Monetary Assets Expenditures and Economic Growth[1]

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ABSTRACT

The research showed, that monetary phenomena may support us with equally good or even better information on GDP behavior than message coming from analysis of potential output gap. The authors propose a method of modeling GDP changes with a use of Monetary Assets Expenditures (MAE). This variable represents central bank monetary policy restrictiveness, and according to economic theory, its impact is being transmitted on real economy. Empirical results show that MAE, being lagged by three quarters, carry useful knowledge on future GDP performance. MAE added to models with Potential Output Gap (PO) variable, used for forecasting GDP, improves noticeably properties of these models. Moreover, MAE may also be used as a substitute for PO variable in modeling GDP as it delivers slightly better statistical results. MAE variable is a less arbitrary approach than relying on modeling GDP with PO and more practical one as all the data required for modeling MAE is available much faster.

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1. Introduction

In this short paper we introduce a concept of **Monetary Assets Expenditures** (MAE) in modeling GDP changes. Being a measure of restrictiveness of central bank monetary policy, MAE, according to theory, should have impact on real economy behavior. We check existence of these phenomena by using MAE in modeling GDP.

The paper is organized in a following way. Firstly, we briefly present methodological aspects of construction MAE, which are based on Divisa indices methodology [Barnett (1980), (1982)]. Then, we discuss some issues related to construction of MAE for Poland and present the results. Finally, we show empirical results of modeling GDP with a use of MAE. We test effectiveness of this method by using MAE as a supplementary variable or a substitute for **Potential Output** (PO) variables used in modeling GDP.

2. Methodology of computing Monetary Assets Expenditures

Concept of MAE comes from Divisia method of measuring monetary aggregates. Its detailed methodology of computing is presented in [Kluza K., Kluza S., (2003)]. Below, some main methodological issues are outlined.

Divisa index method consist in calculating relative changes of selected monetary aggregate (M_t) as a weighted sum of changes of its components (m_{it}). In its general form Divisia index is continuous with respect to time (see Equation 1) [Divisia, 1925].

$$\frac{d\log M_t}{dt} = \sum_{i=1}^{n} s_{it} \frac{d\log m_{it}}{dt} \qquad (1)$$

In practice, this approach was not very useful due to property of time continuity. The formula was approximated with a discrete time variable. The modified formula (Eq. 2) is known as Tornqvist-Theil approximation [Tornqvist (1936), Theil (1966)].

$$\log M_t - \log M_{t-1} = \sum_{i=1}^{n} \bar{s}_{it} (\log m_{it} - \log m_{i,t-1}) \qquad (2)$$

where:
m_{it} – values of monetary aggregate components in period *t*
$\bar{s}_{it}$ – shares of individual monetary assets (m_{it}) in total expenditures of monetary assets (Y_t).

$$\bar{s}_{it} = \tfrac{1}{2}(s_{it} + s_{i,t-1}), \qquad (3)$$

where:

$$s_{it} = \frac{\pi^*_{it} m_{it}}{Y_t} \qquad (4)$$

and

$$y_{it} = \pi^*_{it} m_{it}, \qquad (5)$$

$$Y_t = \sum_{i=1}^{n} \pi^*_{it} m_{it} \qquad (6)$$

π^*_{it} – monetary asset real user cost
y_{it} – expenditures for monetary services (transactional services) borne by a selected component of monetary aggregate (m_i) in period *t*.
Y_t - aggregated expenditures for monetary services. The Equation 6 can be treated as the general equation for calculating MAE.

User cost required for computing MAE is derived as follows:

$$\pi^*_{it} = \frac{R_t - r_{it}}{1 + R_t}, \qquad (7)$$

or

$$\pi_{it} = p^*_t \frac{R_t - r_{it}}{1 + R_t}, \qquad (8)$$

where

$$\pi^*_{it} = \frac{\pi_{it}}{p^*_t} \qquad (9)$$

π_{it} – monetary asset nominal user cost
r_{it} – nominal interest rate for monetary asset (m_{it})
R_t – benchmark interest rate in period *t*
p^*_t – aggregated index of price changes in economy e.g. Consumer Price Index.

