Stevens Institute of Technology

School of Business

**AACSB  
ASSURANCE OF LEARNING**

**Bachelor of Science in Quantitative Finance**

**(QF)**

**LEARNING GOAL # 3**

**Students are able to develop and use financial models and technical systems from a perspective of a broad critical understanding of the financial system.**

**Responsibility: Zachary Feinstein**

December 2023

**Table of Contents**

1. INTRODUCTION: LEARNING GOAL #3 3

2. LEARNING OBJECTIVES AND TRAITS 3

3. RUBRICS 4

4. ASSESSMENT PROCESS 5

5. RESULTS OF LEARNING GOAL ASSESSMENT – INTRO 6

6. RESULTS OF ASSESSMENT: Fall 2021 7

A. The direct measurement is the written assignment 7

B. Indirect measurement is use periodically 7

7. RESULTS OF ASSESSMENT: Fall 2022 9

A. The direct measurement is the written assignment 9

B. Indirect measurement is use periodically 9

8. RESULTS OF ASSESSMENT: Fall 2023 11

A. The direct measurement is the written assignment 11

B. Indirect measurement is use periodically 11

9. Outcomes from Previous Assessments: 12

10. Close Loop Process – Continuous Improvement Record 13

# 1. INTRODUCTION: LEARNING GOAL #3

**Goal: Students are able to develop and use financial models and technical systems from a perspective of a broad critical understanding of the financial system.**

*Objective 1: Students develop sound financial time series models based on major economic and financial trends and events.*

This goal is assessed in QF301 Financial Time Series – a required course in the QF curriculum.

# 2. LEARNING OBJECTIVES AND TRAITS

|  |  |
| --- | --- |
|  | **QF Learning Goal - 3: Objectives and Traits** |
| **QF 3** | **Students are able to develop and use financial models and technical systems from a perspective of a broad critical understanding of the financial system.** |
| **Learning Objectives** |  |
| **Objective 1:** | *Students develop sound financial time series models based on major economic and financial trends and events.* |
| **Traits** |  |
| Trait 1: | Student identifies appropriate models for the time series under study |
| Trait 2: | Student tests alternative models and selects best model |
| Trait 3: | Student forecasts time series with selected model and uses forecast to solve a specific financial problem (i.e. test different trading strategies). |

# 3. RUBRICS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **QF LEARNING GOAL - 3: RUBRIC 1** |  |  |  |
| **QF 3** | **Students are able to develop and use financial models and technical systems from a perspective of a broad critical understanding of the financial system.** | | | |
| **Objective 1** | *Students develop sound financial time series models based on major economic and financial trends and events.* | | | |
|  | **Trait** | **Poor** | **Good** | **Excellent** |
|  | **Value** | **0** | **5** | **10** |
| Trait 1: | Student identifies appropriate models for the time series under study | Does not identify any time series method | Identifies one time series method | Identifies one or more appropriate time series methods |
| Trait 2: | Student tests alternative models and selects best model | Does not test any alternative method | Tests alternative methods | Tests alternative methods and selects at least one relevant method |
| Trait 3: | Student forecasts time series with selected model and uses forecast to solve a specific financial problem (i.e. design at least a trading strategy). | Does not forecast any time series | Forecasts time series without including any additional application | Forecasts time series and includes results of at least one application (i.e. design at least a trading strategy) |
| **Criterion:**  **Does not meet expectations: 0 – 14; Meets: 15-19 ; Exceeds: 20-30** | | | | |

# 4. ASSESSMENT PROCESS

|  |  |  |
| --- | --- | --- |
| **Where & when measured?** | **How measured?** | **Criterion** |
| Course-embedded project in required course *QF301 Financial Time Series. A*ssessed in the Fall semester each year. | Description: project is graded by course owners and aggregated to obtain a total score.  Sampling: All students in the QF program are assessed. | 85% of students get a grade of GOOD or better as measured by the rubric for this learning goal |

# 5. RESULTS OF LEARNING GOAL ASSESSMENT – INTRO

The results of the initial learning goal assessments carried out to date are included below.

**Explanation**

Each learning goal has a number of learning objectives, and performance on each objective is measured using a rubric that, in turn, contains a number of desired “traits.” Students are scored individually on each trait.

