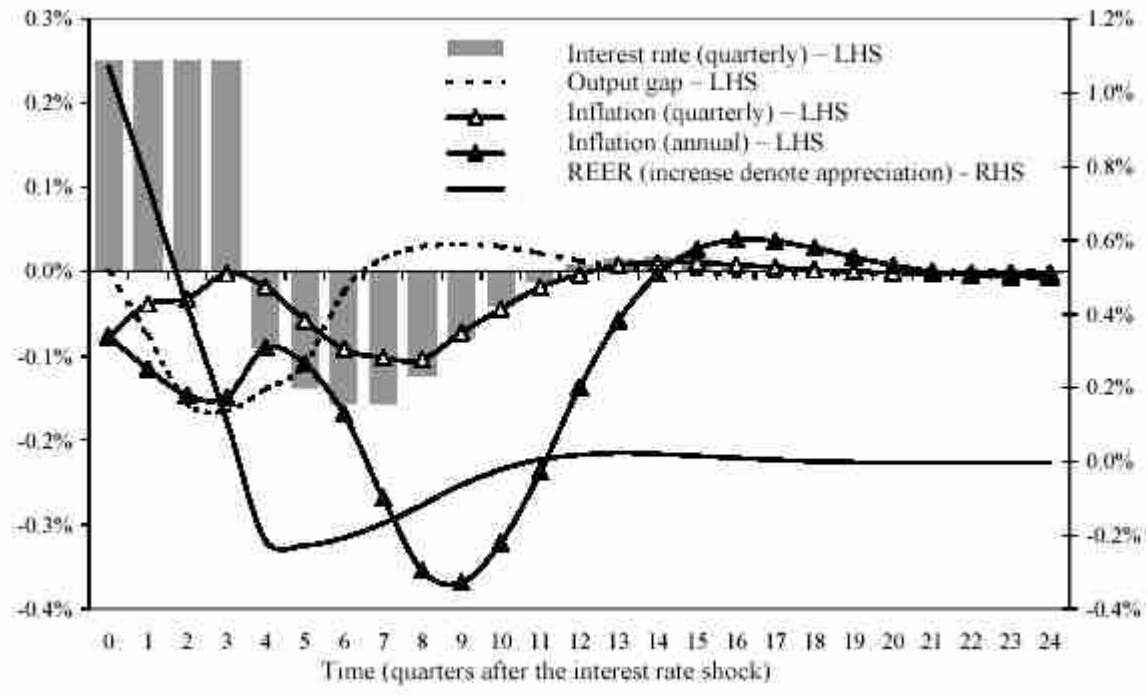
4.2 Results for Poland

This section reviews some of the results on monetary transmission in Poland and discusses the issues involved in various approaches. It is intended to give an overview of results from various strands of literature in a country where data availability is an issue. It is worth bearing in mind that throughout the analysed period Polish monetary policy regime was gradually moving towards increased exchange rate flexibility with direct inflation targeting introduced in 1999. Recent years also saw a no-interventions policy of the central bank that did not try to affect the exchange rate of the zloty by entering the forex market.

Kokoszczyński et al. (2002) review results pertaining to monetary policy transmission in the Polish economy using the variety of approaches. One set of results (see also Łyziak, 2002) is based on the small structural model motivated by the framework of Clarida, Gali and Gertler (1999). Impulse response analysis (Figure 2) reveals a rather typical pattern. Output gap falls with a strongest impact felt 3 quarters after the initial monetary policy tightening. The strongest impact on inflation materialises after some 7-9 quarters.

While these results appear realistic and in line with some evidence pertaining to other countries they should be treated as providing just a rough approximation of monetary transmission in Poland in the period up to 2001 (1994-2001 data were used to estimate the underlying model). Kokoszczyński et al. (2002) note significant changes in impulse responses to monetary policy shocks depending on the version of the model employed and data sample used to estimate the model equations. This should not be surprising given the substantial changes in the whole monetary policy framework in Poland during the last 15 years (from various forms of pegged exchange rate regime to a free float), anyway short time series used to estimate models (implying large error margins) and simplicity of the model.

Figure 2. **Impulse responses to a shock defined as an interest rate increase by 1 percentage point for one year derived using the version of National Bank of Poland's small structural model**



Source: Excerpted from Kokoszczyński et al. (2002).

Another set of results comes from analysis based on identified vector autoregressions (VARs). Such an approach requires a selection of variables included in the analysis and a selection of identification schemes (to be able to simulate orthogonal shocks in one variable – interest rate). Kokoszczyński et al. (2002) and Wróbel and Pawłowska (2002) report the results for a three and five variables VARs with identification based on Choleski decomposition motivated by the sequencing of information available to market participants and a set of a-priori assumptions on which variables can impact the other when. Given the very short sample period for this analysis it is not surprising that some of the results appear to be consistent with the 'consensus view' on monetary transmission (e.g. Leeper, Sims and Zha (1998) and Christiano, Eichenbaum and Evans (2000)) while the other appear to contradict the common wisdom. Some surprises in the results of VAR analyses are not typical for Poland only. For instance there is a substantial variation in the results for individual euro area countries as reported by Peersman and Smets (2001).

Kokoszczyński et al. (2002) as well as Wróbel and Pawłowska (2002) also report some results concerning the first step of monetary policy transmission as defined in this paper, i.e. the reaction of commercial banks' interest rates in response to central bank's rates changes. The analysis based on error correction model (ECM) using aggregate data reveal that nearly all deposit rates adjust to official rates within around 3-4 months and credit rates appear to adjust very quickly (up to 4 months – visibly faster than in the euro area). Short and quite specific sample that covered mostly a period of interest rate declines did not allow for making any more robust inference about asymmetry of reactions, i.e. different patterns of banks' responses to tightening and loosening monetary policy. The analysis based on panel data on individual banks reveals that credit adjustment is stronger in the case of small banks with low capital. It also produces a result of stronger adjustment in credit provision among more liquid banks (which is the opposite of what one usually finds in studies e.g. for the euro area). One should, however, be aware that the whole banking system was over-liquid throughout the period under investigation and that most of the period was characterised by monetary easing.

4.3 Selected results from other countries

This section provides an overview of empirical work in some other economies that appear to be potentially relevant for the future work on Ukraine. This selection is not based on any strictly defined rules and is certainly not extensive.

Results on monetary transmission in the Baltic States could be interesting from the Ukrainian perspective. The major difference with the Polish case is that three Baltic States are much smaller and more open to trade economies and that they have followed the fixed exchange rate regime for the last few years in an environment of liberalised capital account. An implication of this is that there has been very limited scope for discretionary monetary policy on the side of central banks. In practice their actions can be confined to controlling the reserve/liquidity requirements and possibly playing the role of the lender-of-last-resort. For example Vetlov (2004) describes the experience of the Bank of Lithuania that in an environment of the currency board regime was experimenting with carrying out open market operations in the 1997-1999 period. These actions were firstly motivated by plans to gradually abandon the currency board arrangements. However, after the decision was made that in view of external shocks (Asian and Russian crises) the original exchange rate arrangement should be maintained, the Bank soon realised that there was little need for open market operations,

little guidance as to what the optimal interest rate strategy should be and that continuing with conducting such operations could send unwanted signals to market participants. Consequently, open market operations were abandoned.

Bank of Estonia (2004) reviews the results for the three Baltic States generated using small scale structural models developed at the respective central banks. One difficulty in modelling is how to incorporate monetary policy shocks in a way that would be consistent with the overall monetary system (e.g. interest rates are not under the control of central bank). The results are generally in line with those obtained for European advanced economies and specific features of reaction functions appear to be very much model dependant, thus their detailed description is skipped here.

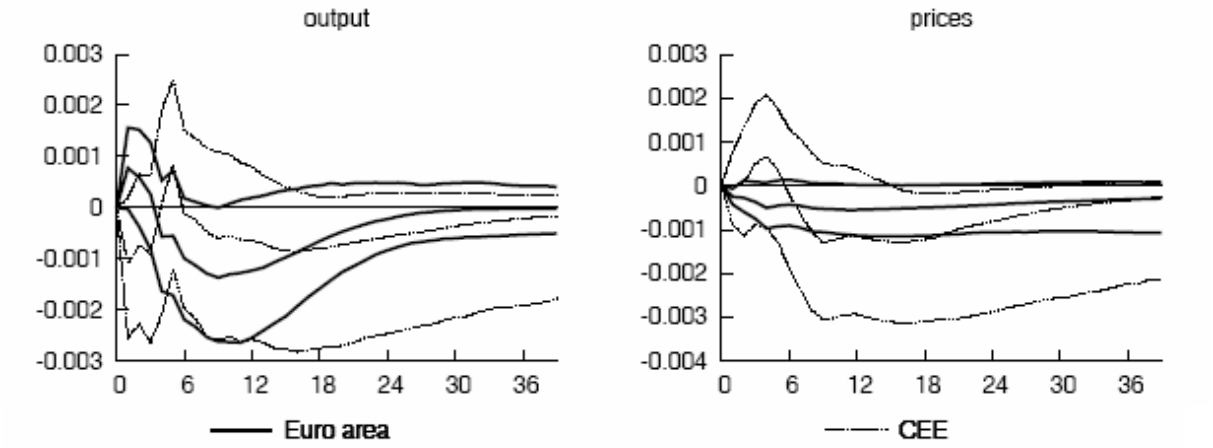
EFN (2004) provide a set of results from VAR analyses using relatively recent data for a number of EU new member states. The identification scheme is by Choleski decomposition using different orderings of variables for countries with relatively independent monetary policy (Czech Republic, Poland, Hungary, Slovak Republic and Slovenia) and for countries with fixed exchange rate regimes (Estonia, Latvia and Lithuania). The results for the majority of countries are broadly similar to the results found for the euro-zone, though the error bands of impulse responses are wide such that differences in observed average impulse responses are unlikely to be significant. This illustrates the problems with the VAR analysis using simple identification schemes in countries with data limitations. In the Czech Republic, output contracts strongly in response to monetary tightening, while prices appear to actually be rising for at least 1.5 years after monetary tightening (price puzzle). In Hungary, the reaction of both output and prices is of expected sign (though not statistically significant), very prompt (maximum contraction after around 3 quarters) and short lived. In Slovenia and the Slovak Republic the results would suggest output strengthening after tightening of monetary policy. In Baltic States, the results suggest an overall weak impact of (EMU) monetary policy shocks on domestic output and prices.

Jarociński (2004) attempts to overcome some of the problems with VAR identification by using a Bayesian approach and combining the information from across countries in the panel. Comparing the euro-zone with Central and East European countries (see Figure 3) the following general findings emerge:

- there are no clearly distinguishable differences in output responses,
- in the short run prices react stronger in the euro-zone,
- in the medium run prices react stronger in the CEE.

At the individual country level, impulse responses were found to be the strongest in the Czech Republic and Slovenia. The response of prices turned out insignificant in Poland and in Hungary output response was insignificant.

Figure 3. **Impulse responses of output and prices to one standard deviation in interest rates – median, and 5th and 95th percentiles of the posterior distribution for the euro-zone and CEE**



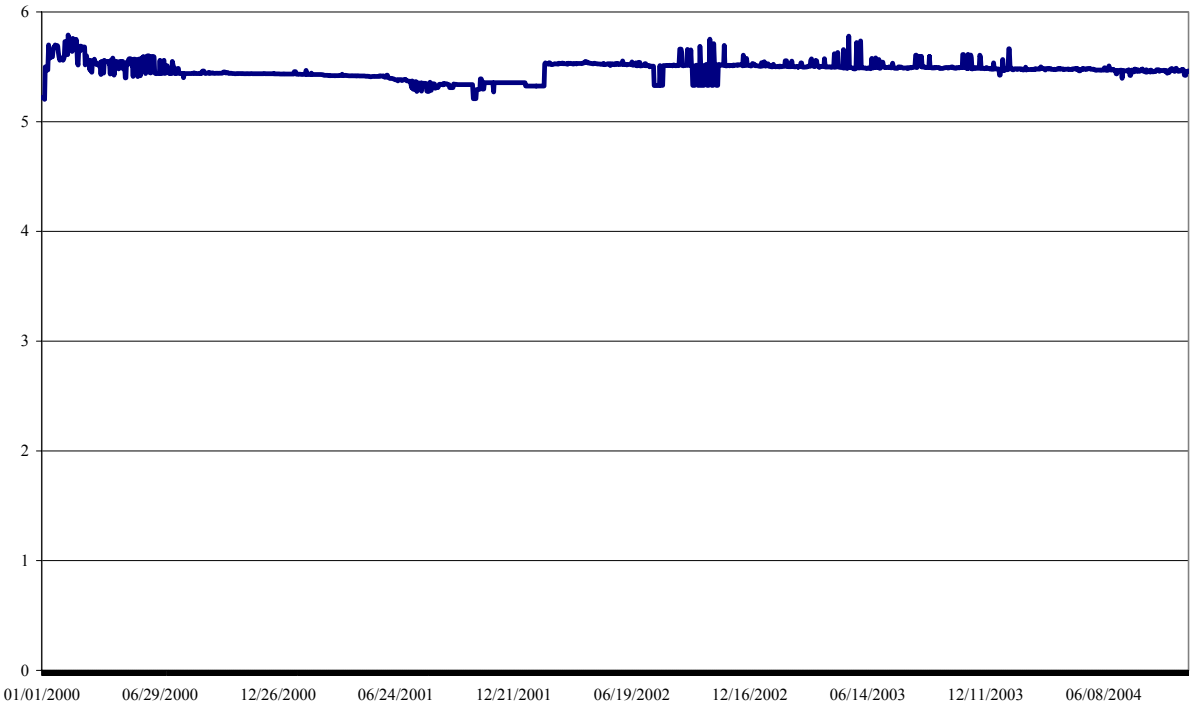
Note: In this exercise CEE region comprised the Czech Republic, Hungary, Poland and Slovenia.
Source: Excerpted from Jarociński (2004).

5. Research agenda for Ukraine[3]

The period starting from the turn of 1999/2000 was characterised by *de facto* exchange rate targeting with monetary authorities aiming at stabilising the hryvnia – dollar rate. (See Figure 4. For a discussion of *de jure* monetary regime see Novoseletska, 2004.) This period was also characterised by somewhat limited and changing over time openness to capital mobility. Also, as discussed in Novoseletska (2004) Ukrainian financial sector remains underdeveloped along several dimensions. All these factors have had a significant impact on the monetary transmission in Ukraine. The National Bank of Ukraine has conducted the active interest rate policy (which so far did not hamper the exchange rate objective due to limited capital openness), though there was no discount interest rate change since end-2002 till end-2004, despite major swings in money market rates and CPI inflation during that period.

