Another Monetary Inflation Coordinate. Studies on the US Federal Reserves' Monetary Base,

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Abstract

Be it 'excess reserves' that deposit money part of all entities at the central bank not used to satisfy statutory reserve requirements, plus all disposable cash held by the same institutions and not used to satisfy statutory reserve requirements either. Would this be rather common place, influenced or not by inflation, or, on the contrary, as significant as influencing and well correlating with inflation rate? Or, this might be equally viewed in the mirror, i.e. once, under representative money-gold standard, no excess reserves, inflation going down to zero. We could see more than expectable about so far in this paper, here including some long term causalities between these two, as monetary variables.

Key concepts: inflation rate, excess monetary reserves, fiat and representative money, central bank
JEL Classification: B1, C5, E5

Introduction

This below debate is just part of our preoccupations about money basics (Andrei, 2011a, 2011b) for which's fundamentals (the opposite) theses of *fiat,* versus *representative* money stay more deeply than, for instance, the already large view and genuine *quantitative theory* (Andrei 2013), due to that the last becomes partisan, as related to both previous. Not too long ago, scholars argued that money out of gold reference would be just 'real money' (Guitton & Bramoulé 1987), as opposite to reticence of leaving what once was monetary gold (Rueff, 1973) but in line with either the post-crisis Keynesian thesis of 'absurd fetish' (that was gold), or with Eichengreen (1992) openly alleging the old gold standard for that crisis' actual damages. But instead of seeing itself passed over for good, this issue comes back after long decades (i.e. at least a former Fed's governor like Alan Greenspan talks on the former gold standard's qualities after a long and unshaken career of serving the opposite money that had dropped out gold) re-asking the question whether human individual would ever be able to design money better than gold ever had.

It is right that our below approach keeps interested in theory testing, rather than in prognosis or monetary policy goals (Patat 1991; Goodhart,1989). However, the concrete issues cannot be really or entirely missing here – i.e. see possibility of shifting monetary system base (Brunner, 1997), as key issue. From another viewpoint, the above polemics being large enough would expect a larger analysis, be it quantitative, as well. Here, in this

paper, there is just a piece of this, which is relationship between excess reserves (that belongs to representative money) and inflation (that was ever proper to fiat money). Otherwise, what we'll have is the retort to 'no inflation for no excess reserves' that was pure gold standard once upon a time.

1. Definition and generalities

Excess Reserves (here in this paper noted as Rx or EXCESSRES) are those deposits held by depository institutions at the Federal Reserves (see also Friedman & Schwarz, 1963) not used to satisfy statutory reserve requirements plus that vault cash held by the same institutions not used to satisfy statutory reserve requirements (FRED – Federal Reserves Economic Data, from Federal Reserves of Saint Louis State's online Statistics of monetary base). In fact, excess reserves equals total reserves less required reserves. Or, these might not theoretically be fully involved in the inflation rate results, but another correlation here searched for might become rather useful. Figure 1 uses excess reserves ratio in total monetary reserves.

Figure 1: FED's comparing inflation rate to excess reserves' ratio in total reserves (%)
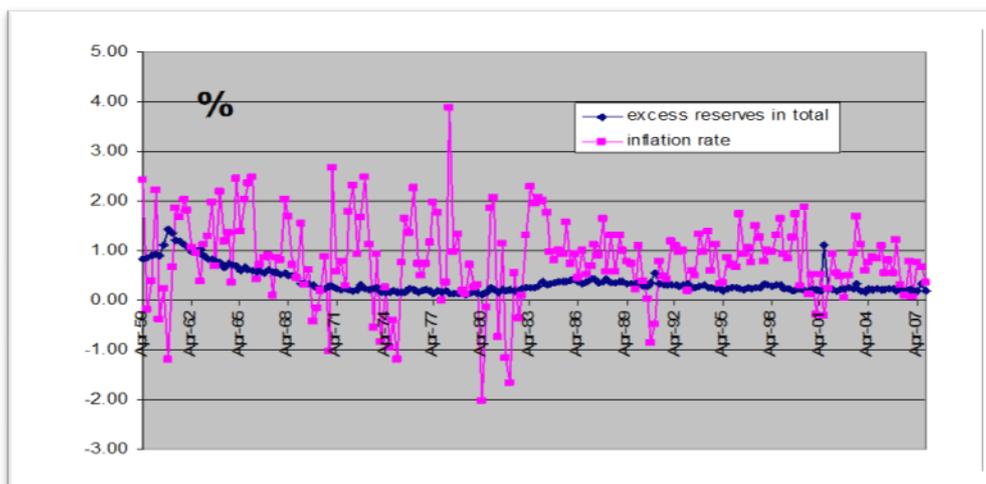
Data source: FRED/ Federal Reserves Economic Data. Federal Reserves of Saint Louis State

