HOMEWORK / CHAPTER 8

DUE MONDAY, APRIL 13, BY 11:30AM

STATISTICAL TEST FOR PPP

Summary

(Details, specifications, pictures and instructions in the corresponding step below)

1. Get monthly data from FEBRUARY 2018 TO PRESENT.
2. Use your data to create the two columns you'll use to test for PPP. The **first** should be the percentage growth of the direct exchange rate. The **second** should be the differential of the inflation rates.
3. ***Do a scatter plot*** with the two new columns. Explain if it looks like PPP holds or not.
4. Conduct a formal REGRESSION ANALYSIS. You are going to regress XR growth on inflation differential.
5. Estimate the t-statistics for the two parameters a_0 and a_1 you obtained in the regression.
6. Determine whether the values of the parameters a_0 and a_1 are statistically significant.

TURN IN A SINGLE XLS FILE BY E-MAIL

Details, specifications, pictures and instructions

1. Get the following data from FEBRUARY 2018 TO PRESENT from FRED (link):
   a. The DIRECT EXCHANGE RATE dollar/British Pound
      DEXUSUK
      U.S. / U.K. Foreign Exchange Rate, U.S. Dollars to One British Pound, Monthly, Not Seasonally Adjusted
   b. The Inflation in the US (measured by CPI)
      CPALTT01USM661S
      Consumer Price Index: Total All Items for the United States, Index 2015=100, Monthly, Seasonally Adjusted
   c. The inflation in the UK
      GBRCPIALLMINMEI
      Consumer Price Index of All Items in the United Kingdom, Index 2015=100, Monthly, Not Seasonally Adjusted

Your downloaded data should look like this:

FRED Graph Observations			
Federal Reserve Economic Data			
Link: https://fred.stlouisfed.org			
Help: https://fred.stlouisfed.org/help-faq			
Economic Research Division			
Federal Reserve Bank of St. Louis			
DEXUSUK	U.S. / U.K. Foreign Exchange Rate, U.S. Dollars to One British Pound, Monthly, Not Seasonally Adjusted		
CPALTT01USM661S	Consumer Price Index: Total All Items for the United States, Index 2015=100, Monthly, Seasonally Adjusted		
GBRCPIALLMINMEI	Consumer Price Index of All Items in the United Kingdom, Index 2015=100, Monthly, Not Seasonally Adjusted		
Frequency: Monthly			
observation_date	DEXUSUK	CPALTT01USM661S	GBRCPIALLMINMEI
1971-01-01	2.4058	16.8342355189712	8.82012890691148
1971-02-01	2.4178	16.8342355189712	8.86812960844570
1971-03-01	2.4187	16.8764265854348	8.94013066074701
1971-04-01	2.4179	16.9186176518984	9.13213346688386
1971-05-01	2.4187	17.0029997848256	9.19213434380162
1971-06-01	2.4188	17.0873819177527	9.25813530841116
1971-07-01	2.4185	17.1295729842163	9.31213609763716
1971-08-01	2.4346	17.1717640506799	9.31813618532893
1971-09-01	2.4694	17.2139551171435	9.33013636071249
1971-10-01	2.4896	17.2561461836071	9.38413714993848
1971-11-01	2.4933	17.2983372500707	9.43813793916446
1971-12-01	2.5266	17.3405283165343	9.48613864069868
1972-01-01	2.5705	17.3827193829978	9.54013942992466
1972-02-01	2.6037	17.4671015159250	9.58814013145888
1972-03-01	2.6181	17.4671015159250	9.61814056991776
1972-04-01	2.6102	17.5092925823886	9.70814188529441
1972-05-01	2.6124	17.5514836488522	9.75614258682862
1972-06-01	2.5691	17.5936747153158	9.82214355143816

2. Estimate two NEW COLUMS. The **first** should be the percentage growth of the direct exchange rate. The **second** should be the differential of the inflation rates. You may re-name the columns and clean your data. ***I NEED TO CLICK ON A CELL AND SEE THE FORMULA***. It should look something like this:

bservation_date	XR	CPI_US	CPI_UK	XR Growth	Infl_Differential
2017-10-01	1.3202	104.0376850605650	104.40000000000000	-0.010362676	-0.36231493943501
2017-11-01	1.3217	104.3520085057190	104.70000000000000	0.001188333	-0.34799149428100
2017-12-01	1.3404	104.5920756738970	105.00000000000000	0.014083655	-0.40792432610300
2018-01-01	1.3824	105.0068138572340	104.50000000000000	0.03135405	0.50681385723399
2018-02-01	1.3961	105.2114405295820	104.90000000000000	0.009909316	0.31144052958200
2018-03-01	1.3976	105.2658670053200	105.10000000000000	0.001056441	0.16586700532001
2018-04-01	1.4079	105.4591020897230	105.50000000000000	0.007412894	-0.04089791027700
2018-05-01	1.3470	105.7502204483220	105.90000000000000	-0.043281771	-0.14977955167801
2018-06-01	1.3294	105.9561128526650	105.90000000000000	-0.01303861	0.05611285266500
2018-07-01	1.3162	106.1514574903910	105.90000000000000	-0.009950641	0.25145749039099
2018-08-01	1.2878	106.2704362978180	106.50000000000000	-0.021540458	-0.22956370218201
2018-09-01	1.3066	106.[illegible]57065948860	106.60000000000000	0.014592233	-0.27429340511399
2018-10-01	1.30[illegible]	106.65[illegible]45559600	106.70000000000000	-0.004167369	-0.04351544404000
2018-11-01	1.2900	106.6421335[illegible]3620	106.90000000000000	-0.008600892	-0.25786040663800
2018-12-01	1.2664	106.[illegible]652889[illegible]710	107.10000000000000	-0.018312302	-0.47347110122900
2019-01-01	1.2901	106.605[illegible]3365[illegible]90	106.40000000000000	0.018713122	0.20543336553899
2019-02-01	1.3016	106.7910740[illegible]79790	106.[illegible]0000000000000	0.008963338	-0.00892594202099
2019-03-01	1.3167	107.2277515958[illegible]70	107.00000000000000	0.011542275	0.22775159587700
2019-04-01	1.3029	107.5694992342320	107.6[illegible]000000000000	-0.01042092	-0.03050076576800

