Monetary targeting in Belarus:

A preliminary econometric assessment

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1. Introduction and motivation

- Reduction of inflation is one of the most important tasks of current economic policy in Belarus
- In 2015, the National Bank of Belarus (NBB) implemented monetary targeting to stabilize high inflation and to make monetary policy more credible
- Implementation of monetary targeting assumes clear-cut, stable relationships between the variables used as operational target, intermediate target and final target
- The lack of such relationships would make monetary targeting ineffective in reducing inflation

1. Introduction and motivation

The basic ideas of monetary targeting in Belarus are discussed in:

- Mironchik, N., Bezborodova, A. (2015). The possibilities of using monetary targeting regime in the Republic of Belarus, *Bankovskiy Vestnik*, 1, 3–9.
- Kalechits, D. (2015). About the key aspects of monetary policy in 2015, *Presentation of the NBB*.

The authors present the rationale for monetary targeting in Belarus and some quantitative justifications of its effectiveness for controlling inflation.

We use these materials as a starting point of our analysis

1. Introduction and motivation

Key points of monetary targeting in Belarus:

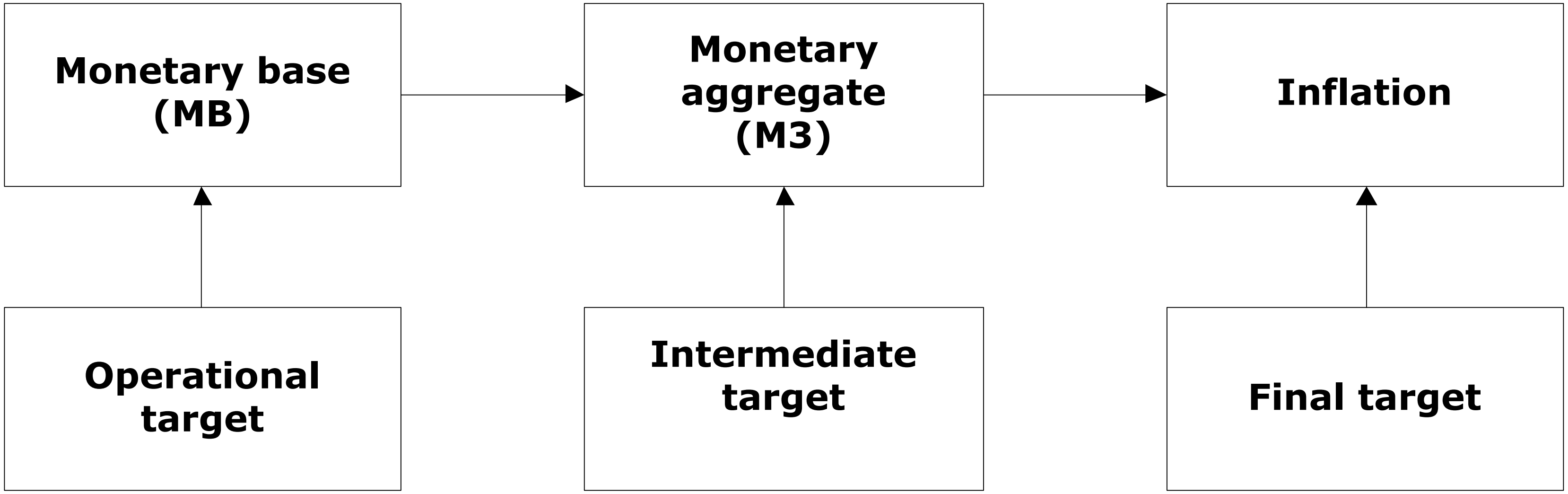
1. The NBB choses an operational target and an intermediate target to control inflation
2. The NBB should be able to control the operational target
3. The NBB choses an appropriate monetary aggregate as an intermediate target. This monetary aggregate has to meet the following criteria:

- Stable relationship between operational and intermediate target;
- Stable (real) money demand function for this aggregate;
- Stable relationship between monetary aggregate and inflation.

1. Introduction and motivation

- M3 is chosen as a an intermediate target (ΔM3)
- Ruble monetary base controllable by the NBB is chosen an operational target (ΔMB, monthly and quarterly)

Figure 1. Monetary targeting in Belarus: The general concept



1. Introduction and motivation

Some simple correlations:

Table 1. Correlation matrix (variables in natural logs, nsa)

	1995Q1–2014Q4			2002Q1–2014Q4		
	Δmb	$\Delta m3$	Δcpi	Δmb	$\Delta m3$	Δcpi
Δmb	1.00	-	-	1.00	-	-
$\Delta m3$	0.74	1.00	-	0.51	1.00	-
Δcpi	0.56	0.83	1.00	0.23	0.76	1.00

The correlations between operational and intermediate target, and intermediate and final target are significant, but for 2002Q1–2014Q4 they are lower

1. Introduction and motivation

Some Granger causality tests: *A variable X Granger-causes variable Y, if Y can be better predicted using the histories of both X and Y than using the history of Y alone*

Table 2. Granger causality (Toda, Yamamoto (1995) procedure)

Direction of causality	1995Q1–2014Q4		2002Q1–2014Q4	
	χ^2(Wald) test	*p*-value	χ^2(Wald) test	*p*-value
mb→*m*3	3.58	0.1669	0.14	0.9328
*m*3→*mb*	13.72	0.0011	9.32	0.0095
*m*3→*cpi*	2.33	0.6753	26.42	0.0000
cpi→*m*3	26.20	0.0000	46.60	0.0000

Note: for (*mb*, *m*3) and (*m*3, *cpi*) lags length equal to 2 and 4 are chosen respectively. Additional lag is added to each test in accordance with Toda, Yamamoto (1995). Seasonal dummies are also included. All equations are tested for serial correlation.

