F.I.T. (Forecast Instability Test) Toolbox*

Forecast Evaluation Tests in the Presence of Instabilities

User Guide
Version 1.3

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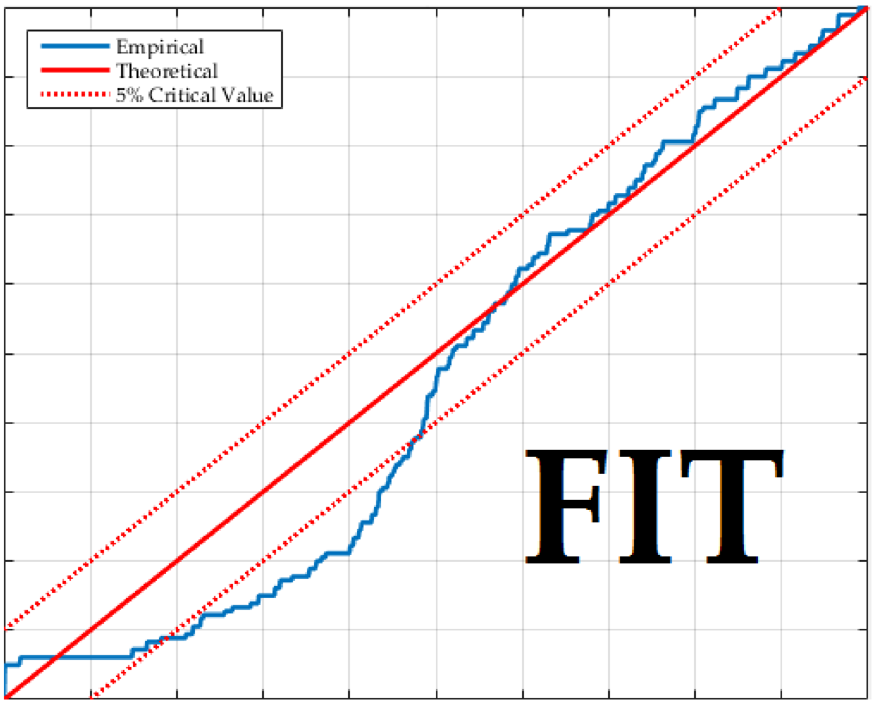

*If you need assistance on installing or deploying the app please contact Francesca Loria at francescaloria.work@gmail.com. We thank Tatevik Sekhposyan for comments.

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FIT Toolbox

In the following we present the interface of the **FIT** toolbox. We first give indications on how to install it in MATLAB and then give detailed instructions on how to deploy it. Details on the statistical tests can be found in the technical guide.

1 Installation and Requirements

The toolbox is designed to work on PCs and MACs as well as in every MATLAB version. However, users need to make sure that the *Image Processing Toolbox* and the *Statistics and Machine Learning Toolbox* are available in their MATLAB installation in order for the toolbox to work correctly.

The toolbox can be installed following these steps:

1. Request the folder which contains the toolbox to Barbara Rossi.
2. Save it in a directory of your choice.
3. Open MATLAB.
4. Within MATLAB, browse to the directory where you have saved the toolbox folder and open it.
5. The folder contains a file called `FIT.mlappinstall`. Double click on this file. MATLAB will prompt you to install it among its apps. Click on `Install` to add the toolbox to your MATLAB apps.

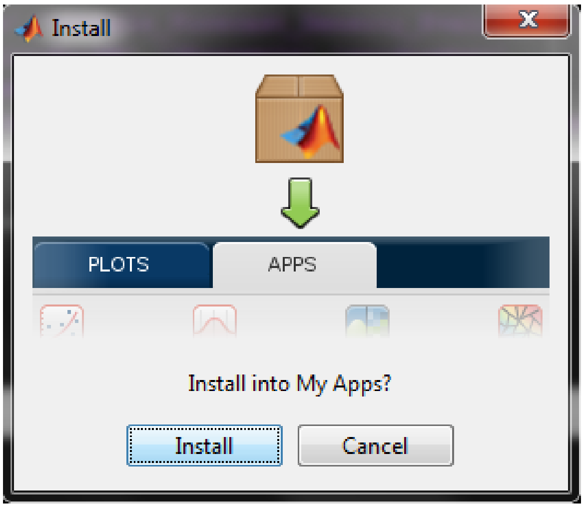


Figure 1: Installation Window.

In case one of the required toolboxes is not available MATLAB will display a product dependency warning of the following type.

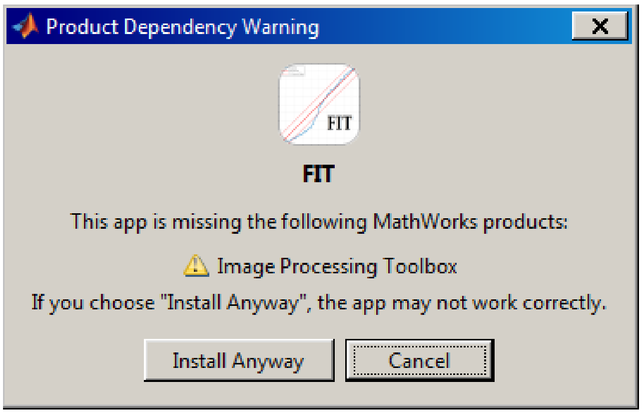


Figure 2: Product Dependency Warning.

Be aware that if you proceed with installation the **FIT** toolbox might not run error-free.

6. Upon successful installation the toolbox will now appear among your MATLAB apps in the `APPS` tab (see red circle in Figure 3).