The grading sheets for each student are used to develop a Summary Results Sheet for each learning goal objective. A selection of these summaries is included below.

The first table in the Summary Results Sheet for a learning objective/trait gives the counts of students falling in each of the three categories:

* Does Not Meet Expectations
* Meets Expectations
* Exceeds Expectations

The right-hand column in the table is used to record the average score of the students on each trait. This table provides an indication of the relative performance of students on each trait.

The second table on each sheet provides the counts of students who fall in each of the above three categories for the overall learning objective.

The person doing the assessment provides explanatory comments and recommendations on the bottom of the Results Summary Sheet. The recommendations improve content or pedagogy changes for the next time the course is given.

**Explanation of Indirect Measurements**

Indirect measurements will be taken at periodic intervals. Depending on the measurement chosen a diagnostic tool will be selected for analysis. The indirect measurements being considered are:

* Internships
* job placement statistics
* starting salaries
* mid-career salaries (5 years out)

# 6. RESULTS OF ASSESSMENT: Fall 2021

NOTICE THAT THE DIRECT ASSESSMENT IS DONE FOR ON CAMPUS; WEBCAMUS AND COMBINED THIS IS NOW A REQUIREMENT FOR AOL

WE WILL START ASSESSMENTS IN FALL OF 2021

## The direct measurement is the written assignment

1. Indirect measurement is use periodically.

RESULTS OF ASSESSMENT: Fall 2021

**LEARNING GOAL #3:***Students are able to develop and use financial models and technical systems from a perspective of a broad critical understanding of the financial system.*

**LEARNING OBJECTIVE #1:***Students develop sound financial time series models based on major economic and financial trends and events.*

*.*

**ASSESSMENT DATE: December 17, 2021**

**ASSESSOR: Zachary Feinstein**

**NUMBER OF STUDENTS TESTED: 95   
COURSE: QF301**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Number of Students** | | |  |
| **Learning Goal Traits** | **Not Meet Expectations** | **Meets Expectations** | **Exceeds Expectations** | **Average Grade** |
| Student identifies appropriate models for the time series under study | **0** | **11** | **84** | **9.42** |
| Student tests alternative models and selects best model | **8** | **13** | **74** | **8.47** |
| Student forecasts time series with selected model and uses forecast to solve a specific financial problem (i.e. design at least a trading strategy). | **0** | **26** | **69** | **8.63** |
| **Average Grade (Out of 10) =** | | | | **8.84** |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Not Meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Total Students by Category**  *(Based on average score across all traits)* | **0** | **15** | **80** |

**COMMENTS:** Students explored different statistical learning techniques through R. This matched the sample code provided by the assigned textbooks and the code provided within the course. Difficulties with installing Keras (neural network package) in R caused difficulties in exploring that tool. Many students struggled to expand their analysis beyond simply forecasting time series (Train 3). Throughout the semester, the importance of testing alternative models (Trait 2) was emphasized which ultimately assisted in identifying appropriate models (Trait 1) as well.

**REMEDIAL ACTIONS:**

* Students can choose if they want to work with R or Python (especially for Neural Networks).
* Add further assignment problems earlier in the semester in which students need to use the forecasts to solve specific financial problems (beyond forecasting).
* Include open-ended homework problems for students to gain more experience in identifying appropriate models and testing alternative models.

# 7. RESULTS OF ASSESSMENT: Fall 2022

NOTICE THAT THE DIRECT ASSESSMENT IS DONE FOR ON CAMPUS; WEBCAMPUS AND COMBINED THIS IS NOW A REQUIREMENT FOR AOL

WE WILL START ASSESSMENTS IN FALL OF 2021

## The direct measurement is the written assignment

1. Indirect measurement is use periodically.

RESULTS OF ASSESSMENT: Fall 2022

**LEARNING GOAL #3:***Students are able to develop and use financial models and technical systems from a perspective of a broad critical understanding of the financial system.*

**LEARNING OBJECTIVE #1:***Students develop sound financial time series models based on major economic and financial trends and events.*

