

Homework Assignment 8 (for Unit 8) – 20 points

Consider the following model of the monetary sector for 2009Q2-2009Q3:

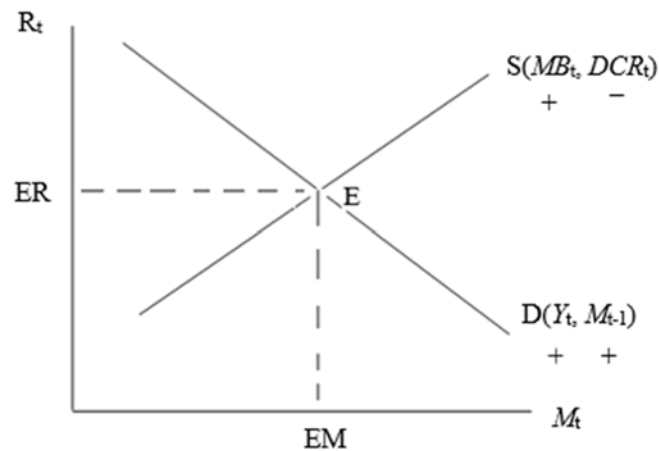
$$MD_t = \alpha_1 + \alpha_2 Y_t + \alpha_3 R_t + \lambda MD_{t-1} + u_t \quad \text{Money demand function}$$

$$MS_t = \beta_1 + \beta_2 MB_t + \beta_3 R_t + \beta_4 DCR_t + v_t \quad \text{Money supply function}$$

where MD_t = growth in quantity of money demanded by the public for transaction purposes (%),
 MS_t = growth in quantity of money supplied (%),
 Y_t = growth in national income (%),
 MB_t = growth in monetary base (%) – controlled by the central bank,
 R_t = interest rate (%) – the rate at which commercial banks lend money to the public,
 DCR_t = discount rate (%) – the rate at which the central bank lends money to commercial banks.

Below is the model at **equilibrium** ($M_t = MD_t = MS_t$), where M_t = growth in money demanded and supplied.

$$\begin{cases} M_t = \alpha_1 + \alpha_2 Y_t + \alpha_3 R_t + \lambda M_{t-1} + u_t & \text{Money demand function} \\ M_t = \beta_1 + \beta_2 MB_t + \beta_3 R_t + \beta_4 DCR_t + v_t & \text{Money supply function} \end{cases}$$



Q1: What are the theoretically expected signs for the slope parameters in the demand function (α_2 , α_3 , and λ) and for the slope parameters in the supply function (β_2 , β_3 , and β_4).

Q2: Do the OLS slope estimates of the demand function (below) have the theoretically expected signs? Explain. Do the OLS slope estimates of the supply function (below) have the theoretically expected signs? Explain.

Dependent Variable: M Method: Least Squares Sample (adjusted): 2009Q2 2019Q3 Included observations: 42 after adjustments					Dependent Variable: M Method: Least Squares Sample: 2009Q2 2019Q3 Included observations: 42				
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.741248	0.394228	1.880250	0.0678	C	1.842015	0.278579	6.612191	0.0000
Y	0.190106	0.053930	3.525025	0.0011	MB	0.278451	0.102334	2.721005	0.0098
R	-0.122116	0.077031	-1.585280	0.1212	R	0.479077	0.146139	3.278218	0.0022
M(-1)	0.482070	0.118290	4.075322	0.0002	DCR	-0.727017	0.123645	-5.879893	0.0000
R-squared	0.660679	Mean dependent var	1.046714		R-squared	0.733632	Mean dependent var	1.046714	
Adjusted R-squared	0.633891	S.D. dependent var	0.772884		Adjusted R-squared	0.712603	S.D. dependent var	0.772884	
S.E. of regression	0.467649	Akaike info criterion	1.408193		S.E. of regression	0.414339	Akaike info criterion	1.166127	
Sum squared resid	8.310415	Schwarz criterion	1.573685		Sum squared resid	6.523709	Schwarz criterion	1.331619	
Log likelihood	-25.57206	Hannan-Quinn criter.	1.468853		Log likelihood	-20.48866	Hannan-Quinn criter.	1.226786	
F-statistic	24.66279	Durbin-Watson stat	2.076199		F-statistic	34.88654	Durbin-Watson stat	2.016445	
Prob(F-statistic)	0.000000				Prob(F-statistic)	0.000000			