Otherwise, excess reserves (Rx) might here reflect the banks' abstention from crediting on the investments level, given an *inflation rate* already reached. In reality, the inflation rate level isn't supposed to be fully *endogenized* by happenings of the banking system only. But there also is to be considered the converse circumstance of inflation endogenized by given excess reserves. FRED (Federal Reserves Economic Data. Data from Federal Reserves of Saint Louis State) are primary exposed as quarterly and will so be approached in this paper as *yearly* (cumulated from quarterly) and *quarterly* data, as concomitantly.

There will be studied relationship between excess reserves (Rx/EXCESSRES) and inflation rate (IR), as in the basic equation that follows: $Rx/Rt = (E) + (F) IR$

In which, equally, Rt is total reserves, so Rx/Rt is excess reserves ratio, and (E) and (F) are constant (coefficients). Notice that basically excess reserves ratio is so primarily and arbitrarily identifying endogenous.
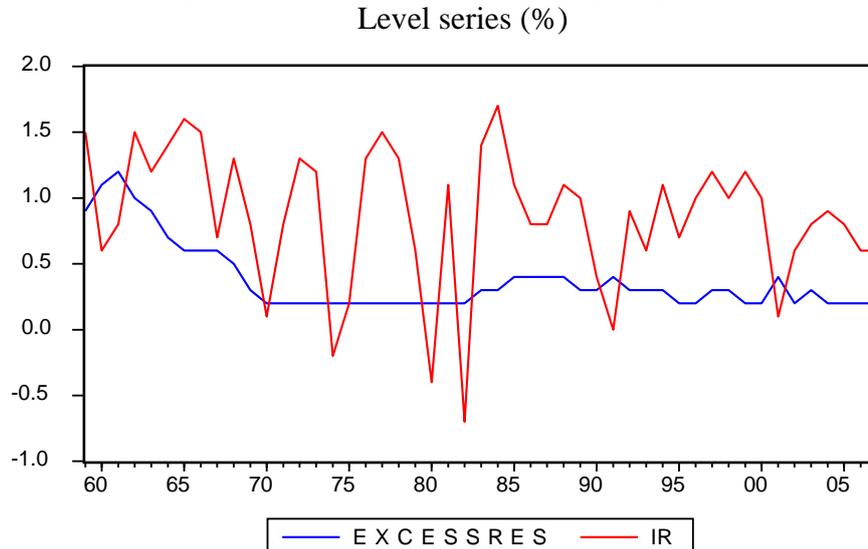
2. The model
See also ANNEX/ Synthesis of the Model

2.1. Yearly data series
Yearly data series (1961-2007; 47 pair observations, after adjustments). See level series in the first graph that follows in Figure 2.

Figure 2. Excess monetary reserves and inflation rate on yearly data series.

Level series (%)

Data source: FRED, EVIEWS, own calculations

That actually proves stationary.

Table 1. Trace Statistic test for cointegration/yearly data series

Date: 02/19/14   Time: 13:50
Sample (adjusted): 1961 2007
Included observations: 47 after adjustments
Trend assumption: Linear deterministic trend
Series: EXCESSRES IR
Lags interval (in first differences): 1 to 1
Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.4215	35.66569	15.49471	0
At most 1 *	0.190653	9.941798	3.841466	0.0016

* denotes rejection of the hypothesis at the 0.05 level
 **MacKinnon-Haug-Michelis (1999) p-values
Source: FRED & EVIEWS

Then, Trace test indicates two co-integrating equations at the 0.05 level (Baghestani & Mott 1997).

