

Your Name \_\_\_\_\_

## ARE 106

### Quantitative Methods

#### Problem Set 3

*Due before midnight on Friday, December 11, 2020*

#### Financial Markets and COVID-19

The data set “financial\_data\_ps3.dta” contains daily information on the closing price of the S&P 500 stock, gold, bitcoin, as well as the interest rate on the U.S. 10-year Treasury note since January 2015 to October 2020. These data were retrieved from Yahoo finance. The following table defines the variables in this data set:

Variable	Variable name in Stata	Description
Date	date	Year-month-day
Time trend	timetrend	Numerical variable that goes from 1 to T
Closing price of S&P 500 stock	sp500_close	Closing price in US dollars
Closing price of gold	gold_close	Closing price in US dollars
Closing price of bitcoin	bitcoin_close	Closing price in US dollars
Interest rate on the U.S. 10-year Treasury note	treasury_close	Interest rate

Before you begin, however, please read through these important instructions:

- Be sure to write your name on this page! Please submit your assignment **by Midnight (CA time) Friday December 11th**. (Note: You will lose a full grade point (e.g., from A- to B-) for turning in your assignment one day late. No submissions will be accepted after Saturday December 12th.) The submission process involves two steps, both of which are required to receive full credit for the Problem Set:
  - Part 1: Upload your Stata do-file to the Problem Set 3 Assignment on Canvas. You will lose a full grade point if you do not submit the Stata do file.
  - Part 2: Upload your PDF via *Gradescope*. If you have any questions about how to upload via *Gradescope*, please consult this helpful page: <https://help.gradescope.com/article/ccbpppziu9-student-submit-work>
- You are permitted to discuss the assignment with your classmates, but all estimation and write-up should be done independently. Assignments like this are designed for you to generate your own ideas, and this should be reflected in your submitted work. We will be looking out for evidence that each student is submitting their own work and not that of classmates.

- Enter your answers onto this document in the space provided. More than enough space is provided, so do not worry about filling up the space! Focus more on the quality of your responses than on the quantity of words used in the responses.
- You have a few options for how to enter your responses. This PDF is fillable, which means you can type out your responses in the boxes provided. (Note: It is highly recommended that you print your final document as a PDF file and read over your submission to make sure everything is as you want it before uploading to *Gradescope*.) You can also handwrite your responses on a printed copy of the document, scan that document as a PDF, and upload the submission. Alternatively, you could handwrite answers using a tablet. If you choose to handwrite your responses, be sure to keep your handwriting within the boxes provided for each question. Answers outside of the boxes are liable to be missed by *Gradescope*, resulting in unnecessary points lost.
- When typing out equations, you may use lower-case letters in parentheses instead of subscripts. For example,  $Y(i)$  is accepted in place of  $Y_i$ . If you are handwriting your responses, please use subscripts for full credit.
- In order to open “financial\_data\_ps3.dta”, go to “File – Open”, and locate your local drives where this dtafile is saved.
  - For Windows users, your local drives should be under “This PC” - “C on {your computername}.”
  - For Mac users, "This PC" - "[folder name] on [your computer name]." The folder is the one which you set up first in "Preference - General tab" in Microsoft Remote Desktop App when you install Stata. You should move “financial\_data\_ps3.dta” to this folder.
- All the Stata commands have useful documentation with examples. If you want to see these documents, you can type “help [command name].”
  - For example, if you type “**help reg**” in Stata, a new window will be open and provide a detailed information on syntax, options, and examples for **reg** command.

- [5 points] The S&P 500 is an index of stock prices for the largest corporations in America. It includes all the FAANG (Facebook, Amazon, Apple, Netflix, Google) stocks, but it also includes “old economy” stocks like United Airlines, Hilton Hotels, and Carnival Cruises. Estimate an OLS regression to predict the S&P 500 price at close of each trading day, based on its close price the previous day and a time trend. That is, use the model to capture basic dynamics that is Professor Taylor’s preferred starting model (see ppt for CH 9). Report your results. Hint: before running the regression, make sure to declare the data to be a time series by typing *tsset timetrend* in Stata.<sup>1</sup>

Variables	Estimated Coefficient	Standard Error	t-statistic	95% Confidence Interval	
				Lower	Upper
S&P 500 (t-1)					
Time trend					
Constant					

Sample size	
$R^2$	

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<sup>1</sup> *timetrend* is a numerical variable that goes from 1 to T, where T is the total number of days in the dataset.

2. [5 points] Is there evidence of serial correlation in this model at 5% of significance? Please write down the auxiliary model, the null hypothesis, the test statistic and the critical value. **DO NOT USE THE CANNED COMMAND THAT DOES THIS TEST IN STATA!** We want to see how you did it.

3. [5 points] Briefly explain how the Newey West procedure addresses the serial correlation problem.

4. [5 points] Now re-estimate this basic dynamics model using the Newey West procedure with 6 lags.<sup>2</sup> (It is fairly common to set the number of lags equal to the integer part of  $T^{1/4}$ , which satisfies the conditions in Newey and West’s seminal paper.) Report your results and compare them to the results you got using OLS.

