The topic of the project, related to macroeconomic, financial or business issues, will be of the student's own choice. For example this can be a study of relationships between different features of labor market and other areas like productivity, inflation, demography etc., or it can characterize differences between women and men in labor market. Other examples could be problems around R&D or financial series of stock markets.

Each project should contain

- Clearly stated goal or hypotheses to be verified
- Description of the data set used to verify student's hypotheses
- Choice of dependent and explanatory variables
- Initial model statement and its subsequent improvements
    - correlation analysis
    - testing model's validity using F test
    - elimination of nonsignificant variables
    - detection of outliers
- Final verification of model's assumptions
    - normality test of residuals
    - homoscedasticity test (White's test)
    - Durbint Watson errors correlation test (for time series)
- Conclusions

Statistical calculations should be made in the Gretl package.

You should also send me the analyzed data.

Deadline: 23.12.2022

Example of a project:

The relationship among Money, Income and Interest rate. Data is based on U.S. from 1900-89

INTRODUCTION

The interest rate and income are linking variables transmitting changes from the monetary sector to the goods sector and from the goods sector to the money sector. We now examine this relationship in more detail and analyze the concept of general equilibrium in the whole economy, consisting of the goods and money sectors

The relationship between real income and the interest rate and occur in the money (financial sector of the economy). How does monetary policy change the interest rate and indirectly, planned autonomous spending and the level of real income.

We link money, income and interest rate; the demand for money in real term depends on both income and the interest rate. Income is related to past and present values of money. The results of different researches have generally indicated a relatively strong association between money and income occurring several quarters after the initial change.

All else being equal, a larger money supply lowers market interest rates. Conversely, smaller money supplies tend to raise market interest rates. The current level of liquid money (supply) coordinates with the total demand for liquid money (demand) help to determine interest rates.

BASIC DEFINITON

Money is not ideally distributed; people have different knowledge for money. Money increases income at first in some places and in other later on. Money goes into economy through credit market which lowers the interest rate. (Quantity Theory of Money)

Money is any item or verifiable record that is generally accepted as payment for goods and services and repayment of debts in a particular country or socio-economic context, or is easily converted to such a form.

Income is the consumption and savings opportunity gained by an entity within a specified timeframe, which is generally expressed in monetary terms. However, for households and individuals, "income is the sum of all the wages, salaries, profits, interests' payments, rents, and other forms of earnings received in a given period of time.

An interest rate, is the amount of interest due per period, as a proportion of the amount lent, deposited or borrowed (called the principal sum). The total interest on an amount lent or borrowed depends on the principal sum, the interest rate, the compounding frequency, and the length of time over which it is lent, deposited or borrowed.

DATA

Data on log (money) log (income) and interest rate from US.
Source: Stock and Watson (1993) Econometric - unsmoothed data.
Period is 1900-1989 (annual data). Data compiled by Graham Elliott.

A summary of the variable is provided in the Table 1 below:

Variable Descriptions
(Annual data for the US for 1900-89)

lmoney	Log of Money
lincome	Log of Income
Intrate	Interest rate

Calculative Results

Obtaining descriptive statistics is among the first steps in a regression analysis, because it summarizes the data in an easy and understandable way.

Summary Statistics, using the observations 1900 - 1989

Variable	Mean	Std. Dev.	Median	Minimum	Maximum
lmoney	0.977332	0.692195	1.50399	-0.373867	1.84047
lincome	2.26098	0.795599	2.29394	0.903020	3.59334
intrate	4.55469	2.89956	4.32500	0.690000	14.6100