See how I changed the names to something easy to understand. The direct exchange rate is XR, US inflation is CPI_US and UK Inflation is CPI_UK.

The **first new column** is **XR growth**. Estimated as follows:

$$XR_{Growth} = \frac{XR_{t+1} - XR_t}{XR_t}$$

$$XR_{Growth} = \frac{XR_{t+1} - XR_t}{XR_t}$$

The **second column** is **inflation differential**. It is just (CPI_US) - (CPI_UK)

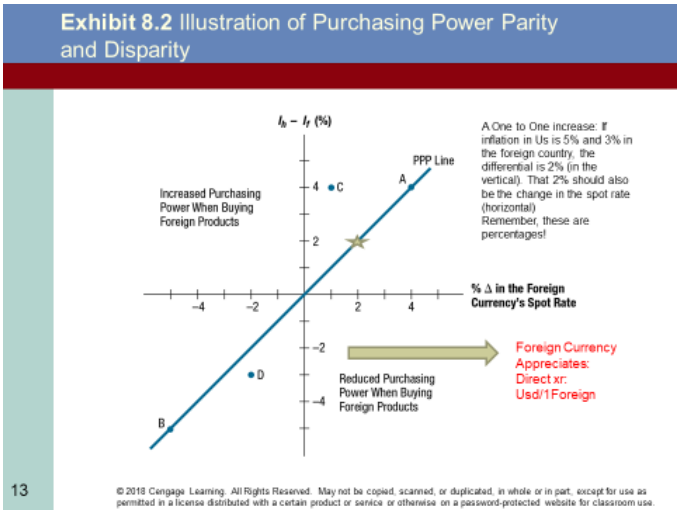
WHAT WE DID HERE, IS PREPARING THE DATA TO DO THE STATISTICAL TEST FOR PPP, which applies linear regression analysis to historical exchange rates and inflation differentials. Look at the formula and see how the two new columns are needed to run the regression:

$$e_f = a_0 + a_1(\pi_h - \pi_f) + \mu$$

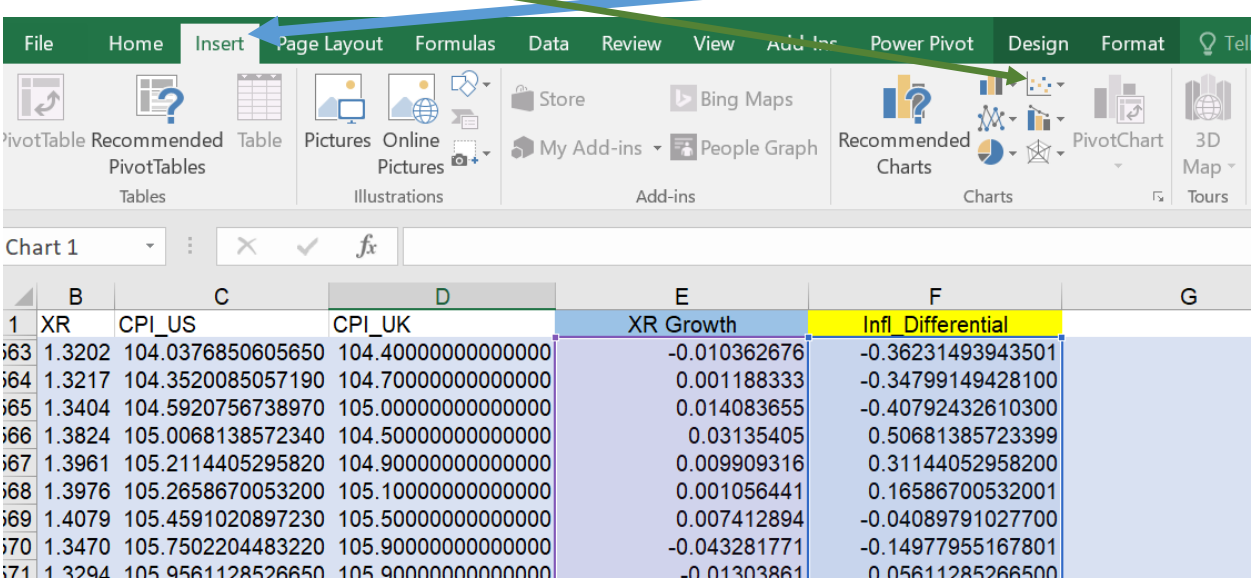
$$XR\ growth = a_0 + a_1(Inflation\ Differential) + \mu$$

