Introductory Econometrics

Using Excel

Testing for Heteroskedasticity
BP test

R15

The Breusch- Pagan LM test

Breusch and Pagan (1979) developed a LM test for heteroscedasticity. Let's assume that we have the following model:

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \cdots + \beta_k X_{ki} + u_i \qquad \text{(i)}$$

where $var(u_i) = \sigma_i^2$. The B-P test involves the following steps:

Step 1: Run a regression model (i) and obtain the residuals $\hat{u}_i$.
Step 2: Run the following auxillary equation:

$$\hat{u}_i^{\,2} = \alpha_1 + \alpha_2 X_{2i} + \alpha_3 X_{3i} + \cdots + \alpha_k X_{ki} + v_i \qquad \text{(ii)}$$

Step 3: Formulate the null and the alternative hypothesis. The null hypothesis of homoscedasticity is that:

$$H_0: \alpha_1 = \alpha_2 = \cdots = \alpha_k = 0$$

while the aletrnative hypothesis is that at least one of the $\alpha' s$ is different from zero.

Step 4: Compute $LM = nR^2$ statistic, where n is the number of observations used in order to estimate the auxillary regression in step 2. The LM statistic follows χ^2 distribution with $k - 1$ degrees of freedom.

Step 5: Reject the null and conclude that there is a significant degree of heteroscedasticity when LM statistic is greater than the critical value. Alternatively compute p-value and reject the null if the p-value is less than the level of significance α (usually α = 0.05).

Use the excel file arrests.xlsx

B-P Test (p) [Compatibility Mode] - Excel

Pravesh Tamang

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Q9

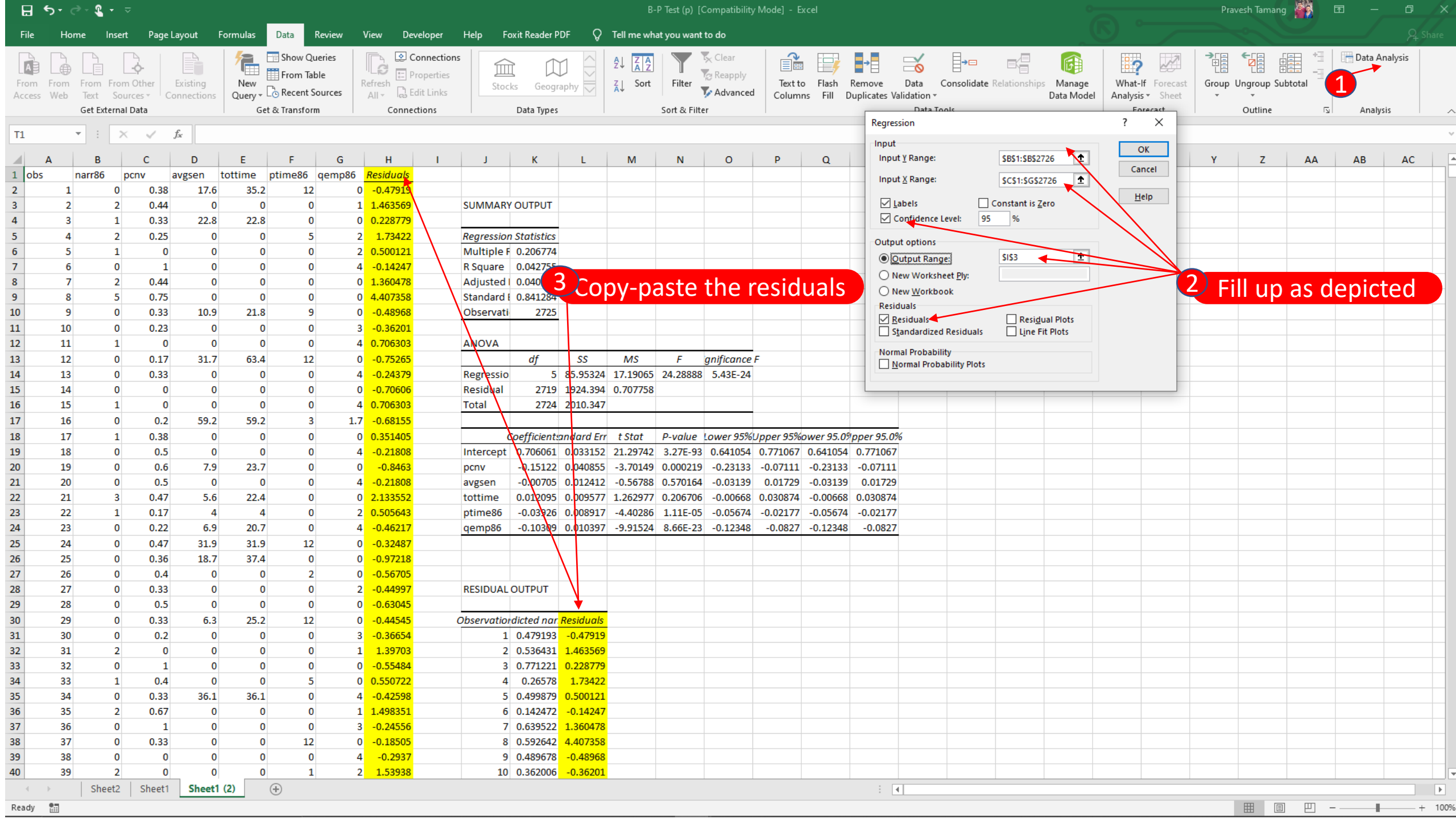
	A	B	C	D	E	F	G
1	obs	narr86	pcnv	avgsen	tottime	ptime86	qemp86
2	1	0	0.38	17.6	35.2	12	0
3	2	2	0.44	0	0	0	1
4	3	1	0.33	22.8	22.8	0	0
5	4	2	0.25	0	0	5	2
6	5	1	0	0	0	0	2
7	6	0	1	0	0	0	4
8	7	2	0.44	0	0	0	0
9	8	5	0.75	0	0	0	0
10	9	0	0.33	10.9	21.8	9	0
11	10	0	0.23	0	0	0	3
12	11	1	0	0	0	0	4
13	12	0	0.17	31.7	63.4	12	0
14	13	0	0.33	0	0	0	4
15	14	0	0	0	0	0	0
16	15	1	0	0	0	0	4
17	16	0	0.2	59.2	59.2	3	1.7
18	17	1	0.38	0	0	0	0
19	18	0	0.5	0	0	0	4
20	19	0	0.6	7.9	23.7	0	0
21	20	0	0.5	0	0	0	4
22	21	3	0.47	5.6	22.4	0	0
23	22	1	0.17	4	4	0	2
24	23	0	0.22	6.9	20.7	0	4
25	24	0	0.47	31.9	31.9	12	0
26	25	0	0.36	18.7	37.4	0	0
27	26	0	0.4	0	0	2	0

Dependent variable
narr86 = number of times arrested

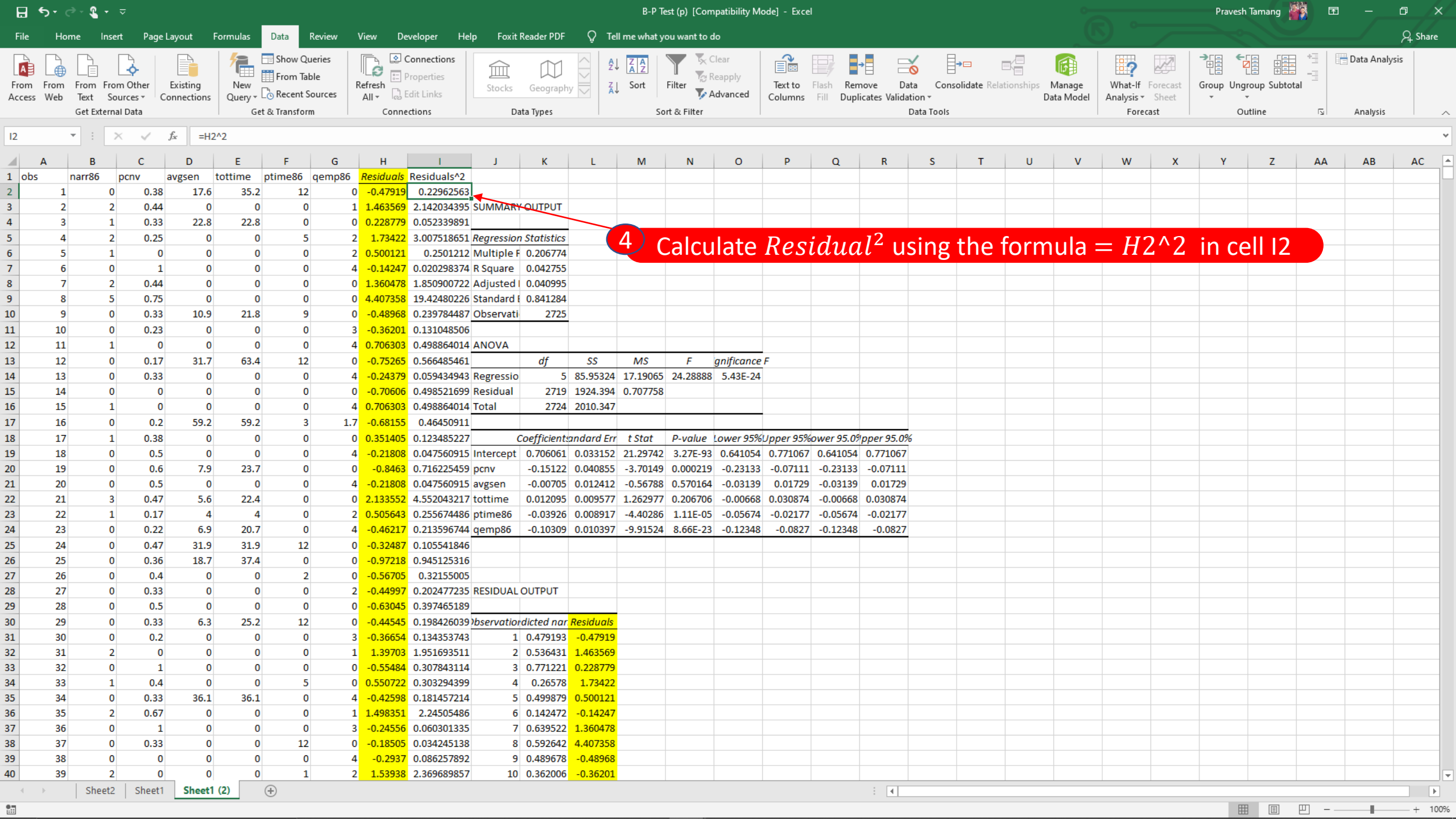
Independent variables
pcnv = proportion of prior convictions
avgsen = average sentence length, months
tittime = time in prision
ptime86 = months in prision
qemp86= number of quarters employed
inc86 = legal income, 1986

Sheet2 model1 model2 Sheet1

145%



	A	B	C	D	E	F	G	H
1	obs	narr86	pcnv	avgsen	tottime	ptime86	qemp86	*Residuals*
2	1	0	0.38	17.6	35.2	12	0	-0.47919
3	2	2	0.44	0	0	0	1	1.463569
4	3	1	0.33	22.8	22.8	0	0	0.228779
5	4	2	0.25	0	0	5	2	1.73422
6	5	1	0	0	0	0	2	0.500121
7	6	0	1	0	0	0	4	-0.14247
8	7	2	0.44	0	0	0	0	1.360478
9	8	5	0.75	0	0	0	0	4.407358
10	9	0	0.33	10.9	21.8	9	0	-0.48968
11	10	0	0.23	0	0	0	3	-0.36201
12	11	1	0	0	0	0	4	0.706303
13	12	0	0.17	31.7	63.4	12	0	-0.75265
14	13	0	0.33	0	0	0	4	-0.24379
15	14	0	0	0	0	0	0	-0.70606
16	15	1	0	0	0	0	4	0.706303
17	16	0	0.2	59.2	59.2	3	1.7	-0.68155
18	17	1	0.38	0	0	0	0	0.351405
19	18	0	0.5	0	0	0	4	-0.21808
20	19	0	0.6	7.9	23.7	0	0	-0.8463
21	20	0	0.5	0	0	0	4	-0.21808
22	21	3	0.47	5.6	22.4	0	0	2.133552
23	22	1	0.17	4	4	0	2	0.505643
24	23	0	0.22	6.9	20.7	0	4	-0.46217
25	24	0	0.47	31.9	31.9	12	0	-0.32487
26	25	0	0.36	18.7	37.4	0	0	-0.97218
27	26	0	0.4	0	0	2	0	-0.56705
28	27	0	0.33	0	0	0	2	-0.44997
29	28	0	0.5	0	0	0	0	-0.63045
30	29	0	0.33	6.3	25.2	12	0	-0.44545
31	30	0	0.2	0	0	0	3	-0.36654
32	31	2	0	0	0	0	1	1.39703
33	32	0	1	0	0	0	0	-0.55484
34	33	1	0.4	0	0	5	0	0.550722
35	34	0	0.33	36.1	36.1	0	4	-0.42598
36	35	2	0.67	0	0	0	1	1.498351
37	36	0	1	0	0	0	3	-0.24556
38	37	0	0.33	0	0	12	0	-0.18505
39	38	0	0	0	0	0	4	-0.2937
40	39	2	0	0	0	1	2	1.53938