During the 1900-1989 periods in the United States, the above data shows the means, standard deviations, minimums and maximums. According to the data, log of money in mean is 0.977 and standard deviation is 0.692. While log of income is 2.26 in mean and is 0.795 in Standard deviation. Interest rate is 4.554 and 2.899 in mean and standard deviation respectively.
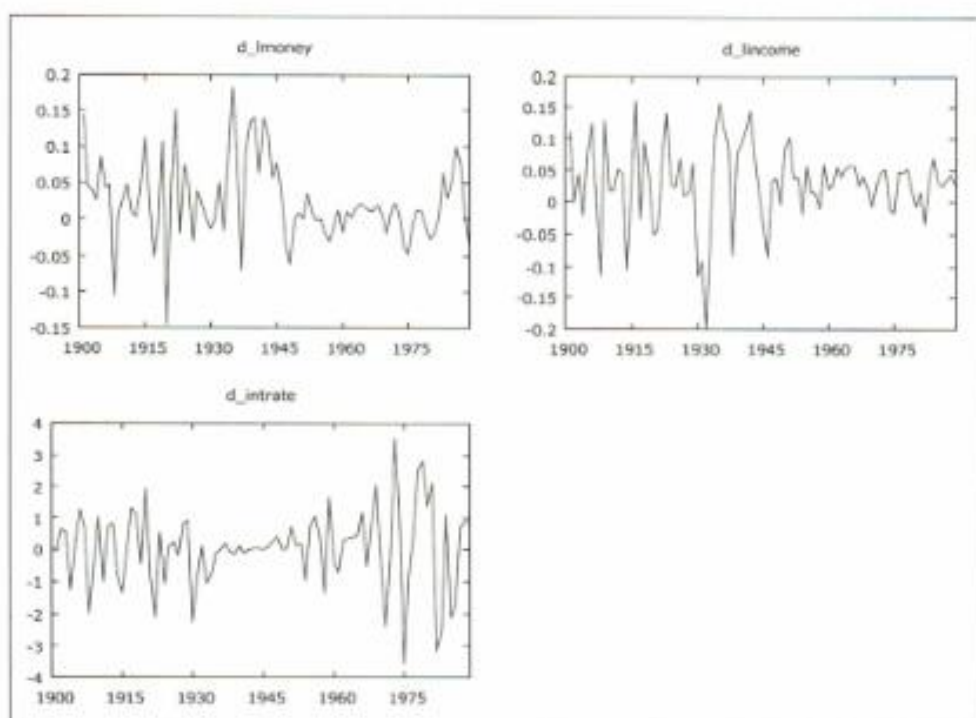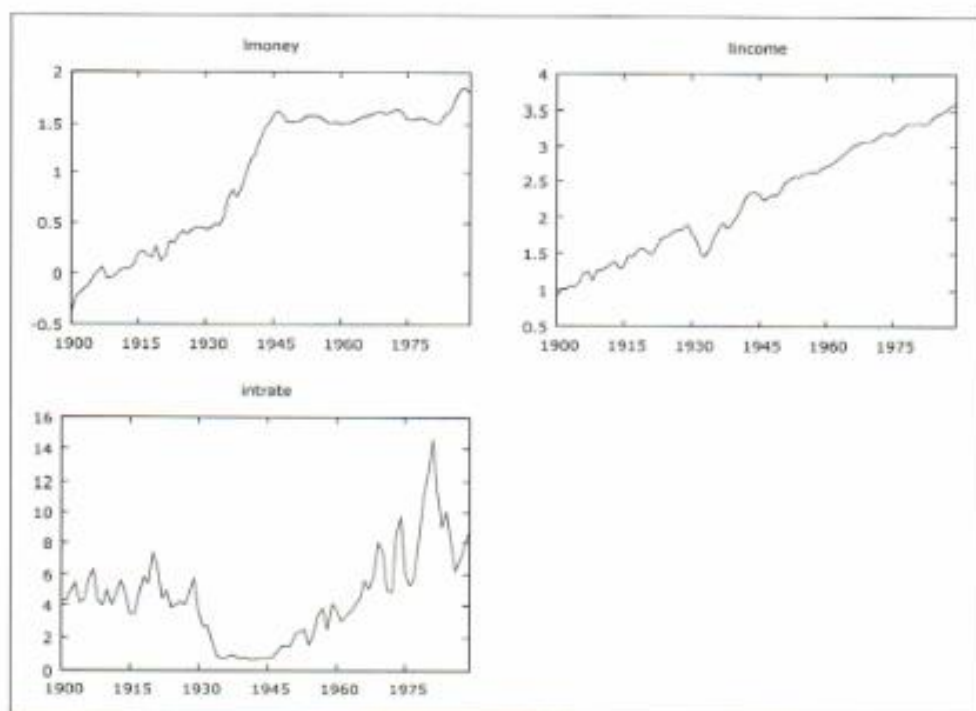
The minimum and maximum amounts indicate the lowest and highest value for each variable.
While the lmoney, lincome and interest rate (explainers' variables) do not have strong correlation coefficients, by using multicollinearity with this analysis, there is no issue.