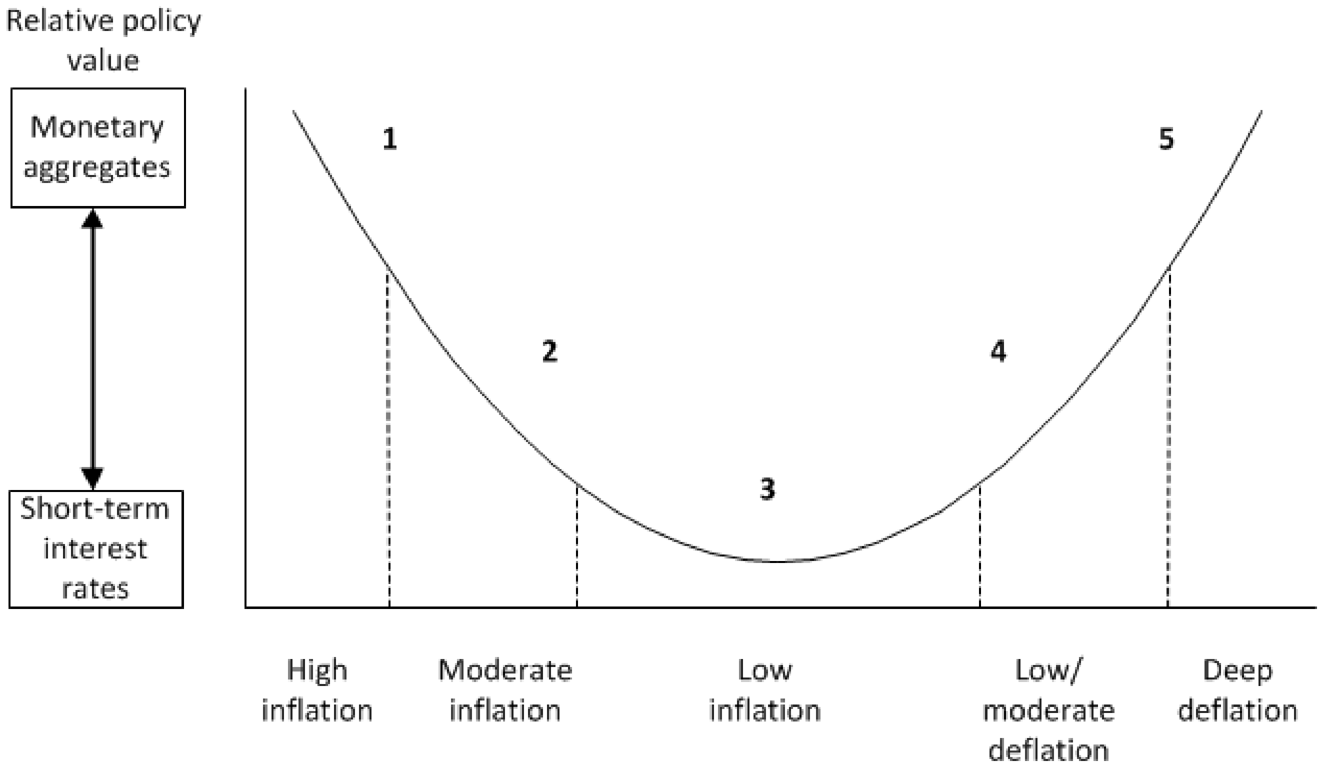
1. Introduction and motivation

Some preliminary conclusions:

- Operational, intermediate and final target are moderately correlated, but over the last years these correlations became lower
- The operational target does not Granger cause the intermediate target, but one can see a reverse causality
- Over 1995Q1–2014Q4, M3 did not Granger cause CPI, but the other way around. Over 2002Q1–2014Q4, a bi-directional causality was observed. However, the sum of the coefficients at M3 lags is not statistically different from zero
- Simple correlations and causalities cannot justify monetary targeting in Belarus → **A more comprehensive analysis is needed**