Figure 4. **Hryvnia exchange rate against the US dollar, January 2000- October 2004**

[3] The current version of this section should be seen as an invitation to a wider discussion rather than as providing a final assessment of the situation. Any comments are particularly welcome.



Note: Daily data are plotted. The average exchange over the period was 5.47. Standard deviation was 0.08. Maximum and minimum rates were within +/-6% from the average rate.
Source: Oanda.com

Along the expected gradual liberalisation of capital account and increasing financial integration of Ukraine with rest of the world one can expect that the whole monetary policy system will need some modifications. Broadly speaking one can expect either an evolution towards a more coherent form of fixed exchange rate system or a move towards greater currency flexibility that would allow for monetary policy being assigned other objectives, notably price stability. Each option involves several pros and cons and any decision concerning such an important policy choice should be preceded by in-depth analysis of various aspects involved.

An interesting question arises as to what specific challenges to monetary transmission research would be associated with each of the above described options. Clearly, once the monetary policy regime has been decided, pursuing the policy aiming at price stability (including, prominently, the direct inflation targeting) would require much more information on the lags, strengths and interactions associated with particular channels of transmission. In fact, the success of such a monetary strategy hinges on the proper understanding of monetary transmission (unless one wants to hope for pure luck to help in hitting, say, the inflation target due to a combination of messy domestic policies and external shocks). Only after monetary authorities get a detailed understanding of monetary transmission processes (provided they are strong enough and broadly stable), they can hope to be able to run efficient monetary policy. In contrast, fixed exchange rate system (such as e.g. currency board) radically limits the scope for independent monetary policy and thus somewhat limits the need for studying monetary policy transmission with a view of building its comprehensive picture. However, Ukraine currently finds itself at the stage when its future monetary policy framework is yet to be decided. For this decision to be taken the following information could turn out important:

- as precise as possible knowledge of monetary transmission processes in Ukraine under various institutional arrangements in the past,

- realistic assessment of how accurate the information discussed in the previous bullet point can be,
- experience of other countries that decided on their monetary policy strategies in the past having at their disposal limited empirical evidence on monetary policy effectiveness (e.g. Polish and Czech experience with direct inflation targeting, Bulgarian experience with currency board, etc.).

Ultimately, the Ukrainian monetary authorities will need a well specified structural model (or a class of models) of the economy to guide further work on monetary transmission and to provide policy relevant insights into everyday actions. Given the limited data availability and the recent history of major structural changes in the economy, at the early stage efforts should perhaps concentrate on building simple small scale models able to capture the most important features of Ukrainian economy. In this work, the most natural and appropriate source of expertise should be other central banks. Bank of Estonia (2004) provides an interesting overview and discussion of the models developed in the three Baltic States. This experience of alternative modelling approaches and ensuing differences in model behaviour might be worth looking at given the otherwise similar characteristics of the countries. Another potentially interesting lessons can be drawn from the analysis of small scale models such as Bank of Finland's EDGE model for the euro area (Kortelainen, 2002), FPS model for the New Zealand (Black et al., 1997), small structural model of the National Bank of Poland (Łyziak, 2002), some of the (very well documented) models used at the Bank of England (Bank of England, 2000) and several other.

Clearly, the historical record provides a far-from-perfect data source for elaboration of empirical specifications. As noted by van Aarle et al. (2004) 'the monetary transmissions are still subject to uncertainties as witness e.g. volatile velocity and money multipliers, making econometric testing difficult'. Thus, in learning about monetary transmission mechanism it appears that the best approach is of extracting all possible information from existing data on Ukraine and at the same time closely monitoring the results obtained for other countries that share some important characteristics with Ukraine. Institutional aspects surrounding the financial sector as a whole and *de facto* monetary policy framework are important elements that should not be overlooked in the analysis.

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Overview of Ukrainian Money Market

Oksana Novoseletska[1]

1. Introduction

To make monetary policy more effective, it is necessary to pay a proper attention to the operation of transmission mechanisms of monetary policy, that is the way the changes in monetary policy instruments affect the macroeconomic variables such as consumption, investments, output or prices. It is a widely shared opinion between the monetary authorities of countries, which have decided to switch to the policy of controlling the inflation.

As stipulated in the "Comprehensive program for the banking sector development in 2000-2003" that was adopted in 2001 and the "Monetary Policy Goals for the year 2004", the National Bank of Ukraine would be assessing the possibility of gradual adoption of direct inflation targeting in Ukraine. Therefore the issue of thorough understanding of economic processes and the interdependencies between the monetary and other macroeconomic indicators should become crucial for exerting better monetary controls and increasing the credibility of monetary policy in Ukraine.

Unlike the traditional monetarist view, Keynesian analysis attempts to specify concrete channels through which the monetary policy exhibits its influence on economic activities: interest rates, asset prices and credit channels (Mishkin, 1997). Regardless of the very direction in which the monetary transmission occurs, analysts usually distinguish its two principal stages. The whole process starts from the manipulation of monetary instruments that leads to a change of certain intermediate variables (interest and exchange rates, bank deposits and loans, etc.), which in turn transmits to a change of ultimate macroeconomic variables (consumption, investment, external balance, GDP, etc.).

This paper (which is part of a larger research program looking at monetary policy transmission) analyses the role of money market as an enabling factor for the first stage of monetary transmission in Ukraine. In particular, it is suggested to examine the money market instruments that are in place in Ukraine in order to conclude whether the institutional conditions have been favourable for the monetary policy to take its full effect on the Ukrainian economy.

2. Development of the banking sector and trends in monetary policies in Ukraine: a historical overview

After declaring its independence in 1991, Ukraine started reconstructing its banking sector from scratch. The regional department of State bank of USSR was subsequently transformed into the National Bank of Ukraine and local offices of specialized state banks – into Oschadbank, Agroprombank, Ukreximbank, Prominvestbank and Ukrsotsbank. Nowadays most of these banks constitute a core of Ukrainian banking system.

Early 1990s gave an active boost to the development of the Ukrainian banking sector. According to the data of the National Bank of Ukraine (NBU), at the end of 1991 there were

[1] CASE Ukraine

76 banks in Ukraine, while in next four years their number increased almost fourfold (to 230 in 1995). By 1994-1995 the consequences of too liberal bank chartering policy of NBU started to show up in the form of monetary destabilization and bank capital requirements have been revised upwards[2]. As a result, since mid-1990s the number of registered banks has been gradually falling and reached 179 by 2003.

In 1995-1996, the National Bank of Ukraine started significantly constraining the money emission. If in 1993 money emission increased 30 times (compared to the previous year), in 1995 it increased 3 times and during 1996-1998 – 2.6 times. This became possible due to abandoning of the policy of direct money emission and undertaking active measures to control money growth by the NBU. As a result, since 1996, although remaining rather high, inflation rates have been reduced to a two-digits (and since 2002 - to a one-digit) level.

The second half of 1990s was characterised by further tightening of monetary policy. The rate of growth of monetary aggregates reduced from 40% in mid-1990s to 30% in 1999. By 2002 the rate of money base growth was established at 11-13% and of money supply – at 18-20% (see Table 1). Following the year 2002, recognising the need to stimulate the somewhat slowing economic growth, NBU has taken a decision to pursuit expansionary monetary policy. As a result, the established growth rates of monetary aggregates resumed to 20-30% in 2004.

Table 1. **Ukraine: monetary policy goals, 1999-2005[3]**

	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
CPI, % (Dec-to-Dec)	19.2	18.5	15.4	9.8	6.0-7.0	5.8-6.3	6.0-7.0
rate of money base growth, % per annum	30.0	16.0	16.0-18.0	11.0-13.0	17.0-20.0	20-32	20.0-26.0
rate of money supply growth, % per annum	28.0	19.7	18.0-20.0	18.0-20.0	22.0-27.0	32.0-39.0	28.0-33.0
UAH/USD rate	n/a	n/a	n/a	5.6	5.48	5.38-5.42	5.27-5.31

Source: National Bank of Ukraine

Measures undertaken by the National Bank of Ukraine over the second half of 1990s allowed bearing their fruits: the banking systems started gradually re-attaining the control over the monetary aggregates in Ukraine. First, the level of economy's monetization increased from 0.2 at the beginning of 1995 to 0.5 at the end of 2003. Even though being low, an increase in the level of monetization started signalling a wider use of the hryvnia as a medium of exchange in Ukraine. Second, within the overall structure of money supply (M3) the share of currency outside the banks (M0) decreased from 48.9% in 1997 to 34.8% in 2003, which is a sing of a growing confidence in the Ukrainian banking system.

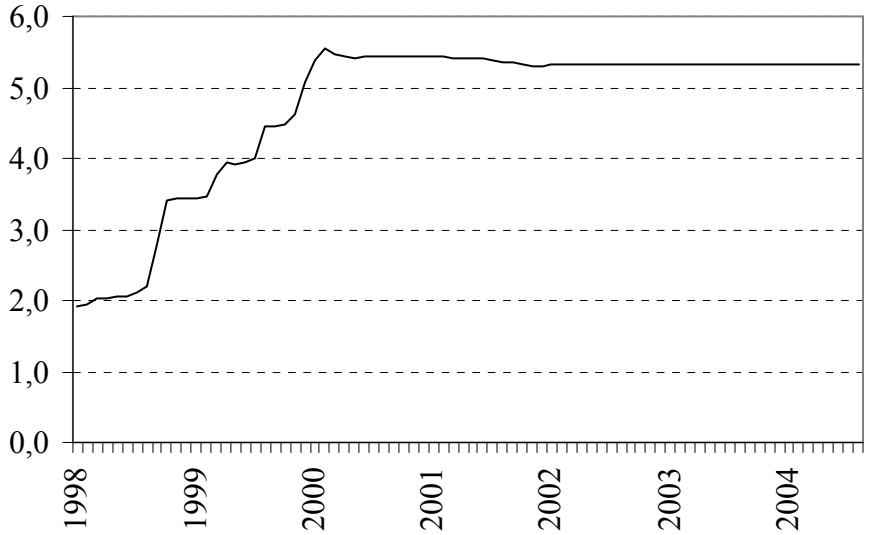
While speaking about the changes that have occurred to the monetary policy (goals) formulation, it is worth mentioning that the very structure of money emission has changed over time. Following the introduction of the mechanism of state securities emission to finance budget deficit of Ukraine in 1997, operations with state securities has been one of the leading emission channels in Ukraine: 63% of credit emission in 1998 and almost 51% in 1999. In

[2] The Resolution of NBU #368 dated of August 28 2001 stipulated the most recent revision of capital requirements.

[3] It is worth of mentioning that most of monetary policy goals were not met by NBU. Let set an example with the money base growth: in 1999 it increased by 39.2% (instead of 30%), in 2000 by 29-30% (16%), in 2001 by 18-19% (16-18%) and etc.

2000, the primary source of money emission into economy has been already the purchase of foreign currency to replenish foreign exchange reserves (83% of credit emission). This became possible due to maintaining exchange rate of hryvnia stable from 2000 (see Figure 1). Consequently, the policy of "managed float" coupled with the intention of NBU to raise its foreign reserves and, therefore, resulted in the increase of money supply.

Figure 1. **Monthly dynamics of nominal UAH/USD exchange rate, 1998-Q1`2004**



Source: National Bank of Ukraine

3. The National Bank of Ukraine: instruments of interest rate policy

According to the Constitution of Ukraine (article #99) adopted in 1996, the primary objective of the National Bank of Ukraine (NBU) is to maintain stability of the national currency. Within the scope of this objective, the NBU is also to ensure the stability of the Ukrainian banking system and facilitate price stability in the country. As stipulated by the law, the NBU could achieve its objectives by means of enacting any of the below tools (or their combinations):

- required reserves;
- interest rates policy;
- refinancing of commercial (retail) banks;
- gold and currency reserves' management;
- open market operations;
- capital import/export regulations;
- emission of own liabilities and operations with them.[4]

The interest rate policy of central bank helps managing the liquidity of the whole banking sector and, therefore, reaching the objectives of monetary and other policies. The National Bank of Ukraine establishes discount and overnight rates on a systematic basis: the adoption of other rates (short- and medium-term tenders, repo rates, etc.) depends on the utilization of particular instruments by NBU.

[4] Article #25 in the Law of Ukraine "On the National Bank of Ukraine" adopted in 1999.

NBU establishes the *discount* rate on a monthly basis. It is supposed to serve as a benchmark indicator for the value of deposited and credited resources for the participants of money market. The discount rate is established based on the considerations of the inflation rates, the supply and demand for the money in economy, inter-bank and retail (commercial) banks' rates, and other factors. Until recently (before August 2004) a more rigid estimation formula for the discount rate has been followed[5]:

$$Dr = Br + K * If(Ia) - 0.5\ GDP,$$

Were Dr – is the discount rate, Br – base rate[6], K – a coefficient decided by the NBU, which stands for the increment of discount rate due to the 1%-percent increase of inflation rate[7], If – forecasted inflation rate[8], Ia – actual annual inflation rates, GDP – reduction in real GDP growth rate.[9] However, following the Regulation of NBU #389 dated of August 18 2004, there are no more strict requirements stipulated on how to establish the regulated level of discount and other NBU rates in Ukraine.

While establishing the rate of discount, NBU recognized it to serve both as a benchmark indicator and an active tool of monetary policy implementation. The bank keeps track of the discount rate dynamics to prevent its real rate from turning to negative: the rate of discount should exceed inflation rate at least by 3 percent points[10]. The discount rate indicates the bottom-level (the lowest) interest and is closely linked with the other NBU instruments (overnight, credit tender, repo, etc.).

Overnight rate is established by NBU on daily basis since April 2001[11]. It defines the interest earned by NBU in the case of lending funds to commercial banks to support their short-term (immediate) liquidity. According to NBU 2001 Regulation, the overnight rate has been established at the level of discount rate plus 2% per annum in the case of blank credit (without collateral) or at discount rate plus 1% per annum in the case of T-bill pledged overnight[12]. The credit has provided to financially sound banks that have a limited participation at inter-bank market.