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	obs	narr86	pcnv	avgsen	tottime	ptime86	qemp86	*Residuals*	Residuals^2									
2	1	0	0.38	17.6	35.2	12	0	-0.47919	0.22962563									
3	2	2	0.44	0	0	0	1	1.463569	2.142034395	SUMMARY OUTPUT								
4	3	1	0.33	22.8	22.8	0	0	0.228779	0.052339891									
5	4	2	0.25	0	0	5	2	1.73422	3.007518651	*Regression Statistics*								
6	5	1	0	0	0	0	2	0.500121	0.2501212	Multiple F	0.206774							
7	6	0	1	0	0	0	4	-0.14247	0.020298374	R Square	0.042755							
8	7	2	0.44	0	0	0	0	1.360478	1.850900722	Adjusted I	0.040995							
9	8	5	0.75	0	0	0	0	4.407358	19.42480226	Standard E	0.841284							
10	9	0	0.33	10.9	21.8	9	0	-0.48968	0.239784487	Observati	2725							
11	10	0	0.23	0	0	0	3	-0.36201	0.131048506									
12	11	1	0	0	0	0	4	0.706303	0.498864014	ANOVA								
13	12	0	0.17	31.7	63.4	12	0	-0.75265	0.566485461		*df*	*SS*	*MS*	*F*	*gnificance F*			
14	13	0	0.33	0	0	0	4	-0.24379	0.059434943	Regressio	5	85.95324	17.19065	24.28888	5.43E-24			
15	14	0	0	0	0	0	0	-0.70606	0.498521699	Residual	2719	1924.394	0.707758					
16	15	1	0	0	0	0	4	0.706303	0.498864014	Total	2724	2010.347						
17	16	0	0.2	59.2	59.2	3	1.7	-0.68155	0.46450911									
18	17	1	0.38	0	0	0	0	0.351405	0.123485227		*Coefficients*	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
19	18	0	0.5	0	0	0	4	-0.21808	0.047560915	Intercept	0.706061	0.033152	21.29742	3.27E-93	0.641054	0.771067	0.641054	0.771067
20	19	0	0.6	7.9	23.7	0	0	-0.8463	0.716225459	pcnv	-0.15122	0.040855	-3.70149	0.000219	-0.23133	-0.07111	-0.23133	-0.07111
21	20	0	0.5	0	0	0	4	-0.21808	0.047560915	avgsen	-0.00705	0.012412	-0.56788	0.570164	-0.03139	0.01729	-0.03139	0.01729
22	21	3	0.47	5.6	22.4	0	0	2.133552	4.552043217	tottime	0.012095	0.009577	1.262977	0.206706	-0.00668	0.030874	-0.00668	0.030874
23	22	1	0.17	4	4	0	2	0.505643	0.255674486	ptime86	-0.03926	0.008917	-4.40286	1.11E-05	-0.05674	-0.02177	-0.05674	-0.02177
24	23	0	0.22	6.9	20.7	0	4	-0.46217	0.213596744	qemp86	-0.10309	0.010397	-9.91524	8.66E-23	-0.12348	-0.0827	-0.12348	-0.0827
25	24	0	0.47	31.9	31.9	12	0	-0.32487	0.105541846									
26	25	0	0.36	18.7	37.4	0	0	-0.97218	0.945125316									
27	26	0	0.4	0	0	2	0	-0.56705	0.32155005									
28	27	0	0.33	0	0	0	2	-0.44997	0.202477235	RESIDUAL OUTPUT								
29	28	0	0.5	0	0	0	0	-0.63045	0.397465189									
30	29	0	0.33	6.3	25.2	12	0	-0.44545	0.198426039	*bservatior*	*dicted nar*	*Residuals*						
31	30	0	0.2	0	0	0	3	-0.36654	0.134353743	1	0.479193	-0.47919						
32	31	2	0	0	0	0	1	1.39703	1.951693511	2	0.536431	1.463569						
33	32	0	1	0	0	0	0	-0.55484	0.307843114	3	0.771221	0.228779						
34	33	1	0.4	0	0	5	0	0.550722	0.303294399	4	0.26578	1.73422						
35	34	0	0.33	36.1	36.1	0	4	-0.42598	0.181457214	5	0.499879	0.500121						
36	35	2	0.67	0	0	0	1	1.498351	2.24505486	6	0.142472	-0.14247						
37	36	0	1	0	0	0	3	-0.24556	0.060301335	7	0.639522	1.360478						
38	37	0	0.33	0	0	12	0	-0.18505	0.034245138	8	0.592642	4.407358						
39	38	0	0	0	0	0	4	-0.2937	0.086257892	9	0.489678	-0.48968						
40	39	2	0	0	0	1	2	1.53938	2.369689857	10	0.362006	-0.36201						

B-P Test (p) [Compatibility Mode] - Excel

Pravesh Tamang

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P11

obs	narr86	pcnv	avgsen	tottime	ptime86	qemp86	Residuals	Residuals^2
1	0	0.38	17.6	35.2	12	0	-0.47919	0.22962563
2	2	0.44	0	0	0	1	1.463569	2.142034395
3	1	0.33	22.8	22.8	0	0	0.228779	0.052339891
4	2	0.25	0	0	5	2	1.73422	3.007518651
5	1	0	0	0	0	2	0.500121	0.2501212
6	0	1	0	0	0	4	-0.14247	0.020298374
7	2	0.44	0	0	0	0	1.360478	1.850900722
8	5	0.75	0	0	0	0	4.407358	19.42480226
9	0	0.33	10.9	21.8	9	0	-0.48968	0.239784487
10	0	0.23	0	0	0	3	-0.36201	0.131048506
11	1	0	0	0	0	4	0.706303	0.498864014
12	0	0.17	31.7	63.4	12	0	-0.75265	0.566485461
13	0	0.33	0	0	0	4	-0.24379	0.059434943
14	0	0	0	0	0	0	-0.70606	0.498521699
15	1	0	0	0	0	4	0.706303	0.498864014
16	0	0.2	59.2	59.2	3	1.7	-0.68155	0.46450911
17	1	0.38	0	0	0	0	0.351405	0.123485227
18	0	0.5	0	0	0	4	-0.21808	0.047560915
19	0	0.6	7.9	23.7	0	0	-0.8463	0.716225459
20	0	0.5	0	0	0	4	-0.21808	0.047560915
21	3	0.47	5.6	22.4	0	0	2.133552	4.552043217
22	1	0.17	4	4	0	2	0.505643	0.255674486
23	0	0.22	6.9	20.7	0	4	-0.46217	0.213596744
24	0	0.47	31.9	31.9	12	0	-0.32487	0.105541846
25	0	0.36	18.7	37.4	0	0	-0.97218	0.945125316
26	0	0.4	0	0	2	0	-0.56705	0.32155005
27	0	0.33	0	0	0	2	-0.44997	0.202477235
28	0	0.5	0	0	0	0	-0.63045	0.397465189
29	0	0.33	6.3	25.2	12	0	-0.44545	0.198426039
30	0	0.2	0	0	0	3	-0.36654	0.134353743
31	2	0	0	0	0	1	1.39703	1.951693511
32	0	1	0	0	0	0	-0.55484	0.307843114
33	1	0.4	0	0	5	0	0.550722	0.303294399
34	0	0.33	36.1	36.1	0	4	-0.42598	0.181457214
35	2	0.67	0	0	0	1	1.498351	2.24505486
36	0	1	0	0	0	3	-0.24556	0.060301135
37	0	0.33	0	0	12	0	-0.18505	0.034245138
38	0	0	0	0	0	4	-0.2937	0.086257892
39	2	0	0	0	1	2	1.53938	2.369689857

5 Regress using $Residuals^2$ as the dependent variable

6 The X's remain the same

SUMMARY OUTPUT

Regression Stat	
Multiple F	0.20677
R Square	0.04275
Adjusted I	0.040995
Standard E	0.841284
Observati	2725

	df	SS	MS	F	Significance F
Regressio	5	85.95324	17.19065	24.28888	5.43E-24
Residual	2719	1924.394	0.707758		
Total	2724	2010.347			

	Coefficients	Standard Err	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.706061	0.033152	21.29742	3.27E-93	0.641054	0.771067	0.641054	0.771067
pcnv	-0.15122	0.040855	-3.70149	0.000219	-0.23133	-0.07111	-0.23133	-0.07111
avgsen	-0.00705	0.012412	-0.56788	0.570164	-0.03139	0.01729	-0.03139	0.01729
tottime	0.012095	0.009577	1.262977	0.206706	-0.00668	0.030874	-0.00668	0.030874
ptime86	-0.03926	0.008917	-4.40286	1.11E-05	-0.05674	-0.02177	-0.05674	-0.02177
qemp86	-0.10309	0.010397	-9.91524	8.66E-23	-0.12348	-0.0827	-0.12348	-0.0827

RESIDUAL OUTPUT

Observation	Predicted narr	Residuals
1	0.479193	-0.47919
2	0.536431	1.463569
3	0.771221	0.228779
4	0.26578	1.73422
5	0.499879	0.500121
6	0.142472	-0.14247
7	0.639522	1.360478
8	0.592642	4.407358
9	0.489678	-0.48968
10	0.362006	-0.36201

SUMMARY OUTPUT

Standard E	3.947408
Observati	2725

	df	SS	MS	F	Significance F
Regressio	5	6			
Residual	2719	42367.53	15.58203		
Total	2724	42968.85			

	Coefficients	Standard Err	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 9
Intercept	1.424994	0.155555	9.160695	9.87E-20	1.119976	1.730013	1.119976	1.730
pcnv	-0.02281	0.191697	-0.11901	0.905279	-0.3987	0.353073	-0.3987	0.353
avgsen	-0.0561	0.05824	-0.96323	0.335516	-0.1703	0.0581	-0.1703	0.0
tottime	0.04948	0.044936	1.101122	0.270941	-0.03863	0.137591	-0.03863	0.137
ptime86	-0.08624	0.041838	-2.0613	0.039369	-0.16828	-0.0042	-0.16828	-0.0
qemp86	-0.29591	0.048785	-6.06567	1.5E-09	-0.39157	-0.20025	-0.39157	-0.20

RESIDUAL OUTPUT

Observation	Predicted Residu	Residuals
1	1.135796	-0.90617
2	1.119042	1.022992
3	1.266557	-1.21422
4	0.396261	2.611257
5	0.833165	-0.58304
6	0.218524	-0.19823
7	1.414956	0.435944
8	1.407884	18.01692
9	1.108489	-0.8687
10	0.532004	-0.40096

Regression

Input
Input Y Range: $I$1:$I$2726
Input X Range: $C$1:$G$2726
Labels
Constant is Zero
Confidence Level: 95 %

Output options
Output Range: $T$3
New Worksheet Ply:
New Workbook

Residuals
Residuals
Residual Plots
Standardized Residuals
Line Fit Plots

Normal Probability
Normal Probability Plots

OK
Cancel
Help

Sheet2 Sheet1 Sheet1 (2)