It is important to properly identify benchmark interest rate (R). Benchmark interest rate should be the highest interest rate available for monetary assets on the market. Usually it represents less liquid assets (low transaction properties). Benchmark interest rate should not provide other monetary services except from return for keeping savings in it. According to aggregation theory (Barnett, Hinich, Yue (1991)), the monetary asset with the highest return shall be always selected. This rule doesn't restrict changing this benchmark asset. In different time periods, benchmark interest rate may be connected with different monetary assets.

Benchmark interest rate has a characteristic of expected rate of return. It may be defined as in (10), where (r_{it}) is a rate of return for any given monetary asset being a part of analyzed aggregate.

$$E(R_t - r_{it}) \geq 0 \quad \rightarrow \quad E(R_t) \geq E(r_{it}) \qquad (10)$$

If interest rate (r_{it}) were higher than (R_t) then (r_{it}) should be selected as benchmark interest rate for a given time period.

3. Monetary Assets Expenditures in Poland

In the case of Poland, the highest average WIBOR interest rate (*Warsaw Interbank Offered Rate*) was selected as the benchmark interest rate in a given time period *t*. If any component of monetary aggregate had a higher interest rate than WIBOR, then the highest rate would be selected (11).

$$R_t = \max_{(i,j)} \{ \mathbf{WR}_{it} , \mathbf{r}_{jt} \} , \qquad (11)$$

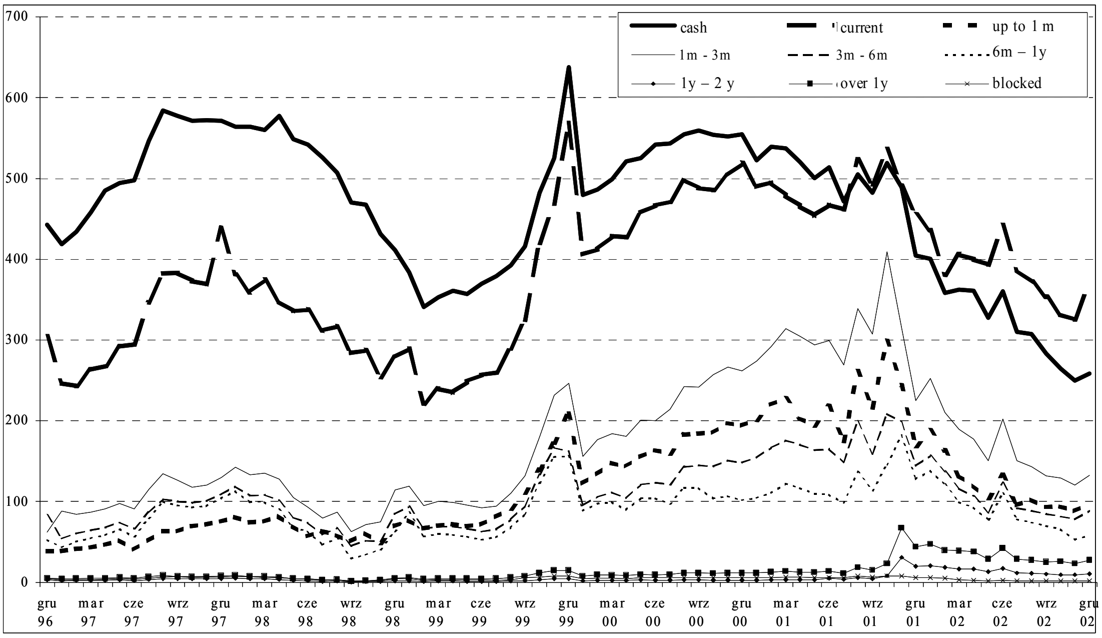
where:

WR_{it} – arithmetic mean for WIBOR rate in period *t*,

r_{jt} – expected return from individual components of monetary aggregate.