The other type of NBU interest is established on short- (up to 14 days) and medium-term (up to 365 days) *tender credits*[13]. Tenders are held on weekly basis (three short-term and one mid-term) and could be either quantitative (with fixed interest rate) or interest[14]. The interest rate

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[5] Resolution of NBU #183 dated of April 27 2001 (hereinafter, NBU 2001 Regulation).

[6] Base rate of discount is estimated as the average of refinance rates adopted by the central banks of European countries. The exact list (and number) of European central banks included into the sample is defined and reconsidered by NBU Board.

[7] The size of increment coefficient is adopted based on inflation expectations and the considerations of key money market tendencies and varies in the range 1.0-1.5.

[8] Here inflation rate is calculated as year-to-year ratio of this year CPI in December to that in December of previous year.

[9] The negative sign with variable "GDP" implies that with the reduction of real GDP growth rate (slowing down dynamics of real domestic product) the level of discount rate should decrease as well. And, on the contrary, with the speed-up of real GDP growth rate the discount rate should go up.

[10] 3% `margin` has been stipulated by NBU 2001 Regulation, which has been laxed by NBU in August 2004.

[11] Prior to the overnight rate, Lombard rate had been operational since 1996.

[12] If bank is applying for overnight credit during more than 3 subsequent working days, it would be charged the interest equal the discount rate plus 3% per annum.

[13] Tender mechanism has been launched in April 2001. Prior to it in 1994-1997 the mechanisms of credit auctions was in place. The procedure of latter differed former that of the former: credits disbursed via auctions involved the procedure of distributing refinance volumes according to quotas, which have been proportional to the capital size of applicant-bank.

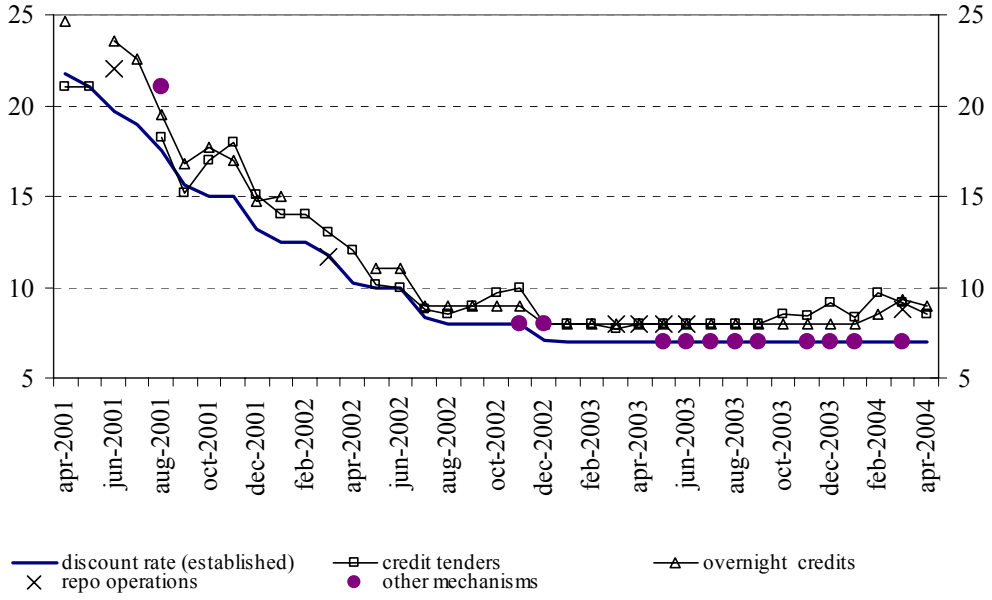
[14] NBU credits distributed via interest tenders usually are allocated to the group of applicants offering NBU higher interest than others.

on quantitative tenders is established by NBU and communicated to commercial banks on preceding Friday. In the case of interest tender, NBU defines the rate based on the proposals of banks: banks, which have offered the most attractive conditions for obtaining the credit (highest rate of interest), win the tender. At any rate, the threshold rate in interest tender is not allowed to be lower than the discount rate.

Prior to August 2004, banks had to meet certain criteria in order to become eligible for tender credits. First, applicant-banks had to ensure that their total arrears on NBU credits (excluding overnight) were not exceeding 50% of their regulatory capital. Second, in the case of applying for a medium-term tender credit, two more restrictions on banks' credit portfolios were imposed: up to 20% inter-bank credits and up to 10% overdue and doubtful credits. One bank could submit only one application to obtain tender credit and was allowed to obtain not more than 50% of total tender amount. The above conditions are not stipulated in 2004 NBU Regulation.

Repo credits[15] could become available for banks for the period of up to 30 days. Repo can take a form of tender (with T-bills' collateral) or be arranged as a *direct deal* (with T-bills or foreign currency collateral). In the case of tender repo banks are to formulate terms of operation (its volume, interest and other parameters) and NBU is to select the *best proposals* among banks-applicants. In the case of direct deal, NBI selects the highest interest-paying banks to conduct repo operation. The direct repo interest is established based on discount rate, inter-bank credit rate and T-bills yield.

Figure 3. **Comparison of selected NBU refinance rates, April 2001 – April 2004, %**



Source: National Bank of Ukraine

Comparison of the dynamics of the above-described NBU rates allows for making several observations (see Figure 3). First, except few rare cases (April and September 2001), the discount rate appears to be the lowest rate of interest. Second, repo operations and other mechanisms are the least utilized means of injecting liquidity into the banking system of

[15] Repo credit mechanism has been launched in 1997, since by that time Ukrainian T-bill market started operating.

Ukraine. Third, the interest rates on overnight and tender credits are among the highest, most probably because they have been actively utilised by Ukrainian banks to improve their liquidity (see Table 2). Both rates move together rather closely and the most significant discrepancies between tender and overnight rates tend to occur in the fourth quarter of each year.

Refinancing ('discount window' operations) is an instrument to support short-term retail banks' liquidity and, in ideal case, should be executed as rarely as any rescue operation. Data show that the contribution of refinancing to the total credit emission has been at a relatively stable level (up to 14.2% total credit emission) during 1999-2002 and in 2003 it picked at more than 60% (see Table 2).

Table 2. **Sources of credit emission in Ukraine, 1999-2002**

	Credit emission		
	total, bln UAH	out of which (%):	
		purchases of foreign currency	refinancing
1999	7.4	40.5	5.9 (60.0%*)
2000	10.4	82.9	0.8 (53.4%*)
2001	17.6	66.5	14.2 (84.6%*)
2002	13.0	73.1	9.2 (30.8%*)
2003	41.5	36.6	63.4 (86.9%*)

*- share of overnight (Lombard) credits in total volume of banks' refinancing.
Source: Annual Report of NBU 1999, 2000, 2001, 2002, 2003.

4. Banking sector

As it has been discussed in section 2 above, after declaring its independence Ukraine started to build its banking sector "from scratch". In 1991, only five state banks operated at the territory of Ukraine, while at the beginning of October 2004 there have been 183 Ukrainian banks, 159 out of which were carrying out banking operations. Such a quantitative and qualitative change of Ukrainian banking sector should have impacted the ability of banking system to transmit monetary policy signals.

At the end of September 2004 two state banks and 19 (out of which only 7 have a 100% of foreign capital) foreign banks operated at the market of Ukraine. As of October 1, the share of foreign capital in the total amount of authorised capital of Ukrainian banks has been slightly exceeding 10%, which has had a downward tendency over the last five years. Therefore, one could conclude that the competition at the Ukrainian banking market (in particular, between the foreign and Ukrainian banks) has been reducing over time.

The reduced competition in the banking sector of Ukraine could be a consequence of sector consolidation, especially as concerns the Ukrainian banks, which are required to raise their capitalisation level gradually. The level of concentration among 10 largest Ukrainian banks remained almost without a change (55.3% of total sector assets in December 2000 and 54.9% in June 2004), while the concentration among 25 largest banks increased slightly (from 71.4% in December 2000 to 72.3% in June 2004). Among the top-10 banks, those with the high volume of assets, there are Savings bank, Aval, Ukrsotsbank, Ukreximbank, Prominvestbank and Privatbank, out of which two banks are state and two more have been formerly state-owned. Over last several years the "leading" group of banks remained stable, which could suggest us that the Ukrainian banking market is segmented, that is divided into several groups

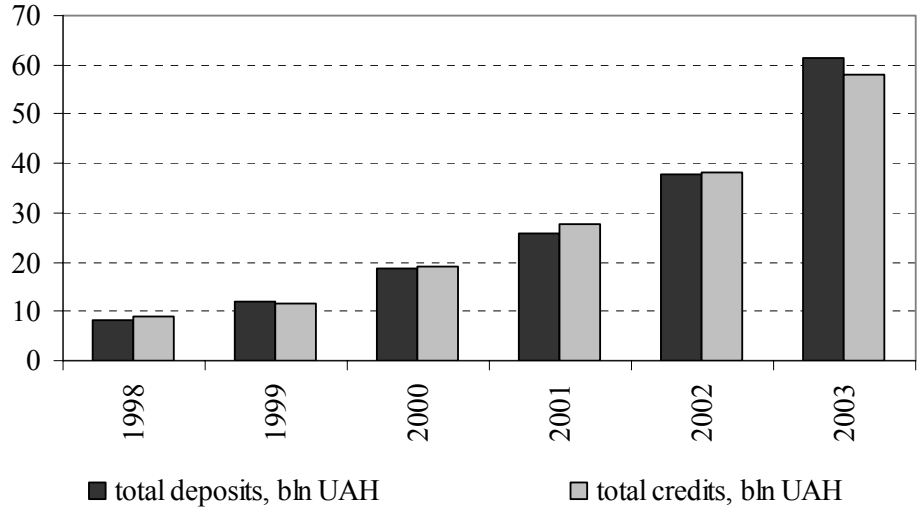
with the sounder and more financially solid banks having higher chances to maintain operational at the market.

During 2001-2003, credits have expanded significantly in Ukraine, so that the average growth rate for the period was slightly over 50%. Although being positive, the tendency raises a number of concerns, one of which is the quality of assets. In 2000-2002, the share of non-performing (substandard, doubtful, and loss) loans reduced from 29.6% of total loans to 21.9%. As of June 2004, the share of non-performing loans constituted 27.5%, which is not comparable with earlier figures, since NBU introduced new loan classification rules in 2003. The international comparison shows that this indicator is relatively higher that in other transition countries, where it is usually below 5% (Russia, Czech Republic, Croatia, Bulgaria, Lithuania, Latvia, Hungary, Estonia, etc.).

The soundness of Ukrainian banks, at least as far as the capital adequacy ratio is concerned, remained unchanged: from 15.5 in 2000 to 15.2 in June 2004. Bigger banks are more capitalised that the other, which makes them a major source of injecting new credits into economy. As proven by Karcheva (2004), only more capitalised Ukrainian banks with the bigger share of attracted long-term household deposits are capable of increasing credits and investments into economy. Therefore, the credit channel of monetary transmission would be limited to these banks only in Ukraine.

In 2001-2003, the Ukrainian banking sector experienced a credit boom. Over three last years the size of Ukrainian banks' liabilities almost tripled (see Figure 4). As of October 1 2004 the share of time deposits in total deposits constituted around 77.2% (77.4% as of January 2001) for the household and above 36.4% (37.1%) for the corporate sectors. At the same time, the credit portfolio of Ukrainian banks more than tripled (from 23.6 to 97.0 bln UAH) and the share of long-term credits within its structure grew up from 14.0% in 2000 to 38.3% in 2003. As a result, the ratio of deposits to credits reduced from 1.3 at the beginning of 2001 to 1.2 at the end of September 2004, thereby indicating the improving intermediation capacity of Ukrainian banks.

Figure 4. **Ukrainian banks' liabilities and credit portfolio, 1998-2003, annual, bln UAH**

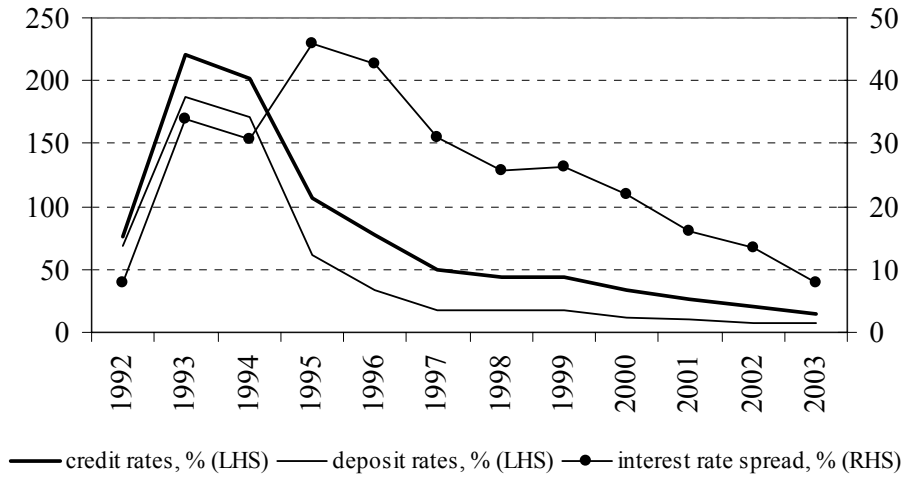


Source: NBU data

In order to infer on the banking intermediation efficiency, we could concentrate on the interest rates spread – the difference between credit and deposit rates. As indicated in economic literature, the value of interest rate spread should be positive and allow banks to compensate their operating expenses and to provide a proper remuneration to their capital (Fabozzi, Modigliani and Ferri, 1997). However, the interest spread also should be as low as possible, since otherwise it will discourage bank clients (Lindgren, Garcia and Saal, 1996). High interest spreads could imply either unfavourable for depositors lowering of deposit rates or unfavourable for lenders increasing of credit rates. Hence, in order to be efficient, banks should maintain their interest rate spreads at a relatively low level.

During the second half of 1990s both the deposit and credit rates, as well as the discount rate, were falling (see Figure 5). After reaching its maximum in 1995, the interest rates spread declined to 7.9 percentage points in 2003 (compared to 45.9 percentage points in 1995).

Figure 5. **Dynamics of the average weighted bank credit and deposit interest rates, and interest rate spread in Ukraine during 1992-2003, annual, %**



Source: National bank of Ukraine, 2002

As indicated by the above graph, since mid1990s the size of interest rates spread was decreasing indicating that the efficiency of banking sector intermediation should have been increasing in Ukraine. First, following 1995 the rate of inflation declined dramatically. As a result, NBU eased the reserve requirements (from 15% in 1995 to 0-12% in 2003)[16] and both credit and deposit rates exhibited a synchronised downward trend.