Ready

100%

B-P Test (p) [Compatibility Mode] - Excel

7

		Formula
nR2=	38.13416095	=V10*V7
p-value=	0.0000004	=CHIDIST(Y4,5)
decision=	Reject Ho	=IF(Y5<0.05,"Reject Ho","Do not Reject Ho")

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.1183
R Square	0.01399
Adjusted R Square	0.01218
Standard Error	3.94741
Observations	2725

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	601.314	120.263	7.71804696	3.22389E-07
Residual	2719	42367.5	15.582		
Total	2724	42968.8			

	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	1.42499	0.15556	9.1607	9.87336E-20	1.119975653	1.73001	1.11998	1.73001
pcnv	-0.02281	0.1917	-0.11901	0.905278711	-0.39869957	0.35307	-0.3987	0.35307
avgsen	-0.0561	0.05824	-0.96323	0.335515859	-0.170297285	0.0581	-0.1703	0.0581
tottime	0.04948	0.04494	1.10112	0.270940929	-0.038631923	0.13759	-0.03863	0.13759
ptime86	-0.08624	0.04184	-2.0613	0.039369193	-0.168277184	-0.0042	-0.16828	-0.0042
qemp86	-0.29591	0.04879	-6.06567	1.49643E-09	-0.391573881	-0.20025	-0.39157	-0.20025

SS	*MS*	*F*	*gnificance F*
85.9532	17.1906	24.2889	5.4E-24
1924.39	0.70776		
2010.35			

andard Err	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
0.03315	21.2974	3.3E-93	0.64105	0.77107	0.64105	0.77107
0.04086	-3.70149	0.00022	-0.23133	-0.07111	-0.23133	-0.07111
0.01241	-0.56788	0.57016	-0.03139	0.01729	-0.03139	0.01729
0.00958	1.26298	0.20671	-0.00668	0.03087	-0.00668	0.03087
0.00892	-4.40286	1.1E-05	-0.05674	-0.02177	-0.05674	-0.02177
0.0104	-9.91524	8.7E-23	-0.12348	-0.0827	-0.12348	-0.0827

Sheet2 | Sheet1 | Sheet1 (2)

Testing for Heteroskedasticity Glesjer test

The Glesjer test

Variation of BP test

Let's assume that we have the following model:

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \cdots + \beta_k X_{ki} + u_i \qquad \text{(i)}$$

where $var(u_i) = \sigma_i^2$. The B-P test involves the following steps:

Step 1: Run a regression model (i) and obtain the residuals $\widehat{u_i}$.

Step 2: Run the following auxillary equation:

$$|e_i| = \alpha_1 + \alpha_2 X_{2i} + \alpha_3 X_{3i} + \cdots + \alpha_k X_{ki} + v_i \qquad \text{(ii)}$$

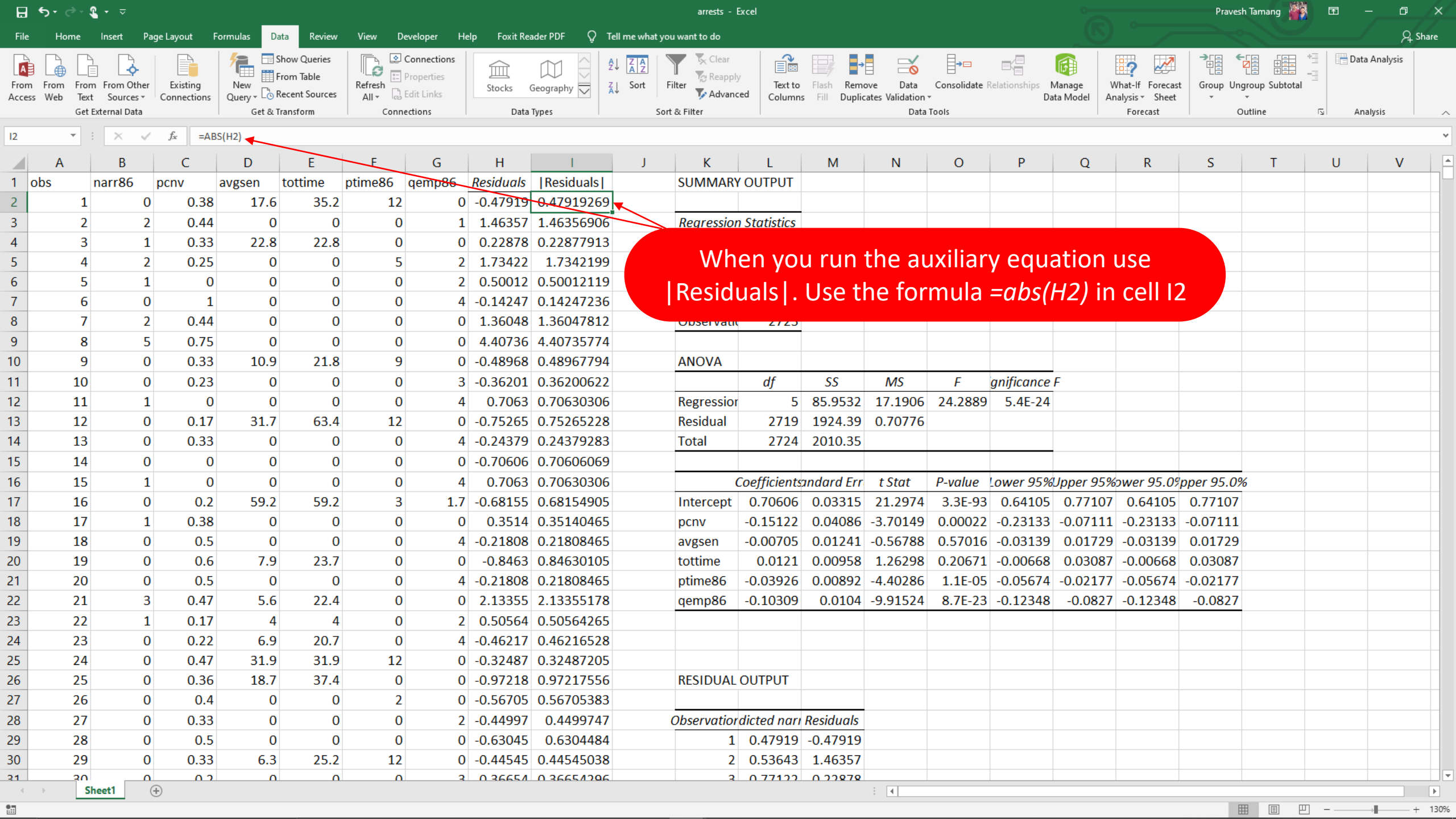
Step 3: Formulate the null and the alternative hypothesis. The null hypothesis of homoscedasticity is that:

$$H_0: \alpha_1 = \alpha_2 = \cdots = \alpha_k = 0$$

while the aletrnative hypothesis is that at least one of the $\alpha' s$ is different from zero.

Step 4: Compute $LM = nR^2$ statistic, where n is the number of observations used in order to estimate the auxillary regression in step 2. The LM statistic follows χ^2 distribution with $k - 1$ degrees of freedom.

Step 5: Reject the null and conclude that there is a significant degree of heteroscedasticity when LM statistic is greater than the critical value. Alternatively compute p-value and reject the null if the p-value is less than the level of significance α (usually α = 0.05).



	A	B	C	D	E	F	G	H	I
1	obs	narr86	pcnv	avgsen	tottime	ptime86	qemp86	*Residuals*	|Residuals|
2	1	0	0.38	17.6	35.2	12	0	-0.47919	0.47919269
3	2	2	0.44	0	0	0	1	1.46357	1.46356906
4	3	1	0.33	22.8	22.8	0	0	0.22878	0.22877913
5	4	2	0.25	0	0	5	2	1.73422	1.7342199
6	5	1	0	0	0	0	2	0.50012	0.50012119
7	6	0	1	0	0	0	4	-0.14247	0.14247236
8	7	2	0.44	0	0	0	0	1.36048	1.36047812
9	8	5	0.75	0	0	0	0	4.40736	4.40735774
10	9	0	0.33	10.9	21.8	9	0	-0.48968	0.48967794
11	10	0	0.23	0	0	0	3	-0.36201	0.36200622
12	11	1	0	0	0	0	4	0.7063	0.70630306
13	12	0	0.17	31.7	63.4	12	0	-0.75265	0.75265228
14	13	0	0.33	0	0	0	4	-0.24379	0.24379283
15	14	0	0	0	0	0	0	-0.70606	0.70606069
16	15	1	0	0	0	0	4	0.7063	0.70630306
17	16	0	0.2	59.2	59.2	3	1.7	-0.68155	0.68154905
18	17	1	0.38	0	0	0	0	0.3514	0.35140465
19	18	0	0.5	0	0	0	4	-0.21808	0.21808465
20	19	0	0.6	7.9	23.7	0	0	-0.8463	0.84630105
21	20	0	0.5	0	0	0	4	-0.21808	0.21808465
22	21	3	0.47	5.6	22.4	0	0	2.13355	2.13355178
23	22	1	0.17	4	4	0	2	0.50564	0.50564265
24	23	0	0.22	6.9	20.7	0	4	-0.46217	0.46216528
25	24	0	0.47	31.9	31.9	12	0	-0.32487	0.32487205
26	25	0	0.36	18.7	37.4	0	0	-0.97218	0.97217556
27	26	0	0.4	0	0	2	0	-0.56705	0.56705383
28	27	0	0.33	0	0	0	2	-0.44997	0.4499747
29	28	0	0.5	0	0	0	0	-0.63045	0.6304484
30	29	0	0.33	6.3	25.2	12	0	-0.44545	0.44545038
31	30	0	0.2	0	0	0	3	0.36654	0.36654296

SUMMARY OUTPUT

Regression Statistics

Observati 2725

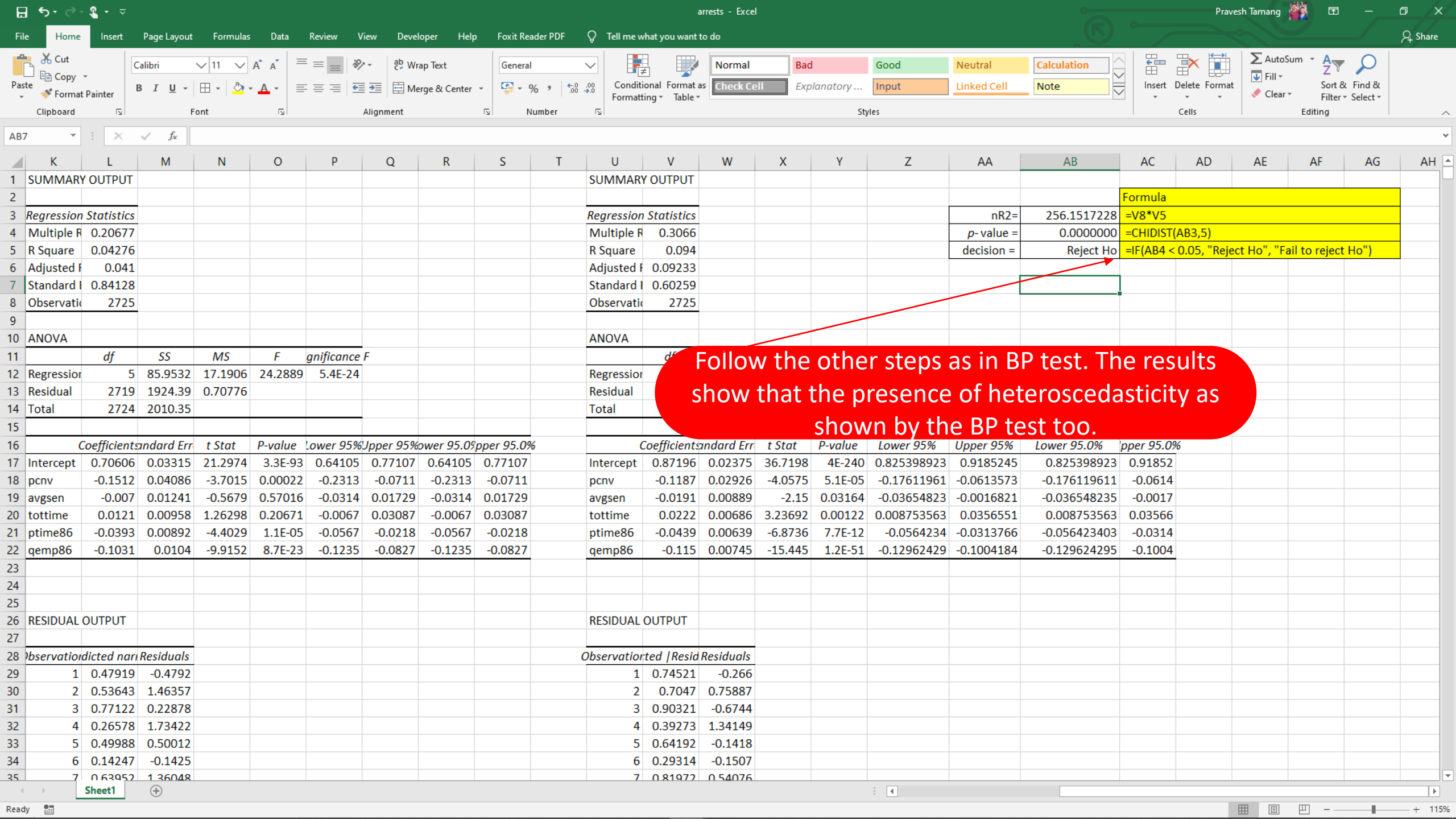
ANOVA

	df	*SS*	*MS*	*F*	*gnificance F*
Regressior	5	85.9532	17.1906	24.2889	5.4E-24
Residual	2719	1924.39	0.70776		
Total	2724	2010.35			