See correlation results below:

Correlation coefficients, using the observations 1900 - 1989
5% critical value (two-tailed) = 0.2072 for n = 90

lmoney	lincome	intrate	
1.0000	0.9304	0.1208	lmoney
	1.0000	0.4331	lincome
		1.0000	intrate

lmoney

lincome

intrate

d_lmoney

d_lincome

d_intrate

Summary Statistics, using the observations 1900 - 1989
(Missing values were skipped)

Variable	Mean	Std. Dev.	Median	Minimum	Maximum
d_lmoney	0.0244928	0.0558264	0.0112950	-0.145140	0.184289
d_lincome	0.0302284	0.0622739	0.0356900	-0.198254	0.160062
d_intrate	0.0486236	1.23497	0.0900000	-3.57417	3.52417

Correlation coefficients, using the observations 1901 - 1989
5% critical value (two-tailed) = 0.2084 for n = 89

d_lmoney	d_lincome	d_intrate	
1.0000	0.3263	-0.1997	d_lmoney
	1.0000	0.2277	d_lincome
		1.0000	d_intrate

Correlation Model

The following estimated model was used the time series analysis. In order to examine the effect of Income and interest rate on money in the United States, a data containing duration of 1900-89. Since this is:

$$d\_lmoney = a_0 + a_1\, d\_lincome + a_2\, d\_intrate + e_t$$

- d_lmoney = Difference of log of Money
- $d\_lincome$ = Difference of log of Income
- $d\_intrate$ = Difference of log of Interest Rate
- e_t = Error Term / Residual
- a_0, a_1, a_2 = Coefficients – they show the relation of dependent variable and explainers. If explainer changes then dependent variable will also change.

This model estimates that there is a relationship between the explainers and the dependent variable. This model is clearly showing dependence of money with income and interest rate. There is positive/negative relationships among money, income and interest rate that's need to be explained.

Furthermore this examination will show the existence of statistical problems that are Multicollinearity and Autocorrelation, and make corrections in the results, this is necessary in order to boost the statistical feedback.

Model 1: OLS, using observations
1902-1989 (T = 88)
Dependent variable: d_lmoney

	Coefficient	Std. Error	t-ratio	p-value	
const	0.0127554	0.00631681	2.0193	0.0467	**
d_lincome	0.263757	0.0962913	2.7392	0.0075	***
d_lincome_1	0.117702	0.0932931	1.2616	0.2106	
d_intrate	−0.0125602	0.00456281	−2.7527	0.0073	***
d_intrate_1	−0.00715385	0.00474749	−1.5069	0.1356	

Mean dependent var	0.023139	S.D. dependent var	0.054658
Sum squared resid	0.207557	S.E. of regression	0.050007
R-squared	0.201424	Adjusted R-squared	0.162938
$F(4, 83)$	5.233750	P-value(F)	0.000827
Log-likelihood	141.3196	Akaike criterion	−272.6391
Schwarz criterion	−260.2524	Hannan-Quinn	−267.6488
rho	0.140621	Durbin-Watson	1.708858

Model 4: OLS, using observations
1902-1989 (T = 88)
Dependent variable: d_lmoney

	Coefficient	Std. Error	t-ratio	p-value	
const	0.014152	0.00595053	2.3783	0.0196	**
d_lincome	0.328292	0.0893801	3.6730	0.0004	***
d_intrate	−0.0126939	0.00446459	−2.8432	0.0056	***

Mean dependent var	0.023139	S.D. dependent var	0.054658
Sum squared resid	0.215147	S.E. of regression	0.050310
R-squared	0.172220	Adjusted R-squared	0.152743
$F(2, 85)$	8.842167	P-value(F)	0.000325
Log-likelihood	139.7392	Akaike criterion	−273.4785
Schwarz criterion	−266.0464	Hannan-Quinn	−270.4843
rho	0.142572	Durbin-Watson	1.700056

