Code Description for

"Assessing Financial Stability: The Capital and Loss Assessment under Stress Scenarios (CLASS) Model"*

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This document briefly describes how to use the data and code provided in this zip file to reproduce the figures and tables in the 2016 *Journal of Banking and Finance* paper "Assessing Financial Stability: The Capital and Loss Assessment under Stress Scenarios (CLASS) Model". A brief description of each program is also provided.

Figure 7 is the only figure in the paper that cannot be reproduced using these files. This figure was created using data the authors purchased or received from another party who did not give permission for the data to be shared publicly.

There are four instances in which the results produced using the attached programs will differ slightly from those in the paper. These differences appear in Appendix Tables 1 and 2B, figure 8, and the tables presented in section 2 of the online appendix. A description of these differences and the reasons behind them can be found within the description of the individual programs that produce the output, or 2regs.do, 8capgapgraphs.do, and asset_macro_comp.do, respectively, (under the headings Erratum #1, Erratum #2 and Erratum #3). The differences in results from the published version are minor, and do not affect the overall conclusions of the paper.

Note: The CLASS model was programmed in Stata, and you will need Stata to reproduce the results from the paper.

I. Set- Up

The zip folder contains four folders: ado, data, output, and programs.

A. Ado

The ado folder contains necessary Stata functions, including those written by the authors, to run the code.

* Particular thanks to April Meehl and Ulysses Velasquez, who developed this readme file and carefully checked and cleaned the code and input files which reproduce the results in Hirtle et al. (2016). Any questions should be directed to james.vickery@ny.frb.org. Opinions in this document represent those of the authors and are not the opinions of the Federal Reserve Bank of New York or the Federal Reserve System.

B. Data

The data folder has two subfolders: class_data and raw.

The class_data subfolder contains all datasets created for use in the CLASS model. Other datasets will be created and saved in this folder during the running of the concurrent capgap model. Below is a description of each file located in the class_data subfolder:

- capital.dta – this dataset includes the necessary bank observations and characteristics for the last historical quarter (2013Q3) that are needed to calculate the CLASS projections. As such, the dataset includes the 200 largest banking institutions, as well as the aggregated remainder of the industry.
- capital_long.dta – this dataset is similar to capital.dta except it includes data from 2002Q1 through 2013Q3 that are needed to calculate the historical capital gap series.
- class_rawcore.dta – this dataset includes the full set of banking institutions, not just the largest 200, across all historical quarters.
- core.dta – this dataset includes historical data on the 200 largest banking institutions and the aggregated remainder of the industry; foreign firms are not included.
- core_wf.dta – this dataset is similar to core.dta except it includes foreign firms.
- macro_class_wfcasts.dta – this dataset includes the macroeconomic scenarios that are used when calculating CLASS projections.
- macro_log.dta – this dataset includes the historical macroeconomic data that are used when estimating the CLASS model.

The subfolder raw contains other given data. Below is a description of each file located in the raw subfolder:

- CCAR_Data.dta – this dataset includes DFAST projections, which are used to compare to CLASS projections in Table 7 of the paper.
- quarterly_trends_data.xls – this dataset comes from the Quarterly Trends report data for 2013Q3, available on the Federal Reserve Bank of New York's website. This dataset is used in the construction of tables found in section 2 of the Online Appendix.
- table_mapping_data files – these files can be safely ignored as they are not used in any of the CLASS analyses found in the paper; they are merely used as a means to construct the final, formatted tables found in the CLASS paper.

Two other subfolders will be created through the course of running the program: EPR and EPR_concurrentcapgap. Each will hold temporary files used in generating figures and tables.

C. Output

The output folder contains a spreadsheet called finalized_tables.xlsx. As the program runs, this spreadsheet will be filled in with the data presented in Tables 1, 2, 5, 7, and 8 in the paper and Tables 1, 2A, and 2B in the Appendix. Each table has already been formatted to match that of the paper.

In order to reset finalized_tables.xlsx to its original state (in the case you wish to re-run the program), manually clear all cells containing numbers.

Two subfolders will be created through the course of the program: figures and tables. All figures, as well as their underlying data, will be saved in figures while all other tables not saved in finalized_tables.xlsx will be saved in tables.