Second, following the crisis of 1998 the downward tendency of interest rates spread slowed down slightly in 1999 and resumed shortly after. Analysts consider that the very crisis of 1998 and economic reforms of 2000-2001 helped improving the overall market discipline and ceasing the operations of less effective entities (Dabrowski et al., 2003). Although it would be difficult to verify this argument, we can refer to official data indicating that the share of problematic (overdue and doubtful) credits reduced significantly from 11.3% in 2000 to 3.4% in 2003.[17] Also in 2001-2003, one could observe slight reduction of reserves for the

[16] In 2001 the National Bank of Ukraine introduced differentiated schedule of reserve requirements (RR) for Ukrainian retail banks. The size of RR varies depending on the currency and the term of deposits.

[17] Eventually, the very amount of problematic loans did not change significantly in 2000—2003, but fluctuated around 2.6-2.7 bln UAH. In fact, a reduction of problematic loans' share was mainly due to the augmentation of banks' assets.

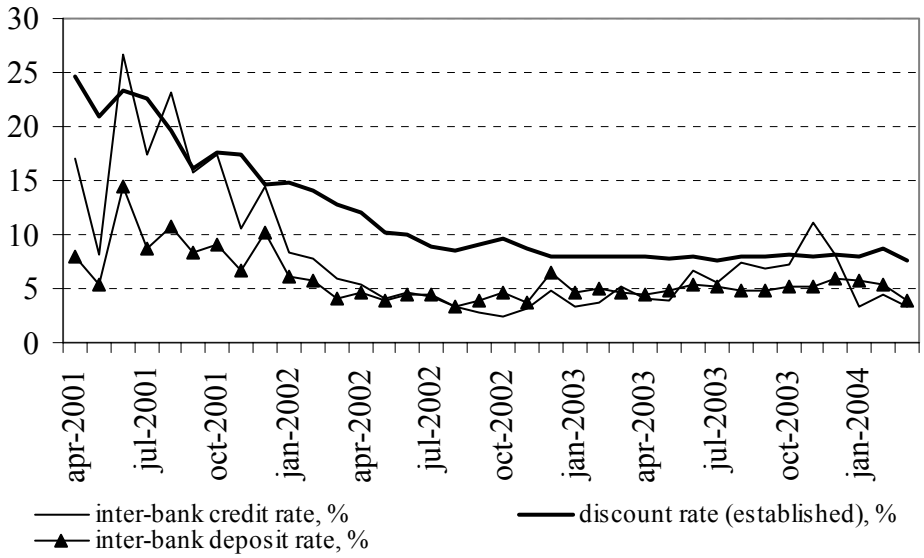
reimbursement of losses incurred on credit operations as a share of credit portfolio from 9.2% to 6.8%. However, it would be premature to conclude whether the observed tendency is on its systematic trend.

5. Inter-bank market

Serving as a deposit taking institutions, banks should be attracting deposits at the interest and could use available funds in order to make investments (lend money) at their own risk. In certain instances banks could find themselves in financial distress and would require the "lender-of-last-resort" (LOLR) to support temporary liquidity of banks. Such a practice, however, should be rather limited in order not to overburden LOLR facility. Therefore, it would be preferred if banks could look for the alternative sources of funding, among which one could mention open market (re-purchase) operations and inter-bank funding.

Ukrainian banks appear to be active at inter-bank market. As of March 1 2004, the total volume of inter-bank credits contributed to 18% of total banks' credit portfolio[18]. Data suggest that with few exceptions Ukrainian banks were capable of attracting funds at the money market at a much lower expense than from the discount window (see Figure 6).

Figure 6. **Dynamics of NBU discount and inter-bank rates, 2001-2004, monthly, %**



Source: NBU Bulletin

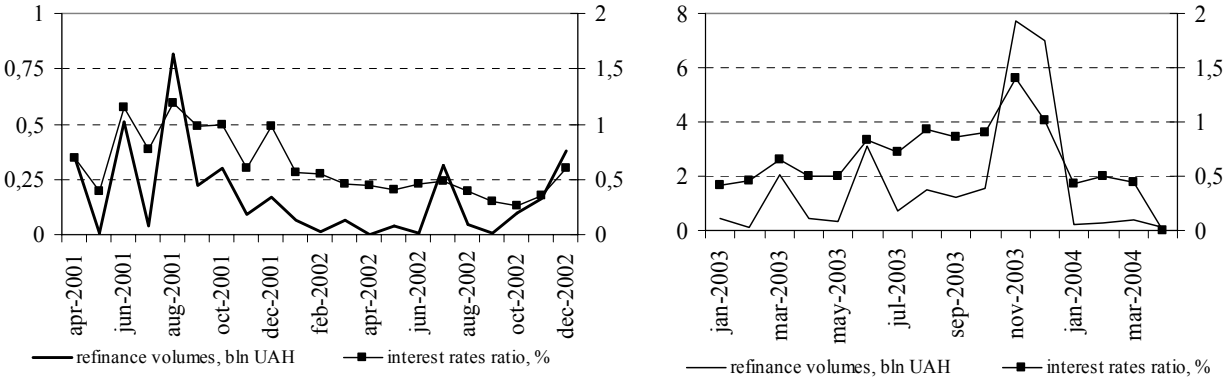
While analyzing the utilization of 'discount window' facility vis-à-vis inter-bank market operations, one should mention that the interrelationship between them has been strong, especially during several crisis episodes at the inter-bank market in 2001 and 2003[19] (see Figure 7 part (a) and (b)). Data show that even though inter-bank credit rate remained below discount rate most of the time, in 2001 any relative increase in the former (perhaps indicating banks' problems with too low liquidity) resulted, not surprisingly, in higher volumes of refinance credits in Ukraine. In 2002, owing to the deflationary period, no significant changes in inter-bank rates and volumes of refinance credit were recorded. However, in late 2003 the

[18] Author's estimate based on the data obtained from Financial Risks No 1(35) 2004, pages VI, X.

[19] It would be expected that the volumes of banks' refinance credit should grow with the increasing interest rate ratio (that is the inter-bank rate growing in excess of discount rate).

situation reverted: inter-bank rates sky-rocked thereby motivating the retail banks to utilize the 'lender-of-last-resort' facility more actively. Consequently, the volumes of refinancing increased several times as much: from 1.2 bln UAH in 2002 to 26.3 bln UAH in 2003.

Figure 7. **The dynamics of refinancing volumes (LHS) and interest rate (inter-bank credit to NBU discount) ratio (RHS), April 2001- March 2004, monthly**

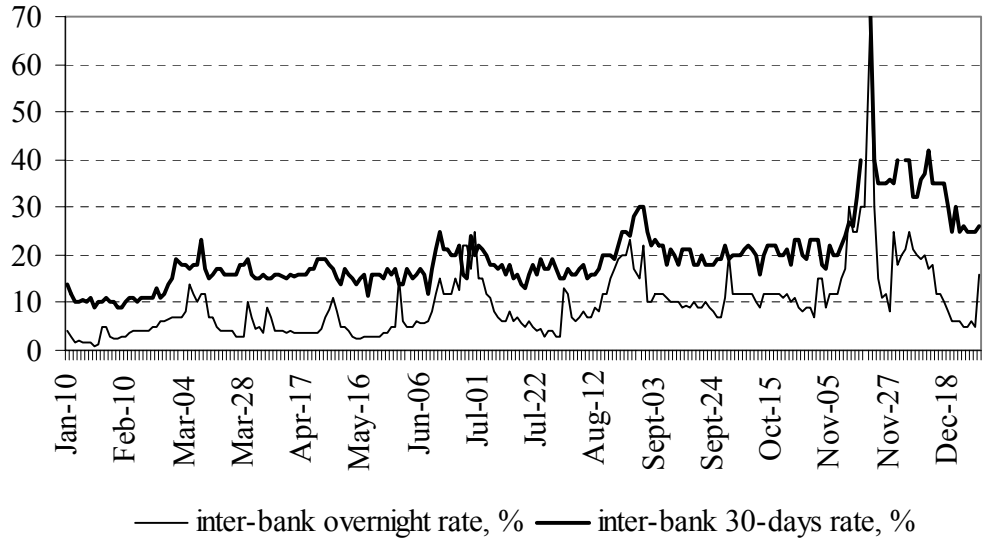


(a) April'01 – December'02 (b) January'03 – March'04

Source: National Bank of Ukraine

Data show that inter-bank rates are extremely volatile. The year 2003 brought several problematic periods forwards during which inter-bank interest rates speeded up (end February – beginning of March, early April) and even sky-rocked in November 2003 (Figure 8). Some "destabilization" episodes use to appear due to sudden and significant NBU interventions at inter-bank exchange market (June 2003) or malfunctioning of budget spending schedules that result in the accumulation of budget funds at Treasury accounts (November 2003). In addition to it, many observers say that Ukrainian banks suffer from poor management of their assets and liabilities.

Figure 8. **Dynamics of inter-bank credit rates in 2003: overnight and 30-days rates, daily, % per annum**



Source: Ukrainian Financial Server (http://ufs.com.ua/ports/credits.php)

In the view of the Roe et al. (2001), NBU excessive regulations, especially those pertaining the exchange market, resulted in excess volatility of UAH overnight rate at the inter-bank

market. NBU pursues the policy of eliminating any deviations of exchange rates from its 'target' level. Therefore, banks' risk diversification capacities are limited so that while experiencing problems with liquidity, they have nothing to do then borrow from each other. The share of inter-bank operations in credit portfolio of Ukrainian banks has been rather significant, in the absence of other income sources banks become heavily dependant on the capacities of inter-bank market. Since in the past there have been many episodes, during which the inter-bank rate to went up, therefore causing the credit rate to increase in Ukraine.

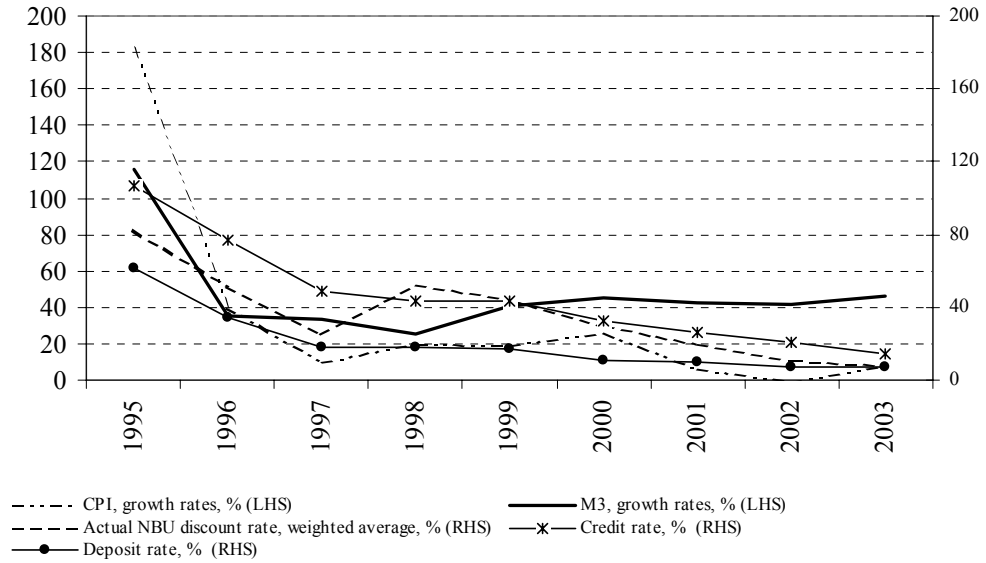
Recently, NBU issued regulation enabling it to better control the inter-bank market[20]. In the document it is stipulated that retail banks are obliged to provide NBU with the information on conducted inter-bank sales/purchases contracts not later than 10 minutes after the deal.

6. Monetary transmission in Ukraine

Money market plays a principal role in the mechanism of monetary policy transmission. Serving as an interlocutor between the monetary and "intermediate" environment, money markets condition and calibrate the initial impulse "sent" by monetary authorities either to stimulate or tranquillise economic activities. Therefore, its efficiency would be decisive for the overall effectiveness of monetary policy conduct (both the magnitude and timeliness of its impact on the ultimate indicators of macroeconomic development).

Examining the functioning of monetary transmission mechanism in Ukraine since the middle of 1990s, one could notice that the interrelationships between its principal variables were not stable over the time (see Figure 9 and Figure 10).

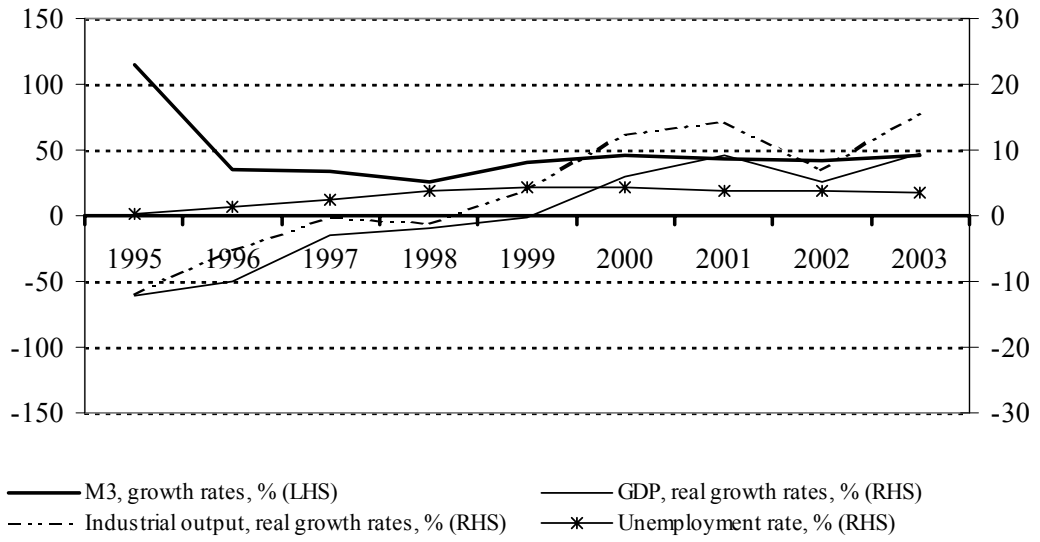
Figure 9. **Ukraine: dynamics of selected monetary indicators, 1995-2003, annual growth rates, %**



Source: National Bank of Ukraine

Figure 10. **Ukraine: dynamics of selected macroeconomic indicators, 1995-2003, annual rates, %**

[20] Resolution of NBU "On approving the principles for the Ukrainian banks of providing information UAH-nominated inter-bank credits sales/purchases" #20 dated of January 21 2001.