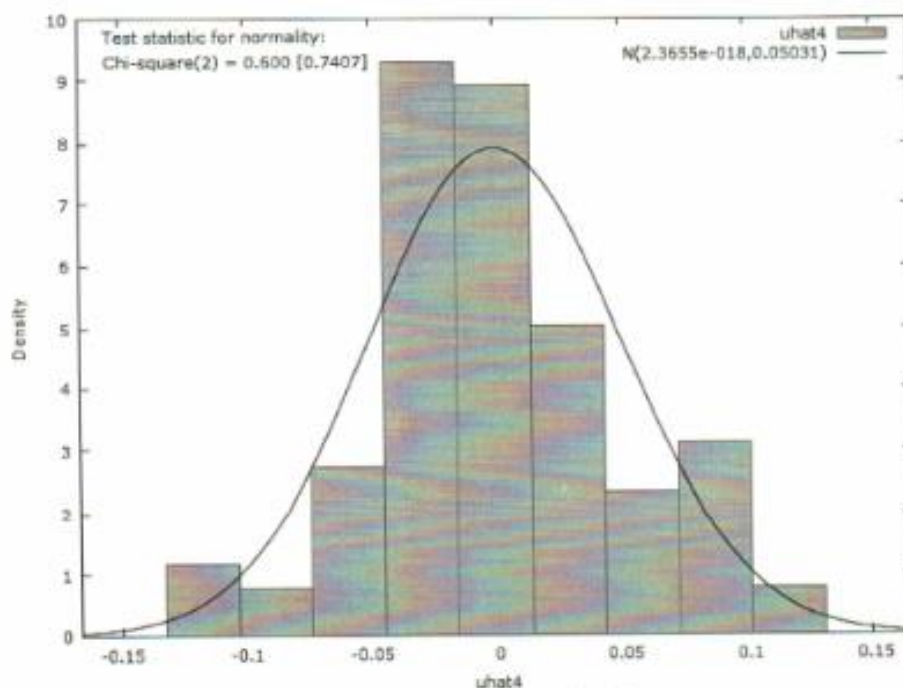$$d\_lmoney = 0.0142 + 0.328\ d\_lincome - 0.0127\ intrate + e_t$$

The following is expositing the correlation of each coefficient that, if money is increased by 1% the income would be enhanced by 0.33% and there is inverse connection between money and interest rate, if money enriched by 1% then interest decreased by 0.13% and vice versa.

The adjusted R-squared is 0.15 and p-value of the F-test is almost zero, which can reject the Null Hypothesis that all coefficient are equal to zero. Both results mean that the overall fit is good.

Durbin-Watson

Durbin-Watson is 1.70. This is higher than the upper critical value of the 1% one side test (1.56), which cannot the Null Hypothesis of no positive serial correlation. The sample Durbin-Watson test of statistics is 1.70 and critical Durbin-Watson test is about to be 1.45.

Normality of the Residuals

Test statistic for normality:
Chi-square(2) = 0.600 [0.7407]

N(2.3655e-018,0.05031)

uhat4

Frequency distribution for uhat4,
obs 3-90
Number of bins = 9, mean = 2.36553e-018, sd = 0.0503105

interval		midpt		frequency	rel.	cum.
	<	-0.10306	-	0.11772	3	3.41% 3.41% *
-0.10306	-	-0.073736	-	0.088398	2	2.27% 5.68%
-0.073736	-	-0.044413	-	0.059075	7	7.95% 13.64% **
-0.044413	-	-0.015091	-	0.029752	24	27.27% 40.91% *********
-0.015091	-	0.014232	-	0.00042912	23	26.14% 67.05% *********
0.014232	-	0.043555	-	0.028894	13	14.77% 81.82% *****
0.043555	-	0.072878	-	0.058217	6	6.82% 88.64% **
0.072878	-	0.10220	-	0.087540	8	9.09% 97.73% ***
	>=	0.10220	-	0.11686	2	2.27% 100.00%