	Coefficients	*ndard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	0.70606	0.03315	21.2974	3.3E-93	0.64105	0.77107	0.64105	0.77107
pcnv	-0.15122	0.04086	-3.70149	0.00022	-0.23133	-0.07111	-0.23133	-0.07111
avgsen	-0.00705	0.01241	-0.56788	0.57016	-0.03139	0.01729	-0.03139	0.01729
tottime	0.0121	0.00958	1.26298	0.20671	-0.00668	0.03087	-0.00668	0.03087
ptime86	-0.03926	0.00892	-4.40286	1.1E-05	-0.05674	-0.02177	-0.05674	-0.02177
qemp86	-0.10309	0.0104	-9.91524	8.7E-23	-0.12348	-0.0827	-0.12348	-0.0827

RESIDUAL OUTPUT

Observatior	*dicted nari*	*Residuals*
1	0.47919	-0.47919
2	0.53643	1.46357
3	0.77122	0.22878


arrests - Excel
Pravesh Tamang
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Paste Cut Copy Format Painter
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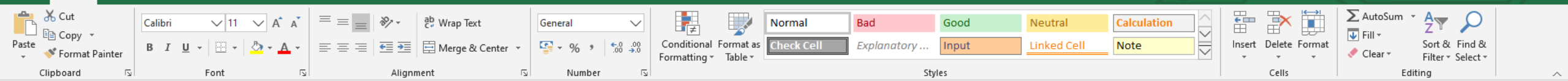
Wrap Text
General
Merge & Center
Normal Bad Good Neutral Calculation
Check Cell Explanatory ... Input Linked Cell Note
Conditional Formatting Format as Table
Insert Delete Format
AutoSum Fill Clear
Sort & Filter Find & Select
Clipboard Font Alignment Number Styles Cells Editing
AB7
SUMMARY OUTPUT
Regression Statistics
Multiple R 0.20677
R Square 0.04276
Adjusted R 0.041
Standard E 0.84128
Observatio 2725
ANOVA
df SS MS F gnificance F
Regressior 5 85.9532 17.1906 24.2889 5.4E-24
Residual 2719 1924.39 0.70776
Total 2724 2010.35
Coefficients andard Err t Stat P-value Lower 95% Upper 95% ower 95.0% pper 95.0%
Intercept 0.70606 0.03315 21.2974 3.3E-93 0.64105 0.77107 0.64105 0.77107
pcnv -0.1512 0.04086 -3.7015 0.00022 -0.2313 -0.0711 -0.2313 -0.0711
avgsen -0.007 0.01241 -0.5679 0.57016 -0.0314 0.01729 -0.0314 0.01729
tottime 0.0121 0.00958 1.26298 0.20671 -0.0067 0.03087 -0.0067 0.03087
ptime86 -0.0393 0.00892 -4.4029 1.1E-05 -0.0567 -0.0218 -0.0567 -0.0218
qemp86 -0.1031 0.0104 -9.9152 8.7E-23 -0.1235 -0.0827 -0.1235 -0.0827
RESIDUAL OUTPUT
bservatio dicted nar Residuals
1 0.47919 -0.4792
2 0.53643 1.46357
3 0.77122 0.22878
4 0.26578 1.73422
5 0.49988 0.50012
6 0.14247 -0.1425
7 0.63952 1.36048
SUMMARY OUTPUT
Regression Statistics
Multiple R 0.3066
R Square 0.094
Adjusted R 0.09233
Standard E 0.60259
Observatio 2725
ANOVA
Regressior
Residual
Total
Coefficients andard Err t Stat P-value Lower 95% Upper 95% Lower 95.0% pper 95.0%
Intercept 0.87196 0.02375 36.7198 4E-240 0.825398923 0.9185245 0.825398923 0.91852
pcnv -0.1187 0.02926 -4.0575 5.1E-05 -0.17611961 -0.0613573 -0.176119611 -0.0614
avgsen -0.0191 0.00889 -2.15 0.03164 -0.03654823 -0.0016821 -0.036548235 -0.0017
tottime 0.0222 0.00686 3.23692 0.00122 0.008753563 0.0356551 0.008753563 0.03566
ptime86 -0.0439 0.00639 -6.8736 7.7E-12 -0.0564234 -0.0313766 -0.056423403 -0.0314
qemp86 -0.115 0.00745 -15.445 1.2E-51 -0.12962429 -0.1004184 -0.129624295 -0.1004
RESIDUAL OUTPUT
Observatio ted |Resid Residuals
1 0.74521 -0.266
2 0.7047 0.75887
3 0.90321 -0.6744
4 0.39273 1.34149
5 0.64192 -0.1418
6 0.29314 -0.1507
7 0.81972 0.54076
nR2= 256.1517228 Formula
p- value = 0.0000000 =CHIDIST(AB3,5)
decision = Reject Ho =IF(AB4 < 0.05, "Reject Ho", "Fail to reject Ho")
Follow the other steps as in BP test. The results show that the presence of heteroscedasticity as shown by the BP test too.
Sheet1
Ready
115%

Testing for Heteroskedasticity Goldfeld Quandt test



C21

Goldfeld – Quandt Test

Steps:

1. Identify one variable that is closely related to the variance of the disturbance term (by inspecting the residual plots) and order the observations of this variable in descending order.
2. Split the ordered sample into equally sized sub-samples by omitting *c* central observations, so that the two sub-samples will contain $\frac{1}{2}(n-c)$ observations. The first will contain the largest values and the second will contain the lowest values.
3. Run an OLS regression of Y on the X variable that you have used in step 1 for each sub sample and obtain the RSS for each equation
4. Calculate the F-statistic as follows:

$$F = \frac{RSS_1}{RSS_2}$$

Where RSS_1 is the *RSS* with the largest value i.e. $RSS_1 > RSS_2$. The F statistic is distributed with $F_{(\frac{1}{2(n-c)}-k, \frac{1}{2(n-c)}-k)}$ degrees of freedom.

Reject the hull hypothesis of homoscedasticity if pvalue of F is less than 0.05.
To calculate pvalue use =FDIST(F, degrees of freedom1, degrees of freedom2)

BP test [Compatibility Mode] - Excel

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Sort | Filter | Clear | Reapply | Advanced — Sort & Filter

Text to Columns | Flash Fill | Remove Duplicates | Data Validation | Consolidate | Relationships | Manage Data Model — Data Tools

What-If Analysis | Forecast Sheet — Forecast

Group | Ungroup | Subtotal — Outline

Data Analysis — Analysis

AN32

obs	narr86	pcnv	avgsen	tottime	ptime86	qemp86
1	0	0.38	17.6	35.2	12	0
2	2	0.44	0	0	0	1
3	1	0.33	22.8	22.8	0	0
4	2	0.25	0	0	5	2
5	1	0	0	0	0	2
6	0	1	0	0	0	4
7	2	0.44	0	0	0	0
8	5	0.75	0	0	0	0
9	0	0.33	10.9	21.8	9	0
10	0	0.23	0	0	0	3
11	1	0	0	0	0	4
12	0	0.17	31.7	63.4	12	0
13	0	0.33	0	0	0	4
14	0	0	0	0	0	0
15	1	0	0	0	0	4
16	0	0.2	59.2	59.2	3	1.7
17	1	0.38	0	0	0	0
18	0	0.5	0	0	0	4
19	0	0.6	7.9	23.7	0	0
20	0	0.5	0	0	0	4
21	3	0.47	5.6	22.4	0	0
22	1	0.17	4	4	0	2
23	0	0.22	6.9	20.7	0	4
24	0	0.47	31.9	31.9	12	0
25	0	0.36	18.7	37.4	0	0
26	0	0.4	0	0	2	0
27	0	0.33	0	0	0	2
28	0	0.5	0	0	0	0
29	0	0.33	6.3	25.2	12	0
30	0	0.2	0	0	0	3
31	2	0	0	0	0	1
32	0	1	0	0	0	0
33	1	0.4	0	0	5	0
34	0	0.33	36.1	36.1	0	4
35	2	0.67	0	0	0	1
36	0	1	0	0	0	3
37	0	0.33	0	0	12	0
38	0	0	0	0	0	4
39	2	0	0	0	1	2
40	1	0.43	0	0	0	1
41	0	0.5	0	0	0	0
42	0	0	0	0	0	0
43	3	0.39	11.3	11.3	0	3
44	0	0.5	0	0	0	0
45	3	0.44	0	0	0	1
46	0	0	0	0	0	0
47	0	0	0	0	0	0
48	2	0	0	0	0	0
49	0	0.57	0	0	0	4
50	2	0.41	0	0	0	1
51	1	0	0	0	0	4
52	0	0.1	0	0	0	4
53	0	1	0	0	0	4
54	1	0.83	0	0	0	1
55	1	0	0	0	0	4
56	0	0.33	0	0	8	0
57	0	0	0	0	0	4

narr86 = number iof times arrested
nparr86 = number of property crimes arrested
pcnv = proportion of prior convictions
avgsen = average sentence length, months
tottime = time in prision
ptime86 = months in prision
qemp86= number of quarters emplo
inc86 = legal income, 1986

SUMMARY OUTPUT

Regression Statistics

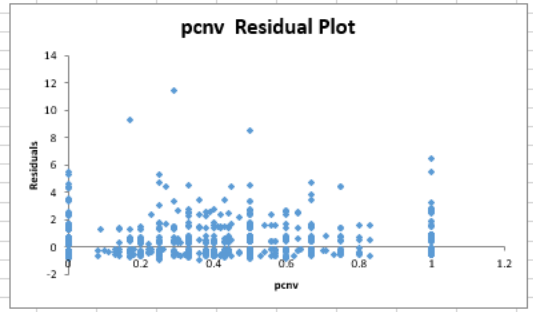
Multiple F	0.2068
R Square	0.0428

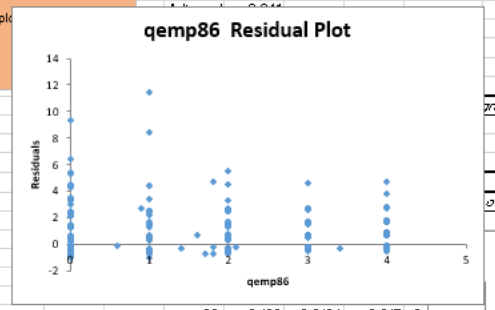
gnificance F
5E-24

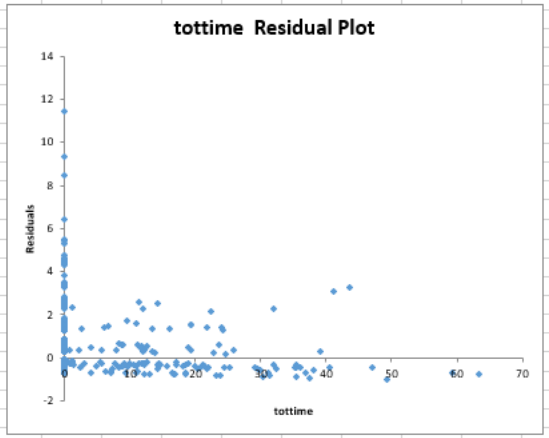
	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
	0.6411	0.7711	0.6411	0.7711
qemp86	-0.103	0.0104	-9.915	8.(