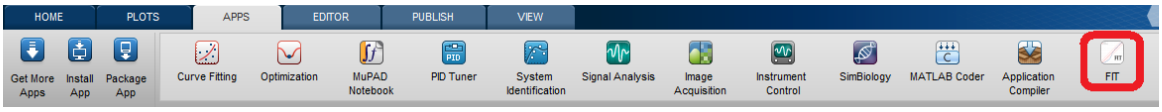


Figure 3: MATLAB Apps tab.

IMPORTANT:

- Should you encounter a MATLAB crash when opening or using the **FIT** toolbox please update the graphic drivers of your graphics card. If the problem persists please contact us.
- The GUI (Graphical User Interface) of the toolbox appears best on machines with a resolution of 1360 x 768 or higher. Should some parts of the GUI be cropped or only partially displayed we recommend increasing the screen resolution.

2 Workflow

To deploy the toolbox you need to double-click on its symbol in the MATLAB `APPS` tab list. The home panel will open.

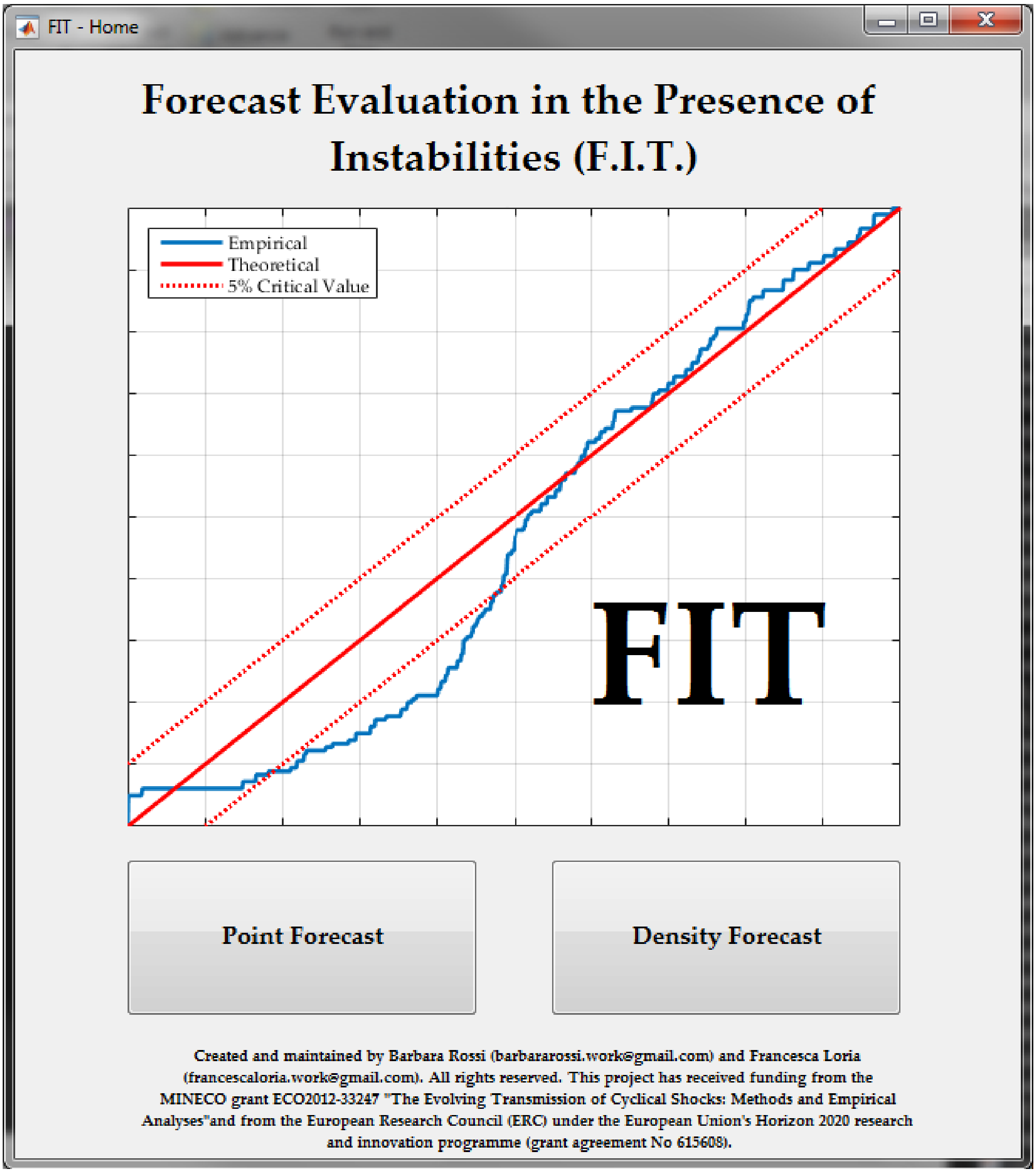


Figure 4: Home Panel.

You can now decide whether you want to perform the forecast evaluation tests in the presence of instabilities for point forecasts or for density forecasts by clicking on the respective push button.

2.1 Point Forecast Evaluation Tests

Upon clicking on `Point Forecast` in the home panel the following window will appear.