3. Once you have your data, ***do a scatter plot*** and analyze it. EXPLAIN IF IT LOOKS LIKE PPP HOLDS OR NOT.

You have to have XR growth in the horizontal axis and Inflation Differential on the vertical axis***. Remember that a 45-degree line means that the foreign currency appreciates by the exact inflation differential. If our data lies ON THE PPP line then PPP holds. We can get an idea of it by looking at the data in a scatter plot.***

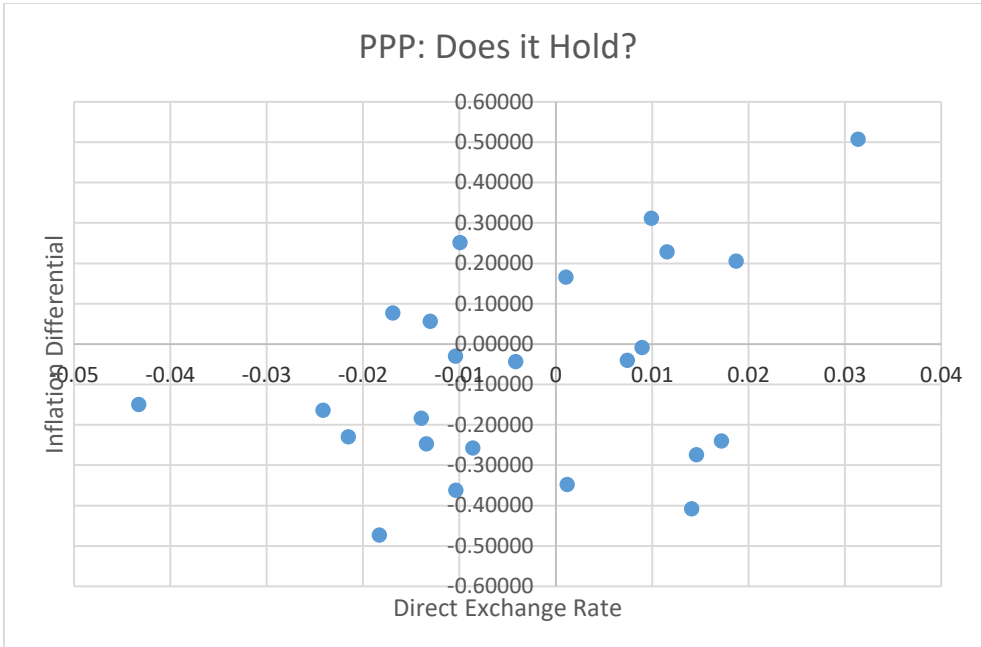


To produce the scatter plot, select the two newly created columns (XR growth should be the first column and inflation differential the second). Then, click on **Insert** and choose **scatter plot.**

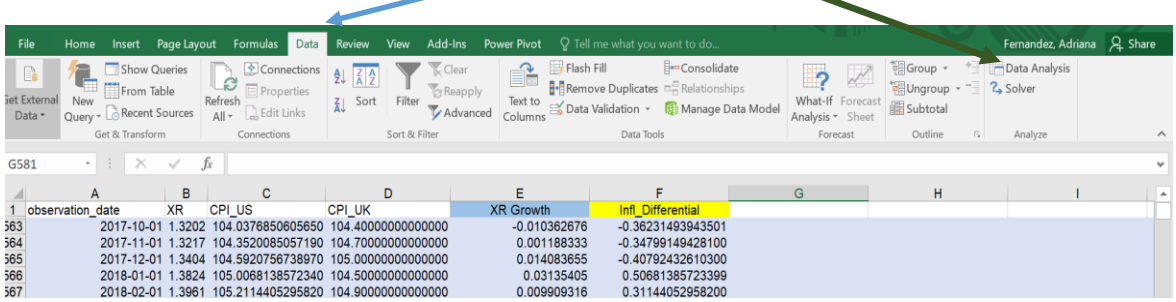


	B	C	D	E	F	G
1	XR	CPI_US	CPI_UK	XR Growth	Infl_Differential	
63	1.3202	104.0376850605650	104.40000000000000	-0.010362676	-0.36231493943501	
64	1.3217	104.3520085057190	104.70000000000000	0.001188333	-0.34799149428100	
65	1.3404	104.5920756738970	105.00000000000000	0.014083655	-0.40792432610300	
66	1.3824	105.0068138572340	104.50000000000000	0.03135405	0.50681385723399	
67	1.3961	105.2114405295820	104.90000000000000	0.009909316	0.31144052958200	
68	1.3976	105.2658670053200	105.10000000000000	0.001056441	0.16586700532001	
69	1.4079	105.4591020897230	105.50000000000000	0.007412894	-0.04089791027700	
70	1.3470	105.7502204483220	105.90000000000000	-0.043281771	-0.14977955167801	
71	1.3294	105.9561128526650	105.90000000000000	-0.01303861	0.05611285266500	