2. When can monetary aggregates be useful for monetary policy?

Figure 2. Monetary policy: Zonal view



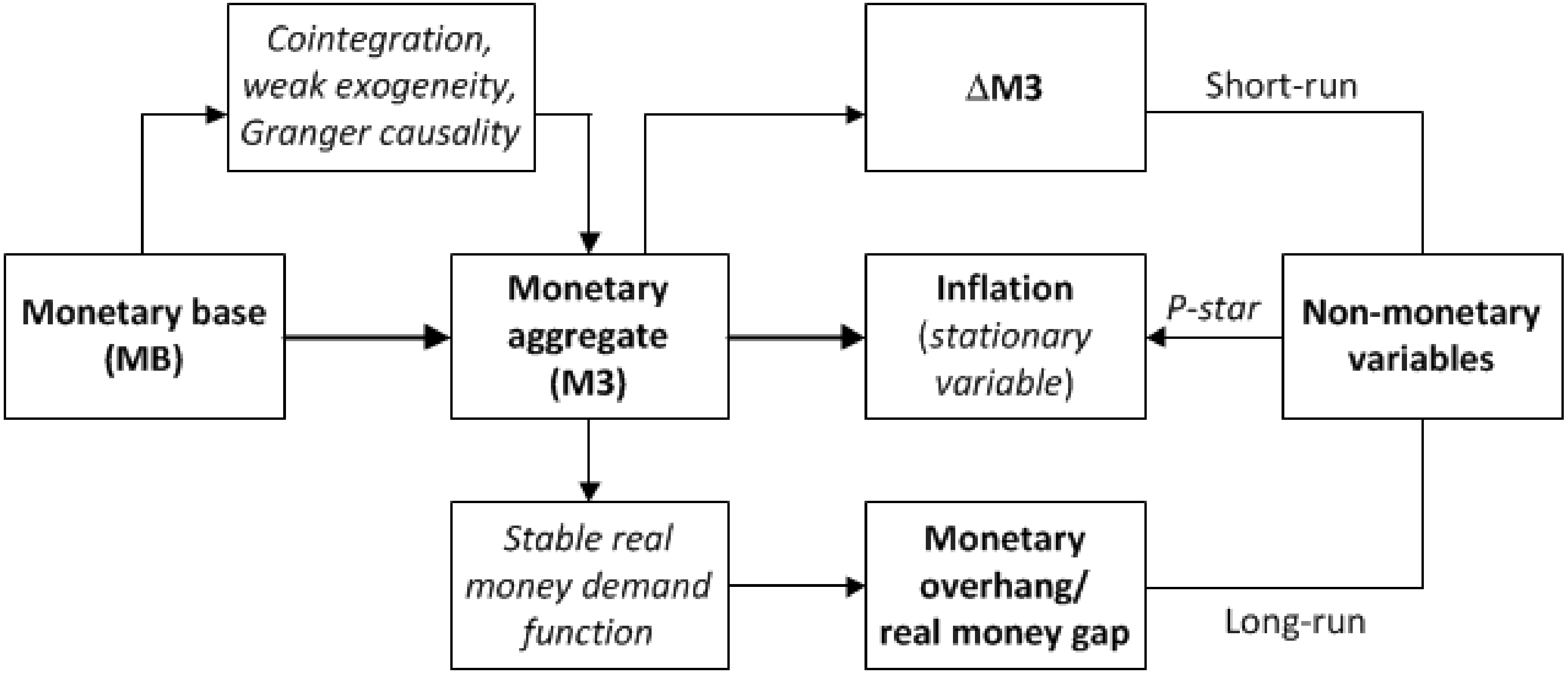
Source: Bordo, M. D., Filardo, A. (2007). Money still makes the world go round: The zonal view, *Journal of the European Economic Association*, 5, 509–523.

2. When can monetary aggregates be useful for monetary policy?

- Many leading monetary economists have come to regard monetary aggregates as obsolete measures of the stance of monetary policy (although the ECB is still using “two pillar” strategy)
- A U-shaped pattern exists between different zones and the usefulness of monetary aggregates relative to real short-term interest rates as measures of the stance of monetary policy (<u>empirically validated</u>)
- Monetary aggregates are useful for monetary policy especially under high inflation (<u>Belarusian case</u>) and deep deflation. Ultimately, the degree to which this is relevant is an empirical issue

3. Research strategy and methodology

Figure 3. The econometrics of monetary targeting



Note: hypotheses to be tested are presented in italic.

3. Research strategy and methodology

Three steps in the empirical analysis:

- Analysis of money supply (testing for cointegration, exogeneity, Granger causality) using CVAR procedure.

  The main hypothesis to be tested: Intermediate target (M3) is controllable through an operational target (MB)

- Analysis of money demand for M3, using CVAR procedure.

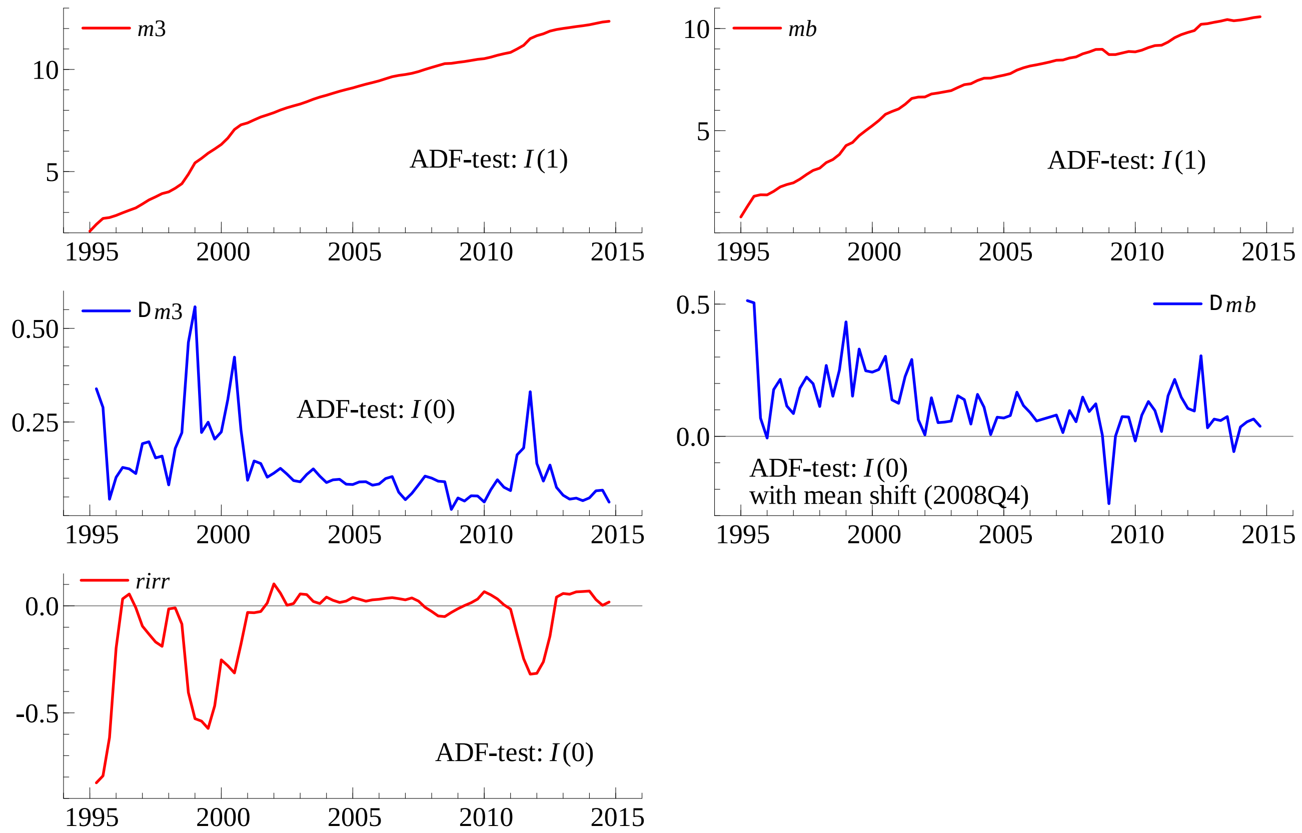
  The main hypothesis to be tested: There is a stable long run real money demand function for M3