Source: National Bank of Ukraine

Data from Figure 9 above suggest that during 1995-2003 the correlation between money supply (M3) and interest rates was positive (except 1999, 2000 and 2003). That is smaller rates of money supply growth have been associated with lower interest rates (see Figure 9). Similarly, Figure 10 suggests that over 1995-2003 we did not observe the 'standard' relationship of stronger economic activity being accompanied by faster money growth: during this period domestic product and industrial output have been growing, while money supply growth was slowing in Ukraine. Both tendencies appear contradicting the very logic of economic theory, according to which money supply should be inversely related to interest rates and positively related to output and production volumes.

If we are to shorten time series by excluding 1995-1997 (the pre-crisis years) from the sample, the results will change (see Table 3). First, the relationship between money supply growth and interest rates will remain in its magnitude, but change sign: for bank credit/deposit rates from 0,66/0,78 to -0.67/0,74 and for actual discount rate – from 0,58 to –0.76.[21] Second, the relationship between money supply and output changed both in sign and magnitude: for real GDP/ real industrial production – from –0,43/-0,46 to 0,79/0,86. The observed above "inconsistencies" between monetary and other macroeconomic tendencies could signal of combating and ceasing down the hyperinflation and a switch-off NBU to stabilisation policies (see Jakubiak, 2004).

Table 3. **The comparison of correlation coefficients between M3 (annual growth rates) and other selected variables**

Correlation between M3 growth rates (%) and:	for the time period:	
	1995-2003	1998-2003
CPI, growth rates, %	0,93	-0,27
Actual discount rate, %	0,58	-0,76
Bank credit rates, %	0,66	-0,67
Bank deposit rates, %	0,78	-0,74
Real GDP, growth rates, %	-0,43	0,79
Industrial output, real growth rates, %	-0,46	0,86

[21] Pairwise correlation coefficients have been estimated based on monthly data. Coefficients in Table 3 are estimated for two different time periods in order to should what kind of change in variable relations (if any) occurred within the time.

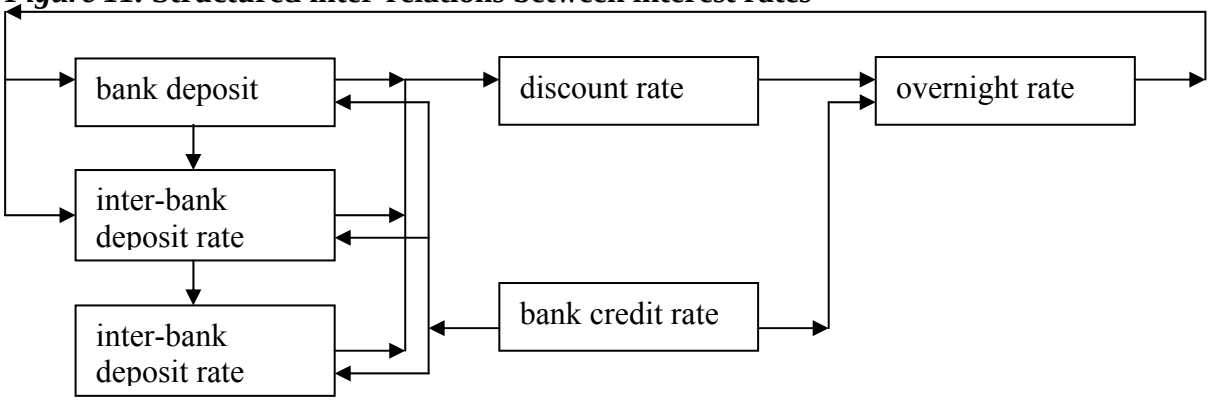
Unemployment rate, %	-0,64	0,20

Source: official data and author's calculations

6.1. Ukrainian money market: focusing the "first stage" monetary transmission

The whole transmission mechanism of monetary policy to credit availability, investments and volume of production could be split into two principal parts. The first one is the transmission from monetary authorities' instruments to some intermediate indicator (for example, interest rates of retail banks, assets price, etc.) and the second one – from the intermediate indicator to the ultimate target variable (amount of credits, volumes of production, net exports, etc). Following the analysis of NBU instruments, functioning of Ukrainian banking system and operation of inter-bank market, in this section of paper it is suggested to look inside the relationships existing between the discount (actual NBU discount and overnight), inter-bank (credit and deposit) and retail banks' (credit and deposit) interest rates.

Figure 11. **Structured inter-relations between interest rates**[22]



Based on the examined variables interrelationships during January 2001-March 2004 (monthly data), we can conclude with the following observations:

1. The level of actual discount rate depends on inter-bank (credit and deposit) rates and retail deposit rate, but also defines the actual level of NBU overnight. This conclusion naturally fits our prior expectations, since according to NBU 2001 and 2004 Regulations, the level of discount rate should be established based on the dynamics of inter-bank and retail rates, as well as other factors.

2. NBU overnight rate influences the retail deposit rate, thereby making inter-bank deposit rate to change as well. This could imply that monetary transmission starts from the discount rate and impacts the retail deposit rates directly through the overnight rate. It means that the level of deposit rate is put into dependence on the stance of short-term liquidity of banking system as a whole. And there is practically no "first stage" monetary transmission at least as far as the bank deposit rates are concerned.

3. As far as the retail credit rates concerned, it has been defined that they influence the actual overnight rate. This could mean that usually banks encounter short-term liquidity problems due to their crediting operations that frequently result in the maturity mismatch. Also it could be noticed that retail credit rates define the dynamics of inter-bank (credit and deposit) and retail deposit rates.

[22] The schematic presentation of interest rates interrelationships.

4. Quite unexpectedly the results of simulation showed that neither the discount, nor the overnight rates could have an impact on retail credit rates. It might be possible that credit rates appear to be sensitive to other, for instance, bank specific factors, which have not been investigated in detail in this paper.

Provided observation 4, we can conclude that the "first stage" transmission of monetary policy could be hampered by money market malfunctioning. This might not be favourable for the changes of monetary instruments to take their full effect during the second stage of monetary transmission. This conclusion, however, should be validated while examining the functioning of monetary transmission at its second stage. As concerns the finding out the interest rate to better capture the money market conditions, it could be possible to use either bank deposit rate or inter-bank rates as proxies.

7. Conclusions

This paper forms an integral part of a wider framework for the overall analysis of monetary policy conduct in Ukraine. The subject examined – the money market and its institutions – is a principal facility to transfer monetary policy signals onto production and growth indicators. The current research was undertaken to define whether money market conditions has been favourable for the effective monetary policy conduct ("first stage" of transmission).

As concerns the monetary transmission, we have seen that during 1995-2003 no standard relations between monetary and other macroeconomic variables (GDP, volumes of industrial production, unemployment, etc.) has been observed. On the one hand, this could signal of the switch in NBU policy in 1998-1999: from combating hyperinflation towards more effective stabilisation policies. On the other, this imply, most probably, the malfunctioning of the very money market not being able to properly transmit the changes of monetary instruments to economy.

The analysis of "first stage" monetary transmission indicated that unlike the other rates, retail credit rates remain exogenous to the whole array of different interest instruments. Most probably, we could attribute this to other factors having more influence on bank credit rates. Among them one could mention bank specific, for example, competition, bank soundness, assets quality and others, which could significantly hamper the efficiency of banking sector as a whole.

The erogeneity of credit rates could mean that monetary authorities are not capable to influence them in the desired manner. Changes in credit availability might be inadequate provided the changes of monetary instruments and, therefore, costly in its economic sense. However, to better shed the light on this we should switch to the analysis of "second stage" of monetary transmission.

Appendix 1. Results of Granger causality test

Sample: 2001:01 2004:03
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
ONA does not Granger Cause DA	27	27.6011	1.0E-06
DA does not Granger Cause ONA		1.98554	0.16116
CBC does not Granger Cause DA	34	0.57968	0.56643
DA does not Granger Cause CBC		1.33380	0.27916
CBD does not Granger Cause DA	34	0.35751	0.70246
DA does not Granger Cause CBD		5.89218	0.00712
IBD does not Granger Cause DA	34	1.10518	0.34470
DA does not Granger Cause IBD		7.50742	0.00236
IBC does not Granger Cause DA	34	1.11133	0.34274
DA does not Granger Cause IBC		3.61021	0.03981
CBC does not Granger Cause ONA	27	0.02721	0.97319
ONA does not Granger Cause CBC		3.23446	0.05869
CBD does not Granger Cause ONA	27	4.71550	0.01976
ONA does not Granger Cause CBD		0.99383	0.38617
IBD does not Granger Cause ONA	27	3.55892	0.04580
ONA does not Granger Cause IBD		0.97950	0.39128
IBC does not Granger Cause ONA	27	1.37906	0.27274
ONA does not Granger Cause IBC		0.15088	0.86084
CBD does not Granger Cause CBC	37	4.70066	0.01622
CBC does not Granger Cause CBD		0.36300	0.69842
IBD does not Granger Cause CBC	37	3.71253	0.03548
CBC does not Granger Cause IBD		1.50259	0.23784
IBC does not Granger Cause CBC	37	3.71232	0.03549
CBC does not Granger Cause IBC		1.46964	0.24512
IBD does not Granger Cause CBD	37	5.95061	0.00635
CBD does not Granger Cause IBD		1.97971	0.15467
IBC does not Granger Cause CBD	37	9.51180	0.00057
CBD does not Granger Cause IBC		4.53631	0.01843
IBC does not Granger Cause IBD	37	5.36762	0.00977
IBD does not Granger Cause IBC		0.42415	0.65795

where CBC – retail credit rate (average weighted), CBD – retail deposit rate (average weighted), IBD – inter-bank deposit rate, IBC – inter-bank credit rate, DA – actual discount rate, ONA – actual overnight rate.

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Problems of Attaining the Monetary Policy Goals of Ukraine

Volodymyr Ryaboshlyk[1], *Viktor Maziarchuk*[1]

A considerable deviation of monetary indicators actually achieved from those prescribed by indicative plans still takes place in Ukraine - see Table:

Table 1. **Indicative and Actual Monetary Parameters after "Basic Principles of Monetary Policy of Ukraine"**

		2003		2004		2005
		Plan	In fact	Plan	Expec-tations	Plan*
CPI December to December %		6 – 7%	8,2%	5.8 - 6.3%	12% or more	6 – 7%
Base Money	bln UAH	35,6 - 37,7	40,1	53,55- 57,75	60,5 – 62,5	72,64 - 78,80
	growth %	117 – 120%	130%	126 -132%	151 -155%	120 -126%
Aggregate M3	bln UAH	72,4 - 78,7	95,04	121,93- 132,76	145.4 – 151.1	186,13 - 200,99
	growth %	122- 127%	146%	132- 139%	153- 159%	128- 133%
Exchange Rate UAH/USD year average		5,48	5,33	5.38 - 5.42	5.33 half year	5,27 - 5,31

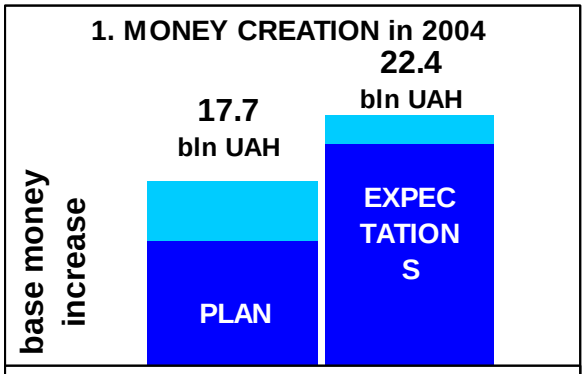
** approved by the Council of the NBU on September 10, 2004, the decision №17*

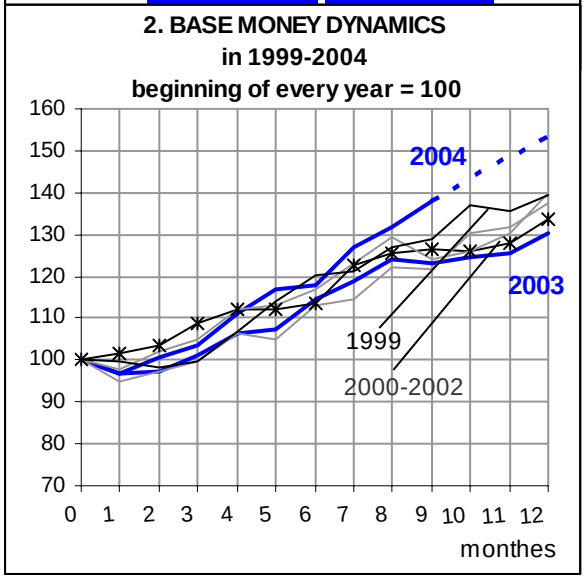
Inflation is systematically planned at level of 6-7% and with the same systematic character substantially exceeded, that in a considerable measure is related to excessive money creation and exceeding of monetary base.

On the other hand noticeable advancing of broad money M3 witnesses about positive process of accelerated growth of deposits that is not taken into account while planning.

Similarly exchange rate of hryvna for dollar systematically falls behind the planned levels as a result of gradual strengthening of national currency after its excessive falling during the crisis of 1998.

Figures 1-2 show a long-term tendency and current dynamics of monetary base which is a result of emission activity of the National bank (base money approximately contains 80% of cash and

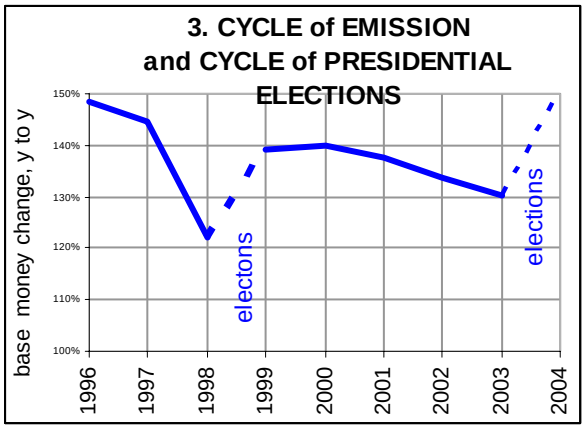




[1] *Institute for Reforms*

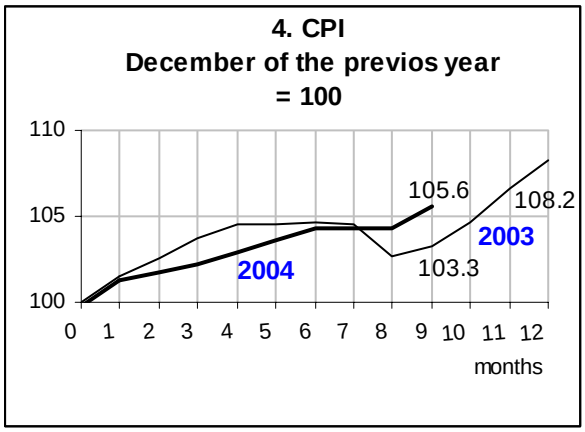
20% of commercial bank's reserves which in a way play a role of cash for banks).