Variables	Estimated Coefficient	Standard Error	t-statistic	95% Confidence Interval	
				Lower	Upper
S&P 500 (t-1)					
Time trend					
Constant					

Sample size	
$R^2$	

What changed, what did not change, and why?

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<sup>2</sup> To conduct the Newey West procedure use the Stata command *newey*. Do not forget to specify the number of lags.

5. On 20200225, the World Health Organization (WHO) announced that COVID-19 was becoming a pandemic. On 20200317 U.S. President Trump requested Congress to send Americans direct financial relief, in the form of stimulus checks and other measures. Please use the variable *date* in the dataset to create two dummy variables, one for each of these two events.<sup>3</sup> (Hint: They should equal to 0 before the relevant date and 1 afterwards.) Include the new COVID dummy variables in your basic dynamic regression to predict S&P 500 prices.

a) [2 points] Write down your model

b) [3 points] Does it make sense to also include the lagged dummy variables? Why or why not?

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<sup>3</sup> *date* is a numerical variable with the corresponding date (year-month-day).

c) [5 points] Report the results in table form

Variables	Estimated Coefficient	Standard Error	t-statistic	95% Confidence Interval	
				Lower	Upper
S&P 500 (t-1)					
Time trend					
Constant					

Sample size	
$R^2$	

Did COVID-19 affect S&P 500 prices? Did the request for stimulus? Explain providing enough details on your tests: null hypothesis, test statistic, critical value. Use a significance level of 5%

6. [5 points] In Question 5, what estimator did you use, and why?

7. [5 points] People traditionally have viewed gold as a “safe haven” to put their money into at times of uncertainty. The COVID-19 pandemic obviously ushered in a new era of uncertainty, whereas the promise of stimulus attempted to alleviate this uncertainty.

Estimate the following equation using the Newey West procedure with the same number of lags as in question 4:

$$gold_t = B_0 + B_1 gold_{t-1} + B_2 timetrend_t + B_3 Pandemic_t + B_4 Stimulus_t + u_t$$

How did COVID-19 pandemic and stimulus affect the demand for gold, as reflected in gold prices? Are these results significant at 5%? Please explain providing enough details on your tests: null hypothesis, test statistic, critical value.

8. [5 points] Bitcoin (BTC) has swept the world with a new and, for many people, confusing asset, seemingly created from “thin air” (though it really is created by a mathematical equation, which limits the total supply of BTC to exactly 21 million, unlike the supply of national currencies in the world, which can be increased infinitely by central banks running their money presses). The COVID-19 pandemic created a lot of uncertainty in the world, and governments printed new money to support their stimulus policies (like the US did to send a \$1,200 check that many Americans received this year).

Estimate a model to test whether the COVID-19 pandemic and the stimulus changed the demand for BTC, as reflected in BTC prices. (Hint: the model should be similar in spirit to the one estimated in question 7). How did COVID-19 pandemic and stimulus affect the demand for bitcoin, as reflected in bitcoin prices? Are these results significant at 5%? Please explain providing enough details on your tests: null hypothesis, test statistic, critical value.

9. Some people consider BTC to be the “new digital gold.” If that is true, then BTC and gold prices could be significantly related to one another.

- a) [5 points] Estimate the following equation and test for autocorrelation. What are the statistic and the critical value?

$$bitcoin_t = B_0 + B_1 gold_t + \beta_2 timetrend_t + u_t$$

Test statistic	
Degrees of freedom for critical value ( $m$ )	
Critical value	

What do you conclude?

- b) [5 points] Now estimate the following autoregressive distributed lagged model and test for autocorrelation.

$$bitcoin_t = \gamma_0 + \gamma_1 bitcoin_{t-1} + \gamma_2 gold_t + \gamma_3 gold_{t-1} + \gamma_4 timetrend_t + \epsilon_t$$

Test statistic	
Degrees of freedom for critical value ( $m$ )	
Critical value	

What do you conclude?

- c) [5 points] Using this autoregressive distributed lagged model, test whether gold prices are significantly correlated with bitcoin prices at a 5% significance level. What do you conclude? Explain providing enough details on your tests: null hypothesis, test statistic, critical value.

10. People dream of getting rich by finding a way to predict stock prices. Our data set has information on S&P 500 stock prices as well as prices of gold, BTC, and the interest rate on the U.S. 10-year Treasury note. Going into each new day of trading, we know the closing price of each of these assets—but only for the previous trading day.

- a) [5 points] Write down an econometric model to predict the S&P 500 market close based on its closing price in the previous day, the closing price of gold and BTC in the previous day, and the interest rate on the U.S. 10-year Treasury note in the previous day. Do not forget to include the time trend as well.

- b) [5 points] Estimate this model using the Newey West procedure and 6 lags. Report your results.

Variables	Estimated Coefficient	Standard Error	t-statistic	95% Confidence Interval	
				Lower	Upper
Constant					

Sample size	
$R^2$	

- c) [5 points] Based on your results, which, if any, of these variables significantly explains S&P 500 performance at 5% level? Please explain providing enough details on your tests: null hypothesis, test statistic, critical value.