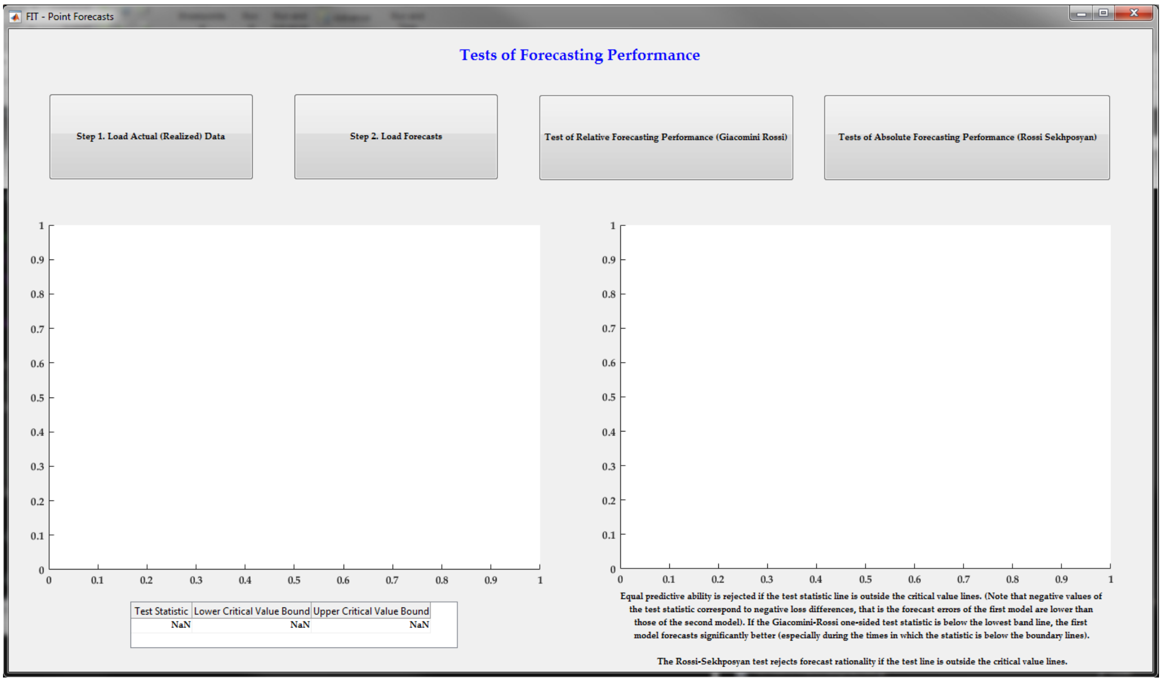


Figure 5: Point Forecast Panel.

You can perform two types of tests, namely the test of relative forecasting performance by Giacomini and Rossi (2010) and the test of absolute forecasting performance by Rossi and Sekhposyan (2016). While it is not necessary to know the particular model which generated the forecasts, these tests require that they are obtained using a rolling window. Irrespectively of the specific test you want to run, you will need to perform the following steps:

1. **Load Actual Data**

   The data has to be saved as a column vector (i.e., each row corresponds to a time series observation) in either `.mat`, `.txt` or `.dat` format. If you have your data saved in an excel file you will first need to put it into this format before passing it to the toolbox.

   To load the data double-click on the button `Step 1. Load Actual (Realized) Data`. You will be able to select the file where you have stored your data.

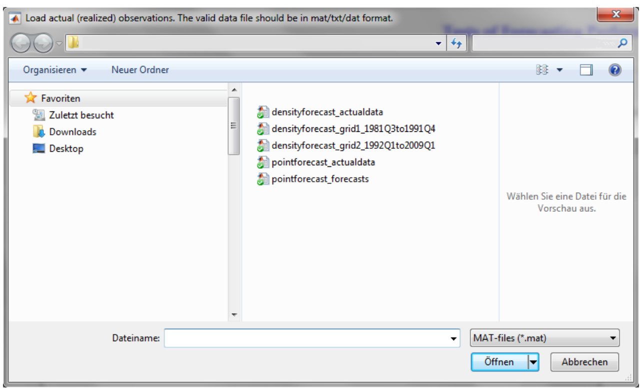
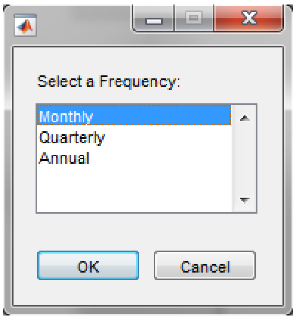


Figure 6: Load Actual Data Prompt.

Then, you will be asked to select the frequency as well as the starting date of your data.



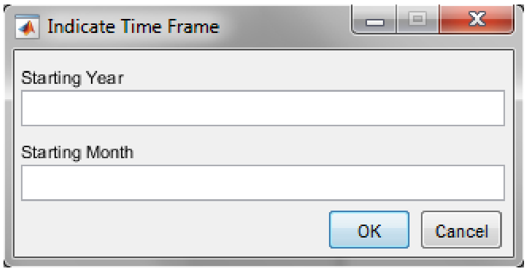


Figure 7: Select Frequency (left) and Starting Date (right).

2. **Load Forecasts**

   Click on `Step 2. Load Forecasts`, you will be able to select the file in which you stored your forecasts. In this file, the forecasts of a model have to be saved as a column vector (i.e., each row corresponds to a time series observation) in either `.mat`, `.txt` or `.dat` format.

   Notice that the maximum number of columns (and, thus, of competing forecast) is two and that the time frame has to match the number of observations of the actual data.

3. **Select and Perform Test**

   To run the Giacomini and Rossi (2010) test press the button `Test of Relative Forecasting Performance (Giacomini Rossi)`.

   If you want to apply the Rossi and Sekhposyan (2016) test press the button `Test of Absolute Forecasting Performance (Rossi Sekhposyan)`. Notice that if in Step 2. you uploaded a file with two columns corresponding to two forecasts series, this test will be applied on the forecasts specified in the first column.