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Table 2. Max-Eigen test for cointegration / yearly data series

	Hypothesized	Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.4215	25.72389	14.2646	0.0005
At most 1 *	0.190653	9.941798	3.841466	0.0016

* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Source: FRED & EVIEWS

Vector of Error Correction Model (VECM, Johansen 1988) type test and model can be here applied and see the following results in the next table as for further equations below.

Table 3. VECM with Least Squares method for coefficients' settling / /yearly data series

System: UNTITLED
Estimation Method: Least Squares
Date: 02/19/14   Time: 13:52
Sample: 1962 2007
Included observations: 46
Total system (balanced) observations 92

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.156198	0.052782	-2.95928	0.0041
C(2)	-0.034248	0.139294	-0.24587	0.8064
C(3)	0.071017	0.133121	0.533476	0.5952
C(4)	-0.054865	0.027008	-2.03147	0.0455
C(5)	-0.013633	0.021674	-0.62902	0.5311
C(6)	-0.021536	0.012197	-1.76563	0.0813
C(7)	1.527922	0.36194	4.221474	0.0001
C(8)	0.692735	0.955168	0.725249	0.4704
C(9)	-0.235387	0.912839	-0.25786	0.7972
C(10)	0.10665	0.185197	0.575877	0.5663
C(11)	0.083318	0.148621	0.56061	0.5766
C(12)	0.006892	0.08364	0.082396	0.9345
Determinant residual covariance		0.001351		

Source: FRED & EVIEWS

The long term causality is revealed as the very strength of this model – C1 appears negative and much lower than 5% null probability. This is similar for C4 (of precedent period inflation rate) to reveal short term causality and these for excess reserves endogenous; the same for C7 (of precedent period excess reserves and inflation rate), as for inflation rate endogenous. On the contrary, weaker coefficients are: C2 (of the precedent period excess reserves), C3 (of the ante-precedent excess reserves), C5 (of the precedent inflation rate) and in a way C6 (the free coefficient) for excess reserves endogenous, and C8 (of precedent period excess reserves), C9 (of ante-precedent period excess reserves), C10 (of percent period

inflation rate), C11(of ante-precedent period inflation rate) and C12 (the free coefficient) for inflation rate endogenous.

Equation 1: D(EXCESSRES) = C(1)*(EXCESSRES(-1) - 1.973203581*IR(-1) + 0.16888253) + C(2)*D(EXCESSRES(-1)) + C(3)*D(EXCESSRES(-2)) + C(4)*D(IR(-1)) + C(5)*D(IR(-2)) + C(6)

Table 4. Final results for equation 1 / yearly data series

Observations: 46			
R-squared	0.206703	Mean dependent var	-0.02174
Adjusted R-squared	0.107541	S.D. dependent var	0.084098
S.E. of regression	0.079447	Sum squared resid	0.252475
Durbin-Watson stat	1.960051		

Source: FRED & EVIEWS

Equation 2: D(IR) = C(7)*(EXCESSRES (-1) - 0.5987051985*IR(-1) +0.16888253) + C(8)*D(EXCESSRES(-1)) + C(9)*D(EXCESSRES(-2)) +C(10)*D(IR(-1)) + C(11)*D(IR(-2)) + C(12)

Table 5. Final results for equation 2 / yearly data series

Observations: 46			
R-squared	0.456399	Mean dependent var	-0.00435
Adjusted R-squared	0.388448	S.D. dependent var	0.696645
S.E. of regression	0.544789	Sum squared resid	11.87178
Durbin-Watson stat	2.100097		

Source: FRED & EVIEWS

And besides the long term causality, it becomes similarly interesting that the inflation rate endogenous seems to be in advantage against excess reserves and this for both R-squared and Durbin-Watson statistics – as exactly the opposite of previously thought.