Test for null hypothesis of normal distribution: Chi-square (2) = 0.600 with p-value 0.74071
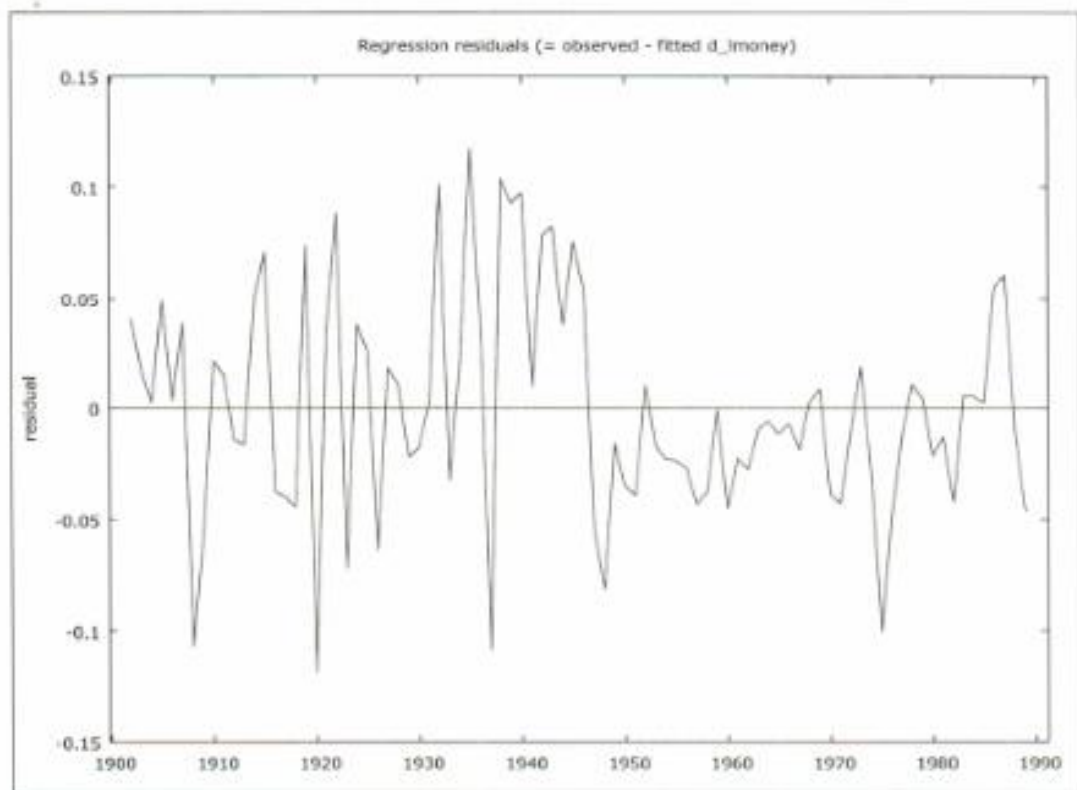
The p-value of the normality of the residual test is higher than 0.05 which is assuring that the error is distributed with a normal distribution.

White's test for heteroskedasticity
OLS, using observations 1902-1989 (T = 88)
Dependent variable: uhat^2

	coefficient	std. error	t-ratio	p-value
const	0.00154891	0.000487751	3.176	0.0021 ***
d_lincome	−0.00944110	0.00565148	−1.671	0.0986 *
d_intrate	−0.000145446	0.000286669	−0.5074	0.6133
sq_d_lincome	0.248388	0.0505872	4.910	4.57e-06 ***
X2_X3	−0.0155782	0.00605441	−2.573	0.0119 **
sq_d_intrate	0.000209141	0.000140410	1.490	0.1402

Unadjusted R-squared = 0.269647
Test statistic: TR^2 = 23.728974,
With p-value = P (Chi-square(5) > 23.728974) = 0.000245

White's test for heteroskedasticity p-value is 0.000245. So, we can reject the Null Hypothesis.

Regression residuals (= observed - fitted d_imoney)

Conclusion

Demand for money shows the quantity of money, people wish to hold at various rates. As the interest rates rises, the quantity of money demanded is less than when the interest rate is lower. An excess of money demanded causes to increase income. This is caused to enhance the balance by selling bonds. This causes the price of bond to fall, thus drive up the interest rate.

Money as reflected is a stable function of income and interest rate.