

## Module 3 – Stock Price Data

### Background

- In this module, you will be working with stock price data for Amazon.com. This stock is listed on the NASDAQ Stock Market (the second largest U.S. stock market, after the New York Stock Exchange). You will analyze the change in the stock prices over time as well as the value of investments over time.
- The Excel workbook for this module consists of 2 tabs.
  1. The “December 2014” tab contains the Amazon stock prices for trading days in the entire month of December 2014.  
The “Table” tab contains the full history of Amazon stock prices from its start in May 1997 until November 2017.
- For each trading day of the stock, a record of each of the following is posted.
  - *Open* = the price when the market opened in the morning.
  - *Close* = the price when the market closed in the afternoon.
  - *High* = the highest price during that trading day.
  - *Low* = the lowest price during that trading day.
  - *Volume* = number of shares of the stock traded that day.
  - *Adj Close* (Adjusted Close) = a price adjusted to make prices comparable over time.
- Note that the dates are listed from most recent to least recent.
- The *Adjusted Close* price on specific day reflects all the dividends and splits since that day. If no such dividends or splits have occurred since that day, the adjusted close equals the close on that day. The change in adjusted closing price is used to calculate the total return of an investment made on some previous date in history.

### Part 0: Percent Change

Expressing the percent (or relative) change is often more effective when you are concerned with comparisons over time than the absolute change of the quantity. For an example, an absolute change of 10 units is almost unnoticeable when the value of a quantity observed is 1000 units. However, that same 10 units more than doubles the value of a quantity of 8 units.

- 1) To begin this Module, view the screencast *Percent Change*.

## Part 1: Calculations for Buying and Selling Stocks

The Part 1 questions here refer only to data from December 2014. In that trading month, there are no adjustments (i.e., Adj Close = Close for every date.) To simplify your navigation in the spreadsheet, use the “December 2014” tab for these exercises.

- 1)
  - a. How much did the stock price change, in dollars and cents, from the **Close** price the previous day to the **Close** price on 12/11/14?
  - b. What was the percentage change in the stock price from the **Close** price the previous day to the **Close** price on 12/11/14?

For all of the following questions, assume there are no transaction fees.

- 2) You bought 100 shares of stock at the **Close** price on the first trading day of the month. How much did that cost?
  - a. You bought 100 shares of stock at the **Close** price on **the first trading day of the month**, held them until the last trading day of the month, and sold at the **Close** price.
    - i. Did you make or lose money?
    - ii. How much (in dollars and cents)? (In other words, how much more or less did you have after the sale compared to before the purchase?)
    - iii. By what percentage did your money change?
  - b. You bought 500 shares of stock at the **Close** price on the first trading day of the month, held them until the last trading day of the month, and sold at the **Close** price.
    - i. Did you make or lose money?
    - ii. How much money (in dollars and cents)?
    - iii. By what percentage did your money change?



## Part 2: Graphing

Using all the trading days on the “Table” tab, create a graph of **Adjusted Close** price as a function of time. Label the horizontal axis with dates in a readable manner.

Here is an example of a nicely labeled graph using **Close** prices for 2013. Create a graph for all the trading days in the data set.



Check your work by going to [finance.yahoo.com](http://finance.yahoo.com) and examining the historical price charts for AMZN over the whole life of the stock.

## Part 3: Daily Changes in Stock Prices

- 1) Create a column in Excel that shows the **difference**, in dollars and cents, between the **High** and **Low** prices for each day. Call the column **Daily Range**. Note: you will write an Excel formula in the first row of data and drag it down the whole column.
  - a. What was the Daily Range on 12/1/15?
  
- 2) Create a column in Excel that shows the **percentage increase** of the High over the Low. Call the column **Daily Range %**. Show your answer as a percentage with two decimal places, e.g., 10.12%.
  - a. What was the Daily Range % on 12/1/15?
  
- 3) Create a column in Excel that shows the **difference**, in dollars and cents, between the **Adjusted Close that day** and the **Adjusted Close the previous day**. Call the column **Daily Change**.