$$\left\{ \begin{array}{ll} M_t = \alpha_1 + \alpha_2 Y_t + \alpha_3 R_t + \lambda M_{t-1} + u_t & \text{Money demand function} \\ M_t = \beta_1 + \beta_2 MB_t + \beta_3 R_t + \beta_4 DCR_t + v_t & \text{Money supply function} \end{array} \right.$$

Q3: Are the demand and supply functions behavioral or identities? Explain.

Q4: Which variables are endogenous and which are exogenous? Of the exogenous variables, which one is the predetermined variable, and which ones are the monetary policy variables?

Q5: Is the demand equation a structural or reduced-form function? Explain. Is the supply equation a structural or reduced-form function? Explain.

Q6: Explain (no need to show) why classical assumption 2 is violated for the demand function. Discuss the theoretical and empirical consequences for the OLS estimators of α_1 , α_2 , α_3 , and λ .

Q7: Explain (no need to show) why classical assumption 2 is violated for the supply function. Discuss the theoretical and empirical consequences for the OLS estimators of β_1 , β_2 , β_3 , and β_4 .

Q8: Is the demand function identified? Explain with enough reasoning. What would happen if the demand function was not identified?

Q9: Is the supply function identified? Explain with enough reasoning. What would happen if the supply function was not identified?

Q10: Explain why the following functions are called the reduced-form equations.

$$\left\{ \begin{array}{ll} M_t = \pi_{11} + \pi_{12} Y_t + \pi_{13} M_{t-1} + \pi_{14} MB_t + \pi_{15} DCR_t + w_{1t} & \text{Reduced-form equation for } M_t \\ R_t = \pi_{21} + \pi_{22} Y_t + \pi_{23} M_{t-1} + \pi_{24} MB_t + \pi_{25} DCR_t + w_{2t} & \text{Reduced-form equation for } R_t \end{array} \right.$$

Q11: Is it appropriate to use the OLS method to estimate the above reduced-form equations? Explain.

Q12: Explain how the reduced-form equation for R_t is used to obtain the two-stage least squares (TSLS) estimates of the population parameters in the demand function (α_1 , α_2 , α_3 , and λ) and to obtain the two-stage least squares (TSLS) estimates of the population parameters in the supply function (β_1 , β_2 , β_3 , and β_4).

Q13: Consider the TSLS estimates of the money demand function on [pages 4-6](#). Briefly explain whether the estimated demand function passes the diagnostic tests (including autocorrelation, heteroscedasticity, parameter stability, multicollinearity, and normality).

Q14: Is the estimated demand function dynamically stable? Include in your answer the null and alternative hypothesis and the decision rule. State your conclusion.

Q15: Find and interpret the short- and long-run effects of a change in the interest rate on growth in money demand. Draw the pattern of the effects over quarters.

Q16: Consider the TSLS estimates of the money supply function on [pages 7-9](#). Briefly explain whether the estimated supply function passes the diagnostic tests (including autocorrelation, heteroscedasticity, parameter stability, multicollinearity, and normality).

Q17: Interpret the effect of a change in the interest rate on growth in money supply.

Q18: Is money demand or money supply more responsive to a change in interest rate in the immediate quarter? Explain clearly.

Q19: Are you satisfied with the demand function estimates? Are you satisfied with the supply function estimates? Explain clearly by first listing the criteria for satisfactory estimates.