Then, Granger causality (Granger 1986) reveals just one way causality: excess reserves can cause about 10% variation of inflation rate up to 5 time lags (i.e. there is no any such inverse determination, of excess reserves by inflation).

Table 6. Granger Causality tested / yearly data series

| Pairwise Granger Causality Tests			
Date: 03/12/14 Time: 17:27			
Sample: 1959 2007			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Probability
IR does not Granger Cause EXCESSRES	47	0.3792	0.68673
EXCESSRES does not Granger Cause IR		2.67255	0.08081

Source: FRED, EVIEWS, Granger (1986)

And finally there comes the model's validity that actually is errors testing and this includes:
(i) revealing no serial correlation up to the 12th time lag, (ii) finding the normal distribution of errors and (iii) homoskedasticity of errors.

2.2. Quarterly data series (qt. II 1959 – qt. I 2007; 190-192 pair observations, after adjustments)

Look at the level data series in the following first graph, that looks similar to the one of the above yearly data series.

Figure 3. Excess reserves and inflation rate on quarterly data series

Level series (%)
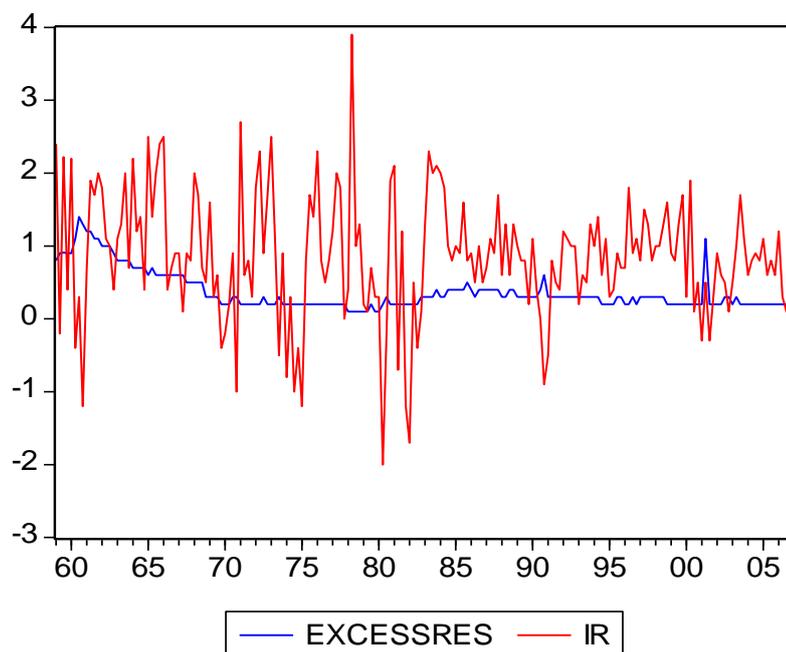
Data source: FRED, EVIEWS, own calculations

Plus, similarly to the yearly data series again this level series of inflation rate proves stationary, whereas the one of excess reserves needs one differentiation in this respect. Though, notice that logarithms are here banned, due to negative numbers in the series.
In such circumstance, associating different orders of differentiation data series – e.g. a level series of the inflation rate with a first order difference series of excess reserves – threatens cointegration. But this isn't compulsory and reconsidering the idea that at least this quarterly data series might be cointegrated. Then Johansen test is applied and confirms such hypothesis.