*.*

**ASSESSMENT DATE: December 12, 2022**

**ASSESSOR: Zachary Feinstein**

**NUMBER OF STUDENTS TESTED: 56   
COURSE: QF301**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Number of Students** | | |  |
| **Learning Goal Traits** | **Not Meet Expectations** | **Meets Expectations** | **Exceeds Expectations** | **Average Grade** |
| Student identifies appropriate models for the time series under study | **5** | **8** | **43** | **8.39** |
| Student tests alternative models and selects best model | **3** | **24** | **29** | **7.32** |
| Student forecasts time series with selected model and uses forecast to solve a specific financial problem (i.e. design at least a trading strategy). | **3** | **10** | **43** | **8.57** |
| **Average Grade (Out of 10) =** | | | | **8.09** |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Not Meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Total Students by Category**  *(Based on average score across all traits)* | **3** | **10** | **43** |

**COMMENTS:** Students explored different statistical learning techniques through R. Due to difficulties last year with using Keras (for neural networks) in R, switched to Python for that unit. Overall, many students struggle to expand their analysis beyond simply forecasting time series (Train 3). Throughout the semester, the importance of testing alternative models (Trait 2) was emphasized which ultimately assisted in identifying appropriate models (Trait 1) as well.

**REMEDIAL ACTIONS:**

* Add further application areas earlier in the semester with appropriate sample code (beyond forecasting).
* Consistently ask students to use the forecasts to solve solve specific financial problems (beyond forecasting).

# 8. RESULTS OF ASSESSMENT: Fall 2023

NOTICE THAT THE DIRECT ASSESSMENT IS DONE FOR ON CAMPUS; WEBCAMPUS AND COMBINED THIS IS NOW A REQUIREMENT FOR AOL

WE WILL START ASSESSMENTS IN FALL OF 2021

## The direct measurement is the written assignment

1. Indirect measurement is use periodically.

RESULTS OF ASSESSMENT: Fall 2023

**LEARNING GOAL #3:***Students are able to develop and use financial models and technical systems from a perspective of a broad critical understanding of the financial system.*

**LEARNING OBJECTIVE #1:***Students develop sound financial time series models based on major economic and financial trends and events.*

*.*

**ASSESSMENT DATE: December 8, 2023**

**ASSESSOR: Zachary Feinstein**

**NUMBER OF STUDENTS TESTED: 34   
COURSE: QF301**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Number of Students** | | |  |
| **Learning Goal Traits** | **Not Meet Expectations** | **Meets Expectations** | **Exceeds Expectations** | **Average Grade** |
| Student identifies appropriate models for the time series under study | **10** | **13** | **11** | **5.14** |
| Student tests alternative models and selects best model | **4** | **5** | **25** | **8.09** |
| Student forecasts time series with selected model and uses forecast to solve a specific financial problem (i.e. design at least a trading strategy). | **0** | **9** | **25** | **8.67** |
| **Average Grade (Out of 10) =** | | | | **7.30** |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Not Meet Expectations** | **Meets Expectations** | **Exceeds Expectations** |
| **Total Students by Category**  *(Based on average score across all traits)* | **4** | **10** | **20** |

**COMMENTS:** Students explored different statistical learning techniques through R. Due to remedial actions added last year, the students improved in applying these methods for financial problems. However, many students this semester struggled to identify the appropriate models for time series (Train 1); this is especially clear in the ability to do cross-validation to determine appropriate hyperparameters.

**REMEDIAL ACTIONS:**

* Discuss the importance of cross-validation and appropriate selection of hyperparameters for model selection consistently throughout the semester.
* Consistently ask students to evaluate what they would do differently if they did the assignment again.

# 9. Outcomes from Previous Assessments:

After the Review Fall 2021

Competencies (knowledge, skills, abilities) addressed in this course:

* Trait 1 – able to identify appropriate models – this skill was well understood
* Trait 2 – tests alternative models – this skill was well understood
* Trait 3 – solve financial problems with forecasts – this trait was well demonstrated

After the Review Fall 2022

Competencies (knowledge, skills, abilities) addressed in this course:

* Trait 1 – able to identify appropriate models – this skill was well understood; the results were lower than the prior assessment
* Trait 2 – tests alternative models – this skill was understood but could be improved; the results declined from the prior assessment
* Trait 3 – solve financial problems with forecasts – this trait was well demonstrated; the results were marginally lower than the prior assessment