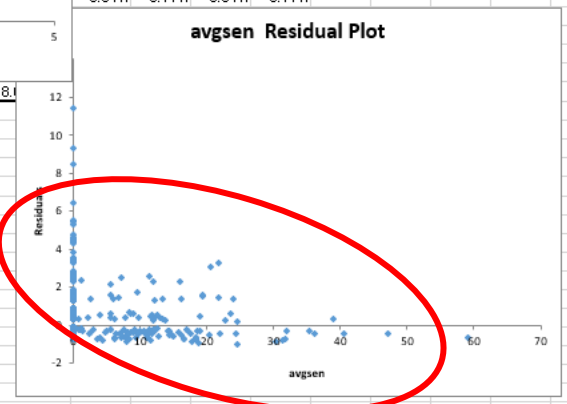
RESIDUAL OUTPUT

Observation	Predicted narr	Residuals
1	0.4792	-0.479
2	0.5364	1.4636
3	0.7712	0.2288
4	0.2658	1.7342
5	0.4999	0.5001
6	0.1425	-0.142
7	0.6395	1.3605
8	0.5926	4.4074
9	0.4897	-0.49
10	0.362	-0.362
11	0.2937	0.7063
12	0.7527	-0.753
13	0.2438	-0.244
14	0.7061	-0.706
15	0.2937	0.7063
16	0.6815	-0.682
17	0.6486	0.3514
18	0.2181	-0.218
19	0.8463	-0.846
20	0.2181	-0.218
21	0.8664	2.1336
22	0.4944	0.5056
23	0.4622	-0.462
24	0.3249	-0.325
25	0.9722	-0.972
26	0.5671	-0.567
27	0.45	-0.45









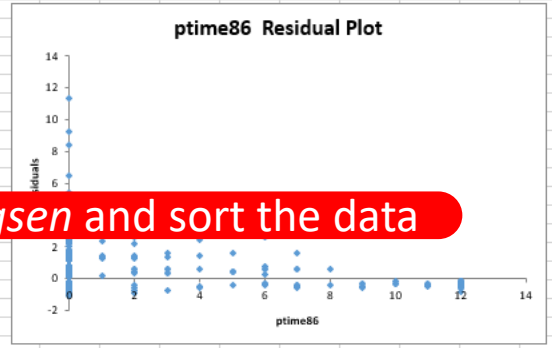


Chart Area

1 Let us consider *avgsen* and sort the data

Sheet1

Ready

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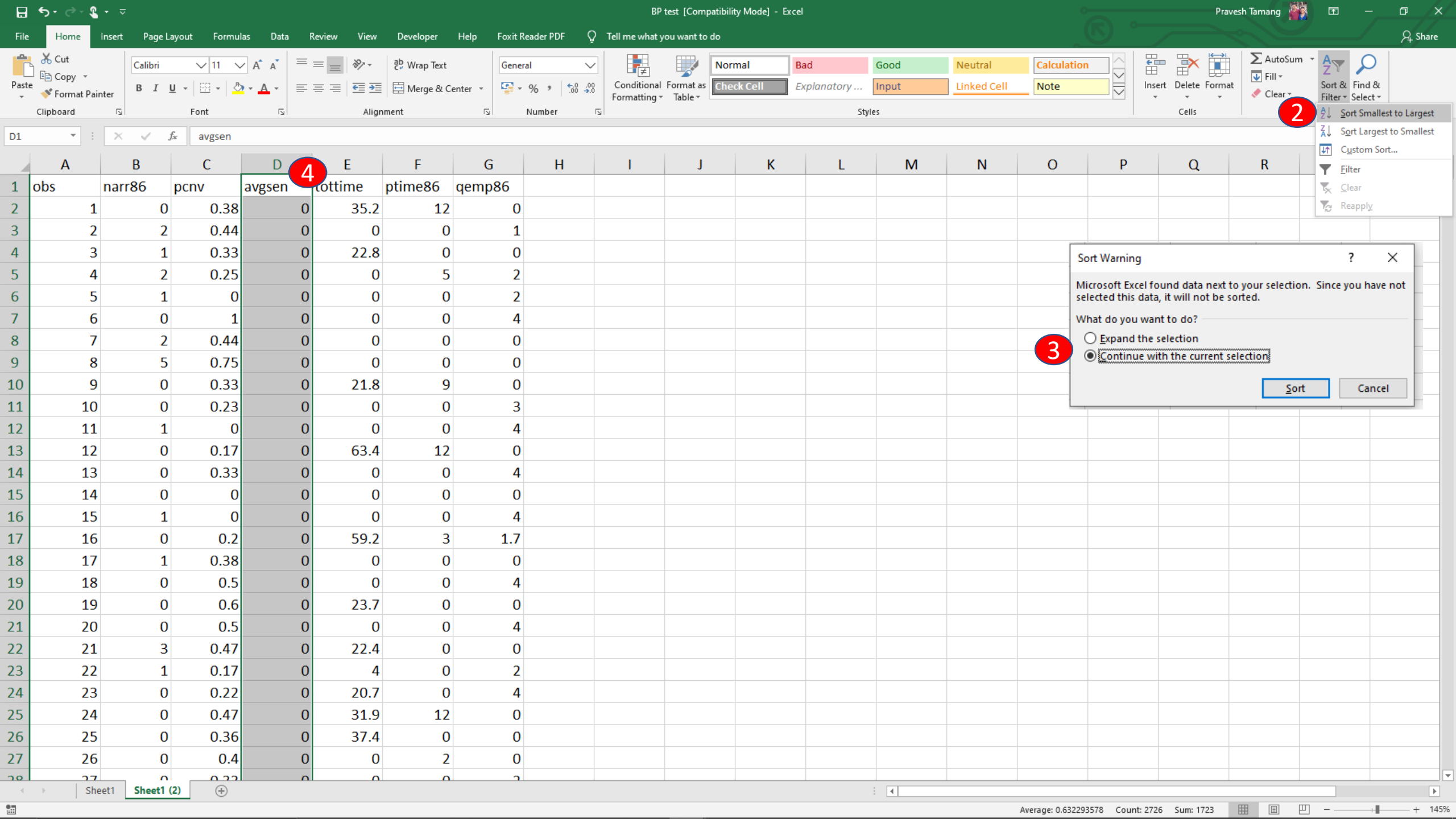
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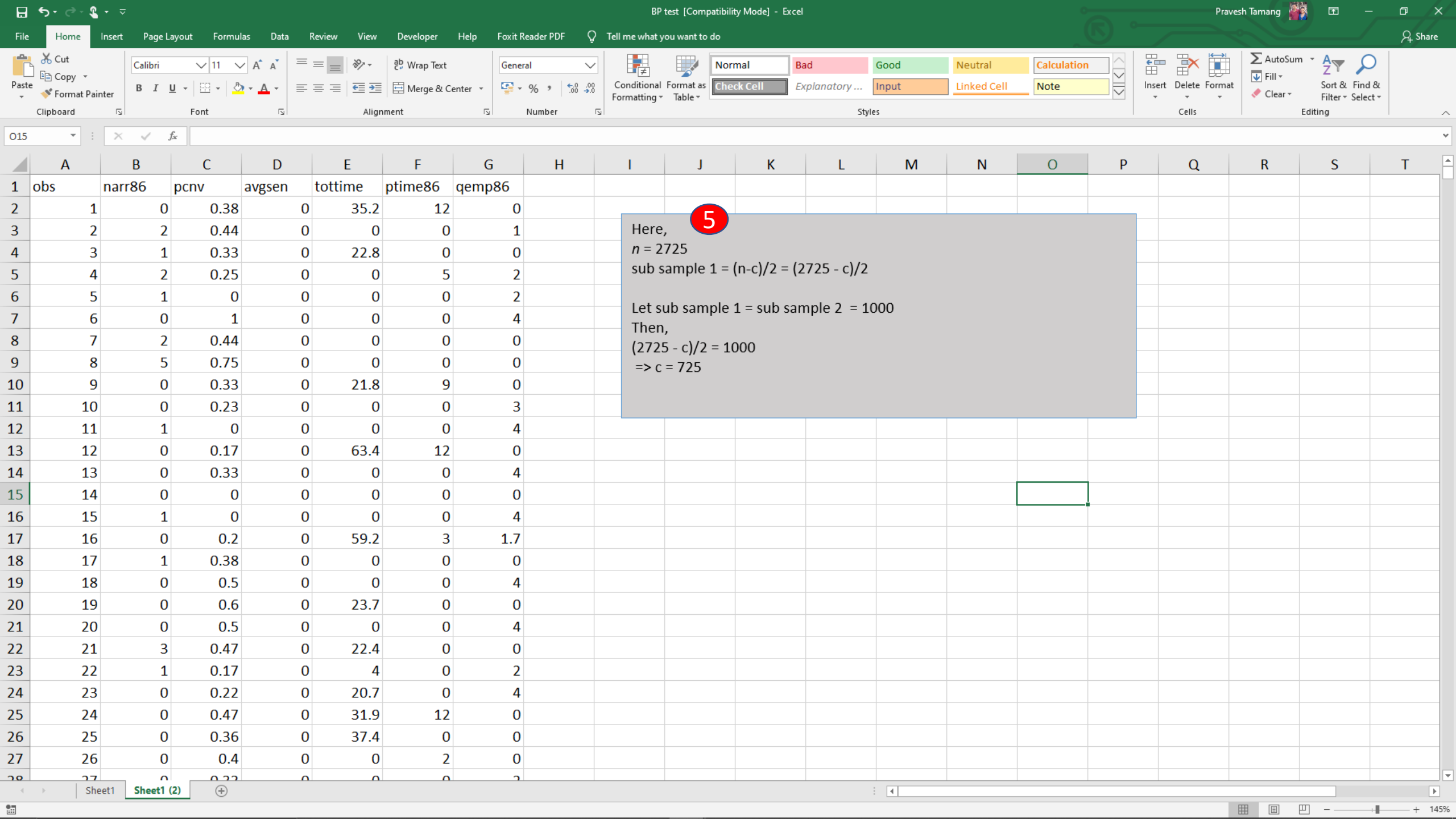
Insert Delete Format Cells
AutoSum Fill Clear
Sort & Filter Find & Select
2
Sort Smallest to Largest
Sort Largest to Smallest
Custom Sort...
Filter
Clear
Reapply
D1
avgsen
4
obs narr86 pcnv avgsen tottime ptime86 qemp86
1 0 0.38 0 35.2 12 0
2 2 0.44 0 0 0 1
3 1 0.33 0 22.8 0 0
4 2 0.25 0 0 5 2
5 1 0 0 0 0 2
6 0 1 0 0 0 4
7 2 0.44 0 0 0 0
8 5 0.75 0 0 0 0
9 0 0.33 0 21.8 9 0
10 0 0.23 0 0 0 3
11 1 0 0 0 0 4
12 0 0.17 0 63.4 12 0
13 0 0.33 0 0 0 4
14 0 0 0 0 0 0
15 1 0 0 0 0 4
16 0 0.2 0 59.2 3 1.7
17 1 0.38 0 0 0 0
18 0 0.5 0 0 0 4
19 0 0.6 0 23.7 0 0
20 0 0.5 0 0 0 4
21 3 0.47 0 22.4 0 0
22 1 0.17 0 4 0 2
23 0 0.22 0 20.7 0 4
24 0 0.47 0 31.9 12 0
25 0 0.36 0 37.4 0 0
26 0 0.4 0 0 2 0
Sort Warning
Microsoft Excel found data next to your selection. Since you have not selected this data, it will not be sorted.
What do you want to do?
3
Expand the selection
Continue with the current selection
Sort
Cancel
Sheet1 Sheet1 (2)
Average: 0.632293578 Count: 2726 Sum: 1723
145%



