

**Homework Assignment # 2** (100 points)

Use a software of your choice to answer the questions. Be sure to upload your answers and code on Carmen. The data for the assignment is available on Carmen (hwk2.2018-dataset.csv).

The purpose of this assignment is to apply time series diagnostics tools and regression theory to come up with an appropriate econometric model for interest-bearing deposits using aggregate deposit data of FDIC-insured financial institutions in the US. The data is divided in two parts. The first part consists of actual data (“scenario=actual”) on bank deposits and other variables (interest rates, GDP growth, consumer price index, housing price index Dow Jones index etc.) that are potential explanators of deposit recorded quarterly from 1984 to end of 2016. The table below contains the list of all variables. The second part consists of quarterly forecast data from the first quarter of 2017 to the first quarter of 2020 for the candidate explanatory variables under three premises for the state the US economy: baseline growth, adverse, and severe economic downturns.

Consider the following econometric models of interest-bearing deposits:

$$Y = X\beta + X_l\beta_l + X_u\beta_u + X_{uu}\beta_{uu} + X_{uuu}\beta_{uuu} \quad (1)$$

$$\Delta Y = \Delta X\beta + \Delta X_l\beta_l + \Delta X_u\beta_u + \Delta X_{uu}\beta_{uu} + \Delta X_{uuu}\beta_{uuu} \quad (2)$$

$$\% \Delta Y = \% \Delta X\beta + \% \Delta X_l\beta_l + \% \Delta X_u\beta_u + \% \Delta X_{uu}\beta_{uu} + \% \Delta X_{uuu}\beta_{uuu} \quad (3)$$

where  $Y$  represents interest-bearing deposits and  $X$  is the matrix of the intercept vector and the remaining variables listed in the table below.

Based on the actual data provided (1984-2016), you are to do the following tasks:

- 1) Transform the deposit data to create the dependent variables for models (2)-(4)
- 2) Undertake the following transformations:
  - create one to four-quarter lags of the explanatory variables—excluding the time trend (command LAG in SAS)
  - create one-quarter differences of the the explanatory variables (command DIF in SAS) and their lags (one to four quarter lags)
- 4) Create quarterly dummies and add them to the dataset to control for potential seasonality
- 5) Graph each of the dependent variables over time to detect evidence of a trend (can be done with Proc Gplot in SAS)
- 6) Check if deposits exhibit seasonality (can be done with Proc X11 in SAS)

7) Check for stationarity of the dependent variables using the augmented Dickey Fuller test and four lags (see “Stationarity” command in Proc Autoreg)

8) Use economic intuition and the forward variable selection model (with a selection entry cutoff of 10%) to come up with a list of variables that best explain the behavior of interest-bearing deposits for each of the model specifications. If there is evidence of seasonality in the data, be sure to force quarterly seasonal dummies into the model (use “Include=” command of Proc Reg). Be sure to refine your variable selection based on a multicollinearity diagnostic (you can use the VIF command in Proc Reg to examine evaluate multicollinearity of the explanatory variables)

9) For each of the four models, test for normality of the residuals (Normal command), autocorrelation of the residuals (Godfrey or Durbin-Watson tests), heteroscedasticity of the errors (Archtest command).

10) Report Newey-West robust standard errors.

11) Use the forecast data (2017-2020) for the explanatory variables to conduct an out of sample prediction of the amount of interest-bearing deposits for your preferred model specification (defend your choice) for each economic growth scenarios (baseline and adverse).

12) Finally, graph actual vs. in-sample predicted values of deposits for the actual sample period (1984-2016) and the out of sample predictions for 2017-2020.

13) Interpret/discuss your overall results.

Variable Name	Definition
Date	Quarter when data is measured
ideposits	Interest-bearing deposits
rgdp	Real GDP growth
rdi	Real disposable income growth
ur	Unemployment rate
cpi	CPI inflation rate
treas_3m	3-month Treasury rate
treas_5y	5-year Treasury yield
treas_10y	10-year Treasury yield
bbb	BBB corporate yield
mort_rate	Mortgage rate
vix	Market Volatility Index (percentage)
dow	Dow Jones Total Stock Market Index (Level)
hpi	House Price Index (Level)

## Background

In general, it is expected that rising rates will incentivize customers to move deposit balances from non-interest-bearing deposit products (e.g., demand deposit accounts) into interest-bearing products (e.g., money market accounts). Furthermore, significant rate increases may incentivize some customers to be selective as to which interest-bearing deposit products they choose. For instance, certificates of deposit (CDs) typically offer higher rates than other interest-bearing deposit products and, depending on the rates offered, customers may elect to hold excess balances in CDs. However, CDs require that customers deposit their money at the bank for an agreed upon term, with early withdrawals typically resulting in a penalty. Similarly, other interest-bearing deposit products typically have requirements that must be met in order for customers to earn the offered rate, e.g., minimum balance requirements. Given these considerations, the impact of interest rate changes on deposit balances and mix, e.g. how much is held in interest-bearing versus non-interest-bearing, is often not clear cut.

Since banks use deposit balances as a core source of funding (banks need deposits to make loans and earn interest on those loans), there is a strong need to understand the underlying drivers of deposit behavior and factors that impact deposit balances and mix. Using industry deposit data available from the FDICs quarterly banking profile (<https://www.fdic.gov/bank/analytical/qbp/>) and economic data available from FRED (<https://fred.stlouisfed.org/>), the RMA team would like help in determining the impact of changes in interest rates, and other economic factors, on industry deposit balances and deposit mix over time. The insights gleaned from this industry study can help inform banks' internal deposit models and potentially bring to light factors currently not being considered.