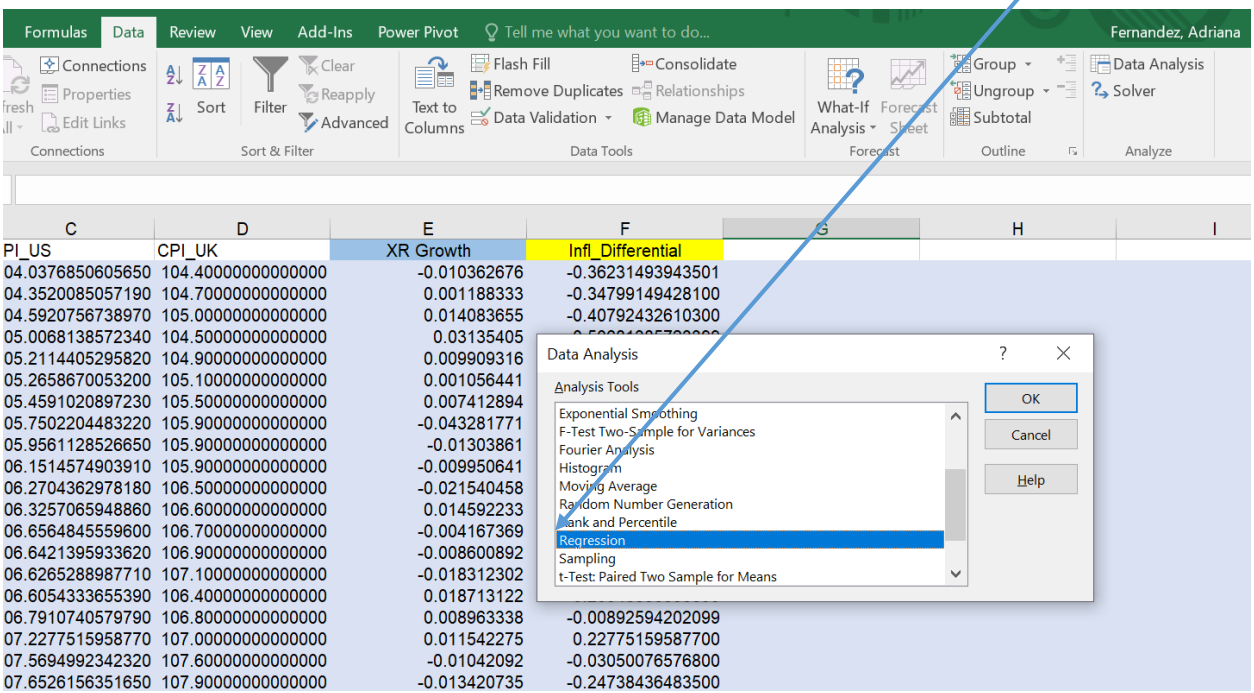
The scatter plot should look like the chart below. The data I'm using for this example is not the using the exact period you'll use. So, your plot should be similar, but NOT EXACTLY the same. You should be able to see if your data lies near the 45-degree line or not. This is just a visual analysis of our data.



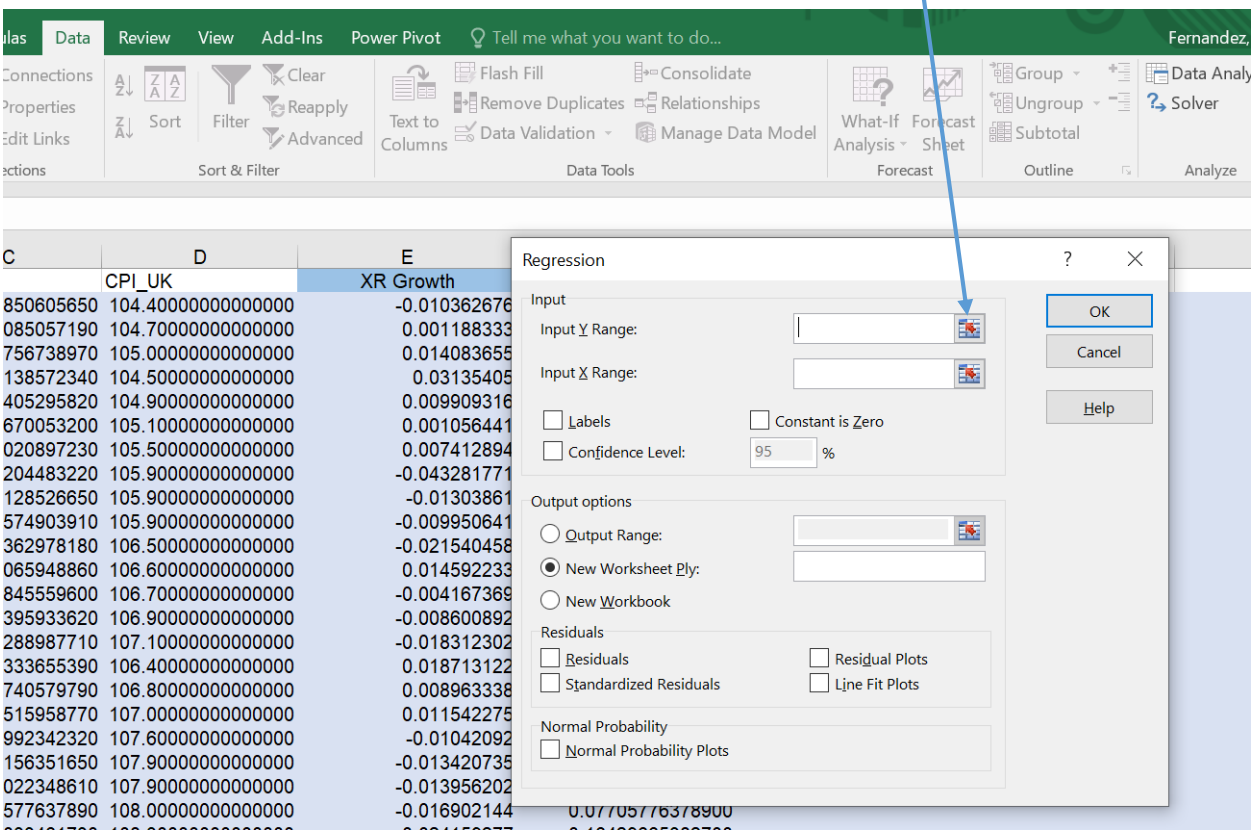
4. Next, you have to conduct the formal REGRESSION ANALYSIS. You are going to regress XR growth on inflation differential. You will use the two newly created columns for this.
    a. In your spreadsheet click on **data.** Then go to **Data Analysis**