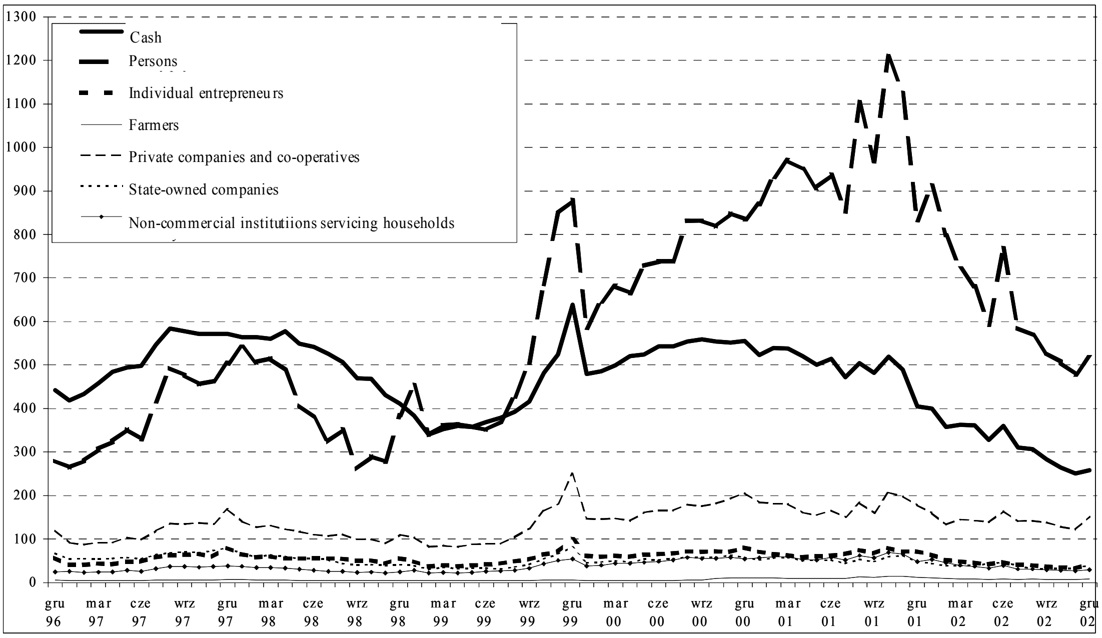
Below, monthly MAE for Poland for period 1996-2002 are presented on charts. MAE have been calculated for local currency deposits as well as for cash. Breakdown by deposit terms and deposit holders is shown. Comments regarding MAE calculations are presented in Appendix 1.

Figure 1. MAE for Poland (in mln PLN) – break-down by deposit type.



Source: own calculations based on NBP data.

Figure 2. MAE for Poland (in mln PLN) – break-down by deposit holder.



Source: own calculations based on NBP data.

Restrictive monetary policy in 2000-2001 resulted in high MAE. In 2001, monthly MAE amounted to around 2 bln PLN. On annual basis, they reached an amount of around 3,5% of GDP. Most of this alternative cost was borne by households. Corporate sector relatively reduced its deposit holdings protecting against high MAE.