After the Review Fall 2023

Competencies (knowledge, skills, abilities) addressed in this course:

* Trait 1 – able to identify appropriate models – this trait was demonstrated, but results were significantly lower than prior assessments.
* Trait 2 – tests alternative models – this skill was understood but could be improved; the results improved from the prior assessment
* Trait 3 – solve financial problems with forecasts – this trait was well demonstrated; the results were marginally better than the prior assessment

The following table shows the average scores on each goal objective.

|  |  |
| --- | --- |
|  | Objective 1  Develop sound financial time series |
| Fall 2021 | 8.84 |
| Fall 2022 | 8.09 |
| Fall 2023 | 7.30 |

# 10. Close Loop Process – Continuous Improvement Record

Assurance of Learning

Assessment/Outcome Analysis

Close Loop Process - Continuous Improvement Record

**Program:** Bachelor of Science in Quantitative Finance

**Goal 3:** Students are able to develop and use financial models and technical systems from a perspective of a broad critical understanding of the financial system

**Goal Owner:** Zachary Feinstein

**Where Measured:** Students are assessed in the fall in the required course:

QF301

**How Measured:** Project/homework assignment is required by course owner and aggregate to obtain a total score.

**Closing the Loop: Actions taken on specific objectives**

|  |  |
| --- | --- |
| **Objective 1** | *Students will be able to write effectively.* |
| **When Assessed:** | *Fall 2023* |
| **Remedial**  **Action** | * Discuss the importance of cross-validation and appropriate selection of hyperparameters for model selection consistently throughout the semester. * Consistently ask students to evaluate what they would do differently if they did the assignment again. |
| **Outcome from previous assessment** | By including more discussions of financial applications, the class improved in that metric. However, this was at the expense of going through model selection in detail. |
| **When Assessed:** | *Fall 2022* |
| **Remedial**  **Action** | * Add further application areas earlier in the semester with appropriate sample code (beyond forecasting). * Consistently ask students to use the forecasts to solve solve specific financial problems (beyond forecasting). |
| **Outcome from previous assessment** | Use of Python for neural networks units impacted student performance as using a second programming language took time away from other material.  Open ended assignments for students aided on Task 2. |
| **When Assessed:** | *Fall 2021* |
| **Remedial**  **Action** | * Students can choose if they want to work with R or Python (especially for Neural Networks). * Add further assignment problems earlier in the semester in which students need to use the forecasts to solve specific financial problems (beyond forecasting). * Include open-ended homework problems for students to gain more experience in identifying appropriate models and testing alternative models. |
| **Outcome from previous assessment** |  |

**Appendix: Final Homework used for Assessment**

**Instructions**

In this assignment, you should use R markdown to answer the questions below. Simply type your R code into embedded chunks as shown above.

When you have completed the assignment, knit the document into a PDF file, and upload both the .pdf and .Rmd files to Canvas.

If you use Python, you will need to include your .ipynb and prinout as .pdf as well.

**Question 1 (100pt)**

In this assignment, you will be required to find a set of data to run a regression or classification on.

**Question 1.1 (10pt)**

For this task, use the quantmod package to obtain the daily adjusted close prices of at least 3 different stocks. You should have at least 5 years of data for all assets. You should inspect the dates to make sure you are including everything appropriately.

Find the daily log returns of all stocks along with (at least) 3 lags for each stock.

Create a data frame of your desired output (whether as a regression of returns or classification) and the lagged returns. Print the first 6 lines of your data frame.

**Question 1.2 (10pt)**

Provide a description of the data below: what is your desired prediction and why do you think your data will aid in this task?

**Question 1.3 (60pt)**

Fit at least four different models in order to run your prediction. You will need to confirm the models you try are as good a fit as you can find for that model type (i.e., feature selection or cross-validation to find model hyperparameters). You need to convince the grader that you have chosen the best model fits, so provide comments as to why you choose the models you use.

If you use neural networks, make reference in your solution below and provide the Python code with your submission.

**Question 1.4 (20pt)**

Determine which of your four (or more) models is the best fit. You will need to provide strong reasons as to why the particular model you chose is the best one. You need to convince the grader that you have chosen the best model.