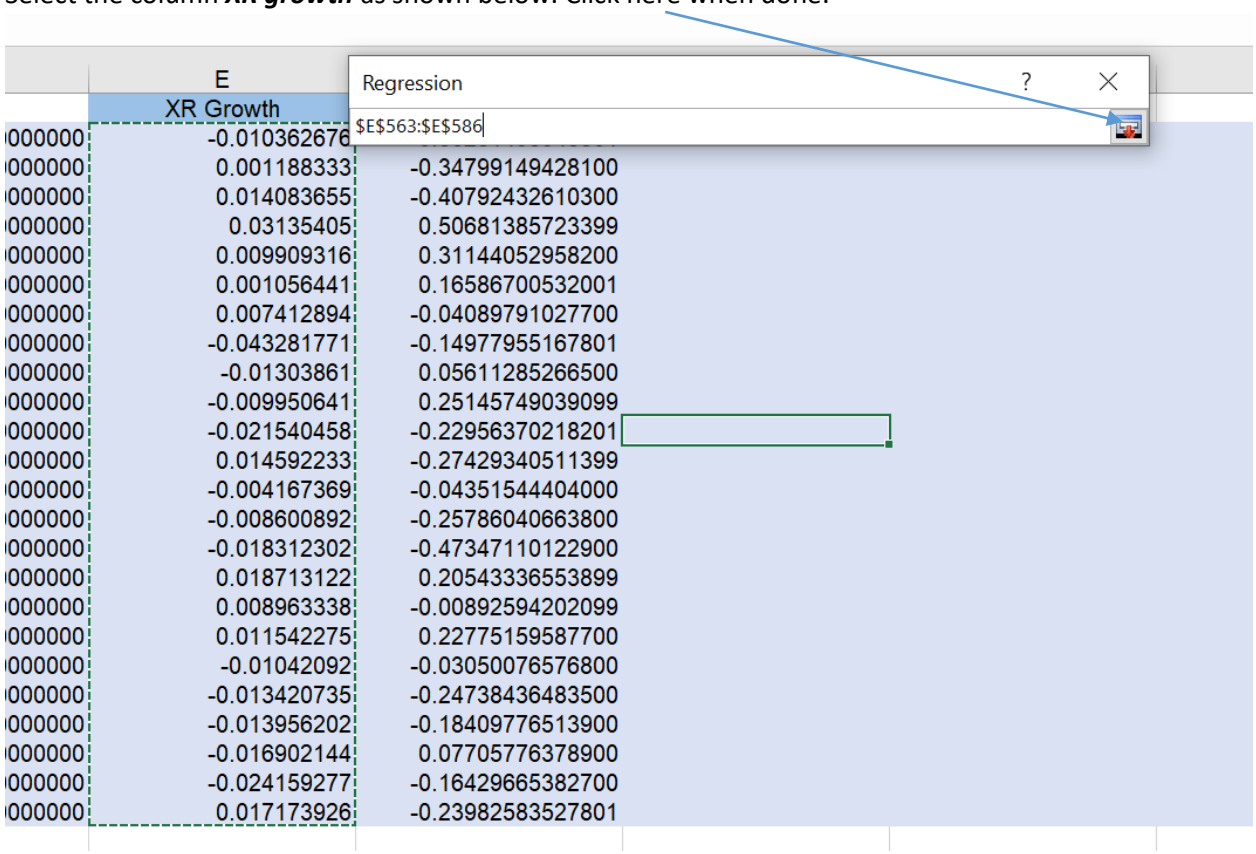
b. Once you click on Data Analysis, you'll see the Data Analysis Tools. Choose Regression and hit OK.



a. Once you hit regression, you'll see the following screen. Hit on **Input Y Range**