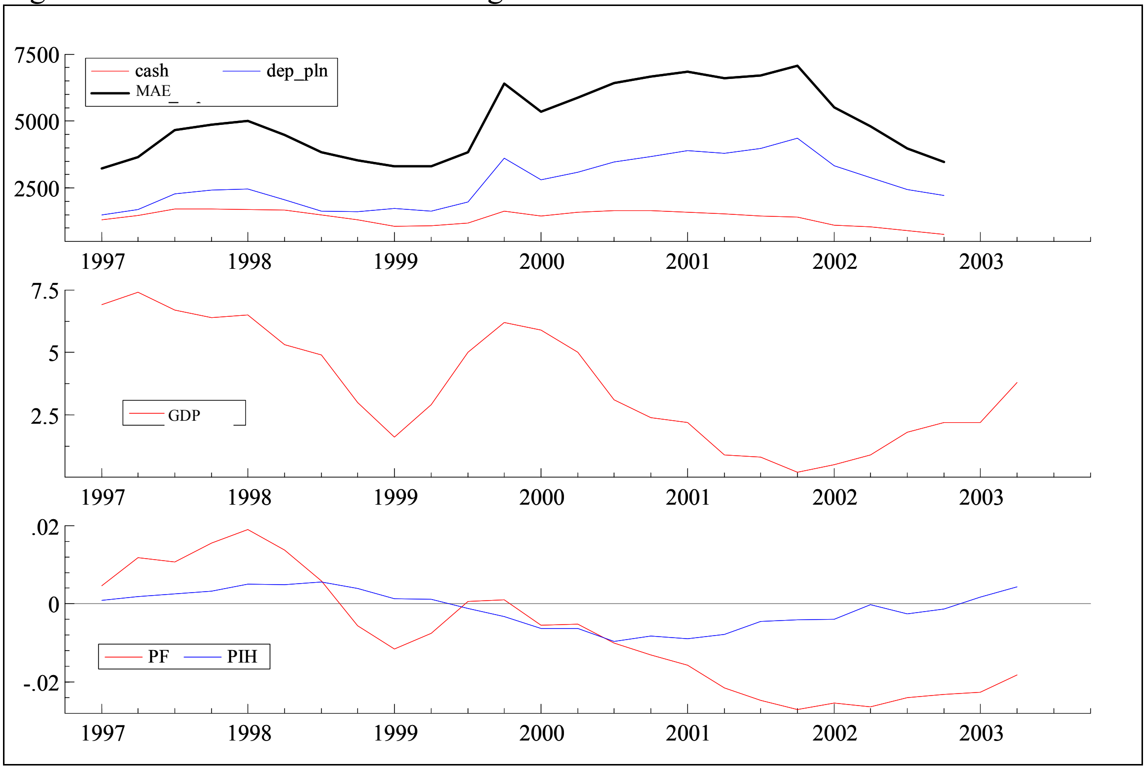
Increased MAE was followed by remarkably slower pace of economic growth in years 2001-2002. According to theory, this may indicate existence of interdependence between monetary phenomena and real economy.

4. Modeling economic growth with Monetary Assets Expenditures

This part of the paper presents results of using MAE in forecasting GDP changes. We show the outcomes of GDP modeling assuming that MAE is either a complementary variable or a substitute for **Potential Output** (PO) variable. The analysis is carried out for Poland for period 1998-1H2003.

In our analysis, we use a percentage **Deviation of GDP from Potential Output** (DPO) for Poland derived in (Gradzewicz and Kolasa, 2003). There are two sets of data available in this paper. The first one shows DPO obtained with a use of Production Function modeling. The second one derives DPO based on Permanent Income Hypothesis. Time series used in modeling are plotted in Figure 3. Detailed data are presented in Appendix 2.

Figure 3. Time series used in modeling



The initial model considered had a form as follows:

$$GDP_t = \alpha_0 + \alpha_i GDP_{t-i} + \beta_k \ln MAE_{t-k} + \gamma_l DPO_{t-l} + \varepsilon_t; \quad i = 1,2,3; \quad k = 0,1,2,3; \quad l = 0,1,2,3; \quad (12)$$

where:

GDP_t - real year-on-year change of Gross Domestic Product in quarter *t*

$\ln(MAE)_t$ - logarithm of Monetary Assets Expenditures in quarter *t*

DPO_t - percentage GDP Deviation from Potential Output in quarter *t*; depending on the method used to calculate PO, DPO_t will be noted as:

PF_t - Deviation from Potential Output calculated with a use of **Production Function** methodology

PIH_t - Deviation from Potential Output calculated with a use of **Permanent Income Hypothesis** methodology

α, β, γ - coefficients for variables GDP_t, MAE_t and DPO_t, respectively

i, *k*, *l* - lag notations for GDP_t, MAE_t and DPO_t variables and their coefficients, respectively

The estimation of the model indicated that:

- GDP is an autoregressive process lagged by one and two periods;
- modeling GDP as AR process noticeably improves after introducing DPO or MAE variable or both

- DPO variable obtained under PF methodology is superior over PIH methodology variable for GDP modeling purposes
- PF is a non-lagged variable
- MAE is a lagged variable by three periods

The best specification for model with GDP and PF variables only is as follows (Eq. 13):

$$GDP_t = \alpha_0 + \alpha_1 GDP_{t-1} + \alpha_2 GDP_{t-2} + \gamma_0 PF_t + \varepsilon_t \qquad (13)$$

Modeling GDP by OLS
The present sample is: 1997 (3) to 2003 (2)