   For the Giacomini and Rossi (2010) test, you will first have to specify whether you want to run a two-sided or a one-sided test. The two-sided test is a test of equal predictive ability of the first and the second model. The one-sided test, instead, tests whether the forecasts of the second model are significantly better than those of the first model.

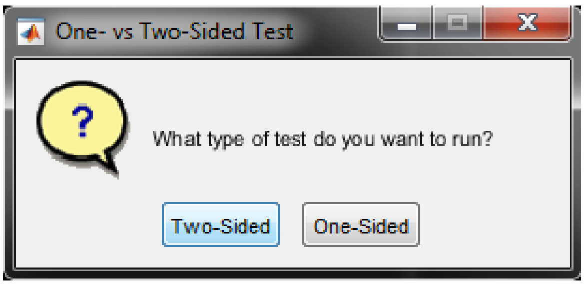


Figure 8: Giacomini and Rossi (2010) Test, Test Type Input Prompt.

Next, you will be prompted to input the window size of the rolling window used to obtain the forecasts as well as the significance level of the test. The number you will input for the window size corresponds to the number of observations in the frequency you have specified in the first step. As to the significance level used in the test, you can input 0.05 for the 5% significance level or 0.1 for the 10% significance level (see Figure 9).

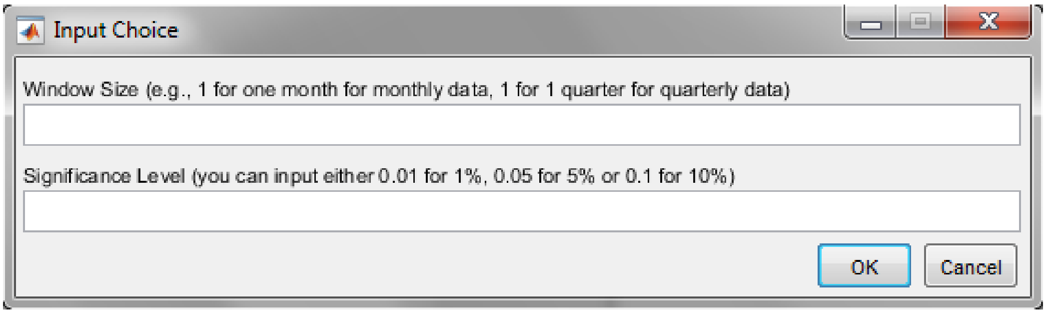


Figure 9: Giacomini and Rossi (2010) Test, Input Prompt.

As to the Rossi and Sekhposyan (2016) test, you will be asked to specify only the window size (see Figure 10).

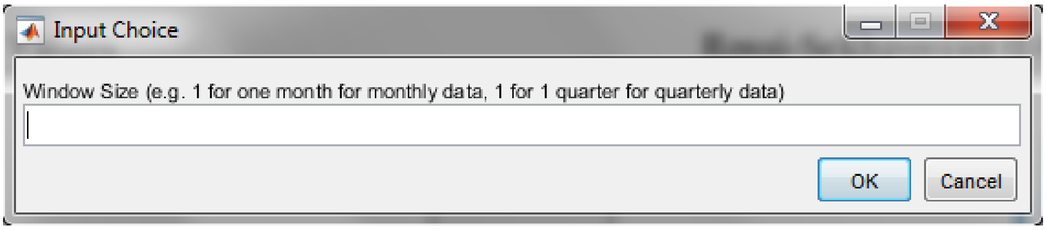


Figure 10: Rossi and Sekhposyan (2016) Test, Input Prompt.

4. **Save Figures**

   Once the test has been performed, you will be asked whether you want to save the figures.

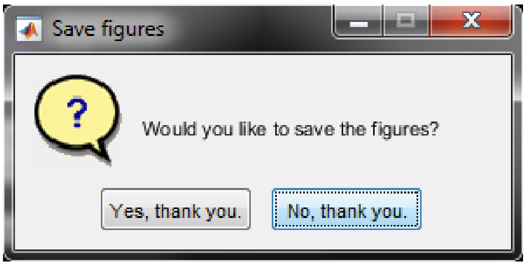


Figure 11: Figure Saving Question Dialog.

If you wish to do so you can select the directory in which you want to save the figures. Then, you can provide the name with which you want to save them.

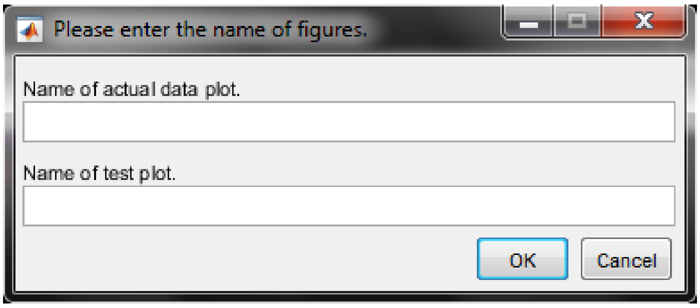


Figure 12: Figures Names Input Dialog.

EXAMPLE: We use quarterly data starting in 1968Q3 (see `pointforecast_actualdata.mat` in the folder `example_data`). Figures 13 and 14 show the output produced by the app when respectively the two-sided and one-sided Giacomini and Rossi (2010) test are performed using a window size of 60 observations and a significance level of 5%. On the left figure the actual data as well as the two forecasted variables (see `pointforecast_forecasts.mat` in the folder `example_data`) are plotted. On the right figure the Giacomini and Rossi (2010) test statistic is reported. In the bottom left corner of the panel the test statistic is reported along with its critical values.