Table 7. Trace Statistic for cointegration tested/ quarterly data series

Date: 02/19/14   Time: 13:09
Sample (adjusted): 1960Q2 2007Q1
Included observations: 188 after adjustments
Trend assumption: Linear deterministic trend
Series: EXCESSRES IR

Lags interval (in first differences): 1 to 4
Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.178658	41.46817	15.49471	0.0000
At most 1 *	0.02348	4.466923	3.841466	0.0345

Data source: FRED, EVIEWS

So, VEC is applicable and then produces results and equations, as follows:

Table 8. VECM with Least Squares for coefficients settling / quarterly data series

System: SYS02
Estimation Method: Least Squares
Date: 02/19/14   Time: 13:17
Sample: 1959Q4 2007Q1
Included observations: 190
Total system (balanced) observations 380

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.000177	0.006295	-0.028118	0.9776
C(2)	-0.477575	0.072117	-6.622268	0.0000
C(3)	-0.245968	0.072583	-3.388774	0.0008
C(4)	-0.006996	0.011603	-0.602955	0.5469
C(5)	0.001405	0.009119	0.154106	0.8776
C(6)	-0.006219	0.007400	-0.840447	0.4012
C(7)	0.343574	0.049061	7.002960	0.0000
C(8)	-1.379856	0.562043	-2.455073	0.0145
C(9)	-0.507467	0.565679	-0.897094	0.3703
C(10)	-0.105002	0.090425	-1.161213	0.2463
C(11)	0.081308	0.071066	1.144116	0.2533
C(12)	-0.016307	0.057671	-0.282760	0.7775
Determinant residual covariance			0.006028	

Source: FRED, EVIEWS

Actually, none of the below equations shows long term variable causalities, i.e. see C1 and C7. Short term causalities, on the other hand, are revealed by C2 (of precedent period excess reserves) and C3 (of the ante-precedent excess reserves) for excess reserves endogenous and C8 (of precedent period excess reserves) for inflation rate endogenous. Weaker coefficients are: C1 (of the precedent period excess reserves and precedent period inflation rate), C4 (of the precedent period inflation rate), C5 (of the ante-precedent period inflation rate) and C6 (free coefficient) for excess reserves endogenous, and C9 (of the ante-precedent excess reserves), C10 (of the precedent inflation rate), C11 (of the ante-precedent inflation rate) and C12 (the free coefficient) for inflation rate endogenous, as respectively.

Equation 1: D(EXCESSRES) = C(1)*(EXCESSRES(-1) - 1.97320*IR(-1) + 1.32822) + C(2)*D(EXCESSRES(-1)) + C(3) *D(EXCESSRES(-2)) + C(4)*D(IR(-1)) + C(5)*D(IR(-2)) + C(6)

Table 9. Final results for equation 1 / quarterly data series

Observations: 190			
R-squared	0.200851	Mean dependent var	-0.00374
Adjusted R-squared	0.179135	S.D. dependent var	0.112392
S.E. of regression	0.101829	Sum squared resid	1.907926
Durbin-Watson stat	2.066623		

Source: FRED, EVIEWS

Equation 2: D(IR) = C(7)*(EXCESSRES(-1) - 1.97320*IR(-1) + 1.32822) + C(8)*D(EXCESSRES(-1)) + C(9)*D(EXCESSRES(-2)) + C(10)*D(IR(-1)) + C(11)*D(IR(-2)) + C(12)

Table 10. Final results for equation 2 / quarterly data series

Observations: 190			
R-squared	0.412341	Mean dependent var	-0.01116
Adjusted R-squared	0.396372	S.D. dependent var	1.02146
S.E. of regression	0.793608	Sum squared resid	115.8857
Durbin-Watson stat	1.970411		

Source: FRED, EVIEWS

See in these two above tables the specific chance offered to this model for correlations revealed. Both VEC variants (i.e. yearly and quarterly data series) find inflation rate endogenous in advantage for R-squared against excess reserves – that is double in yearly and quarterly data series variants. Besides, Durbin-Watson statistics of errors self-correlation are nearly equal.

Then, the same as in the above yearly series case, there is a uni-directional Granger (1986) type causality: from excess monetary reserves towards inflation rate that verifies:

Table 11. Granger causality tested / quarterly data series
Pairwise Granger Causality Tests
Date: 03/12/14   Time: 18:14
Sample: 1959Q1 2007Q1
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
IR does not Granger Cause EXCESSRES	191	0.47918	0.62005
EXCESSRES does not Granger Cause IR		3.38813	0.03587

Source: FRED, EVIEWS, Granger (1986)

The series of errors proves stationary, and there is no series correlation of errors either. Or this is pretty similar to the above yearly data series case. Then, unlike yearly data series case here for quarterly data series there is neither errors' normal distribution, nor homoskedasticity.