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General Number

Conditional Formatting Format as Table

Normal Bad Good Neutral Calculation Check Cell Explanatory ... Input Linked Cell Note Styles

Insert Delete Format Cells

AutoSum Fill Clear Sort & Filter Find & Select Editing

O15

	A	B	C	D	E	F	G
1	obs	narr86	pcnv	avgsen	tottime	ptime86	qemp86
2	1	0	0.38	0	35.2	12	0
3	2	2	0.44	0	0	0	1
4	3	1	0.33	0	22.8	0	0
5	4	2	0.25	0	0	5	2
6	5	1	0	0	0	0	2
7	6	0	1	0	0	0	4
8	7	2	0.44	0	0	0	0
9	8	5	0.75	0	0	0	0
10	9	0	0.33	0	21.8	9	0
11	10	0	0.23	0	0	0	3
12	11	1	0	0	0	0	4
13	12	0	0.17	0	63.4	12	0
14	13	0	0.33	0	0	0	4
15	14	0	0	0	0	0	0
16	15	1	0	0	0	0	4
17	16	0	0.2	0	59.2	3	1.7
18	17	1	0.38	0	0	0	0
19	18	0	0.5	0	0	0	4
20	19	0	0.6	0	23.7	0	0
21	20	0	0.5	0	0	0	4
22	21	3	0.47	0	22.4	0	0
23	22	1	0.17	0	4	0	2
24	23	0	0.22	0	20.7	0	4
25	24	0	0.47	0	31.9	12	0
26	25	0	0.36	0	37.4	0	0
27	26	0	0.4	0	0	2	0

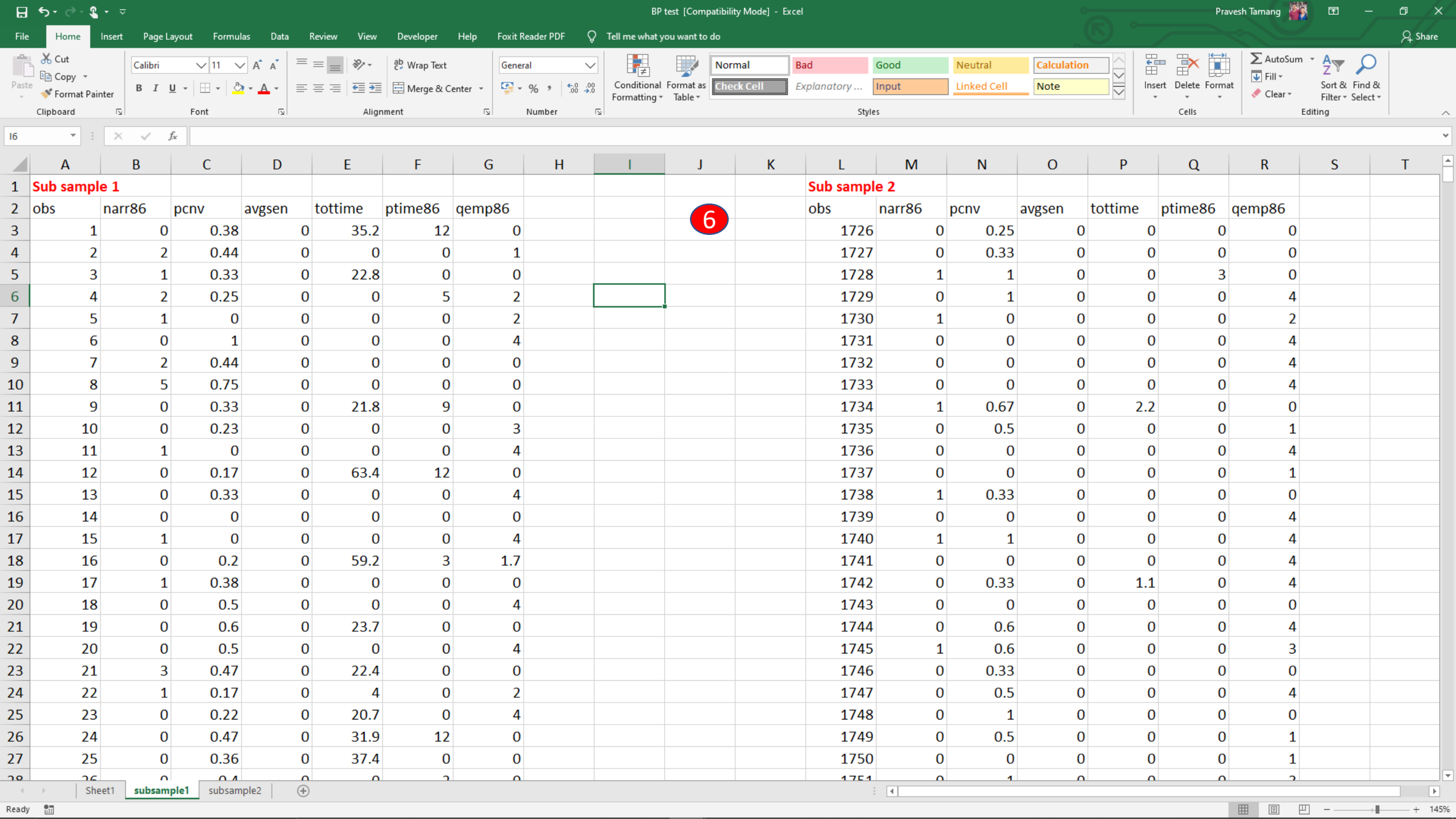
5

Here,
n = 2725
sub sample 1 = (n-c)/2 = (2725 - c)/2

Let sub sample 1 = sub sample 2 = 1000
Then,
(2725 - c)/2 = 1000
=> c = 725

Sheet1 Sheet1 (2)

145%



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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Sub sample 1											Sub sample 2								
2	obs	narr86	pcnv	avgsen	tottime	ptime86	qemp86					obs	narr86	pcnv	avgsen	tottime	ptime86	qemp86		
3	1	0	0.38	0	35.2	12	0					1726	0	0.25	0	0	0	0		
4	2	2	0.44	0	0	0	1					1727	0	0.33	0	0	0	0		
5	3	1	0.33	0	22.8	0	0					1728	1	1	0	0	3	0		
6	4	2	0.25	0	0	5	2					1729	0	1	0	0	0	4		
7	5	1	0	0	0	0	2					1730	1	0	0	0	0	2		
8	6	0	1	0	0	0	4					1731	0	0	0	0	0	4		
9	7	2	0.44	0	0	0	0					1732	0	0	0	0	0	4		
10	8	5	0.75	0	0	0	0					1733	0	0	0	0	0	4		
11	9	0	0.33	0	21.8	9	0					1734	1	0.67	0	2.2	0	0		
12	10	0	0.23	0	0	0	3					1735	0	0.5	0	0	0	1		
13	11	1	0	0	0	0	4					1736	0	0	0	0	0	4		
14	12	0	0.17	0	63.4	12	0					1737	0	0	0	0	0	1		
15	13	0	0.33	0	0	0	4					1738	1	0.33	0	0	0	0		
16	14	0	0	0	0	0	0					1739	0	0	0	0	0	4		
17	15	1	0	0	0	0	4					1740	1	1	0	0	0	4		
18	16	0	0.2	0	59.2	3	1.7					1741	0	0	0	0	0	4		
19	17	1	0.38	0	0	0	0					1742	0	0.33	0	1.1	0	4		
20	18	0	0.5	0	0	0	4					1743	0	0	0	0	0	0		
21	19	0	0.6	0	23.7	0	0					1744	0	0.6	0	0	0	4		
22	20	0	0.5	0	0	0	4					1745	1	0.6	0	0	0	3		
23	21	3	0.47	0	22.4	0	0					1746	0	0.33	0	0	0	0		
24	22	1	0.17	0	4	0	2					1747	0	0.5	0	0	0	4		
25	23	0	0.22	0	20.7	0	4					1748	0	1	0	0	0	0		
26	24	0	0.47	0	31.9	12	0					1749	0	0.5	0	0	0	1		
27	25	0	0.36	0	37.4	0	0					1750	0	0	0	0	0	1		