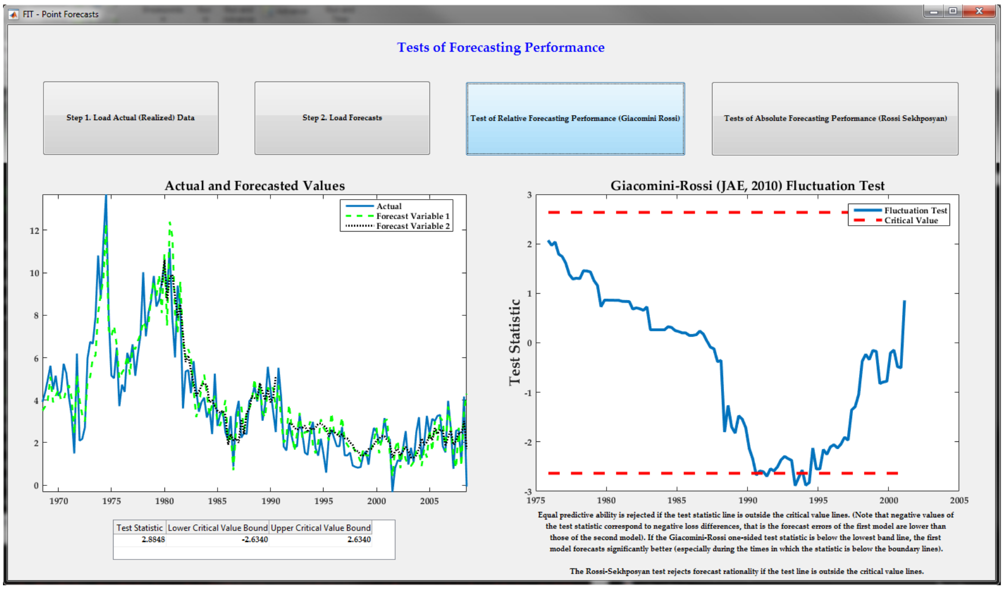


Figure 13: Giacomini and Rossi (2010) Two-Sided Test.

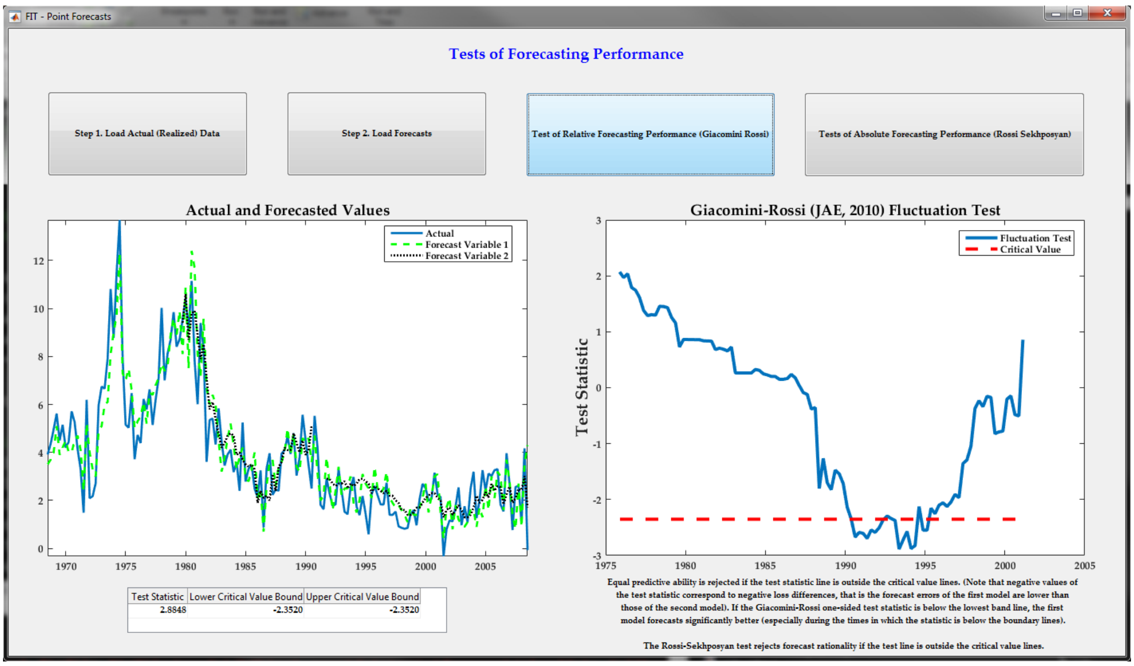


Figure 14: Giacomini and Rossi (2010) One-Sided Test.

For the two-sided Giacomini and Rossi (2010) test, if the test statistic line is outside the critical value lines then equal predictive ability is rejected. (Note that negative values of the test statistic correspond to negative loss differences, that is the forecast errors of the first model are lower than those of the second model). In the one-sided case, if the Giacomini and Rossi (2010) test statistic is below the lowest band line, the first model forecasts significantly better than the second one. This is true especially for those time periods in which the test statistics is below the boundary lines.

Figure 15 reports the output for the Rossi and Sekhposyan (2016) test performed using a window size of 60 observations. In this case, the test statistic is reported alongside the lower critical value bound.