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	3.2283	0.64638	4.994	0.0001	0.5550
PKB_{t-1}	0.87905	0.17363	5.063	0.0001	0.5617
PKB_{t-2}	-0.58063	0.13627	-4.261	0.0004	0.4758
PF	87.828	20.395	4.306	0.0003	0.4811

R^2 = 0.920492 F(3,20) = 77.183 [0.0000] \sigma = 0.643611 DW = 1.76
RSS = 8.284708872 for 4 variables and 24 observations

The form of the best-fitted model assuming MAE being complementary to PO is as follows (Eq. 14):

$$GDP_t = \alpha_0 + \alpha_1 GDP_{t-1} + \alpha_2 GDP_{t-2} + \beta_3 \ln MAE_{t-3} + \gamma_0 PF_t + \varepsilon_t \qquad (14)$$

Modeling GDP by OLS
The present sample is: 1997 (4) to 2003 (2)

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	23.125	5.2365	4.416	0.0003	0.5200
PKB_{t-1}	0.70440	0.14730	4.782	0.0001	0.5596
PKB_{t-2}	-0.42526	0.11473	-3.706	0.0016	0.4329
$\ln MAE_{t-3}$	-2.4267	0.63574	-3.817	0.0013	0.4474
PF	61.080	17.481	3.494	0.0026	0.4041

R^2 = 0.950503 F(4,18) = 86.414 [0.0000] \sigma = 0.504313 DW = 2.06
RSS = 4.577974606 for 5 variables and 23 observations

All the above equations have signs of parameters consistent with theory i.e. the higher PO, the higher expected GDP, and the higher MAE, the lower expected GDP. Equation 14 shows that adding MAE to Equation 13 resulted in noticeably improved model parameters. Both variables are statistically significant. Thus, we may conclude that MAE may be successfully used as a complementary variable in models using PO in modeling GDP behavior. Moreover, one may observe in Equation 14 that MAE variable has larger partial R^2 statistics than PF. This indicates that it explains the modeled variable in a better way. It implies to model GDP with MAE and lagged GDP only.

The third model was estimated under an assumption that MAE could be used as a substitute for PO. It has a specification as follows (Eq. 15):

$$GDP_t = \alpha_0 + \alpha_1 GDP_{t-1} + \alpha_2 GDP_{t-2} + \beta_3 \ln MAE_{t-3} + \varepsilon_t \qquad (15)$$

Modeling GDP by OLS
The present sample is: 1997 (4) to 2003 (2)

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	28.936	6.2609	4.622	0.0002	0.5292
PKB_{t-1}	0.90253	0.17141	5.265	0.0000	0.5933
PKB_{t-2}	-0.33571	0.14101	-2.381	0.0279	0.2298
$lnMAE_{t-3}$	-3.3190	0.73410	-4.521	0.0002	0.5183

R^2 = 0.916932 F(3,19) = 69.91 [0.0000] \sigma = 0.635896 DW = 2.01
RSS = 7.682913722 for 4 variables and 23 observations

Comparing Equation 15 with 13, one may notice that their fitness are very similar. Equation 15 has even slightly better properties in such categories as partial R^2 and Durbin-Watson statistics. As a result, MAE may be used as a substitute for PO in modeling GDP with no harm to model quality.

In general, the above analysis showed that MAE has very good properties in modeling GDP. It could be used as a complementary or supplementary variable for PO in forecasting GDP changes. If one wants to model GDP with a use of PO methodology, than adding MAE variable would improve the overall model characteristics. However, MAE seems to be more effective tool than PO.

Using MAE instead of PO in the above models gives comparable model fitness with slightly better test results for model significance (partial R^2 and Durbin-Watson statistics) and, what is more important, eases the whole modeling exercise. It is a faster and less arbitrary method. By 'faster' we mean that data for monetary statistics is disseminated more frequently than on GDP and it components (e.g. Gross Fixed Capital Formation, Consumption). In addition, MAE has the best properties as a lagged variable, so all the required data is already available. PO has the best properties as a non-lagged variable what slows down forecasting even more (one has to wait for data necessary for calculating PO in a given process). By 'less arbitrary' we mean that it is a measurable (not modeled) phenomenon, computed with a use of relatively precise data (central bank monetary statistics). In a case of PO, it is a result of modeling, thus it 'bears' a model specification error and, moreover, it is dependent on the method used to derive PO (e.g. PF or PIH). As we experienced, not all these methods have comparably good statistical properties with respect to tracking GDP behavior. As a result, using this approach poses us to some difficulties, which we avoid using MAE.