- h. Which day in the data set had the most negative Daily Change % (i.e., biggest percentage drop)?
- 6) For what percentage of days in the data set was the Daily Change percentage strictly greater than 2.00%.
- 7) For what percentage of days in the data set was the **Adjusted Close** on the day lower than the **Adjusted Close** the previous day? Show your answer as a percentage with two decimal places, e.g., 10.12%.
- 8) For what percentage of days in the data set was the **Adjusted Close** on a day higher than the **Adjusted Close** the previous day? Show your answer as a percentage with two decimal places, e.g., 10.12%. Is the sum of the answer to this question and the previous question equal to 100%? Why or why not?
- 9) (*OPTIONAL*): Consider all the days in the data set for which the stock dropped (i.e., Adjusted Close that day < Adjusted Close the previous day). For what percentage of the days following a day on which the stock dropped did the stock rise?
- 10) (*OPTIONAL*): Comparing your answers to the last two questions, answer this: if the stock dropped one day, does that increase the chance of it rising the next day?

## Part 4: Changes in Stock Prices Over Time

- 1) Write formulas in Excel, using cell references, to calculate the following.
  - a. How much did the **Adjusted Close** price change, in dollars and cents, from the first trading day in the data set until the most recent day in the data set?
  
  - b. How much did the **Adjusted Close** price change, in percentage growth, from the first trading day in the data set to the most recent day in the data set? Show your answer as a percentage with two decimal places, e.g., 10.12%.
  
- 2) Find how much the **Adjusted Close** price changed, in dollars and cents, from the first trading day to each date shown in the table below.

Date	Change in Adj. Close, from the first trading day until the given day
1/2/98	\$3.00
1/3/00	
1/2/02	\$9.00
1/3/05	

- 3) Find how much the **Adjusted Close** price changed, as a percentage, from the first trading day to each date shown in the table below.

Date	Change in Adj. Close, as a percentage, from the first trading day until the given day
1/2/98	153.06%
1/3/00	
1/2/02	459.18%
1/3/05	

4) You invested \$10,000 in AMZN stock on the first day of trading in the data set, purchased at the **Close** price (*not* the Adjusted Close), purchasing only whole shares.

a. How many shares did you buy?

b. How much did you spend?

c. Calculate the **value** of your investment on the following dates. *Hint: The percentage growth in investment value is the same as the percentage growth in the **Adjusted Close** price.*

Date	Value of investment, on the given day
First day in the data set (amount of original investment)	
1/2/98	\$25,274.49
1/3/00	
1/2/02	\$55,848.47
1/3/05	
Most recent trading day in the data set	



## Part 5: Applying Adjustments

The data set shows the Adjusted Close prices. Adjustments help make the prices comparable over time and are necessary when the stock splits or pays dividends. (For this class, don't worry if you don't understand those actions.) The data set does not show the adjustments for the other prices given (Open, High, and Low). However, you can adjust those other prices using the ratio of the Adj. Close to the Close price.

- 1) Find the ratio of Adj. Close to Close price for every trading day in the data set. Fill in the blank cells in the table below

Date	Adj. Close/Close
6/2/97	0.083
8/23/99	
1/5/01	
10/25/05	1.000
3/4/16	

- 2) Create a line graph for the Adjustment Ratio as a function of trading days (Hint: Use the data for all the days in the data set, not just the values from the table in Question 1.)
- 3) Looking at the graph, how many adjustments were made?
- 4) Create columns in the data for Adjusted High price (=Adjustment Ratio x High) and Adjusted Low price (=Adjustment Ratio x Low). Use those columns to fill in the blank cells in the following table.

Date	Adj. High	Adj. Low
8/21/97		
7/7/99		60.00
8/1/03	41.63	

- 5) Create a line graph showing both the Adjusted High and Adjusted Low prices for days from the first trading day until December 31, 1999.