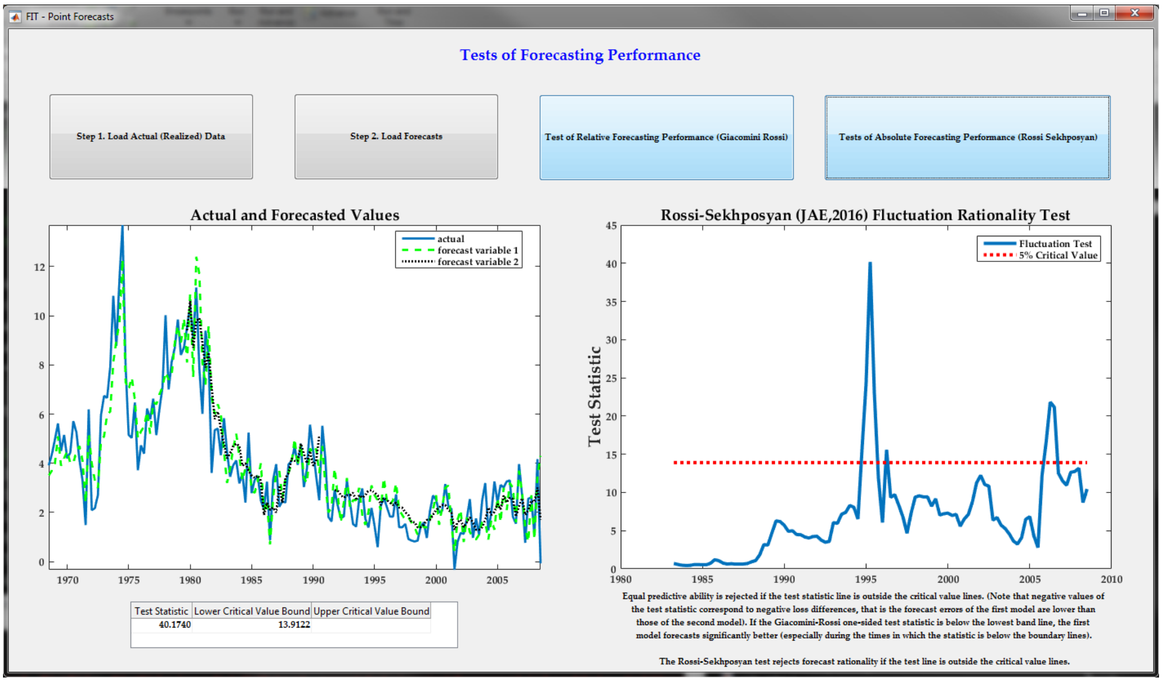


Figure 15: Rossi and Sekhposyan (2016) Test.

The Giacomini and Rossi (2010) and Rossi and Sekhposyan (2016) test reject forecast rationality if the test line is outside the critical value lines.

2.2 Density Forecast Evaluation Test

Upon clicking on `Density Forecast` in the home panel this window will be displayed.

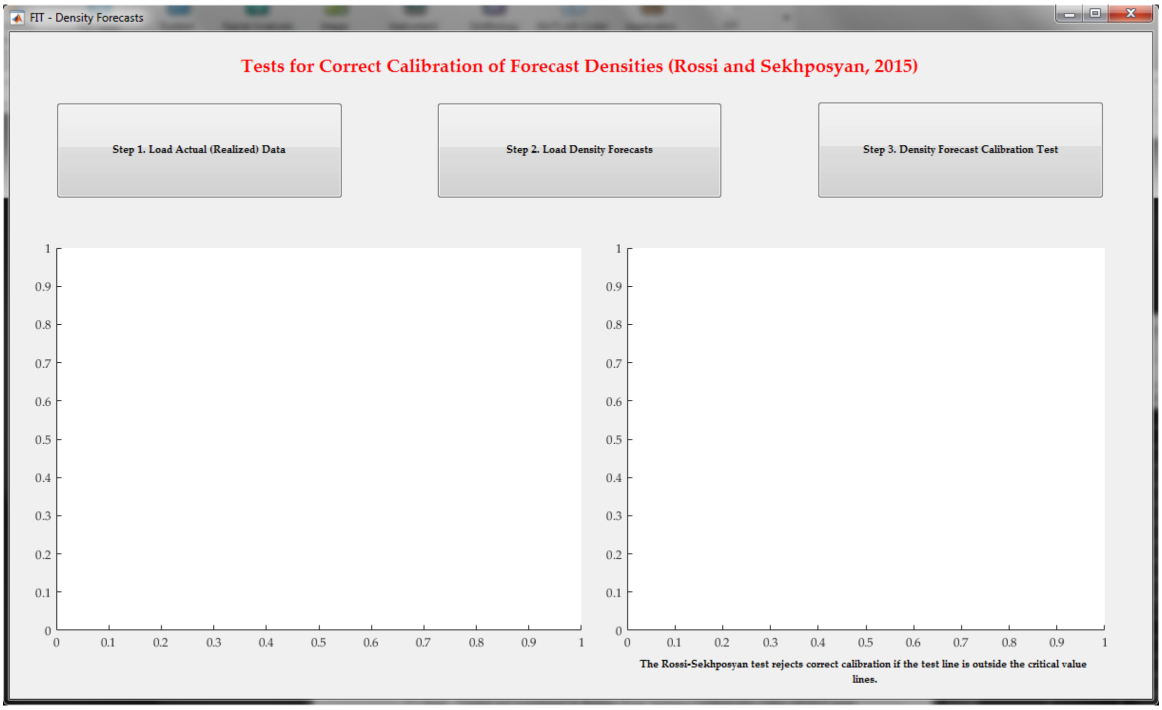


Figure 16: Density Forecast Panel.