A subfolder called capital_forecasts will also be created within the tables subfolder. This folder will save datasets with capital forecasts that will be used later in the creation of Figure 8 and Table 2.

D. Programs

The programs folder contains two subfolders: EPR and EPR_concurrentcapgap.

The EPR subfolder contains eighteen Stata do files and EPR_concurrentcapgap contains six Stata do files. The first do file in the EPR subfolder, 0doall.do, will run the entire program, including those do files found in EPR_concurrentcapgap. The do files in EPR_concurrentcapgap repeat the capital gap analyses done in EPR but calculate the capital gap every quarter using projections based on models that incorporate historical data only up to that quarter, as opposed to the full historical data.

Further description of each program is given in Section III.

II. Running the Program

All figures and tables from the paper can be recreated by running the Stata do file programs/EPR/0doall.do. This master file will execute all other programs in the programs folder in the correct order.

To run 0doall.do, open the do file. At the top of the file, update the local prefix to reflect the path to the folder in which you have saved the zip file. In order to exactly replicate the results of the paper, no other actions need to be taken. Run.

The programs in their entirely can take up to a day to run, depending on your processing power.

III. Description of Programs

Following is a description of each do file used to recreate the figures and tables in the paper. Each description includes the inputs used in the file and the outputs created. The descriptions are given in the order in which they are run in the 0doall.do file.

A. EPR/0doall

This program runs all of the do files in the zip folder, completely replicating the paper's figures and tables. It also sets important globals for paths, folders, assumptions, and graph settings. Additionally, it creates five more folders in the zip folder: figures and tables in the output folder, capital_forecasts in the tables folder, and EPR and EPR_concurrentcapgap in the data folder. Prior to creating these folders, the program erases any existing folders or output that was created during a previous run of the program that will be recreated in the next run.

B. The CLASS Model

The first eight sub-processes recreate the CLASS model.

1) EPR/1macro

> This program creates the macroeconomic forecasts for the next thirteen quarters for each of the three scenarios: baseline, redux, and severely adverse. It uses the historical and forecasted macro variables.
>
> Inputs: data/class_data/macro_class_wfcasts.dta
> Outputs: data/class_data/fcasts_cl_base.dta, data/class_data/fcasts_cl_redux.dta, data/class_data/fcasts_cl_dadv.dta, Table 1

2) EPR/2regs

> This program estimates 22 autoregressive regression models of different components of firm income and expense, using historical macroeconomic and bank data. Regression estimates form a basis for CLASS projections and are used to generate appendix tables found in the paper.
>
> Inputs: data/class_data/core.dta, data/class_data/macro_log.dta
> Outputs: data/EPR/core_industryonly.dta, output/tables/appendix_tables_data.dta, Appendix Table 1, Appendix Table 2A, Appendix Table 2B
>
> Erratum #1: Appendix Table 1 and Appendix Table 2B, both of which can be found in finalized_tables.xlsx, have two coefficients/standard errors that differ from what is reported in the paper. In particular, in the Return on AFS regression specification in Appendix Table 1, the coefficient/standard error of the Quarterly change in BBB Spread is slightly different from what is stated in the paper. Similarly, in the Leases regression specification in Appendix Table 2B, the coefficient/standard error of the constant term is slightly different from what is stated in the paper. We ask the reader to look at the estimated models in the finalized_tables.xlsx spreadsheet for the correct versions of the aforementioned specifications.

3) EPR/3machine

This program uses the regression estimates from 2regs, macroeconomic forecasts from 1macro, and assumptions about provisioning, dividends, and asset growth, among other factors, to generate projections of bank and bank holding company income and capital.

Inputs: data/class_data/capital.dta, data/class_data/macro_log.dta, data/class_data/fcasts_cl_base.dta, data/class_data/fcasts_cl_redux.dta, data/class_data/fcasts_cl_dadv.dta
Outputs: output/tables/capital_forecasts_cl_base.dta, output/tables/capital_forecasts_cl_redux.dta, output/tables/capital_forecasts_cl_dadv.dta

4) EPR/4industry

This program collapses firm-level projections from 3machine into industry-level projections and saves new datasets to be used later in generating graphs of the historical/projected time series of relevant components of firm income, expense, and capital.