## Part 6: Investments

1) You invested \$10,000 in AMZN stock on 1/3/00, purchased at the **Close** price, purchasing only whole shares.

a. How many shares did you buy?

b. How much did you spend?

c. Calculate the value of your investment on the following dates.

Date	Value of investment on the given day
1/3/00 (date of original investment)	
1/2/02	
1/2/04	

1/2/09	\$6,033.96
Most recent trading day in the data set	

- 2) You invested \$10,000 in AMZN stock on 9/16/98, purchasing only **whole shares** at the **Close** price, and then sold it on 5/3/99. You then used the proceeds of the sale to buy (**whole**) shares again on 11/14/02 at the **Close** price.
- How many shares did you buy on 9/16/98? Your answer should be a whole number.
  - How much did you spend on 9/16/98? Show your answer in dollars and cents.
  - By what percentage did the Adj. Close price grow from 9/16/98 to 5/3/99? Show your answer as a percentage with two decimal places, e.g., 10.12%.
  - What was the value of your shares when you sold on 5/3/99? Show your answer in dollars and cents.
  - What was the **Close** price on 11/14/02? Show your answer in dollars and cents.
  - How many shares did you buy on 11/14/02? Your answer should be a whole number.
  - How much did you spend on 11/14/02? Show your answer in dollars and cents.
  - Counting the original (9/16/98) purchase and the second purchase (11/14/02), how much unspent cash did you have? Show your answer in dollars and cents.
  - By what percentage did the Adj. Close price grow from 11/14/02 to the last trading day in the data set? Show your answer as a percentage with two decimal places, e.g., 10.12%.

- j. How much were the shares you purchased on 11/14/02 worth on the last trading day in the data set? Show your answer in dollars and cents.
- k. Using the value of the shares on the last trading day in the data set plus the unspent cash, by what percentage did your original \$10,000 grow? Show your answer as a percentage with two decimal places, e.g., 10.12%.

### Part 7: Dollar-Cost Averaging

“Dollar Cost Averaging” means sticking to a regular investment pattern, such as investing \$1,000 every year, without trying to anticipate whether the price of the stock (or other investment) will rise or fall.

- 1) You bought as many whole shares of AMZN stock as you could with \$1,000 at the **Close** price on the first trading day of each calendar year from 2001 until 2010. Fill in the blank cells in the following table that show how many shares you bought and owned in each year.
- a. Table of Shares Bought in Each Year and Total Owned

As of	# new shares just purchased	Total # of shares owned
1/2/01	72	72
1/2/02		
1/2/03	51	
1/2/04		
1/3/05	22	
1/3/06		
1/3/07		
1/2/08		311
1/2/09		
1/4/10		

- b. How much were the shares owned worth on the most recent trading day in the data set? Is it correct to simply multiply (the total number of shares owned as of 1/4/10) by (the Close price on the most recent trading day)? Why or why not?
- c. How much did you spend in total on these shares? (The answer will be under \$10,000 : somewhat less than \$1,000 per year for ten years.)
- 2) Fill in the table below, under the assumption that you bought as many whole shares of AMZN stock as you could with \$1,000 at the **Close** price on the first trading day of the month of July each year.
- a. Fill in the blanks cells in the following table:

As of	# new shares just purchased	Total # of shares owned
7/2/01	68	68
7/1/02		
7/1/03		
7/1/04	19	186
7/1/05		
7/3/06		241
7/2/07		
7/1/08	13	
7/1/09		
7/1/10		

- b. How much were the shares owned worth on the most recent trading day in the data set?

- c. How much did you spend in total on these shares? (The answer will be under \$10,000: somewhat less than \$1,000 per year for ten years.)

## Part 8: Compound Annual Growth and Extrapolation

- 1) How much did AMZN **Adjusted Close** grow, as a percentage, from the last trading day of 2012 (12/31/12) to last trading day of 2013 (12/31/13)? Show your answer as a percentage with two decimal places, e.g., 10.12%.
  