As it could be seen, in the second half of the current year monetary base noticeably deviated both from the dynamics of the previous year, and from the tendency of other years, and according to the official expectations of the NBU exceeding of actual emission (money creation) above the planned one in this year will make not less than 5 bln hryvnas. It is a considerable additional resource (signiorage) at the disposal of State; however the reverse side of it is a certain strengthening of inflation.

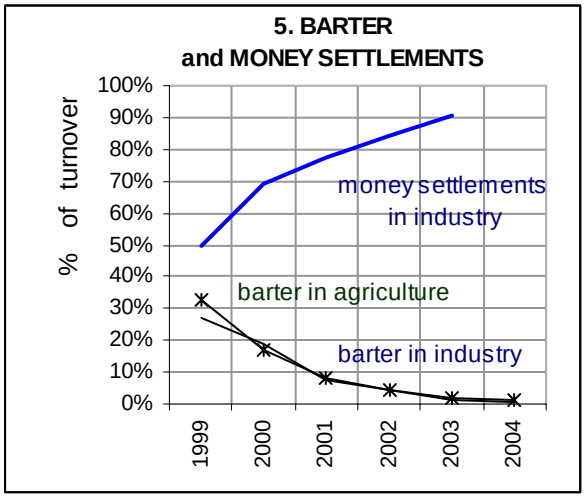


As a result a gradual toughening of control over money creation, when from year to year growth of monetary base was holding back, had been broken up. And now we shall attain the highest monetary expansion during last 8-9 years – Fig. 3.

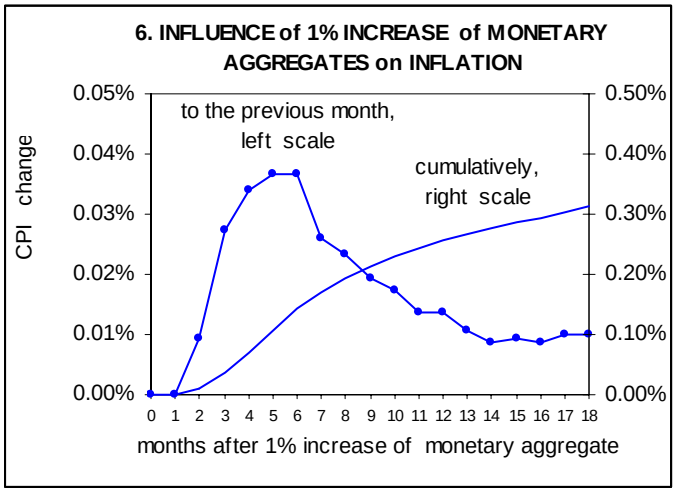
Figure 3 also shows that the other year marked by excessive monetary expansion was 1999 – the year of the previous presidential elections. Thus, a peculiar macroeconomic cycle has been formed in Ukraine tied to periodicity of elections, which is to some extent similar to analogous cycles in the developed countries, for example in the USA.



According to a turn in emission activity a turn in inflation had happened. In contrast to the first half-year when inflation had been falling behind the previous year, in August, a month after beginning of emission expansion, prices began to accelerate too – Fig. 4. It should be noted that beneath average figure of 12% inflation stand both price reduction for bread and rising in price for meat and pig fat in 1,5 times. Consequently taming inflation to European levels would narrow dispersions between different groups of commodities and promote stability.



Monetary base is traditionally planned in Ukraine above real growth, which is explained by extended necessity in national currency due to decline of barter and dollarization of the economy. However barter's decline has almost ended – Fig. 5, and dollarization has stabilized at level of 20% of monetary aggregate M3. So, possibilities for further increase of monetization have been exhausted and, in contrast to the adopted policy, money creation should be dealt with much more carefully.

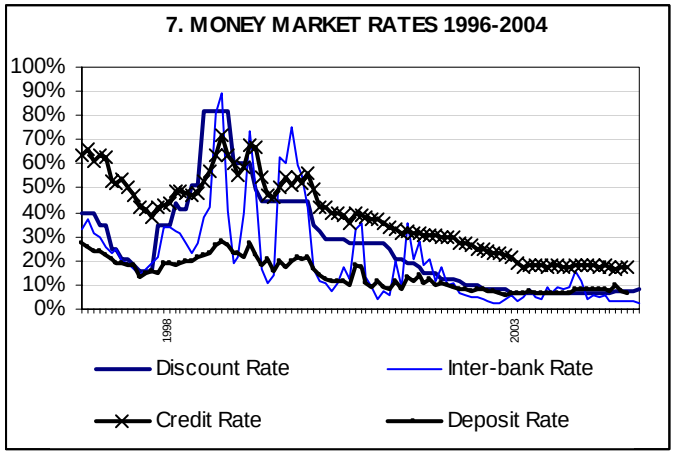


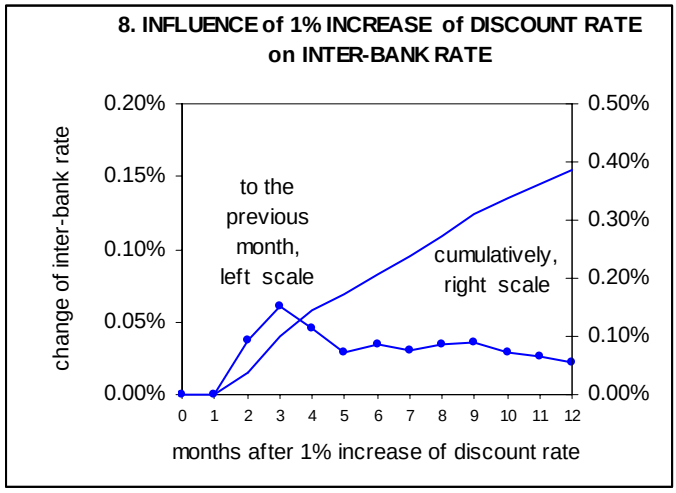
The National Bank of Ukraine regularly declares „creation of effective instruments and mechanisms providing achievement of monetary policy goals" .

However actually we are yet on an intermediate stage between hyperinflation and narrowly-controlled inflation, and now we must shift from simple extrapolation of current data to more sophisticated insight in subsurface processes and turning points, which affect development of events.

One of the ways of monetary policy improvement is econometric analysis of causal effects between different factors – Fig. 6 shows the estimations of influence of monetary expansion on inflation in form of so-called impulse function. This function shows reaction of prices to 1% increase of monetary aggregate. As it could be seen, at the very beginning, on the first month, influence of monetary expansion is of no consequence, and only on 3-6 months, inflation increase becomes significant; whereupon emission effect rapidly dies out.

The other important sphere of monetary regulations is money market interest rates where main instrument is official discount rate set by the NBU. As shows Figure 7 in general market interest rates and the discount rate have identical tendencies.





Econometric analysis also shows that the NBU's discount rate mostly influences the inter-bank rates. At that changes of discount rate have an effect on money market rates with a delay of 3 months, as in the previous case. Cumulatively, 1% increase of discount rate causes 0.17% increase in inter-bank rate after 6 months and 0.39% - after 1 year, see Fig. 8.

Thus the following directions of monetary policy improvements could be proposed.

It is necessary to strengthen the control over money creation and set upper limit of growth of monetary base at the level of no more than 20% per year. Consequently the emission income of the State must be shortened to 10-12 billion hryvnyas per year against today's 20 billions.

If we took into consideration that now monetary emission is mainly used for currency purchases, then two options would be open: either proceed currency purchases using budgetary funds, or revise exchange rate policy in direction of national currency appreciation. And here Polish experience of strengthening of zloty more than in 10% without negative influence on the real economy could stand in good stead.

Econometric analysis of causal effects between factors should be used in monetary policymaking more actively.

Such multi-aspect changes will allow to narrow inflation to 3-5% per year, that will promote stabilization both of prices on consumer market and interest rates on money market, and will become a substantial step in direction of European integration of Ukraine.

Monetary Transmission Mechanism in Ukraine: A VAR Approach

Mykyta Mykhaylychenko[1], Volodymyr Hryniv[1], Wojciech Paczyński[2]

1. Introduction

This work attempts to apply a well established Vector Autoregression (VAR) methodology to study monetary transmission mechanism in Ukraine. Various versions of such studies are perhaps the most common approach in empirical transmission literature in the world. Examples of work in this category include, Leeper et al. (1998), Christiano et al. (2000) and Peersman and Smets (2001). However, to our knowledge, this approach has not been widely applied in Ukraine up to now. This paper attempts to fill this gap by looking at VAR evidence on the monetary transmission process in Ukraine.

Throughout the paper, a benchmark VAR specification, proposed by Peersman and Smets (2001), is used to uncover responses of main Ukrainian macroeconomic variables to interest rate innovation, treated as a monetary policy shock. It is discovered that these responses are present, at least as regards inflation, and the general picture emerging is not at odds with evidence from other countries (e.g. the euro-zone and USA).

Another attribute of this research is that we try to estimate VAR in two "dimensions". Firstly, several different interest rates are used as monetary policy indicators, including NBU's discount rate, interbank rate and loan interest rate of commercial banks. Secondly, core inflation indicators as well as ordinary CPI, calculated by the Ukrainian State Statistics Committee, are involved in the evaluation. It is revealed that the results for VARs with different interest rates are similar with slight differences. There are no clear cut results concerning the choice of core CPI or standard CPI as a better indicator to be potentially controlled by interest rate changes, though some core inflation indices appear to be more appropriate in this respect.

The paper is organized as follows. The second section offers a brief historical survey on monetary transmission research in Ukraine. Section 3 is devoted to the benchmark VAR model and data description and to the presentation of results based on impulse response functions. Section 4 introduces analysis of variance decomposition and discusses some other robustness checks. Conclusions are in section 5.

2. An overview of empirical work on monetary transmission in Ukraine

Up till now there has been relatively little research on monetary transmission mechanism in Ukraine. Examples of work studying various aspects of transmission include Doroshenko (2001), Tyrkalo and Adamyk (1999), Zaderey (2003), Novoseletska (2004), Shevchuk (2001). Below we provide a concise overview of this literature signaling major approaches that have been taken and summarizing the main findings.

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Firstly, there is a relatively large literature dealing with relations between monetary indicators and other macroeconomic variables. Tyrkalo and Adamyk (1999) and Doroshenko (2001) consider relations between both money supply and inflation and between money supply and GDP. The findings confirm a long-run relationship between money growth and inflation (as one would expect). The period of money expansion and high inflation in the decade of the 1990s was accompanied by contraction of output. Novoseletska (2004) also discusses these issues making note of the break point in the statistical relationship. In the more recent period of financial stability (1999-2003) rising monetary aggregates were accompanied by falling inflation and a rebound of output. Clearly, there are major differences between long-run and short-term effects of money expansion. Bilan (2002 and 2003), Bilan and Siliverstovs (2004), and Leheyda (2004) are examples of recent work studying various aspects of impact of monetary aggregates on other variables and in particular of inflation determinants.

Bilan (2003) studies the existence, strength and importance of the 'liquidity effect', i.e. fall of interest rates (interbank) in response to money expansion. The study finds the effect to be present and – more importantly – to remain in place for a relatively long period. It would thus provide some evidence supporting the view *that interest rate channel of monetary transmission has some power* – at least as far as the first stage of the transmission is concerned (i.e. an influence of money expansion on market interest rates).

Doroshenko (2001) considers some aspects of exchange rate channel. The results indicate that exchange rate fluctuations had very limited impact on trade flows over the period 1994-1998. The paper further identifies other factors (different from exchange rates) that shape foreign trade dynamics. The results can be interpreted as giving some support to the hypothesis that exchange rate channel of monetary policy transmission can be relatively weak as there appears to be little impact from exchange rates to the trade balance. The suggested explanations include administrative influences in foreign trade. The period from 1999 onward was characterized by nominal stability of exchange rate (de facto peg), so that the potential importance of the exchange rate channel of monetary transmission is hard to test.

Another aspect of this channel – pass-through from exchange rates to prices – was briefly considered by Novoseletska and Myhaylychenko (2004). Authors note that nominal exchange rate stability could contribute to moderate growth rates of prices during the last few years.

There is not too much work directly addressing the relative importance of the credit channel of transmission. Kryshko (2001) is one example concentrating on the first stage of transmission, i.e. the behavior of commercial banks in response to monetary policy actions. The evidence provided by Zaderey (2003) suggests a rather weak potential for broad credit channel of monetary transmission. Novoseltska (2004) provide institutional analysis that can be helpful in assessing the potential importance of the channel.

Finally, it is worth mentioning that some work using simple structural approaches to modeling of monetary transmission has been initiated. Bolgarin et al. (2000) present some initial results.

3. VAR estimations for Ukraine

This section first describes a benchmark model specification and variables used to later review the results of the VAR exercise, mainly impulse response functions.