Inputs: output/tables/capital_forecasts_cl_base.dta, output/tables/capital_forecasts_cl_redux.dta, output/tables/capital_forecasts_cl_dadv.dta, data/EPR/core_industryonly.do
Output: output/tables/industry_data_cl_base.dta, output/tables/industry_data_cl_redux.dta, output/tables/industry_data_cl_dadv.dta, output/tables/industry_data_all.dta, output/tables/industry_data_pregraphs.dta

5) EPR/5graphs

This program creates all CLASS model graphs, aside from the capgap graphs.

Inputs: output/tables/industry_data_pregraphs.dta
Outputs: Figures 2A-2F, Figure 3, Figure 4A

6) EPR/6reports

This program uses the capital forecasts to generate datasets logging the capital gap for all institutions; as mentioned in the paper, the capital gap is computed in the quarter in which the industry capital ratio is minimized over the forecast horizon.

Inputs: output/tables/capital_forecasts_cl_base.dta, output/tables/capital_forecasts_cl_redux.dta, output/tables/capital_forecasts_cl_dadv.dta
Outputs: output/figures/capdist_graph_all.dta, output/tables/capgap_full.dta, Figure 4B

7) EPR/7capgap

This program loops through the capital gap calculation by quarter. In each quarter of the loop iteration, CLASS model projections are generated, treating that quarter as the last historical quarter. Projections are then used to find the quarter in the forecast horizon in which the industry capital ratio is minimized. In that quarter in the forecast horizon, the capital gap is calculated firm-by-firm and then summed across firms. It is important to note that the CLASS model that is used in each quarter's projections is not re-estimated using data only up to the quarter in question; capital gap calculations based on a re-estimated CLASS model are done in the concurrent_capgap version (see Section E).

Inputs: data/class_data/capital.dta, data/class_data/capital_long, output/tables/capital_forecasts_cl_base.dta, output/tables/capital_forecasts_cl_redux.dta, output/tables/capital_forecasts_cl_dadv.dta
Outputs: data/class_data/capital_capgaploop.dta, output/tables/accum_capgap_full.dta, output/tables/capital_forecasts/capital_forecasts_`scenario'_q`quarter number'.dta

8) EPR/8capgapgraphs

This program creates graphs based on capital gap data: Figure 5 and Figure 8. This program also examines the determinants of change in capital during stress scenarios, the result of which can be seen in Table 2.

Inputs: output/tables/accum_capgap_full.dta, output/tables/capital_forecasts/capital_forecasts_`scenario'_q`quarter number'.dta
Outputs: output/tables/PooledRegsData, Table 2, Figure 5, Figure 8

Erratum #2: The figure 8 found in the paper will differ slightly from the one produced in this program; this is because the figure 8 in the paper was produced using an alternative provisioning method. The figure 8 produced by this program is the correct version.

C. Sensitivity Tests

The next two sub-processes perform sensitivity tests on our model assumptions.

1) EPR/9SensitivityAssume.do

This program changes the assumptions for the asset growth multiplier, the provisioning method, and the dividend distributions used in the CLASS model. It then creates data which will be used to generate graphs comparing the outcomes that arise as a result of using different assumptions.

Inputs: output/tables/industry_data_all.dta, inputs for 1macro, 2regs, 3machine, 4industry
Outputs: output/tables/industry_data_all_assetmultiplier.dta, output/tables/industry_data_all_provisiontype.dta, output/tables/industry_data_all_divar.dt

2) EPR/10SensitivityAssumeGraphs.do

This program creates graphs showing the sensitivity of CLASS outputs to different assumptions on asset growth, provisioning method, and dividend distributions.

Inputs: data/EPR/core_industryonly.dta,
output/tables/industry_data_all_assetmultiplier.dta,
output/tables/industry_data_all_provisiontype.dta,
output/tables/industry_data_all_divar.dta
Outputs: Figures 10a-10c

D. Appendix Graphs

The program EPR/appendix_graphs.do creates graphs of historical provision expense and net charge-offs on loans, which can be found in section 3 of the online appendix.

Inputs: data/EPR/core_industryonly.dta
Outputs: Appendix Graph 1, Appendix Graph 2

E. Concurrent Capital Gap

This group of do files re-runs the CLASS model, but with calculating the capital gap each quarter, using only the data available in up to that quarter.