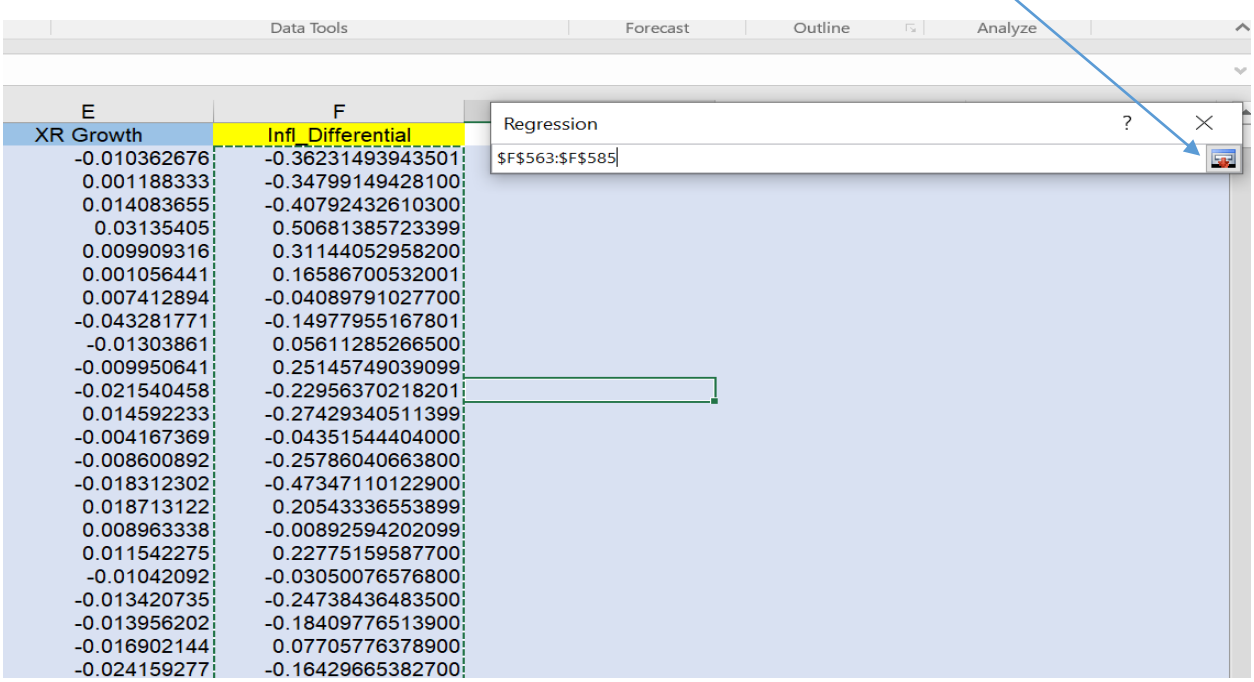


b. Select the column ***XR growth*** as shown below. Click here when done:



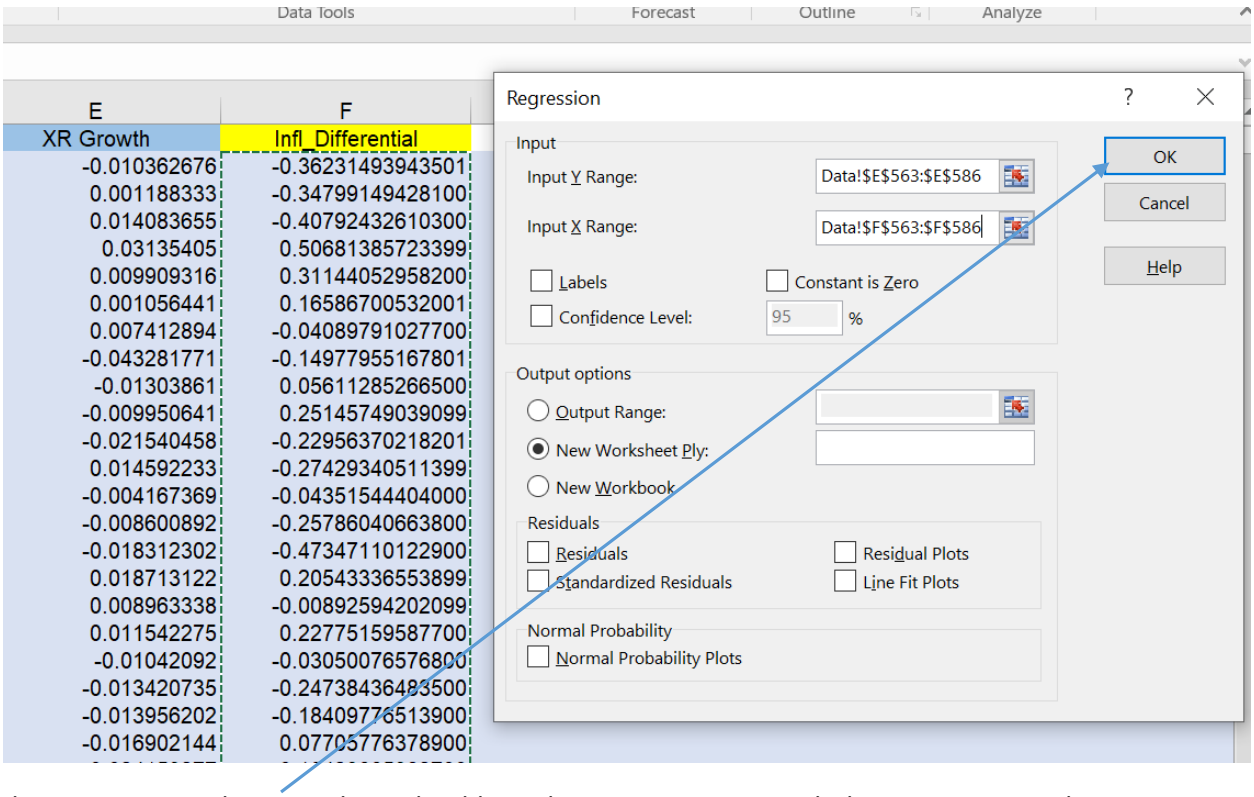
	XR Growth	
000000	-0.010362676	
000000	0.001188333	-0.34799149428100
000000	0.014083655	-0.40792432610300
000000	0.03135405	0.50681385723399
000000	0.009909316	0.31144052958200
000000	0.001056441	0.16586700532001
000000	0.007412894	-0.04089791027700
000000	-0.043281771	-0.14977955167801
000000	-0.01303861	0.05611285266500
000000	-0.009950641	0.25145749039099
000000	-0.021540458	-0.22956370218201
000000	0.014592233	-0.27429340511399
000000	-0.004167369	-0.04351544404000
000000	-0.008600892	-0.25786040663800
000000	-0.018312302	-0.47347110122900
000000	0.018713122	0.20543336553899
000000	0.008963338	-0.00892594202099
000000	0.011542275	0.22775159587700
000000	-0.01042092	-0.03050076576800
000000	-0.013420735	-0.24738436483500
000000	-0.013956202	-0.18409776513900
000000	-0.016902144	0.07705776378900
000000	-0.024159277	-0.16429665382700
000000	0.017173926	-0.23982583527801