- 2) *The **compound annual growth rate (CAGR)** for a span of years is a growth rate that, when compounded annually, yields the actual percentage growth over the whole period.* Watch the screencast [CAGR](#) for more information on computing the CAGR. (Note that to be consistent with the selected answers at the end of this section, use 1 year is equal to 365.25 days.)

What was the **compound annual growth rate (CAGR)** in **Adjusted Close** from the last trading day of 2008 (12/31/08) to the last trading day of 2013 (12/31/13)? Show your answer as a percentage with two decimal places, e.g., 10.12%.

- 3) If the annual growth rate in Adjusted Close from the last day of 2013 to the last day of 2014 was the same as the CAGR in Adjusted Close from the end of 2008 through 2013 calculated above, what would the Adjusted Close of the stock be on the last trading day of 2014 (12/31/14), assuming no further adjustments and annual compounding? Show your answer in dollars and cents, e.g., 150.25.
  
- 4) If the annual growth rate in Adjusted Close from the last day of 2013 through the last day of 2016 was the same as the CAGR from the end of 2008 through 2013 calculated above, what will

the Adjusted Close of the stock be on the last trading day of 2016 (12/30/16), assuming no further adjustments and annual compounding? Show your answer in dollars and cents, e.g., 150.25.

- 5) Create a graph in Excel that shows
- a) the actual daily stock prices (using Adjusted Close prices) from the end of 2008 through the last trading day in the data set
  - b) the Adjusted Close over that period if it grew smoothly at the 2008-2013 CAGR.

Show the smooth growth trend starting from the end of 2008 out through the end of 2018.

- 6) How many years are in the data set? Show your answer as a number with two decimal places, e.g., 10.25.
- 7) What was the **CAGR** of the **Adjusted Close** from the first trading day in the data set to the last trading day in the data set?

- 8) Create a graph in Excel that shows a) the actual daily stock prices (using Adjusted Close prices) from the first trading day through the last trading day in the data set, and b) the Adjusted Close if it grew smoothly at the CAGR. Use the CAGR computed over the whole data set. Show the smooth growth trend starting from the first trading day out through the end of 2019.
  
- 9) Write the equation for the curve of the smooth growth of the Adjusted Close as a function of time  $t$ , where  $t$  is in days since the first trading day.



## Selected Answers

### Part 1

- 1) a) 1.52 (price rose \$1.52)      b) 0.50%
- 2) \$32,600
- a) (i) You lost money. (ii) You lost \$1,565.00. (iii) -4.80%
- c) (ii) is different: it is exactly 5 times as much. Part (iii) is the same.
- 3) a) 15    b) \$4,890.00    c) (i) You lost \$234.75    (ii) -4.80%
- 4) a) \$3,260.00
- 5) 11.11%

### Part 3

- 1) On 12/1/15, Daily Range = 13.14.
- 2) On 12/1/15, Daily Range % = 1.97%.
- 3) On 12/1/15, Daily Change = 14.26.
- 4) On 12/1/15, Daily Change % = 2.15%.
- 5) a) 6/9/17 (largest daily range, 85.99)      b) 6/26/97 (smallest daily range, 0.12)
- c) 9/1/98 (largest daily range %, 33.33%)    d) 3/17/17 (smallest daily range %, 0.38%)
- e) 10/27/17 (largest increase, 128.52)      f) 1/29/16 (largest drop, -48.35)
- g) 11/26/01 (largest daily increase %, 34.47%)    h) 7/24/01 (largest daily drop %, -24.77%)
- 6)
- 20.42%
- 7) Down 49.20% of the days (2539 out of 5161 trading days--excluding the very first day--because there's no previous day to compare to).
- 8) Up 50.13% of the days (2587 out of 5161 trading days). Note that 49.20% + 50.13% does not equal 100%. There are 35 trading days where the adjusted close price was the same as the previous day.
- 9) Of the 2538 days when the stock went down (excluding the most recent day in the data set because we don't know if what happened the subsequent day), for 1297 of them, i.e., 51.10%, it went up the next day.