2.3. The model's result

The excess reserves endogenous prove weak R-Squared and rather long than short terms causalities with inflation, on the yearly data variant. Here the inflation's influence on excess reserves is certain, but negative and weak enough. No certain contrary influence, of excess reserves on inflation, for yearly data variant, either, whereas though R-Squared is here double than the previous.

Things appear more favourable on quarterly data series variant, in which there similarly exist long term causality of excess reserves influenced by inflation and the two R-squared numbers stay pretty similar to the ones of the yearly data variant. Here the excess reserves negatively influence themselves from both time lags taken, but the most significant is the negative influence and even correlation (cumulatively considering coefficient and R-Squared, as more favourable) that excess reserves keep on inflation rate.

3. An extensive conclusion

Shortly on the above developments, inflation could influence excess reserves, but only in long run. On the contrary, excess reserves do influence inflation, but only on the very short time that the quarter time is. And as for the year time period, which is at the middle of these, the story of these two variables becomes pretty unsubstantial.

Cointegration proves appropriate to our above analysis and VECM has also helped extension on equations with each variable as exogenous and endogenous. Inflation and excess reserves really feed each other on the diversity of time terms. As a corollary: when one is missing, so is the other. This is money that is adaptive to diverse changing reality.

References

Andrei, L.C., 2011, *Money and Market in the Economy of All Times.* Xlibris.co, Daartford, UK,

Andrei, L.C., 2012, Fiat, versus representative money under debate, or how right Keynes was once (!), *Theoretical and Applied Economics*,Vol XVIII (2011b), No. 5(558), pp. 45-58 & 'Economics of Networks eJournal' Vol. 4, No. 71, Nicholas Economides, Editor neconomi@stern.nyu.eduBaghestani.

Mott H.T., 1997. A Cointegration Analysis of US Money Supply Process, *Journal of Macro Economics*. 19. pp. 269-283.

Brunner, K., 1997. High Powered Money and the Monetary Base, Lys T. (ed.). *Monetary Theory and Monetary Policy: The Selected Essays of Karl Brunner*.

Eichengreen, B., Fetters, G., 1992. The Gold Standard and the Great Depression. 1919-1939. Preface.

Friedman, M., Schwarz A., 1963. *A Monetary History of the United States, 1867-1960.* Princeton University Press, Princeton.

Goodhart, C., 1989. The Conduct of Monetary Policy, *Economic Journal*. 29, pp. 293-346.

Granger, C.W. 1986. Developments in the study of co-integrated economic variables, *Oxford Bulletin of Economics and Statistics*, 48, 213-228.

Guitton, H., Bramoulé, R., 1987. *La Monnaie*. Paris, Daloz. Sixth Edition.

Johansen, S., 1988, Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control,* 12, 231-254.

MacKinnon, J.G., Haug, A., Michelis, L., 1999. Numerical Distribution Functions of Likelihood Ratio Tests for Cointegration. *Journal of Applied Econometrics*, Vol. 14, No. 5, pp. 563-577.

Patat, J.P., 1973. La Politique Monetaire, *Problemes Economiques,* 2231, of 6 June, 1991.

Rueff, J., 1973. La Réforme du Système Monétaire International, Paris. Plon.