- Determination of the role of money in inflation dynamics using a P*-model.

  The main hypothesis: money is a useful indicator for inflation both in the long-run and in the short run

4. Money supply: Testing the relationship between operational and intermediate target

Figure 4. Data used: monetary aggregate *m*3, monetary base (*mb*), real refinancing rate (*rirr*), all variables in natural logs, nsa, the data span the period 1995Q1–2014Q4



4. Money supply: Testing the relationship between operational and intermediate target

Testing the controllability of intermediate target ($m3$) by means of operation target (mb):

- Cointegration between $m3$ and mb
- Weak exogeneity of mb with respect to $m3$
- Granger causality from Δmb to $\Delta m3$, but not vise versa (strong exogeneity of mb)
- Positive significant long-run impact of mb shock on $m3$ from long-run impact matrix C, but not vise versa

Note: controllability testing within the cointegrated VAR model is discusses, for instance, in Hendry, D. F., Mizon, G. E. (1998). Exogeneity, causality, and co-breaking in economic policy analysis of small econometric model of money in the UK, *Empirical Economics*, 23, 267–294; Johansen, S., Juselius, K. (2003). Controlling inflation in a cointegrated vector autoregressive model with an application to US data*, Discussion paper* 01–03, University of Copenhagen Department of Economics

4. Money supply: Testing the relationship between operational and intermediate target

- Pairwise cointegration between *m*3 and *m*b does not lead to sensible results in terms of weak exogeneity and Granger causality, so we include additional variable to the system – real refinancing rate (*rirr* – stationary variable)
- To handle stationary variable in Johansen cointegration test, we use the approach proposed by Rahbek, A. Mosconi, R. (1999). Cointegration rank inference with stationary regressors in VAR models, *Econometrics Journal*, 2, 76–91
- We use the system (*m*3, *mb*) with 2 lags, unrestricted constant and restricted trend, centered seasonal dummies; *rirr* is included in short-run part of the CVAR with lags 0 and 1, and in cointegrating vector as an accumulated variable, cum(*rirr*)

4. Money supply: Testing the relationship between operational and intermediate target

Table 3. Cointegration analysis (1995Q1–2014Q4)

Rank	LR-trace	*p*-value	*p*-value (bootstrap)
0	54.50	0.0000	0.0010
1	11.79	0.1636	0.2676
Cointegrating vector			
m3	***mb***	**cum(*rirr*)**	***trend***
1	−0.8851	0.1083	−0.0188
Testing exclusion restrictions (for rank = 1), $\chi^2(1)$ and (*p*-value)			
m3	***mb***	**cum(*rirr*)**	***trend***
30.6231	28.9193	10.9169	16.8495
(0.0000)	(0.0000)	(0.0010)	(0.0000)
Weak exogeneity test, (for rank = 1), $\chi^2(1)$ and (*p*-value)			
m3	***mb***		
26.7961	0.5570		
(0.0000)	(0.4555)		

4. Money supply: Testing the relationship between operational and intermediate target

Table 4. Granger causality test (for rank =1)

Direction of causality	χ^2(Wald) test	*p*-value	p-value (bootstrap)
$\Delta mb \rightarrow \Delta m3$	30.5594	0.0000	0.0010
$\Delta m3 \rightarrow \Delta mb$	3.3227	0.1899	0.2796

Table 5. The C-matrix (for rank =1) with standard errors

Variable	Shock	
	ε_{m3}	ε_{mb}
*m*3	0.2167 (0.2758)	**1.0890** **(0.3065)**
mb	0.2443 (0.3116)	**1.2303** **(0.3463)**