c. Then, hit on ***Input X Range*** and select the inflation differential column. Click here when done.



XR Growth	Infl_Differential
-0.010362676	-0.36231493943501
0.001188333	-0.34799149428100
0.014083655	-0.40792432610300
0.03135405	0.50681385723399
0.009909316	0.31144052958200
0.001056441	0.16586700532001
0.007412894	-0.04089791027700
-0.043281771	-0.14977955167801
-0.01303861	0.05611285266500
-0.009950641	0.25145749039099
-0.021540458	-0.22956370218201
0.014592233	-0.27429340511399
-0.004167369	-0.04351544404000
-0.008600892	-0.25786040663800
-0.018312302	-0.47347110122900
0.018713122	0.20543336553899
0.008963338	-0.00892594202099
0.011542275	0.22775159587700
-0.01042092	-0.03050076576800
-0.013420735	-0.24738436483500
-0.013956202	-0.18409776513900
-0.016902144	0.07705776378900
-0.024159277	-0.16429665382700

You should see this:

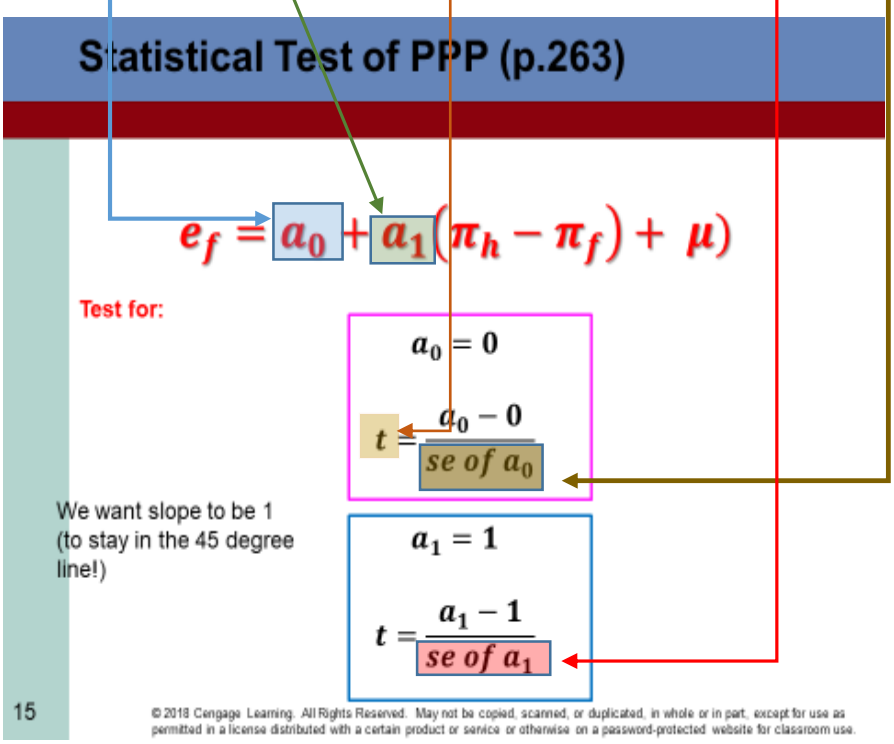


E	F
XR Growth	Infl_Differential
-0.010362676	-0.36231493943501
0.001188333	-0.34799149428100
0.014083655	-0.40792432610300
0.03135405	0.50681385723399
0.009909316	0.31144052958200
0.001056441	0.16586700532001
0.007412894	-0.04089791027700
-0.043281771	-0.14977955167801
-0.01303861	0.05611285266500
-0.009950641	0.25145749039099
-0.021540458	-0.22956370218201
0.014592233	-0.27429340511399
-0.004167369	-0.04351544404000
-0.008600892	-0.25786040663800
-0.018312302	-0.47347110122900
0.018713122	0.20543336553899
0.008963338	-0.00892594202099
0.011542275	0.22775159587700
-0.01042092	-0.03050076576800
-0.013420735	-0.24738436483500
-0.013956202	-0.18409776513900
-0.016902144	0.07705776378900

d. Now, you just hit OK and you should see the OUTPUT screen with the regression results in a new page, as shown below.