1) EPR_concurrentcapgap/0doall.do

This program sets important path, date, and assumption globals to be used in the re-running of the CLASS model. It runs the program EPR_concurrentcapgap/11concurrentcapgap.do.

a) EPR_concurrentcapgap/11concurrentcapgap.do

This program loops through the capital gap calculation by quarter. In each quarter of the loop iteration, CLASS model projections are generated, treating that quarter as the last historical quarter. Projections are then used to find the quarter in the forecast horizon in which the industry capital ratio is minimized. In that quarter in the forecast horizon, the capital gap is calculated firm-by-firm and then summed across firms. It is important to note that the CLASS model that is used in each quarter's projections is re-estimated using data only up to the quarter in question. Various programs are used within 11concurrrentcapgap.do, namely EPR_concurrentcapgap/2regs.do, EPR_concurrentcapgap/3machine.do, and EPR_concurrentcapgap/6reports.do. These programs do not differ materially from EPR/2regs.do, EPR/3machine.do, and EPR/6reports.do, respectively.

Inputs: data/class_data/capital.dta, data/class_data/core.dta, all inputs for EPR/2regs.do, EPR/3machine.do, EPR/6reports.do

Outputs: data/class_data/capital_reserve.dta, data/class_data/core_concurloop.dta, output/tables/accum_capgap_point.dta

2) EPR/figure6.do

This program creates graphs comparing the full-sample and point-in-time capital gap series.

Inputs: output/tables/accum_capgap_point.dta, output/tables/accum_capgap_full.dta
Outputs: output/tables/figure_6.dta, Figure 6

F. Comparing CLASS projections to Performance during Financial Crisis

The program EPR/CLASS_projections_performance.do compares the CLASS model projections to the actual performance during the Financial Crisis.

Inputs: output/tables/capital_forecasts/capital_forecasts_cl_redux_q189.dta, data/class_data/class_rawcore.dta
Outputs: output/tables/ComparisonData.dta, output/tables/Industry_aggregatecrisis.dta, output/tables/ComparisonData_survivors_regs_data.dta

G. Comparison to DFAST

The next two do files compare the CLASS model projections to those of the DFAST model.

1) EPR/CLASS_DFAST_append_data.do

This program formats CLASS data and forecasts to match that of DFAST data and appends the dataset to DFAST.

Inputs: output/tables/capital_forecasts_cl_dadv.dta, data/raw/CCAR_Data.dta
Outputs: output/tables/CCAR_CLASS_EPR_GraphData.dta

2) EPR/CLASS_DFAST_compare.do

This program compares the CLASS projections to those of DFAST and generates Table 7 to display these comparisons.

Inputs: output/tables/capital_forecasts_cl_dadv.dta, data/raw/CCAR_Data.dta, output/tables/CCAR_CLASS_EPR_GraphData.dta
Outputs: Table 7

H. Asset Share Specifications

The program EPR/asset_comp_macro.do runs time series regression models of asset composition for the commercial banking industry based on data from 1991Q1 through 2013Q3. The estimated regression models are presented in section 2 of the online appendix in panels A, B, C, and D. Panel A is derived from output/tables/asset_share_specifications.xlsx; panel B is derived from output/tables/asset_share_specifications_top10.xlsx; panel C is derived from output/tables/asset_share_specifications_bottom.xlsx; and panel D is derived from output/tables/f_tests.dta and output/tables/f_tests_interaction.dta.

Inputs: data/raw/quarterly_trends_data.xlsx, data/class_data/macro_log.dta, data/class_data/core_wf.dta
Outputs: output/tables/asset_share_specifications.xlsx, output/tables/asset_share_specifications_top10.xlsx, output/tables/asset_share_specifications_bottom.xlsx, output/tables/f_tests.dta, output/tables/asset_share_specifications_interaction.xlsx, output/tables/f_tests_interaction.dta

Erratum #3: The asset share specification tables produced will differ from the tables found in Panels A-D of section 2 of the online appendix because the results presented in the original paper incorporate historical macroeconomic revisions done in 2014Q3, even though we use only data up to 2013Q3. The program attached, however, incorporates the macroeconomic data as they stood in 2013Q3, causing the estimates to change slightly as a result. We direct the reader to look at the tables produced by this program for the correct, updated version of section 2 of the online appendix.