10) There is an increase in likelihood as  $51.10\% > 50.13\%$

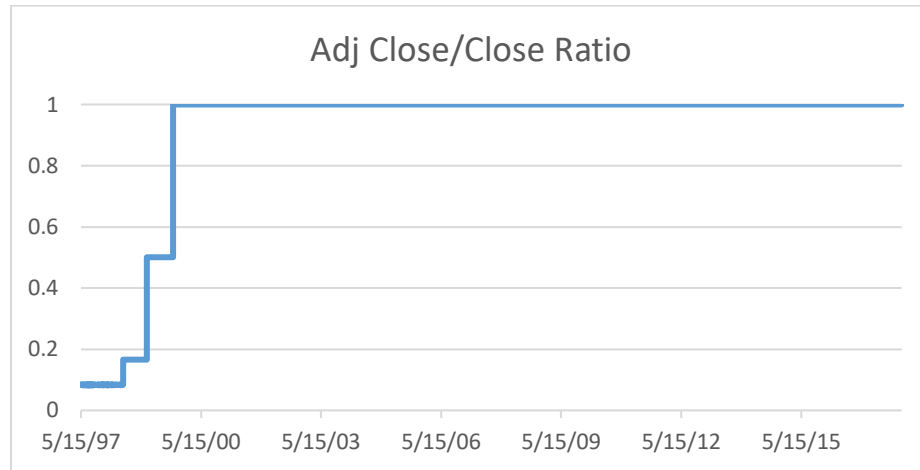
**Part 4**

1) a) \$1,124.73    b) 57384.18%

4) a) 425    b) \$9,987.50    c) Value on most recent day: \$5,741,232.84

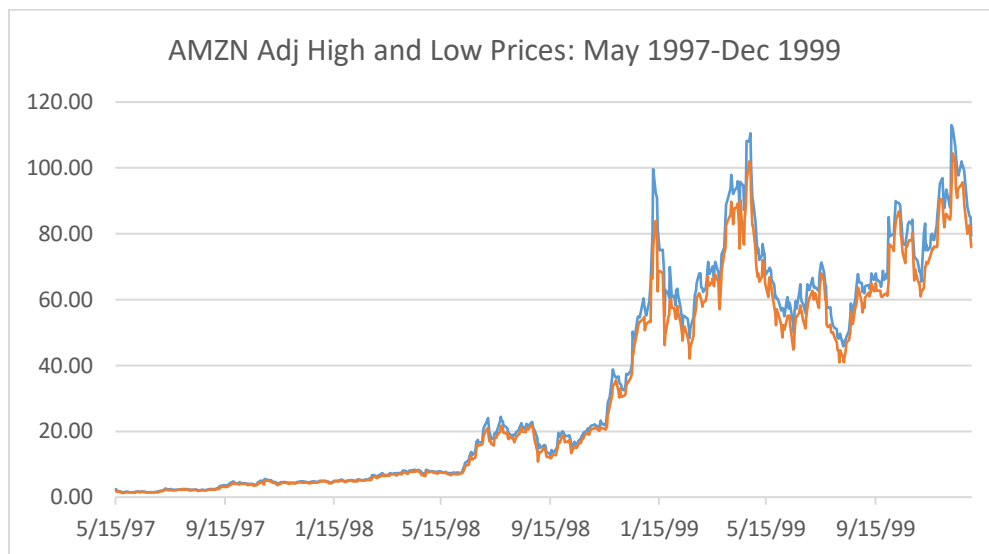
**Part 5**

2) Note: this graph was created using all the points in the data set, not just the 5 you found in the problem above.



3) 3 adjustments were made.