e. This is what your results mean in your SUMMARY OUTPUT:

	A	B	C	D	E	F	G	H	I
1	SUMMARY OUTPUT								
2									
3	*Regression Statistics*								
4	Multiple R	0.381062075							
5	R Square	0.145208305							
6	Adjusted R Square	0.106354137							
7	Standard Error	0.016116705							
8	Observations	24							
9									
10	ANOVA								
11		*df*	*SS*	*MS*	*F*	*Significance F*			
12	Regression	1	0.000970748	0.000971	3.737264556	0.066183309			
13	Residual	22	0.00571446	0.00026					
14	Total	23	0.006685208						
15									
16		*Coefficients*	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
17	Intercept	-0.001231116	0.003415404	-0.36046	0.721941058	-0.008314231	0.005852	-0.00831	0.005852
18	X Variable 1	0.025638221	0.013262059	1.933201	0.066183309	-0.001865607	0.053142	-0.00187	0.053142



5. Estimate the t-statistics for the two parameters a_0 and a_1 .

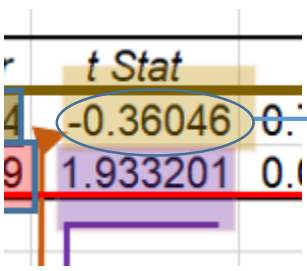
$$\boldsymbol{e_f = a_0 + a_1(\pi_h - \pi_f) + \mu}$$

Looking at the equation, we see that in order for the exchange rate growth (e_f) to be equal to the inflation differential, we need a_0 to be equal to zero and $a_1$equal to 1. Well, the t-statistics need to test if that's the case.

$$\boldsymbol{e_f = 0 + 1(\pi_h - \pi_f) + \mu}$$

(The error term μ is just random).

a. The t-statistics for parameter $\boldsymbol{a_0}$.
By entering the values of a_0 and the **standard** deviation of a_0 (σ_{a_0}) in the formula, we get the t-statistic estimated in the regression output:



$$t_{a_0} = \frac{a_0 - 0}{\sigma_{a_0}} = \frac{-0.001231116 - 0}{0.003415404} = -0.36046$$

b. The t-statistics for parameter a_1. Plug in the values of a_1 and the standard deviation of a_1 (σ_{a_1}) in the formula:

$$t_{a_1} = \frac{a_1 - 1}{\sigma_{a_1}} = \frac{0.025638221 - 1}{0.0132620509} = -73.46991701$$

6. Determine whether the ***values of the parameters*** a_0 and a_1 are statistically significant.
For that, you have to compare the t-statistic of each parameter with its corresponding 95% Critical Value (CV) of the t-table (posted along with the handout for Chapter 8).

CRITERIA:
If the ABSOLUTE VALUE of our t-statistic is bigger than the CV at a 95% level of significance, then our parameter can be accepted as valid.

a. Find the **<u>Critical Value corresponding to 95% Confidence</u>** in the t-table:

i. For that, you need the Degrees of Freedom (df) which is the NUMBER OF OBSERVATIONS MINUS ONE: ***df = (N-1).*** You will find N (number of observations) at the top of your Excel regression output. In this case, it is 24. Degrees of Freedom then are 23:

	A	B	C
1	SUMMARY OUTPUT		
2			
3	*Regression Statistics*		
4	Multiple R	0.381062075	
5	R Square	0.145208305	
6	Adjusted R Square	0.106354187	
7	Standard Error	0.016116705	
8	Observations	24	
9			
10	ANOVA		
11		*df*	*SS*
12	Regression	1	0.000970748
13	Residual	22	0.00571446
14	Total	23	0.006685208
15			
16		*Coefficients*	*Standard Error*
17	Intercept	-0.001231116	0.003415404
18	X Variable 1	0.025638221	0.013262059

ii. Go to the **t-table** and find the CV (below).

1. THE FIRST COLUMN OF THE TABLE IS THE DEGREES OF FREEDOM: Find the degrees of freedom: number 23 in my example.
2. IN THE LAST ROW OF THE TABLE YOU'LL FIND THE CONFIDENCE LEVEL: Find 95%
   a. THE CV will be found where the two intercept. In this case is **2.069** (see table)
3. Now compare the ABSOLUTE VALUE of the t-statistics (If it is negative, make it positive) and the CV:
   a. Do it for $\boldsymbol{a_0}$:

$$t_{a_0} = |-\mathbf{0.36046}| = \mathbf{0.36046}$$

$$CV_{a_0} = \mathbf{2.069}$$

We see that $CV_{a_0} > |t_{a_0}|$ which means that <u>we cannot say</u> with a 95% confidence that the parameter $\boldsymbol{a_0} = \mathbf{0}$

   b. Do it for $\boldsymbol{a_1}$:

$$t_{a_1} = |-73.46991701| = 73.46991701$$

$$CV_{a_1} = \mathbf{2.069}$$

We see that $CV_{a_0} < |t_{a_0}|$ which means that we can say with a 95% confidence that the parameter $\boldsymbol{a_1} = \mathbf{1}$

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	**0.50**	**0.25**	**0.20**	**0.15**	**0.10**	**0.05**	**0.025**	**0.01**	**0.005**	**0.001**	**0.0005**
two-tails	**1.00**	**0.50**	**0.40**	**0.30**	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.002**	**0.001**
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										