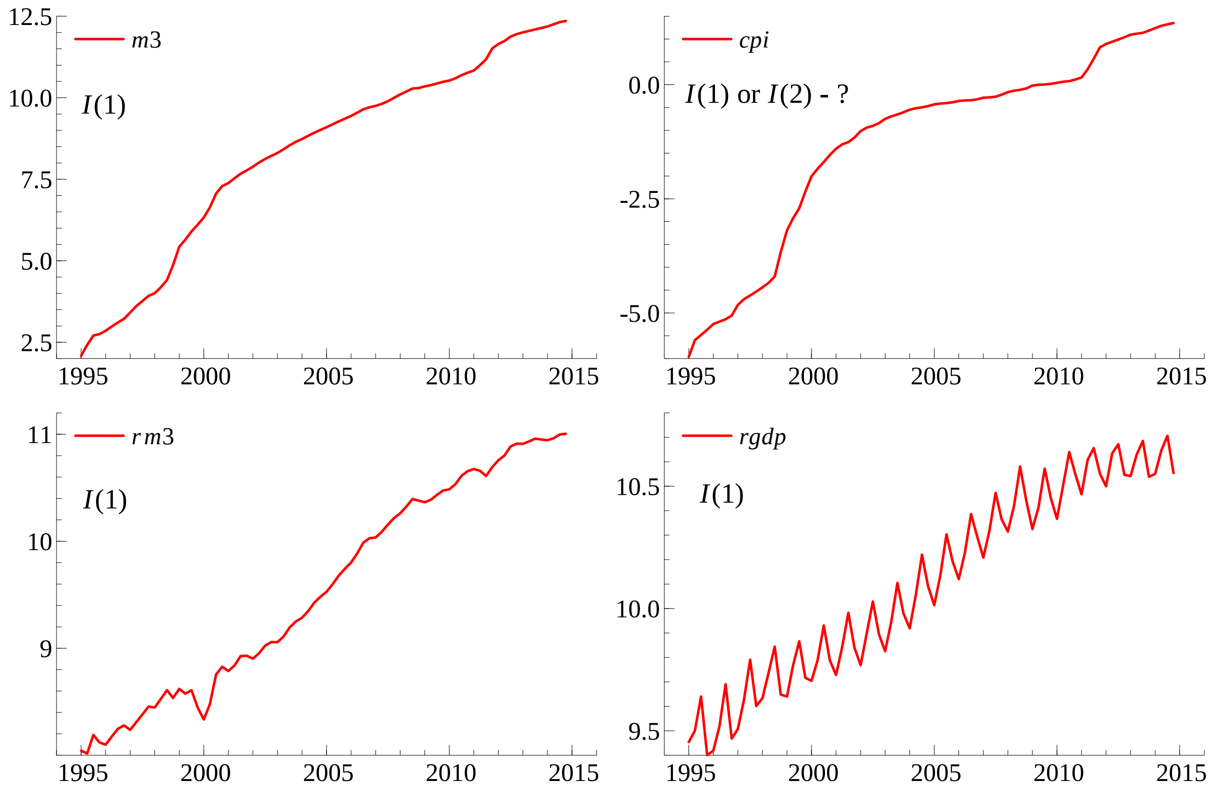
4. Money supply: Testing the relationship between operational and intermediate target

Conclusions (1):

- There is strong evidence for the existence of cointegration (long-run relationship) between operational target (*mb*) and intermediate (*m*3)
- Operational target (*mb*) is strongly exogenous with respect to intermediate target (*m*3), i.e. weak exogeneity of *mb* and Granger non-causality from $\Delta m3$ to Δmb, when the real refinancing rate is included into the system
- There is a significant positive long-run impact of an operational target (*mb*) shock on intermediate target (*m*3), but not vise versa
- Thus, in accordance with Belarusian historical data, **the intermediate target is controllable by the operational target**

5. Estimating M3 money demand

Figure 5. Data used: monetary aggregate *m*3, consumer price index (*cpi*), real gross domestic product (*rgdp*) in 2009 prices, real *m*3 (*rm*3), all variables in natural logs, nsa, the data span the period 1995Q1–2014Q4

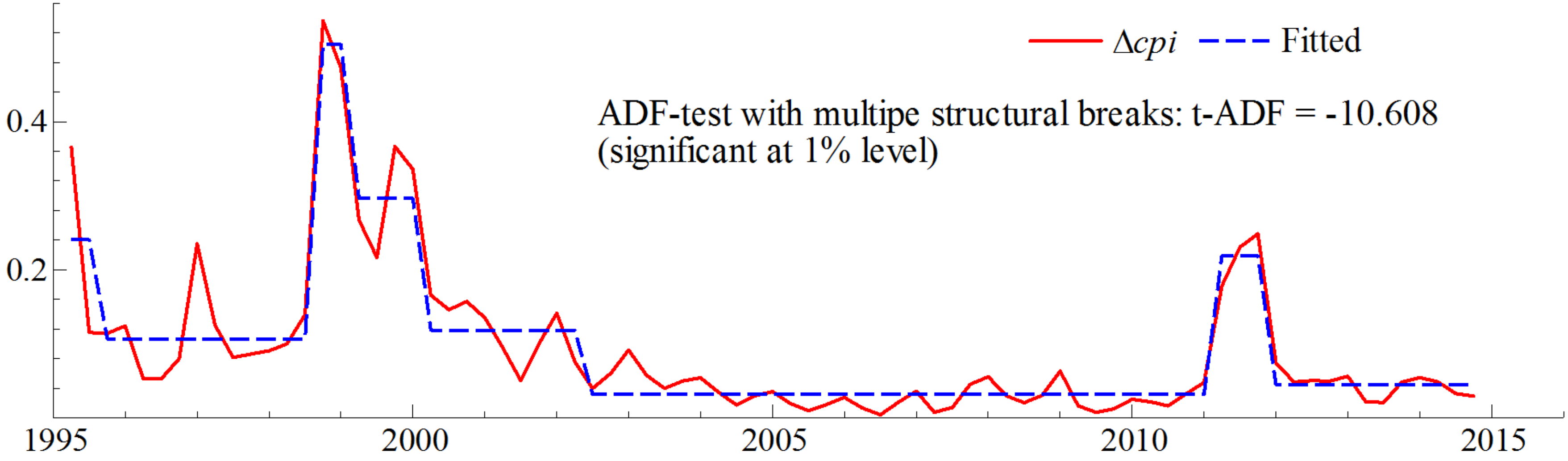


5. Estimating M3 money demand

Is inflation stationary?