5)

**Part 6**

- 1) a) 111 b) \$9,921.18 c) Value on most recent day: \$125,062.59  
 2) a) 118 b) \$9,971.00 c) 436.01% d) \$53,445.41 e) \$21.21 f) 2519  
 g) \$53,427.99 h) \$46.42 i) 5212.07% j) \$2,838,132.11 k) 28281.79%

**Part 7**

1) b) \$378,567.84. Multiplying the number of shares owned as of 1/4/10 by the Close price on the most recent trading day will give the correct value IF there have been no adjustments over that time period (i.e., Adj Close = Close). c) \$9,805.29

2 ) b) \$325,613.41 c) \$9,806.32

### Part 8

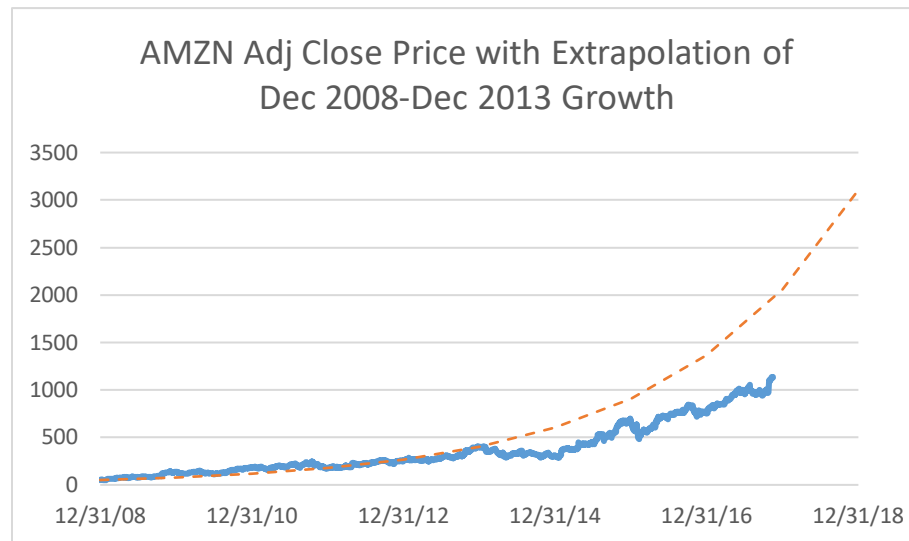
1) 58.96%

2) 50.72% (Or, if you do the calculations using whole years, the answer is 50.72%.)

3) 600.91 (Or, if you do the calculations using whole years, the answer is 601.04.)

4) 1364.36 (Or, if you do the calculations using whole years, the answer is 1365.28.)

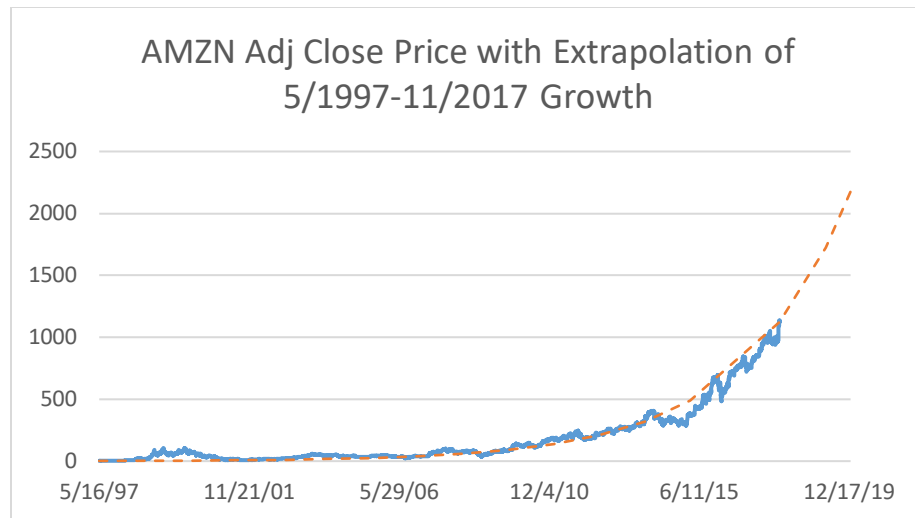
5)



6) 20.50 years

7) 36.33%

8)



9)  $p(t) = 1.96 * (1+0.3633)^{(t/365.25)}$

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