* * * Basic statistics: FRED / Federal Reserves Economic Data / Federal Reserves of St. Louis / data on monetary base / http://research.stlouisfed.org/publications/review/ 03/09/0309ra.xls

ANNEX
Synthesis of the model:
Excess reserves (EXCESSRES) & inflation rate (IR)

I. Equations:
A. Basic equation: Rx/Rt = (E) + (F) IR
B. VECM type equations:
(B1) for yearly data series: 1961-2007; 47 pair observations, after adjustments

Eq.1: D(EXCESSRES) = - 0.156198[EXCESSRES(-1) - 1.973203581*IR(-1) + 0.16888253] -0.034248 D(EXCESSRES(-1)) + 0.071017 D(EXCESSRES(-2) -0.054865 D(IR(-1)) - 0.013633D(IR(-2)) - 0.021536
Observations: 46

R-squared	0.206703	Mean dependent var	-0.02174
Adjusted R-squared	0.107541	S.D. dependent var	0.084098
S.E. of regression	0.079447	Sum squared resid	0.252475
Durbin-Watson stat	1.960051		

Eq. 2: D(IR) = 1.527922 [EXCESSRES (-1) - 0.5987051985*IR(-1) + 0.16888253] + 0.692735 D(EXCESSRES(-1)) - 0.235387D(EXCESSRES(-2)) + 0.10665 D(IR(-1)) + 0.083318 D(IR(-2)) + 0.006892
Observations: 46

R-squared	0.456399	Mean dependent var	-0.00435
Adjusted R-squared	0.388448	S.D. dependent var	0.696645
S.E. of regression	0.544789	Sum squared resid	11.87178
Durbin-Watson stat	2.100097		

(B2) for quarterly data series: qt. II 1959 – qt. I 2007; 190-192 pair observations, after adjustments
Eq.1: D(EXCESSRES) = - 0.000177 [EXCESSRES(-1) - 1.973203581*IR(-1) + 1.328219199] -0.477575 D(EXCESSRES(-1)) - 0.245968 D(EXCESSRES(-2)) - 0.006996 D(IR(-1)) + 0.001405 D(IR(-2)) - 0.006219
Observations: 190

R-squared	0.200851	Mean dependent var	-0.00374	
Adjusted R-squared	0.179135	S.D. dependent var	0.112392	
S.E. of regression	0.101829	Sum squared resid	1.907926	
Durbin-Watson stat	2.066623			

Eq. 2: $D(IR) = 0.343574 [EXCESSRES(-1) - 1.973203581*IR(-1) + 1.328219199] - 1.379856 D(EXCESSRES(-1)) - 0.507467 D(EXCESSRES(-2)) - 0.105002 D(IR(-1)) + 0.081308 D(IR(-2)) - 0.016307$

Observations: 190

R-squared	0.412341	Mean dependent var	-0.01116	
Adjusted R-squared	0.396372	S.D. dependent var	1.02146	
S.E. of regression	0.793608	Sum squared resid	115.8857	
Durbin-Watson stat	1.970411			

II. Comments:

II.1. On equation (1):

Coefficients:

a. Significant (low null probability) for:

  – In yearly data series eq: D(IR(-1)); D(IR(-2); the free coefficient

  – In quarterly data series eq.: D (EXCESSRES (-1)); D (EXCESSRES (-2))

b. Less significant (high null probability) for:

  – In yearly data series eq: D(EXCESSRES(-1)); D(EXCESSRES(-2)); D(IR(-2)); the free coefficient

  – In quarterly data series eq.: EXCESSRES (-1); IR (-1); D (IR (-1)); D (IR (-2)); the free coefficient

  – R-squared (correlation): does not vary too much between yearly and quarterly data series variants, i.e. from 20.6% to 20.0%.

c. Errors self-correlation (Durbin Watson): rather favorably varies from yearly (1.96) to quarterly data series (2.06).

II.2. On equation (2):

Coefficients:

a. Significant (low null probability) for:

  – In yearly data series eq: no one

  – In quarterly data series eq.: D (EXCESSRES (-1))

b. Less significant (high null probability) for:

  – In yearly data series eq: D(EXCESSRES(-1); D(EXCESSRES(-2)); D(IR(-1)); D(IR(-2)); the free coefficient

  – In quarterly data series eq.: D (EXCESSRES (-2)); D (IR (-1)); D (IR (-2)); the free coefficient

  – R-squared (correlation): slightly lowers from yearly (45.6%) to quarterly (41.2%) data series;

c. Errors self-correlation (Durbin Watson): also slightly lowers from yearly(2.1) to quarterly (1.97) data series.