Usual ADF-test with Constant + Seasonals: unit root cannot be rejected (t-ADF = −2.29, 5%= −2.90 1%= −3.52)

Figure 6. Inflation dynamics with a changing mean



5. Estimating M3 money demand

Price homogeneity:

- To test price homogeneity we use the system (*m*3, *cpi*, *rgdp*) with 4 lags, unrestricted constant and restricted trend, centered seasonal dummies.
- Then we test for cointegration and determine the cointegration rank (the number of cointegrated vectors)
- After that, the price homogeneity restriction is tested
- Another interesting question: Adjustments within the system (weak exogeneity test)

5. Estimating M3 money demand

Table 6. Cointegration analysis for nominal *m*3

Rank	LR-trace	*p*-value	*p*-value (bootstrap)
0	51.96	0.0049	0.0540
1	18.37	0.3195	0.6568
2	5.61	0.5120	0.7214
	Cointegrating vector		
***m*3**	***cpi***	***rgdp***	***trend***
1	−0.9412	2.0705	−0.0099
	Testing exclusion restrictions (for rank = 1), $\chi^2(1)$ and (*p*-value)		
***m*3**	***cpi***	***rgdp***	***trend***
9.6191 (0.0019)	9.8489 (0.0017)	12.2439 (0.00050)	1.7750 (0.1828)
	Adjustment coefficients, α		
***m*3**	***cpi***	***rgdp***	
-0.4500	-0.1443	-0.1651	
	Weak exogeneity test, (for rank = 1), $\chi^2(1)$ and (*p*-value)		
***m*3**	***cpi***	***rgdp***	
24.8695 (0.0000)	1.8276 (0.1764)	10.1710 (0.0014)	
	Restricted cointegrating vector (price homogeneity hypothesis)		
***m*3**	***mb***	***rgdp***	***trend***
1	-1	-2.2413	0

LR-test $\chi^2(2)$ = 5.73 (0.0570)
LR-test (bootstrap) $\chi^2(2)$ = 5.73 (0.4592)

5. Estimating M3 money demand

There are two important conclusions from the analysis of the nominal system:

- There is one cointegrating vector among nominal money, prices and real GDP. The hypothesis of price homogeneity within this system cannot be rejected, so we can turn to real money demand function without loss of information
- Prices are an exogenous variable in the considered system. Moreover, the adjustment coefficient for the price equation has a wrong (-) sign. So, it is not econometrically possible to invert the nominal money demand function into an appropriate price equation

Note: see Ericsson, N.R. (1998). Empirical modeling of money demand, Empirical Economics, 23, 295–315 for discussion on the consequences of inappropriate money demand function inversion

5. Estimating M3 money demand

We estimate the following CVAR for real money demand:

- ($m3 - cpi$, $rgdp$) with 2 lags, unrestricted constant and restricted trend, centered seasonal dummies. Additionally, year-on-year inflation ($\Delta_4 cpi$) is included as $I(1)$ variable with lag = 0 in order to take into account the opportunity costs of holding real $m3$ balances
- Without an opportunity cost variable it is not possible to find cointegration between real $m3$ and $rgdp$

5. Estimating M3 money demand

Table 7. Cointegration analysis for real m3

Rank	LR-trace	*p*-value	*p*-value (bootstrap)
0	32.05	0.0345	0.0485
1	5.62	0.7324	0.7304
	Cointegrating vector		
m3−cpi	***rgdp***	Δ_4***cpi***	***trend***
1	−1.8892	0.1271	−0.0110
Testing exclusion restrictions (for Rank = 1), $\chi^2(1)$ and (*p*-value)			
m3−cpi	***rgdp***	Δ_4***cpi***	***trend***
20.7250	16.9850	5.8602	4.5073
(0.0000)	(0.0000)	(0.0155)	(0.0338)
	Adjustment coefficients, α		
m3−cpi	***rgdp***		
-0.3226	0.0981		
Weak exogeneity test, (for Rank = 1), $\chi^2(1)$ and (*p*-value), [p-value bootstrap]			
m3−cpi	***rgdp***		
21.2945	3.1159		
(0.0000)	(0.0775)		
[0.0110]	[0.1671]		

5. Estimating M3 money demand

Stability analysis:

1. Fluctuation tests of the constancy of the non-zero eigenvalues:
- fixed short-run parameters: OK;
- updated short-run parameters: OK

2. Tests for constancy of long-run parameters
- fixed short-run parameters: OK? (marginally > 5%);
- updated short-run parameters: not OK (marginally > 1%);

3. Fluctuation tests for the constancy of short-run parameters:
- for $m3-cpi$: OK
- for $rgdp$: OK

5. Estimating M3 money demand

Conclusions (2):

- We can conclude that for real M3 there is a quite stable money demand function with expected signs of parameters and values of estimated long-run coefficients
- Cointegrating vector can be used for construction of real money gap
- Real money gap is estimated on the basis of cointegrating vector from Table 7, where *rgdp* is replaced by *rgdp** (potential *rgdp*)
- Real money gap can be used as the variable characterizing disequilibrium on the money market within *P**-model of inflation
- The coefficient at real money gap (with lag 1) should be positive and statistically significant in *P**-model

6. Modeling inflation

Autometrics with correction for large residuals ($\alpha = 0.01$)