To run the Rossi and Sekhposyan (2019) test there is no need to know how the forecasts are obtained. The following steps need to be performed:

1. **Load Actual Data**

   The data has to be saved as a column vector (i.e., each row corresponds to a time series observation) in either `.mat`, `.txt` or `.dat` format. If you have your data saved in an excel file you will first need to put it into this format before passing it to the toolbox.

   To load the data double-click on the button `Step 1. Load Actual (Realized) Data`. You will be able to select the file where you have stored your data.

2. **Load Density Forecasts**

   After clicking on `Step 2. Load Density Forecasts`, you will be asked how many distinct grids are in your sample.

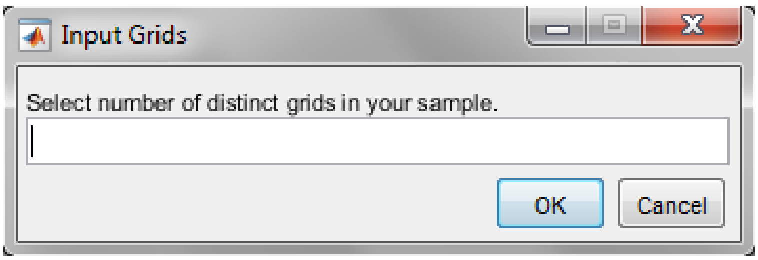


Figure 17: Input Number of Grids.

Second, you will need to input the midpoints of the bins of each grid (see Figure 18 for the case where two grids are used).

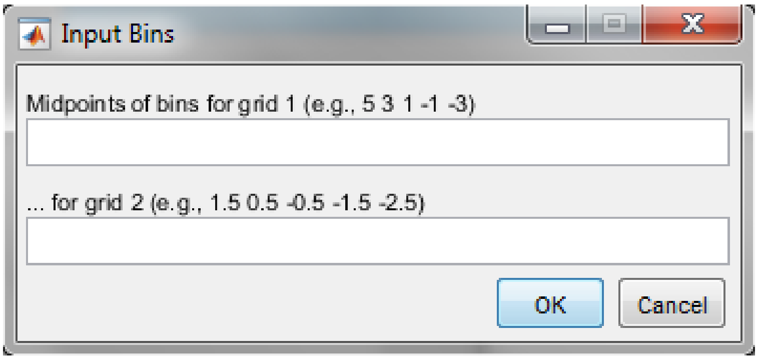


Figure 18: Input Midpoint of Bins for each Grid.

After specifying this input, you will be asked to upload the data file with the forecast densities for each grid. The allowed formats are either `.mat`, `.txt` or `.dat`. If you have your data saved in an excel file you will first need to put it into this format before passing it to the toolbox.

You need to store the forecast densities for each grid in separate files. If two grids have been selected you will be prompted to load the data files sequentially. In the first window you can select and upload the forecast densities corresponding to the first grid. Only after this step a second window will appear in which you can select and upload the forecast densities associated with the second grid. In each data file the rows indicate time series observations whereas the columns are the forecast densities corresponding to the different midpoints of the bins for a specific grid.

You will also be prompted to specify whether the loaded forecasts are one- or multi-step ahead forecasts. In the latter case, you have to specify the forecast horizon as well.

Figure 19: Forecast Horizon Type Input Dialog.

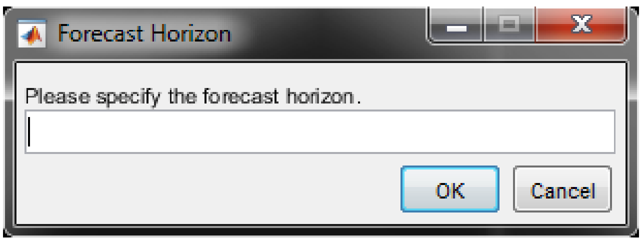


Figure 20: Forecast Horizon Input Dialog.

3. **Perform Test**

   To run the Rossi and Sekhposyan (2019) test press the button `Step 3. Density Forecast Calibration Test`.

   In case you are running the test on multi-step ahead density forecasts, you will need to specify the number of bootstrap replications to calculate the critical values. The default value is 300.

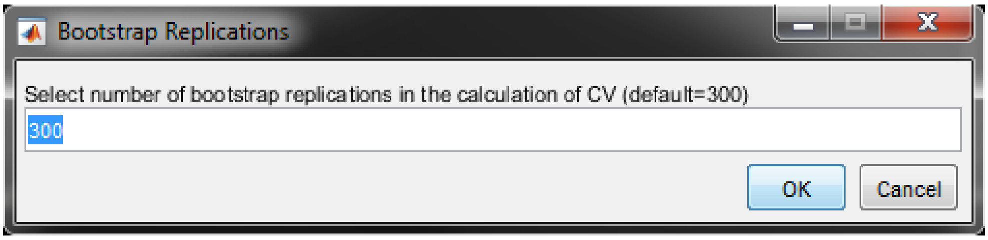


Figure 21: Bootstrap Replications for Critical Values Input Dialog.

4. **Save Figures**

   Once the test has been performed, you will be asked whether you want to save the figures.

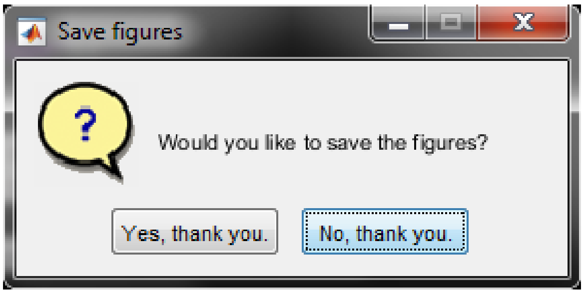


Figure 22: Save Figures Question Dialog.