Sheet1 subsample1 subsample2

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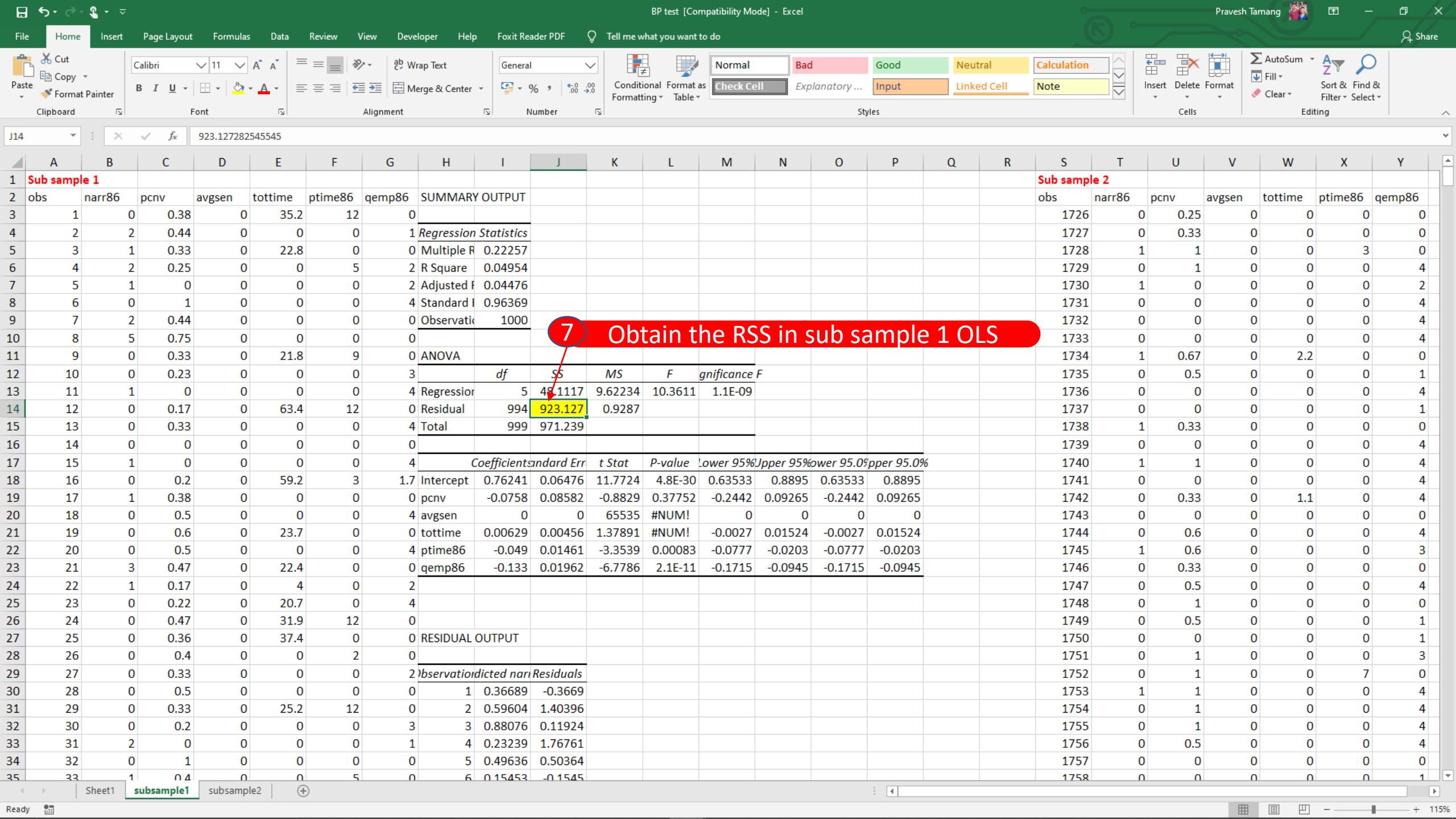
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J14 923.127282545545
7 Obtain the RSS in sub sample 1 OLS
Sub sample 1
obs narr86 pcnv avgsen tottime ptime86 qemp86
SUMMARY OUTPUT
Regression Statistics
Multiple R 0.22257
R Square 0.04954
Adjusted R 0.04476
Standard E 0.96369
Observatio 1000
ANOVA
df SS MS F gnificance F
Regressior 5 48.1117 9.62234 10.3611 1.1E-09
Residual 994 923.127 0.9287
Total 999 971.239
Coefficients tandard Err t Stat P-value Lower 95% Upper 95% ower 95.0% pper 95.0%
Intercept 0.76241 0.06476 11.7724 4.8E-30 0.63533 0.8895 0.63533 0.8895
pcnv -0.0758 0.08582 -0.8829 0.37752 -0.2442 0.09265 -0.2442 0.09265
avgsen 0 0 65535 #NUM! 0 0 0 0
tottime 0.00629 0.00456 1.37891 #NUM! -0.0027 0.01524 -0.0027 0.01524
ptime86 -0.049 0.01461 -3.3539 0.00083 -0.0777 -0.0203 -0.0777 -0.0203
qemp86 -0.133 0.01962 -6.7786 2.1E-11 -0.1715 -0.0945 -0.1715 -0.0945
RESIDUAL OUTPUT
Observatio dicted nar Residuals
1 0.36689 -0.3669
2 0.59604 1.40396
3 0.88076 0.11924
4 0.23239 1.76761
5 0.49636 0.50364
6 0.15453 -0.1545
Sub sample 2
obs narr86 pcnv avgsen tottime ptime86 qemp86
Sheet1 subsample1 subsample2
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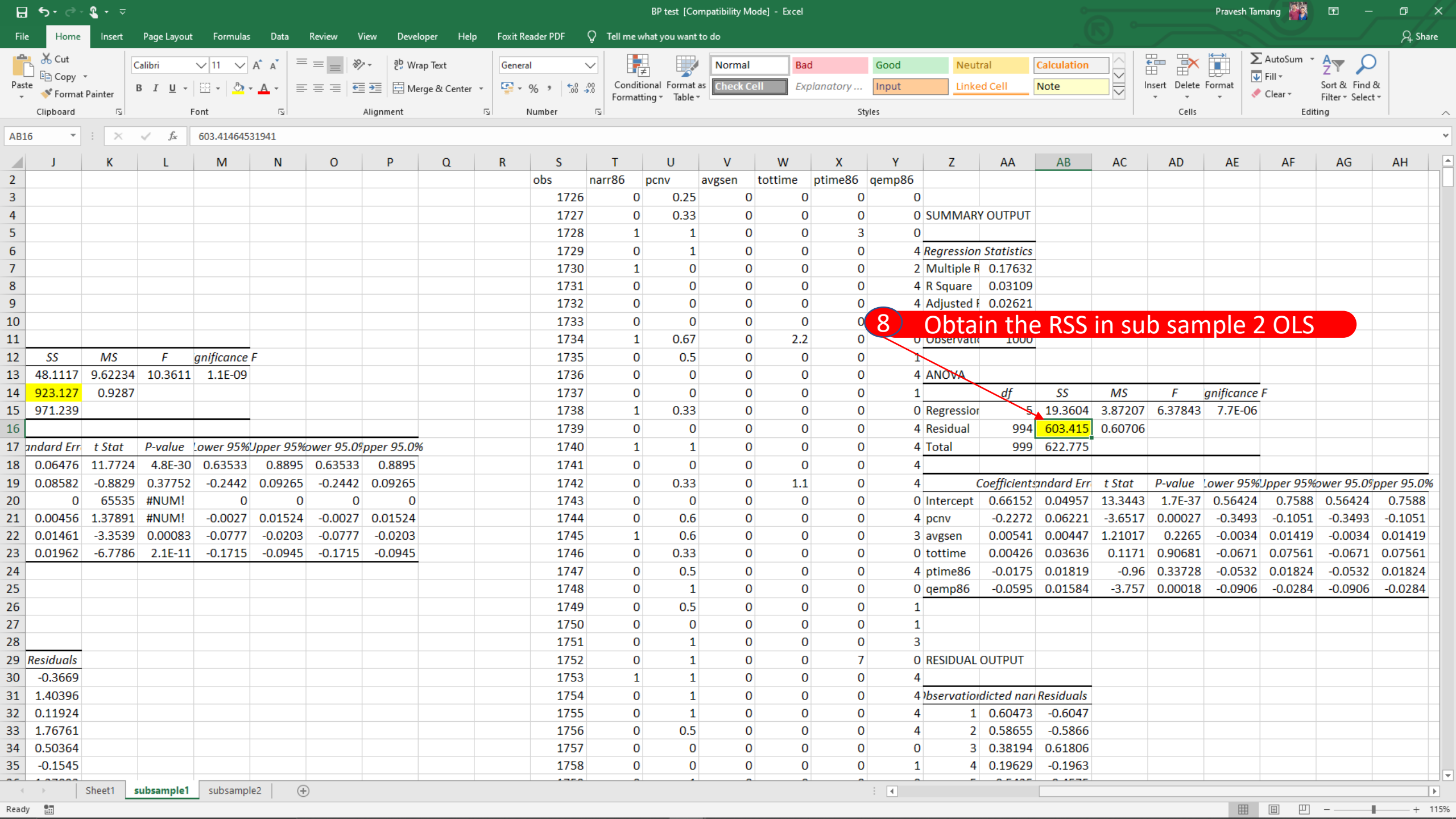

	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
2										obs	narr86	pcnv	avgsen	tottime	ptime86	qemp86									
3										1726	0	0.25	0	0	0	0									
4										1727	0	0.33	0	0	0	0	SUMMARY OUTPUT								
5										1728	1	1	0	0	3	0									
6										1729	0	1	0	0	0	4	*Regression Statistics*								
7										1730	1	0	0	0	0	2	Multiple R	0.17632							
8										1731	0	0	0	0	0	4	R Square	0.03109							
9										1732	0	0	0	0	0	4	Adjusted F	0.02621							
10										1733	0	0	0	0	0	0									
11										1734	1	0.67	0	2.2	0	0	Observati	1000							
12	*SS*	*MS*	*F*	*gnificance F*						1735	0	0.5	0	0	0	1									
13	48.1117	9.62234	10.3611	1.1E-09						1736	0	0	0	0	0	4	ANOVA								
14	923.127	0.9287								1737	0	0	0	0	0	1		*df*	*SS*	*MS*	*F*	*gnificance F*			
15	971.239									1738	1	0.33	0	0	0	0	Regressior	5	19.3604	3.87207	6.37843	7.7E-06			
16										1739	0	0	0	0	0	4	Residual	994	603.415	0.60706					
17	*ndard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*			1740	1	1	0	0	0	4	Total	999	622.775						
18	0.06476	11.7724	4.8E-30	0.63533	0.8895	0.63533	0.8895			1741	0	0	0	0	0	4									
19	0.08582	-0.8829	0.37752	-0.2442	0.09265	-0.2442	0.09265			1742	0	0.33	0	1.1	0	4		*Coefficients*	*ndard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
20	0	65535	#NUM!	0	0	0	0			1743	0	0	0	0	0	0	Intercept	0.66152	0.04957	13.3443	1.7E-37	0.56424	0.7588	0.56424	0.7588
21	0.00456	1.37891	#NUM!	-0.0027	0.01524	-0.0027	0.01524			1744	0	0.6	0	0	0	4	pcnv	-0.2272	0.06221	-3.6517	0.00027	-0.3493	-0.1051	-0.3493	-0.1051
22	0.01461	-3.3539	0.00083	-0.0777	-0.0203	-0.0777	-0.0203			1745	1	0.6	0	0	0	3	avgsen	0.00541	0.00447	1.21017	0.2265	-0.0034	0.01419	-0.0034	0.01419
23	0.01962	-6.7786	2.1E-11	-0.1715	-0.0945	-0.1715	-0.0945			1746	0	0.33	0	0	0	0	tottime	0.00426	0.03636	0.1171	0.90681	-0.0671	0.07561	-0.0671	0.07561
24										1747	0	0.5	0	0	0	4	ptime86	-0.0175	0.01819	-0.96	0.33728	-0.0532	0.01824	-0.0532	0.01824
25										1748	0	1	0	0	0	0	qemp86	-0.0595	0.01584	-3.757	0.00018	-0.0906	-0.0284	-0.0906	-0.0284
26										1749	0	0.5	0	0	0	1									
27										1750	0	0	0	0	0	1									
28										1751	0	1	0	0	0	3									
29	*Residuals*									1752	0	1	0	0	7	0	RESIDUAL OUTPUT								
30	-0.3669									1753	1	1	0	0	0	4									
31	1.40396									1754	0	1	0	0	0	4	*)bservatio*	*dicted nar*	*Residuals*						
32	0.11924									1755	0	1	0	0	0	4	1	0.60473	-0.6047						
33	1.76761									1756	0	0.5	0	0	0	4	2	0.58655	-0.5866						
34	0.50364									1757	0	0	0	0	0	0	3	0.38194	0.61806						
35	-0.1545									1758	0	0	0	0	0	1	4	0.19629	-0.1963						

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	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW
1											9	1	Goldfeld Quand test for Equal Variance									
2												2	Input Data									
3		SUMMARY OUTPUT										3	N1=	1000	= no of observationas in sub sample 1							
4												4	N2=	1000	= no of observations in sub sample 2							
5		*Regression Statistics*										5	K=	6	= no of parameters in the model							
6		Multiple R	0.17632									6	RSS1=	923.0823095	=K14							
7		R Square	0.03109									7	RSS2=	603.4146453	=AE15							
8		Adjusted F	0.02621									8	Alpha =	0.05								
9		Standard I	0.77914									9	Computed values									
10		Observatic	1000									10	df-numerator =	994	=AO3-AO5							
11												11	df-denominator =	994	=AO4-AO5							
12		ANOVA										12	GD(F) =	1.52976451	=AO6/AO7							
13			*df*	*SS*	*MS*	*F*	*gnificance F*					13	F-critical value =	1.110036731	=FINV(AO8,AO10,AO11)							
14		Regressior	5	19.3604	3.87207	6.37843	7.7E-06					14	Decision	Reject Ho of Homoscedasticity	=IF(AO12 >AO15, "Reject Ho of Homoscedasticity", "Fail to Reject Ho")							
15		Residual	994	603.415	0.60706							15	p-value =	0.00000000	=FDIST(AO12,AO10,AO11)							
16		Total	999	622.775																		
17																						
18			*Coefficients*	*ndard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*												
19		Intercept	0.66152	0.04957	13.3443	1.7E-37	0.56424	0.7588	0.56424	0.7588												
20		pcnv	-0.2272	0.06221	-3.6517	0.00027	-0.3493	-0.1051	-0.3493	-0.1051												
21		avgsen	0.00541	0.00447	1.21017	0.2265	-0.0034	0.01419	-0.0034	0.01419												
22		tottime	0.00426	0.03636	0.1171	0.90681	-0.0671	0.07561	-0.0671	0.07561												
23		ptime86	-0.0175	0.01819	-0.96	0.33728	-0.0532	0.01824	-0.0532	0.01824												
24		qemp86	-0.0595	0.01584	-3.757	0.00018	-0.0906	-0.0284	-0.0906	-0.0284												
25																						
26																						
27																						
28																						
29																						
30																						
31																						
32																						
33																						
34																						

Sheet1 Sheet2

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Testing for Heteroskedasticity White test

	A	B	C	D
1	obs	exphlth	income	seniors
2	WY	0.998	9.3	10.9
3	VT	1.499	11.2	12
4	DC	4.285	17.1	13.3
5	AK	1.573	13.8	4.4
6	ND	2.021	10.9	14.8
7	DE	2.26	15.3	12.4
8	SD	1.953	12.8	14.7
9	MT	2.103	14.6	13.4
10	RI	3.428	21.2	15.5
11	ID	2.277	19.3	11.8
12	NH	3.452	25.1	11.9
13	HI	3.485	27.4	11.7
14	ME	3.433	23.3	13.7
15	NV	3.747	31.6	11.1
16	NE	4.4	31.7	14.2
17	NM	3.878	26.4	11
18	WV	5.197	29.4	15.3
19	UT	4.118	30	8.9
20	AR	6.111	38.8	15
21	KS	6.903	50.3	13.9
22	MS	6.187	38.9	12.5
23	IA	7.341	51.6	15.5
24	OR	7.999	59	13.8
25	OK	8.041	55	13.6