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Modelling Dcpi by OLS
The estimation sample is: 1996(2) - 2014(4)
```

	Coefficient	Std.Error	HACSE	t-HACSE	t-prob	Part.R^2
Dcpi_1	0.585108	0.07635	0.09450	6.19	0.0000	0.3674
Constant	2.11113	0.5391	0.5491	3.84	0.0003	0.1830
Dm3	0.514575	0.07449	0.1151	4.47	0.0000	0.2325
Dm3_1	-0.294537	0.07484	0.1017	-2.90	0.0051	0.1128
rmgap_1	0.210042	0.05421	0.05510	3.81	0.0003	0.1804
Seasonal_1	-0.0386840	0.009103	0.01178	-3.28	0.0016	0.1404
Seasonal_2	-0.0325576	0.008824	0.008588	-3.79	0.0003	0.1788
I:1998(4)	0.0702395	0.04838	0.03591	1.96	0.0547	0.0548
I:1999(4)+I:1998(4)	0.166700	0.03110	0.009094	18.3	0.0000	0.8358

```
AR 1-5 test:       F(5,61)    =   1.3126 [0.2706]
ARCH 1-4 test:     F(4,67)    =   4.4838 [0.0029]**
Normality test:    Chi^2(2)   =   19.219 [0.0001]**
Hetero test:       F(10,62)   =   2.0277 [0.0452]*
Hetero-X test:     F(16,56)   =   2.0769 [0.0230]*
RESET23 test:      F(2,64)    =  0.69333 [0.5036]
```

6. Modeling inflation

Analysis of lag structure, coefficients:

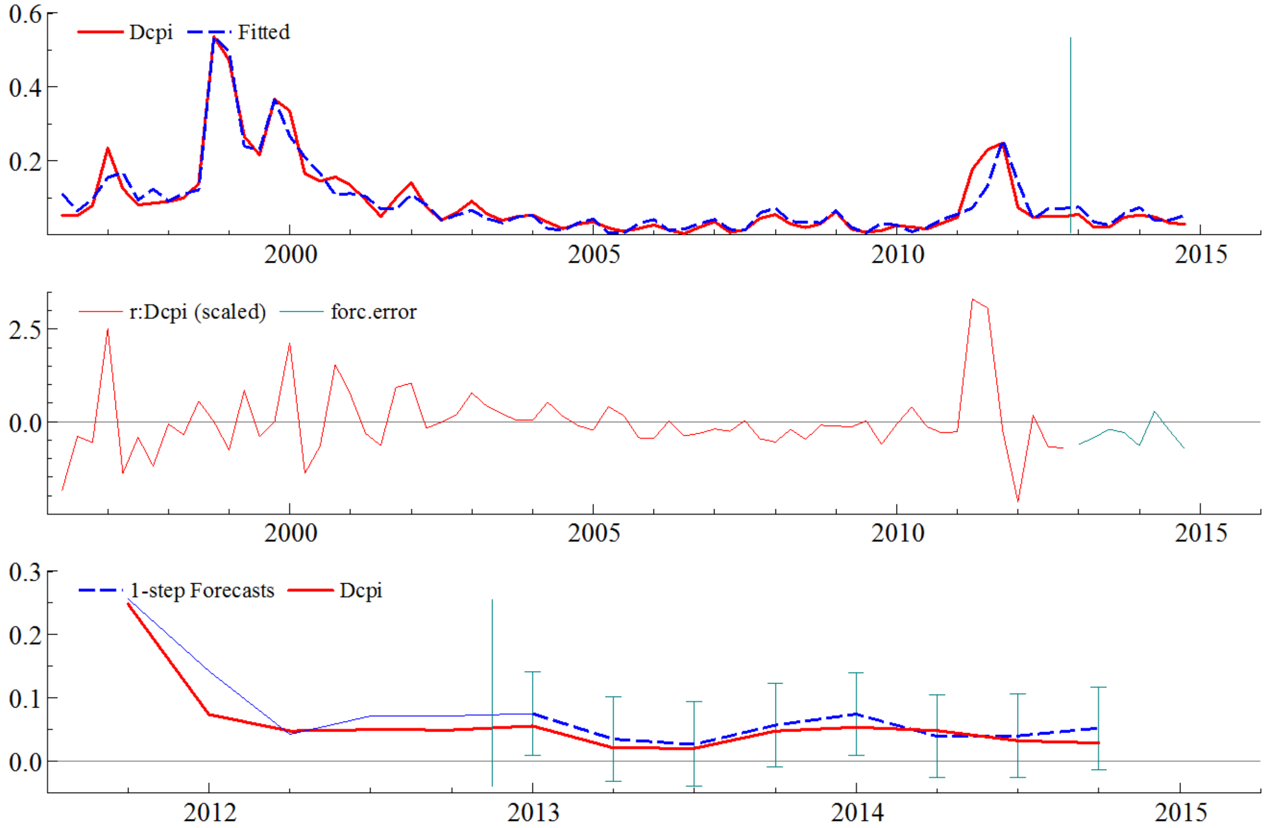
	Lag 0	Lag 1	Sum	SE(Sum)
Dcpi	-1	0.585	-0.415	0.0764
Constant	2.11	0	2.11	0.539
Dm3	0.515	-0.295	0.22	0.0904
ecm3	0	0.21	0.21	0.0542
Seasonal_1	-0.0387	0	-0.0387	0.0091
Seasonal_2	-0.0326	0	-0.0326	0.00882
I:1998(4)	0.0702	0	0.0702	0.0484
I:1999(4)+I:1998(4)	0.167	0	0.167	0.0311

Conclusions (3):

- Money is significant both in long-run and short run in *P**-model of inflation
- Inflation persistence does also matter

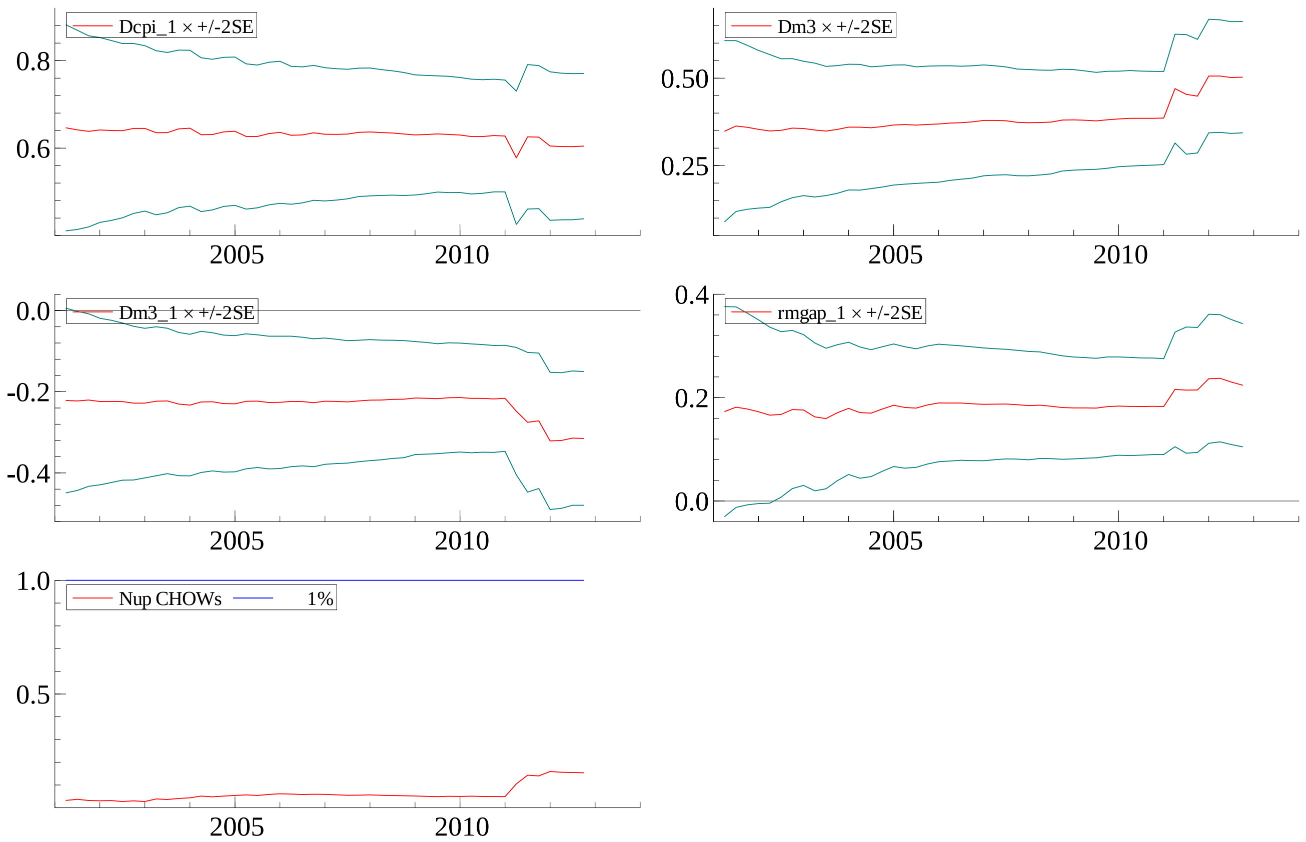
6. Modeling inflation

Pseudo out-of-sample forecast (8 quarters):



6. Modeling inflation

Testing model stability:



7. Conclusions and policy recommendations

- There is econometric evidence that the operational target, intermediate target and final target are related in the right manner for monetary targeting in Belarus. Such relationships are confirmed for a rather long period: 1995Q–2014Q4