   If you wish to do so you can select the directory in which you want to save the figures. Then, you can provide the name with which you want to save the figures.

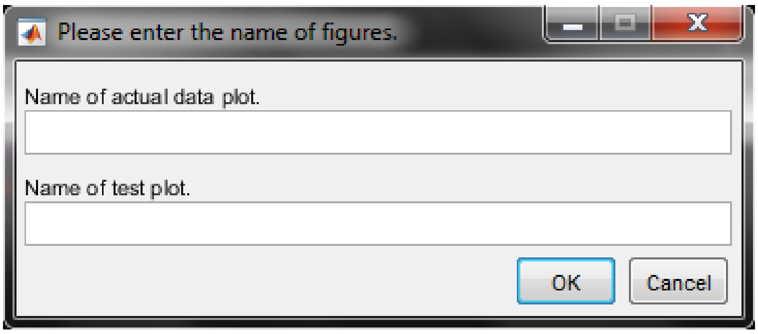


Figure 23: Name of Figures Input Dialog.

EXAMPLE: In the following we perform the test using some example data. In the folder `example_data` you can find a) the actual data in `densityforecast_actualdata.mat`, b) the forecast densities corresponding to the first grid in `densityforecast_grid1_1981Q3to1991Q4.mat` and the ones associated with the second grid in `densityforecast_grid2_1992Q1to2009Q1.mat` and c) the midpoints of the bins for each grid in `grid.txt`. The left figure shows the empirical distribution (or histogram) of the PITs*. In this particular example the histogram concerns the Survey of Professional Forecasters (SPF) mean probability density forecast for current year GDP growth. In general, the Rossi and Sekhposyan (2019) test statistic is displayed in the right figure and below it you can find instructions on how to interpret the results of the test. In particular, the Rossi and Sekhposyan (2019) test rejects correct calibration if the test line is outside the critical value lines.

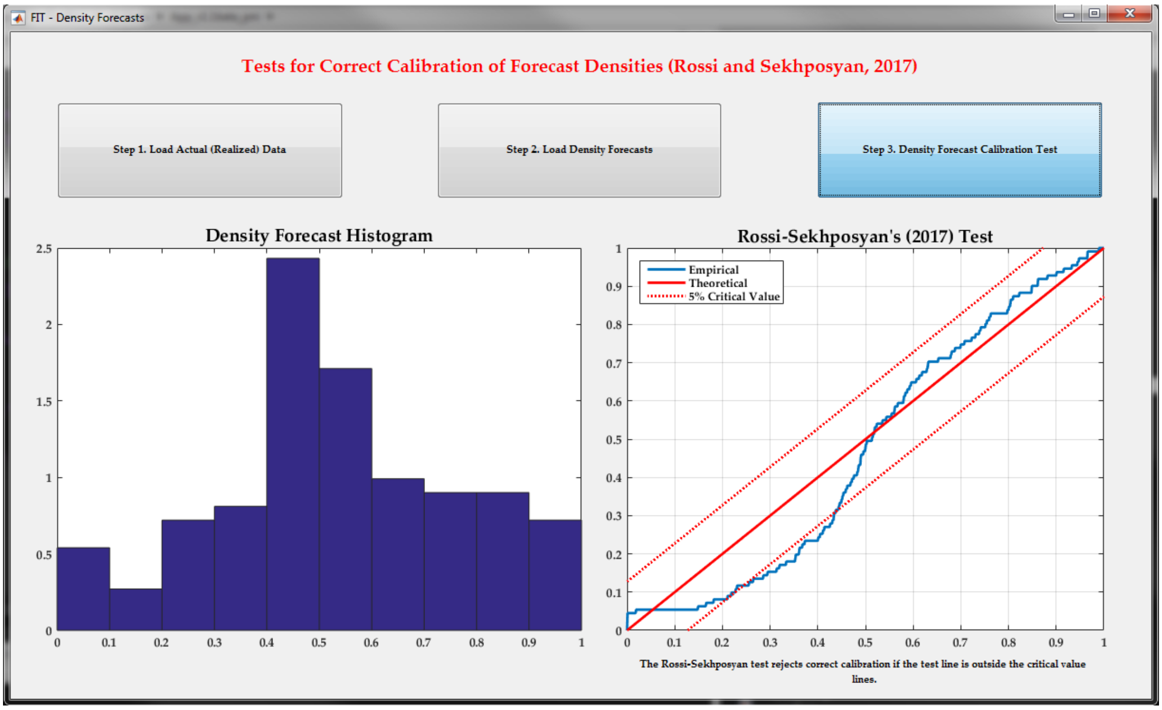


Figure 24: Rossi and Sekhposyan (2019) Test.

*A probability integral transform (PIT) is the cumulative probability evaluated at the actual, realized value of the target variable. It measures the likelihood of observing a value less than the actual realized value, where the probability is measured by the density forecast.

Bibliography

GIACOMINI, R., AND B. ROSSI (2010): “Forecast Comparisons in Unstable Environments,” *Journal of Applied Econometrics*, 25(4).

ROSSI, B., AND T. SEKHPOSYAN (2016): “Forecast Rationality Tests in the Presence of Instabilities, with Applications to Federal Reserve and Survey Forecasts,” *Journal of Applied Econometrics*, 31(3).

——— (2019): “Alternative Tests for Correct Specification of Conditional Predictive Densities,” *Journal of Econometrics*, 208(2), 638–657.