The money demand function estimates

Dependent Variable: M
Method: Two-Stage Least Squares
Sample (adjusted): 2009Q2 2019Q3
Included observations: 42 after adjustments
Instrument specification: C Y M(-1) MB DCR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.269710	0.438309	2.896835	0.0062
Y	0.171851	0.055656	3.087740	0.0038
R	-0.231804	0.086453	-2.681258	0.0108
M(-1)	0.444846	0.121984	3.646758	0.0008
R-squared	0.642573	Mean dependent var		1.046714
Adjusted R-squared	0.614356	S.D. dependent var		0.772884
S.E. of regression	0.479963	Sum squared resid		8.753846
F-statistic	25.01459	Durbin-Watson stat		1.936076
Prob(F-statistic)	0.000000	Second-Stage SSR		7.203898
J-statistic	4.916647	Instrument rank		5
Prob(J-statistic)	0.026599			

Breusch-Godfrey Serial Correlation LM Test:

Obs*R-squared	0.308525	Prob. Chi-Square(2)	0.8570
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Test Equation:
Dependent Variable: RESID
Method: Two-Stage Least Squares
Sample: 2009Q2 2019Q3
Included observations: 42
Presample missing value lagged residuals set to zero.

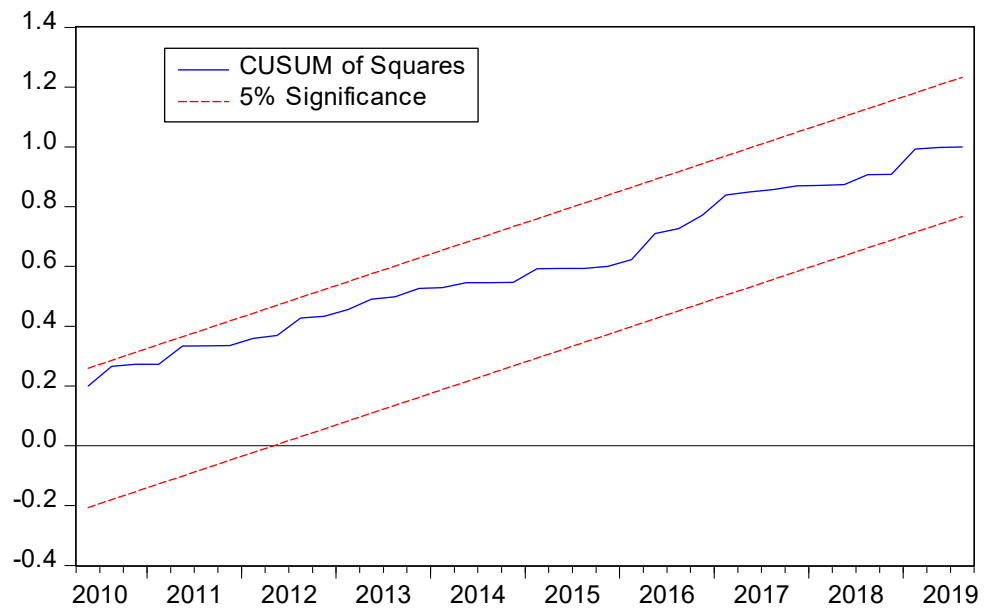
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.202964	0.610235	0.332599	0.7414
Y	0.016469	0.067194	0.245092	0.8078
R	-0.031964	0.109345	-0.292322	0.7717
M(-1)	-0.086248	0.221367	-0.389618	0.6991
RESID(-1)	0.125449	0.291793	0.429923	0.6698
RESID(-2)	0.074851	0.183325	0.408295	0.6855
R-squared	0.007346	Mean dependent var		3.88E-16
Adjusted R-squared	-0.130523	S.D. dependent var		0.462070
S.E. of regression	0.491300	Akaike info criterion		1.548042
Sum squared resid	8.689542	Schwarz criterion		1.796280
Log likelihood	-26.50888	Hannan-Quinn criter.		1.639031
F-statistic	0.053281	Durbin-Watson stat		1.995557
Prob(F-statistic)	0.998065			