The White's test

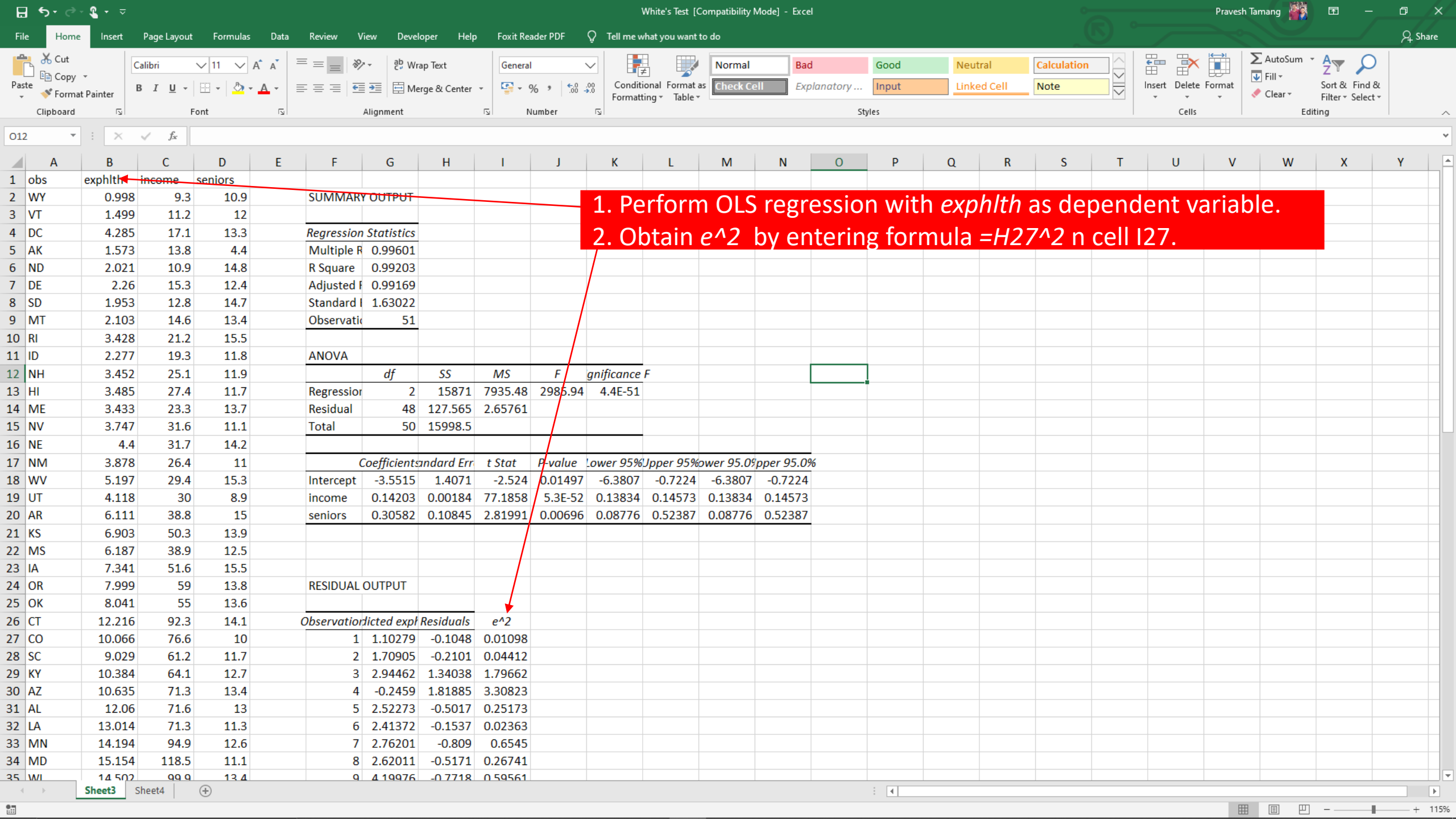
$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + u_i$$

Step 1: Run a regression model (i) and obtain the residuals $\widehat{u_i}$.

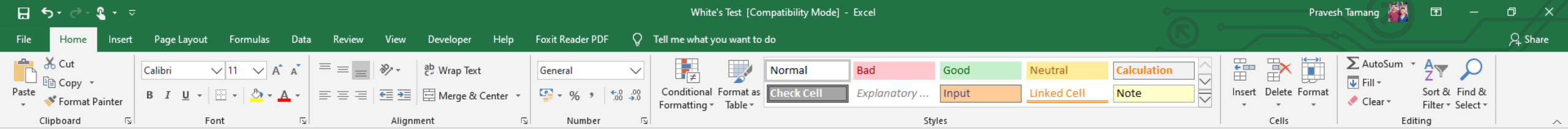
Step 2: Regress the squared residuals $\widehat{u_i}^2$ against a constant, $X_1, X_2, X_3,$, $X_1^2, X_2^2, X_3^2, X_1 X_2, X_1 X_3$ and $X_2 X_3,$

Step 3: Compute $LM = nR^2$ statistic, where n is the number of observations used in order to estimate the auxillary regression in step 2. The LM statistic follows χ^2distribution with $k - 1$ degrees of freedom, where k is the number of independent variables used in step 2.

Step 4: Reject the null and conclude that there is a significant degree of heteroscedasticity when LM statistic is greater than the critical value. Alternatively compute p-value and reject the null if the p-value is less than the level of significance α (usually α = 0.05).



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	obs	exphlth	income	seniors																					
2	WY	0.998	9.3	10.9		SUMMARY OUTPUT																			
3	VT	1.499	11.2	12																					
4	DC	4.285	17.1	13.3		*Regression Statistics*																			
5	AK	1.573	13.8	4.4		Multiple R	0.99601																		
6	ND	2.021	10.9	14.8		R Square	0.99203																		
7	DE	2.26	15.3	12.4		Adjusted F	0.99169																		
8	SD	1.953	12.8	14.7		Standard I	1.63022																		
9	MT	2.103	14.6	13.4		Observati	51																		
10	RI	3.428	21.2	15.5																					
11	ID	2.277	19.3	11.8		ANOVA																			
12	NH	3.452	25.1	11.9			*df*	*SS*	*MS*	*F*	*gnificance F*														
13	HI	3.485	27.4	11.7		Regressior	2	15871	7935.48	2986.94	4.4E-51														
14	ME	3.433	23.3	13.7		Residual	48	127.565	2.65761																
15	NV	3.747	31.6	11.1		Total	50	15998.5																	
16	NE	4.4	31.7	14.2																					
17	NM	3.878	26.4	11			*Coefficients*	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*											
18	WV	5.197	29.4	15.3		Intercept	-3.5515	1.4071	-2.524	0.01497	-6.3807	-0.7224	-6.3807	-0.7224											
19	UT	4.118	30	8.9		income	0.14203	0.00184	77.1858	5.3E-52	0.13834	0.14573	0.13834	0.14573											
20	AR	6.111	38.8	15		seniors	0.30582	0.10845	2.81991	0.00696	0.08776	0.52387	0.08776	0.52387											
21	KS	6.903	50.3	13.9																					
22	MS	6.187	38.9	12.5																					
23	IA	7.341	51.6	15.5																					
24	OR	7.999	59	13.8		RESIDUAL OUTPUT																			
25	OK	8.041	55	13.6																					
26	CT	12.216	92.3	14.1		*Observatior*	*dicted expl*	*Residuals*	*e^2*																
27	CO	10.066	76.6	10		1	1.10279	-0.1048	0.01098																
28	SC	9.029	61.2	11.7		2	1.70905	-0.2101	0.04412																
29	KY	10.384	64.1	12.7		3	2.94462	1.34038	1.79662																
30	AZ	10.635	71.3	13.4		4	-0.2459	1.81885	3.30823																
31	AL	12.06	71.6	13		5	2.52273	-0.5017	0.25173																
32	LA	13.014	71.3	11.3		6	2.41372	-0.1537	0.02363																
33	MN	14.194	94.9	12.6		7	2.76201	-0.809	0.6545																
34	MD	15.154	118.5	11.1		8	2.62011	-0.5171	0.26741																
35	WI	14.502	99.9	13.4		9	4.19976	-0.7718	0.59561																



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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	e^2	income	seniors	income^2	seniors^2	income*seniors																		
2	0.01098	9.3	10.9	86.49	118.81	101.37																		
3	0.04412	11.2	12	125.44	144	134.4			SUMMARY OUTPUT															
4	1.79662	17.1	13.3	292.41	176.89	227.43																		
5	3.30823	13.8	4.4	190.44	19.36	60.72			*Regression Statistics*															
6	0.25173	10.9	14.8	118.81	219.04	161.32			Multiple R	0.60476														
7	0.02363	15.3	12.4	234.09	153.76	189.72			R Square	0.36573														
8	0.6545	12.8	14.7	163.84	216.09	188.16			Adjusted F	0.29526														
9	0.26741	14.6	13.4	213.16	179.56	195.64			Standard I	3.66691														
10	0.59561	21.2	15.5	449.44	240.25	328.6			Observati	51														
11	0.27183	19.3	11.8	372.49	139.24	227.74																		
12	0.0403	25.1	11.9	630.01	141.61	298.69			ANOVA															
13	0.18773	27.4	11.7	750.76	136.89	320.58				*df*	*SS*	*MS*	*F*	*gnificance F*										
14	0.26478	23.3	13.7	542.89	187.69	319.21			Regressior	5	348.905	69.7809	5.18962	0.00076										
15	0.34144	31.6	11.1	998.56	123.21	350.76			Residual	45	605.082	13.4463												
16	0.79846	31.7	14.2	1004.89	201.64	450.14			Total	50	953.986													
17	0.09975	26.4	11	696.96	121	290.4													nR2=	18.2867	=J16*J7			
18	0.0113	29.4	15.3	864.36	234.09	449.82				*Coefficients*	*ndard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*		*p-value=*	0.00261	=CHIDIST(T17,5)			
19	0.47158	30	8.9	900	79.21	267			Intercept	1.88728	8.11696	0.23251	0.8172	-14.461	18.2357	-14.461	18.2357		decision=	Reject Ho	=IF(T18<0.05,"Reject Ho","Do not Reject Ho")		
20	0.1898	38.8	15	1505.44	225	582			income	-0.007	0.04477	-0.1572	0.87576	-0.0972	0.08314	-0.0972	0.08314						
21	0.88486	50.3	13.9	2530.09	193.21	699.17			seniors	-0.0655	1.50214	-0.0436	0.96543	-3.0909	2.96	-3.0909	2.96						
22	0.15262	38.9	12.5	1513.21	156.25	486.25			income^2	-3E-05	2.4E-05	-1.2984	0.20075	-8E-05	1.7E-05	-8E-05	1.7E-05						
23	1.38444	51.6	15.5	2662.56	240.25	799.8			seniors^2	-0.0092	0.0698	-0.1317	0.8958	-0.1498	0.13139	-0.1498	0.13139						
24	1.10207	59	13.8	3481	190.44	814.2			income*se	0.00338	0.00298	1.13706	0.26153	-0.0026	0.00938	-0.0026	0.00938						
25	0.14325	55	13.6	3025	184.96	748																		
26	2.73671	92.3	14.1	8519.29	198.81	1301.43																		
27	0.10273	76.6	10	5867.56	100	766																		
28	0.09606	61.2	11.7	3745.44	136.89	716.04			RESIDUAL OUTPUT															
29	0.89724	64.1	12.7	4108.81	161.29	814.07																		
30	0.00148	71.3	13.4	5083.69	179.56	955.42			*Observatior*	*redicted e^*	*Residuals*													
31	2.1498	71.6	13	5126.56	169	930.8			1	0.35635	-0.3454													
32	8.8966	71.3	11.3	5083.69	127.69	805.69			2	0.14994	-0.1058													
33	0.17068	94.9	12.6	9006.01	158.76	1195.74			3	0.03056	1.76606													
34	2.31092	118.5	11.1	14042.3	123.21	1315.35			4	1.52368	1.78455													
35	0.05461	99.9	13.4	9980.01	179.56	1338.66			5	-0.6298	0.88156													