3.1. Model and data description

The benchmark VAR model, based on the one proposed by Peersman and Smets (2001), has the general representation as follows:

$$Y_t = A(L)Y_{t-1} + B(L)X_t + u_t \quad [1]$$

where Y_t – vector of endogenous variables, X_t – vector of exogenous variables, and A(L) and B(L) are polynomials of the lag operator.
Throughout the paper, the vector of exogenous variables appears in this way:

$$X_t=[y_{rus} \quad oil_w] \quad [2]$$

where y_{rus} is Russia's real output (more precisely – index of 5 basic sectors), and oil_w is an index of world oil prices. The former indicator is included in the model in order to allow for the impact of economic activity in Ukraine's largest trade partner on Ukrainian variables of interest. Secondly, since Ukraine is highly dependent on energy imports a variable capturing fluctuations in the world oil prices was included as well. By denoting these variables as exogenous, we simply assume that they are not affected by conditions of internal (Ukrainian's) economy. They may have contemporaneous influence on Ukrainian variables.
In turn, the vector of endogenous variables includes real GDP of Ukraine (y_t), internal inflation (p_t), real effective exchange rate (x_t) and domestic nominal interest rate (r_t):

$$Y=[y_t \quad p_t \quad x_t \quad r_t] \quad [3]$$

While estimating the model [1] several different interest rates are considered, including discount interest rate of the NBU (refinancing interest rate), interbank interest rate (market interest rate) and interest rate on commercial banks' loans to economic agents.
The NBU discount rate could be seen as the one that reflects the central bank's policy directly. However, in view of the fact that the NBU's actual policy throughout the period was maintaining hryvnia nominal exchange rate stability, the freedom to set the discount rate was arguably limited (for a discussion of NBU interest rates see Novoseletska, 2004). Thus, other rates such as interbank rate may have actually mirrored the combined monetary policy (a combination of exchange rate interventions and interest rate manipulation) closer than the official rate. On the other hand, interbank interest rate and loan rate may fluctuate not only in response to monetary policy but may also react to other market conditions. Nonetheless, comparison of the results obtained using different interest rates ought to increase robustness of analysis and give broader ground for inferences.
Several different price indices are used as well. As noted by Woźniak and Mykhaylychenko (2004), it is important to reference not only to observed ordinary consumer price index (CPI) but also indices that would reflect long run trend of inflation, namely core inflation. There are few basic core CPI indicators for Ukraine. One of them is trimmed mean (TMU CPI) and another one is obtained by excluding components that are most prone to seasonal fluctuations (EXC CPI). Therefore these two indices are also involved in the estimations as alternatives to ordinary CPI in order to investigate sensitivity of the model to employing different inflation indicators.

All the series, except from interest rates and real effective exchange rate (REER) are seasonally adjusted using the Demetra software developed by the Eurostat. Also, all endogenous and exogenous variables apart from interest rates are included in model in logs.

Estimations are carried for monthly data over the time period 1999M1 – 2004M8 (68 observations). We take beginning of 1999 as the starting point since this is the first year after the financial crisis that hit Ukraine in autumn 1998. Lag order is set to 6 (for more details see section 4.2).

VAR models for Ukraine are estimated in levels. Subsequently, check for stationary of any variables is not conducted (the short sample period would render the results dubious, anyway). Noteworthy this issue is quite controversial. For example, Lukyanenko (2002) argues for stationarity as a necessary condition for VAR models. In contrast, Kowalski at al. (2003) point to the choice between less efficiency and less information while talking about VAR evaluation in levels vs. first (n-th) differences. Estimation of VAR models in levels is typical in the kind of monetary transmission analysis as attempted in this paper (e.g. Peersman and Smets, 2001). One should also keep in mind low power of stationary tests applying to relatively short samples (which is exactly the case for Ukraine). Estimation of long-run relations between variables using co-integration theory also seems to suffer from poor efficiency under short series.

Unexpected orthogonal shock in monetary policy (expressed in innovation to interest rate) is identified through Choleski decomposition. Identification of SVAR using the triangular Choleski decomposition depends on the ordering of the variables in Y_t (for more details see for example Zivot (2000)). In our particular case we operate with the ordering as in [3]. Corresponding assumption is that interest rate changes have no contemporaneous impact on other variables (output, inflation and real exchange rate).

3.2. Estimation results

Basic results from VAR models are presented in Figures 1 and 2. There are responses of three different macroeconomic variables (output, inflation and real exchange rate) to one S.D. positive shock of interest rates. In the figure 1 one could observe confidence bands (measured as +/- 2 S.E.) as well. Confidence bands were calculated using Monte Carlo simulations (see EViews 3 Help System). Bold lines in the figure 2 depict results, obtained using models with different interest rates and ordinary observed CPI. Solid thin lines report results for model involving trimmed mean core CPI as domestic inflation measure. Lines with asterisks present impulse response functions corresponding to model specifications with exclusion-based core CPI.

Interest rate increase does not feed to GDP in a statistically significant way. Obtained impulse responses (with close to zero point estimates and wide confidence bands) suggest no transmission from interest rates to output. The downward trend in GDP that is visible from around 1.5 years after the shock (particularly in response to lending rate rise) is not statistically significant and appears to be too late after the monetary shock to be ascribed to this. Among interest rates, commercial banks' interest rate turns out to cause the strongest reaction of other macroeconomic variables and the weakest impact comes from the discount rate of the NBU, though this observation is only based on point estimates of responses and the ordering cannot be confirmed by statistical tests. It should also be noted that results obtained for models with observed CPI and trimmed mean core CPI are very close. Results of VAR with exclusion-based core CPI differ somewhat from them.

In turn, the negative response of inflation to monetary tightening indeed appears to be confirmed. Results are consistent for alternative interest rates and various inflation measures

(apart from exclusion-based core CPI). The results are also statistically significant in some months after the shock as judged from standard confidence bands. The strongest impact on inflation is reached after about year and half after monetary innovation. Inflation reacts the most robustly to the commercial banks' loan interest rates. This impact is roughly equal for CPI and TMU CPI. There is almost no impact on EXC CPI. The strongest influence of NBU interest rate is registered for trimmed mean inflation. According to the model, responds of ordinary CPI and exclusion based core inflation to changes in discount rate are weaker. This is the case for interbank rate as well.

Unexpected shock of monetary policy results immediately in a yearlong appreciation of the real effective exchange rate of hryvnia. Insignificant depreciation follows afterwards. The overall REER depreciation is relatively equal for all three VARs, although REER reaction in a VAR model with lending rates and TMU CPI is somewhat stronger.

These results also give additional rationale as to whether core inflation indicators may improve quality of results in modeling monetary processes. Previously Petryk and Polovnyov (2003) showed that polynomial distributed-lagged models for inflation modeling as a function of money supply or exchange rate give better results (in terms of R^2) when one uses some core inflation indicators instead of ordinary CPI.
Generally speaking, there are few indicators that characterize "quality" of VAR models. Specifically, Akaike and Schwarz criteria indicate determinant magnitude of model residuals covariance matrix. They allow for sample size, amount of endogenous variables and lag-order of the model as well. Therefore, under equality of other characteristics, we suggest comparing few models.
Table 1 contains values of three main statistics for different VAR models. One may notice that using of trimmed mean core inflation seems to be more appropriate in terms of these criteria. However, it should be stressed that these results are quite sensitive to the sample size, particularly for shorter samples. While applying shorter samples (starting, for example, in 7M2000) Akaike and Schwarz criteria are sensitive to lag-order as well.

Table1. **Statistical characteristics of VAR models**

	VAR with NBU's discount interest rate			VAR with interbank interest rate			VAR with loans interest rate		
	CPI	CPI EXC	CPI TMU	CPI	CPI EXC	CPI TMU	CPI	CPI EXC	CPI TMU
Log Likelihood	535.7	544.2	489.5	430.0	431.8	401.2	518.8	533.8	484.5
Akaike Criteria	539.2	547.6	493.0	433.5	435.3	404.6	522.2	537.3	488.0
Schwarz Criteria	542.9	551.3	496.7	437.2	439.0	408.4	526.0	541.0	491.7

4. Variance decomposition and robustness analysis

This section contains description of the variance decomposition functions for VARs that involve different interest rates and CPI together with core inflation indices. The second part presents robustness analysis. Response functions are considered using model specifications for various lag-orders and over different sample periods.

4.1. Variance decomposition

In this section we present results from decomposing the variance of the endogenous variables. The results can provide some information about relative importance of each random innovation to the variability of variables included in the VAR. Figure 3 depicts contributions of different interest rates to variances of Ukrainian macroeconomic indicators. Bold lines give contributions derived from models with ordinary CPI, solid thin lines trace variance

decomposition of different variables for models with trimmed mean core CPI. Finally, lines with asterisks discover information concerning the models with exclusion based core inflation.
All in all, there appears to be evidence of more significant relative contribution of interest rates random innovations for inflation variability and in the case of GDP the interest rates explain very small portion of its variability.

According to the results presented in Figure 2, exclusion based core inflation has the smallest share of its variance due to interest rates (it does not exceed 10%). On the contrary, CPI and TMU CPI dynamics "are explained" by NBU's discount rate and interbank interest rate by 20% (on average). Lending rate of commercial banks has more solid contribution – up to 45%. "Importance" of the interest rates reaches their peak year and a half after the innovation. Another peculiarity is that variance decomposition functions for trimmed mean core inflation and ordinary CPI are the same in case of applying of interbank and loan interest rates. In turn, TMU core CPI is more sensitive to discount rate of the NBU than ordinary CPI index is.

Variance decomposition functions of REER are more stable over time in comparison to those of inflation. They reach their maximum level a little bit earlier – at the end of the first year after an innovation. They are almost equal for models with different inflation indicators. According to the estimation results REER is more sensitive to lending rate (up to 30%). By contrast, "contribution" of discount rate is less than 15%.

As mentioned before, percent of GDP variance due to the interest rates shock is the smallest among all the variables that are considered in this research. For NBU's discount rate and commercial banks' loan rate it is less than 8% and for interbank rate – less than 15%.

4.2. Robustness analysis

In this part we provide robustness analysis by reporting impulse response functions for different sample periods and for different lag-orders. Figures 4 and 5 trace impulse responses of various variables to monetary policy unexpected shock based on the model [1]. They are calculated for models with different interest rates and for different inflation indicators. The figures present results for models with ordinary CPI only since they have the similar character with the core inflation indices.
Stability of response functions calculated for model specifications using different subsamples confirms that the presented results are not just period-specific. Similarity for different lags also confirms models robustness and may serve as an additional rationale for the chosen lag-order.

Figure 4 pictures impulse responses for models recalculated over shorter sample periods. The impulse responses for different samples are calculated for 6 lag-order VARs. Time periods start 6M1998, 1M1999, …, 6M2000 and the sample always runs up till the last month for which data were available, i.e. 8M2004. Thus, 5 different curves are plotted. Results in the figure 4 confirm the stability of the models over time – almost all lines look similar. There is only one significant outlier – REER respond to the lending rate innovation for the sample that starts 1M2000. But at the same time, interval estimate for this case, namely confidence interval, become very wide and contain all the responses for different samples. Therefore, it could not be considered an indication of model's instability in the analyzed period.
As one could expect while choosing the sample, response functions become different for longer periods (that start in 1998 and earlier). Different macroeconomic conditions and the

crises in 1998 are responsible for this. It stands to reason that the curves are deformed for the shorter samples as well. The logical explanation is that sample size amount to only 35 observations and less. At the same time, even though point estimates, that is response functions themselves, look different, confident bands become wider and cover other response functions.

As could be seen from figure 5, impulse responses for different lag-order VARs have similar directions. Similarly to the considerations in the previous paragraphs, although there are some outliers in point estimates (e.g. some GDP responses for lags greater than 6), their confidence bands are quite wide and do not indicate instability of the models.
Coming back to the issue of lag-order selection, it should be noted that low lag-order may not give very credible results, especially taking into account that we work with monthly data. At the same time, inclusion of too many lags could prove problematic because of the short sample. The fact that point estimates become a little bit different in some cases for higher lag-orders (see figure 5, lines with asterisks) was taken as an additional rationale for not using too many lags. Therefore, lag-order set to 6 seems to be more or less adequate.

5. Conclusions

In this paper a VAR model of monetary policy transmission for Ukraine was estimated. Evaluation was conducted in two "dimensions": for different interest rates and for various inflation measures. The main inference form the research is that responses of main macroeconomic variables (namely, GDP and inflation) to monetary policy unexpected shock broadly correspond to the general theory and experience in other countries. In particular, interest rates increase tends to dampen inflation, although the strength of the impact is hard to gauge. On the other hand, output does not appear to be reacting to interest rates in any systematic way. The transmission to the variables takes in some cases year and a half to materialize, a lag which is in the range found for many European economies.
Similarity of the results for different "dimensions" along with stability of response functions and confidence bands over various lag-orders and sample periods confirm robustness of the chosen VAR specification.

However, one should interpret the results with caution since there are several caveats:

1. Under current policy of managed floating influence of monetary policy on real economy through interest rates is limited. This is backed by analysis of variance decomposition functions that evidence relatively insignificant contribution of interest rates shocks for the real GDP and inflation variance.
2. Short data sample and its monthly frequency may tend to distort real picture. Therefore, the quality of such an analysis will increase with coming of new data and widening of the sample.
3. This is only general review of monetary transmission. For more coherent and credible conclusions one would need to undertake more detailed research of each step and different channels of transmission.

This work was attempting to apply in a Ukrainian context a well established methodology commonly used in other countries. Overall, the results are quite encouraging, although further investigation is definitely required.