Heteroskedasticity Test: White

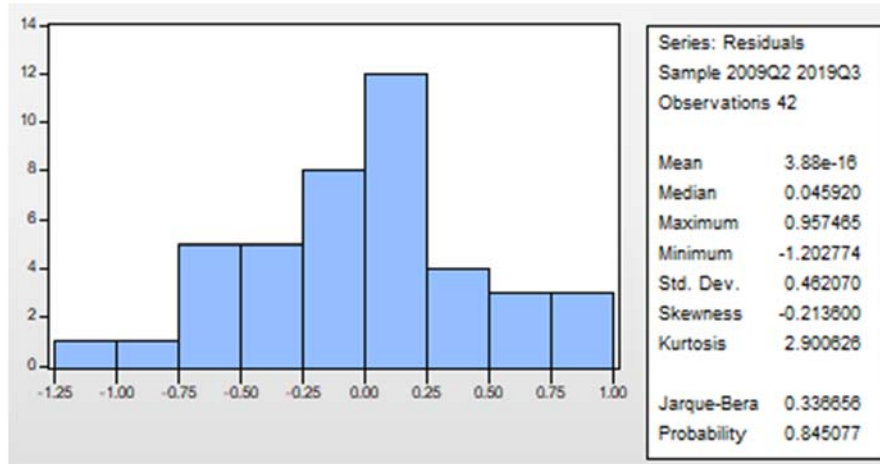
F-statistic	1.622052	Prob. F(3,38)	0.2003
Obs*R-squared	4.767830	Prob. Chi-Square(3)	0.1896
Scaled explained SS	3.708994	Prob. Chi-Square(3)	0.2947

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample: 2009Q2 2019Q3
Included observations: 42

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.492854	0.142526	3.457997	0.0014
Y^2	-0.008454	0.010083	-0.838394	0.4071
R^2	-0.007600	0.005014	-1.515806	0.1378
M(-1)^2	-0.059673	0.041078	-1.452688	0.1545
R-squared	0.113520	Mean dependent var	0.208425	
Adjusted R-squared	0.043534	S.D. dependent var	0.290824	
S.E. of regression	0.284423	Akaike info criterion	0.413687	
Sum squared resid	3.074074	Schwarz criterion	0.579180	
Log likelihood	-4.687434	Hannan-Quinn criter.	0.474347	
F-statistic	1.622052	Durbin-Watson stat	2.559751	
Prob(F-statistic)	0.200319			



Correlation			
	Y	R	M(-1)
Y	1.000000	-0.368738	0.487379
R	-0.368738	1.000000	-0.359087
M(-1)	0.487379	-0.359087	1.000000



Wald Test:
Equation:

Test Statistic	Value	df	Probability
t-statistic	-4.551033	38	0.0001
F-statistic	20.71190	(1, 38)	0.0001
Chi-square	20.71190	1	0.0000

Null Hypothesis: $C(4)=1$
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
$-1 + C(4)$	-0.555154	0.121984

Restrictions are linear in coefficients.

The money supply function estimates

Dependent Variable: M
Method: Two-Stage Least Squares
Sample (adjusted): 2009Q2 2019Q3
Included observations: 42 after adjustments
Instrument specification: C Y M(-1) MB DCR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.710307	0.392072	4.362230	0.0001
MB	0.246289	0.122966	2.002907	0.0524
R	0.602462	0.295430	2.039270	0.0484
DCR	-0.821407	0.232206	-3.537406	0.0011
R-squared	0.728635	Mean dependent var		1.046714
Adjusted R-squared	0.707211	S.D. dependent var		0.772884
S.E. of regression	0.418207	Sum squared resid		6.646088
F-statistic	32.11408	Durbin-Watson stat		1.960846
Prob(F-statistic)	0.000000	Second-Stage SSR		7.641336
J-statistic	8.977046	Instrument rank		5
Prob(J-statistic)	0.002734			

Breusch-Godfrey Serial Correlation LM Test:

Obs*R-squared	1.886888	Prob. Chi-Square(2)	0.3893
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Test Equation:
Dependent Variable: RESID
Method: Two-Stage Least Squares
Sample: 2009Q2 2019Q3
Included observations: 42
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.015537	0.462067	-0.033625	0.9734
MB	-0.021974	0.134720	-0.163107	0.8713
R	0.031143	0.374112	0.083245	0.9341
DCR	-0.027241	0.291855	-0.093338	0.9262
RESID(-1)	0.005008	0.205461	0.024375	0.9807
RESID(-2)	0.214529	0.165821	1.293740	0.2040
R-squared	0.044926	Mean dependent var		9.09E-16
Adjusted R-squared	-0.087723	S.D. dependent var		0.402616
S.E. of regression	0.419904	Akaike info criterion		1.233984
Sum squared resid	6.347506	Schwarz criterion		1.482222
Log likelihood	-19.91366	Hannan-Quinn criter.		1.324973
F-statistic	0.338682	Durbin-Watson stat		2.045972
Prob(F-statistic)	0.886066			

Heteroskedasticity Test: White

F-statistic	0.336384	Prob. F(3,38)	0.7991
Obs*R-squared	1.086523	Prob. Chi-Square(3)	0.7803
Scaled explained SS	1.297392	Prob. Chi-Square(3)	0.7298

Test Equation:

Dependent Variable: RESID^2

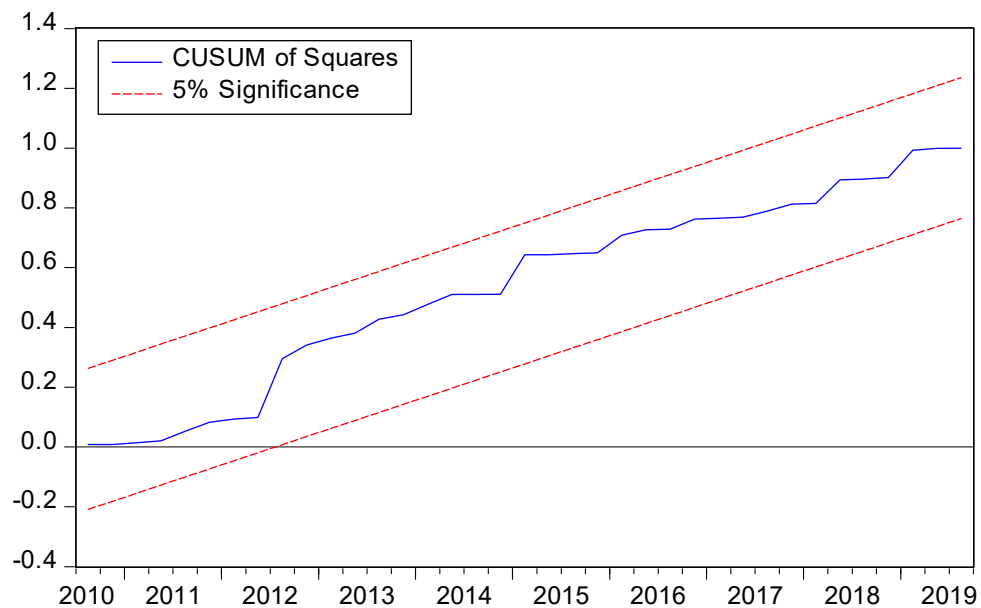
Method: Least Squares

Sample: 2009Q2 2019Q3

Included observations: 42

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.223381	0.103801	2.152008	0.0378
MB^2	-0.036420	0.071202	-0.511497	0.6120
R^2	0.002207	0.009905	0.222781	0.8249
DCR^2	-0.004818	0.008021	-0.600641	0.5516

R-squared	0.025870	Mean dependent var	0.158240
Adjusted R-squared	-0.051035	S.D. dependent var	0.273556
S.E. of regression	0.280450	Akaike info criterion	0.385548
Sum squared resid	2.988776	Schwarz criterion	0.551040
Log likelihood	-4.096502	Hannan-Quinn criter.	0.446207
F-statistic	0.336384	Durbin-Watson stat	2.466643
Prob(F-statistic)	0.799094		



Correlation			
	MB	R	DCR
MB	1.000000	-0.131981	-0.323966
R	-0.131981	1.000000	0.886733
DCR	-0.323966	0.886733	1.000000