- The monetary base and M3 are cointegrated. Monetary base is strongly exogenous related to M3. Intermediate target is controllable by operational target. Thus, **the first requirement for monetary targeting is fulfilled**
- Money and prices are homogeneous, so the usage of real money is an appropriate option. In a nominal system, money does not influence prices, which is bad news for inflation targeting. Probably, the relationship between money and prices is more complex than modeled

7. Conclusions and policy recommendations

- The is quite a stable money demand function for real M3. Thus, **<u>the second requirement for monetary targeting is relatively fulfilled</u>.** However, the absence of relevant opportunity cost indicator (beside inflation) makes real money demand function for M3 less informative concerning the behavior of economic agents.
- Cointegrating vector from real money demand function is used for construction of the real money gap, reflecting disequilibrium on money market
- Real money gap (with one lag) and changes of M3 are statistically significant in a *P**-model of inflation. Thus, **<u>the third requirement for monetary targeting is fulfilled</u>**

7. Conclusions and policy recommendations

- In general, monetary targeting in Belarus can be justified from an econometric point of view using relatively long historical data
- However, the obtained relationships are very sensitive to model specification. Moreover, the real money demand function for M3 is far from a traditional one with a set of opportunity cost measures. There is no direct link between M3 and CPI in nominal terms. So, the money demand function cannot be inverted into a price equation. The impact of money on prices is rather complex through the real money gap measure
- Taking into account these complexities, monetary targeting should be considered as a transitional regime of monetary policy in Belarus

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