From theoretical point of view, modeling GDP changes with MAE is also appealing. It establishes a strong link between GDP behavior and monetary policy conducted by central bank. According to theory, transmission of monetary policy effects on GDP is lagged but remarkable. Our analysis confirms these views.

5. Conclusions

The analysis reveals high usefulness of MAE in modeling GDP. MAE could be used as a complementary variable or a substitute for PO in forecasting GDP changes. If one wants to model GDP with a use of PO methodology, than adding MAE variable would improve the overall model characteristics. In addition, MAE seems to be more effective tool than PO. Using it instead of PO in the above models gives comparable model fitness with slightly better test results for model significance and, what is more important, eases the whole modeling exercise. It is a faster and less arbitrary method.

From theoretical point of view, modeling GDP changes with MAE is also appealing. It establishes a strong link between GDP behavior and monetary policy conducted by central bank. It confirms a theory that there is an impact of monetary phenomena on economic growth and that this effects materialize after a few quarters. The analyses showed that transmission of monetary policy effects on GDP are lagged by three quarters.

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Appendices

Appendix 1. Comments to MAE construction for Poland

1. Monthly increase of deposits of non-monetary financial institutions by 150% in June 2000, and then their drop by 60% in July was caused by huge IPO of company PKN Orlen. During the subscription period, 10 bln USD was deposited on accounts in brokerage houses.
2. Five monetary asset categories, all of them having low user cost, are not included in the model:
   - non-monetary financial institutions
   - local authorities
   - social insurance funds
   - repurchase operations
   - bonds and commercial papers with up to two years tenor
3. Following items are skipped:
   - 'other liabilities' in M1
   - 'central bank liabilities to consumers' in M1
   - 'other term liabilities with maturity up to two years' in M2
4. Deposits with maturity over 2 years are included in MAE though they are not covered by M3
5. We assume that interest rate for blocked deposits is comparable to interest rates for one year deposits

Appendix 2. Time series used in the analysis.

	PF	PIH	lnMAE	GDP
1997-1	0,00467776	0,00087888	7,93906814	6,9
1997-2	0,01176541	0,00180454	8,06271651	7,4
1997-3	0,01077377	0,00261346	8,29226637	6,7
1997-4	0,01557538	0,00316475	8,32686995	6,4
1998-1	0,01898039	0,00501196	8,3297632	6,5
1998-2	0,01381812	0,00487621	8,22588006	5,3
1998-3	0,0058148	0,00556548	8,05126533	4,9
1998-4	-0,00556121	0,00387984	7,97888707	3,0
1999-1	-0,01154211	0,00134221	7,9438211	1,6
1999-2	-0,00762673	0,00111418	7,90861236	2,9
1999-3	0,00053279	-0,00113422	8,05944227	5,0
1999-4	0,00097063	-0,00324658	8,56684647	6,2
2000-1	-0,0055113	-0,00636722	8,36164023	5,9
2000-2	-0,00519633	-0,00637061	8,45150489	5,0
2000-3	-0,0100492	-0,00965208	8,54433524	3,1
2000-4	-0,01304548	-0,00821935	8,58379194	2,4
2001-1	-0,01574802	-0,00898915	8,61071273	2,2
2001-2	-0,02157955	-0,00784478	8,5824813	0,9
2001-3	-0,02465498	-0,00451437	8,60081513	0,8
2001-4	-0,02712101	-0,00408097	8,66185313	0,2
2002-1	-0,02546167	-0,00392499	8,39909411	0,5
2002-2	-0,02637734	-0,00015378	8,27667107	0,9
2002-3	-0,02400642	-0,00257573	8,11295711	1,8
2002-4	-0,0232274	-0,00133375	8,00649433	2,2
2003-1	-0,02263059	0,0017315	-	2,2
2003-2	-0,01819881	0,00429002	-	3,8