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Figure 1. **Response (with confidence bands) of macroeconomic variables to unexpected monetary policy shock**
(Responses are built for 24 months ahead based on the VARs with ordinary CPI)

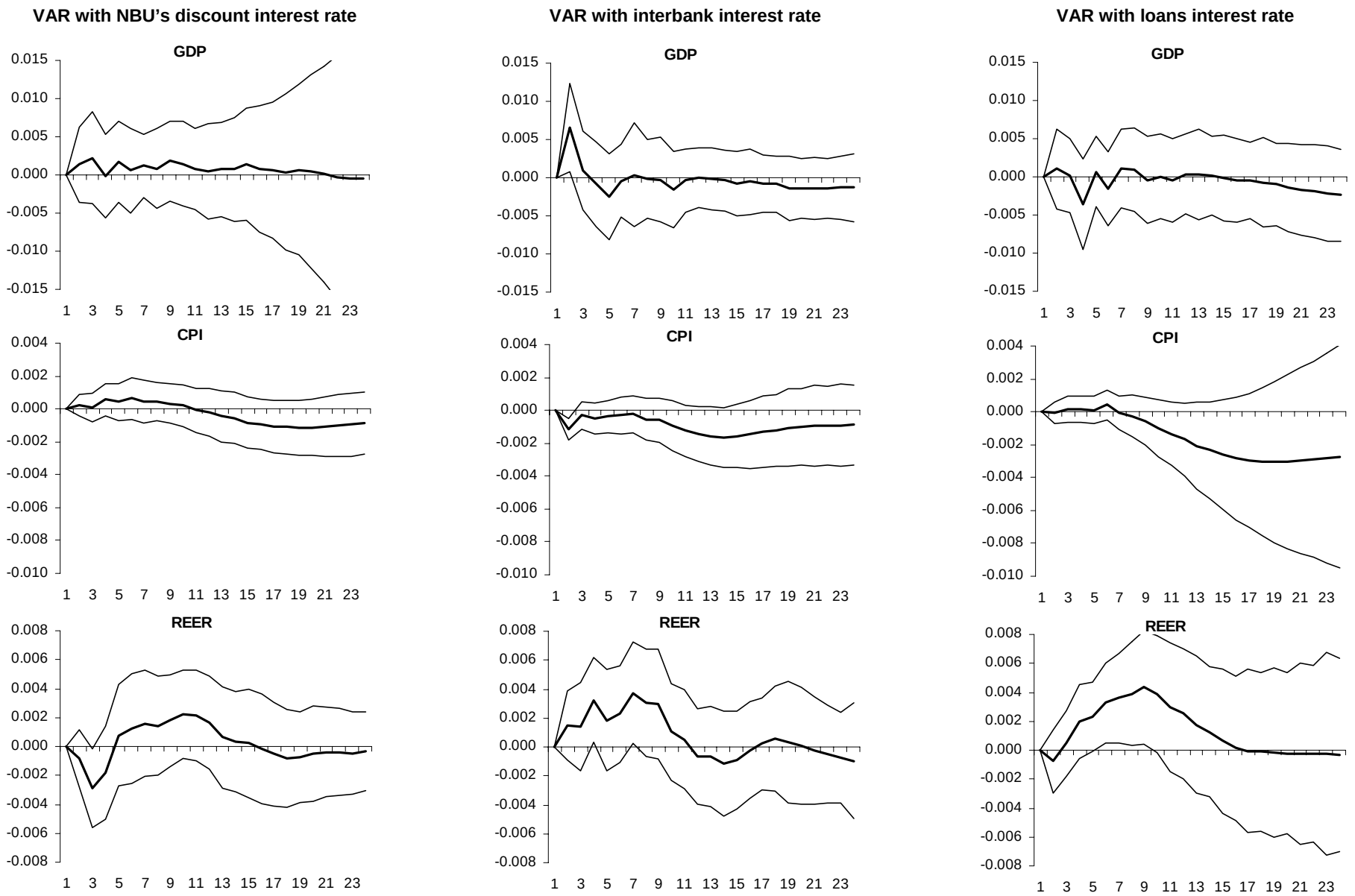

Figure 2. **Response of macroeconomic variables to unexpected monetary policy shock**
(Responses are built for 24 months ahead based on the VARs with different inflation measures)

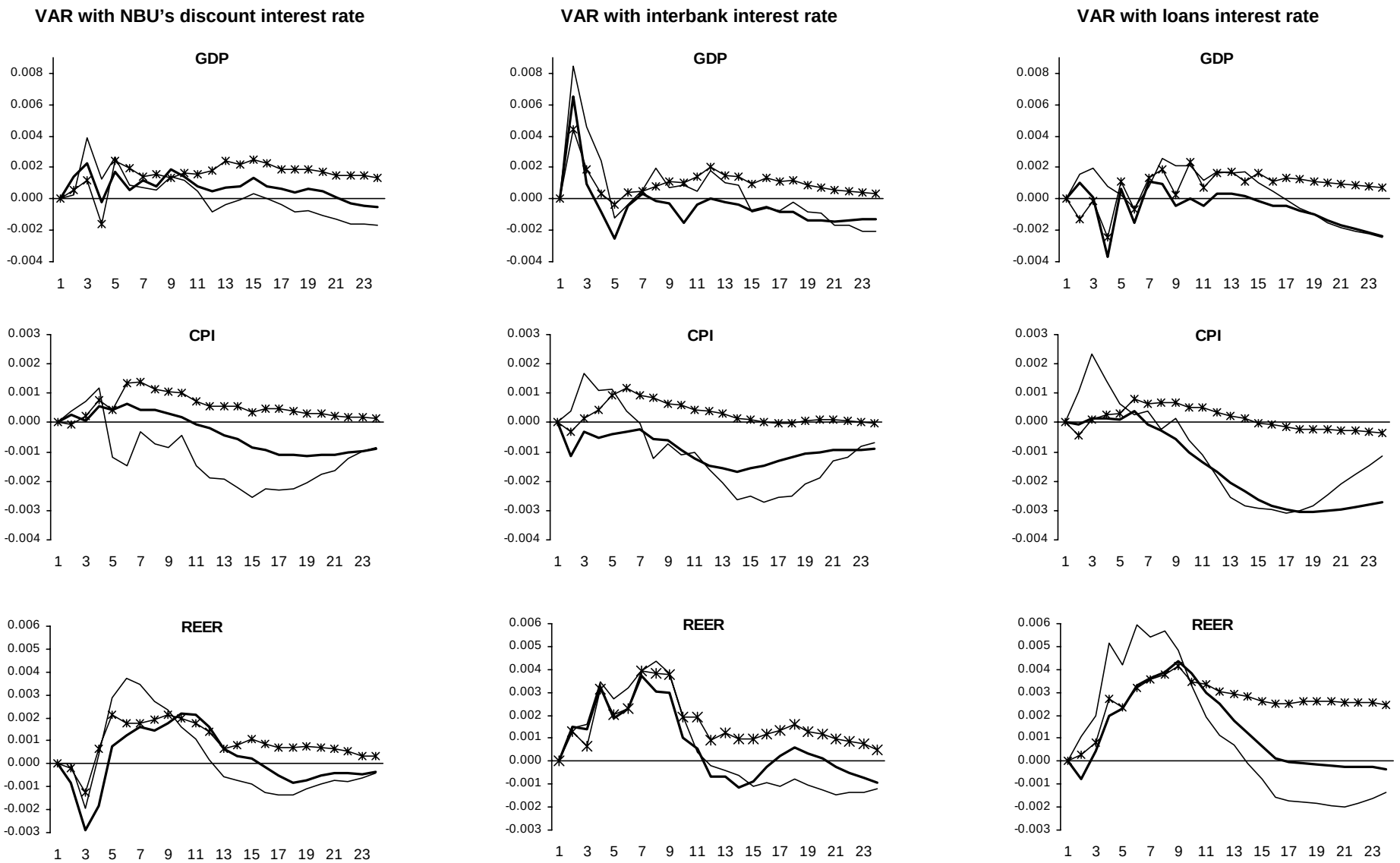

Figure 3. **Variance decomposition functions**

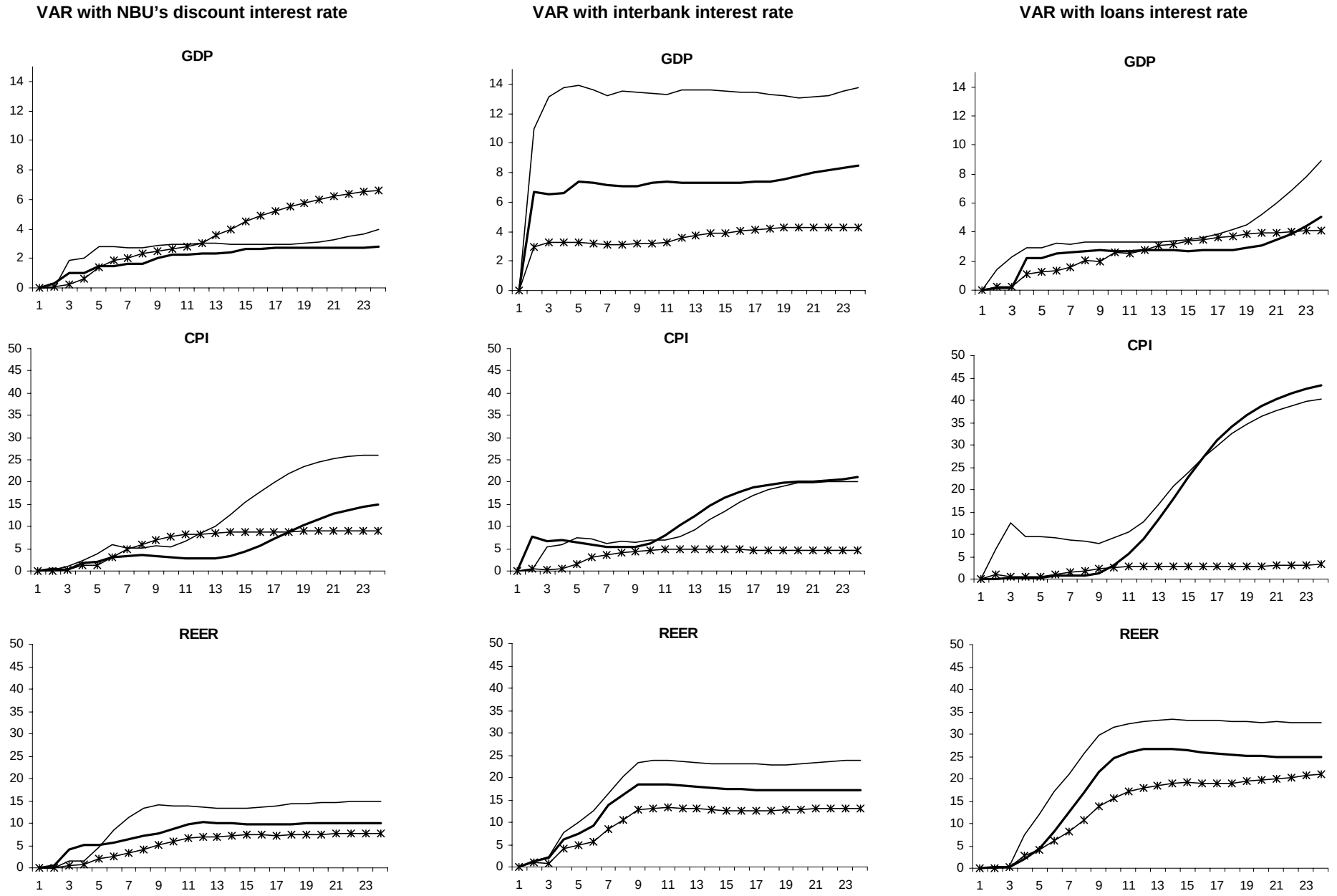

Figure 4. **Response functions of macroeconomic variables for VAR models based on different sample periods**
(Respondse are built for 24 months ahead based the VARs with ordinary CPI)

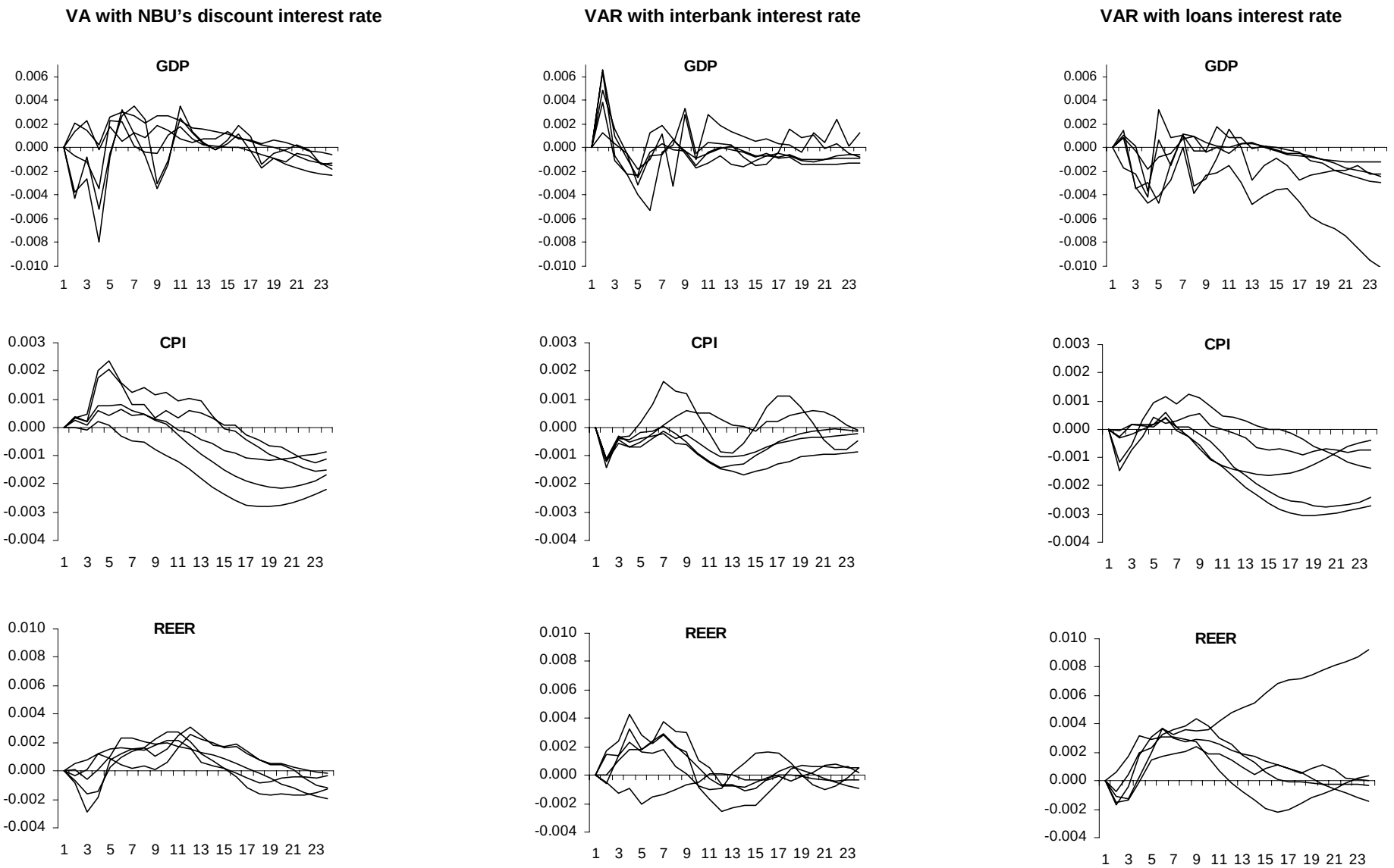

Figure 5. **Response functions of macroeconomic variables for VAR models with different lag-orders (lags 4-8)**
(Responses are built for 24 months ahead based the VARs with ordinary CPI)