Planned Resource Optimization Model with Experimental Design
(PROM-WED)

USER MANUAL

Table of Contents

NOTICE:

The user is cautioned that PROM-WED has not undergone formal verification and validation testing, and comes without any warranty. Informal testing confirms the outputs from PROM-WED match the output from the legacy PRO model.

I. WHAT IS PROMWED

PROM-WED embeds the legacy PRO model within a data farming environment. The foundation of PROM-WED's data farming wrapper is the nearly orthogonal Latin hypercube (NOLH). The NOLH design of experiment (DOE) builds experimental designs that efficiently and effectively explore the solution space. This good space-filling capability means that uncertainties and fluctuations in input variables along with multivariable interactions are adequately investigated.

The 33 and 129 point NOLH designs makeup PROM-WED's data farming wrapper. The 33-point NOLH DOE tests each variable at 33 levels and grows data for 33 legacy PRO model runs, whereas the 129-point NOLH DOE tests each variable at 129 levels and grows data for 129 legacy PRO model runs. PROM-WED's graphical user interface (GUI) allows users to easily enter a range of values for each input variable into the NOLH DOE worksheet, regardless of their level of knowledge or familiarity with data farming or DOE techniques.

A completed PROM-WED excursion grows a data set of either 33 or 129 data points. Automatically generated sensitivity analysis provides users with a basic risk assessment picture focused on the decision variables. Further insights into variable interactions and effects of input variables can be easily explored using commercial statistics software package. PROM-WED transforms the legacy PRO model into a resource that N1 can use to gain robust insights into the optimal allocation of recruiting resources.

II. OUTPUT OPTIONS

PROM-WED provides users with decision support capabilities to analyze the data grown by each excursion. PROM-WED offers two decision support capabilities: (A) automatically generated analysis, and (B) data generated for further analysis requiring a statistical software package.

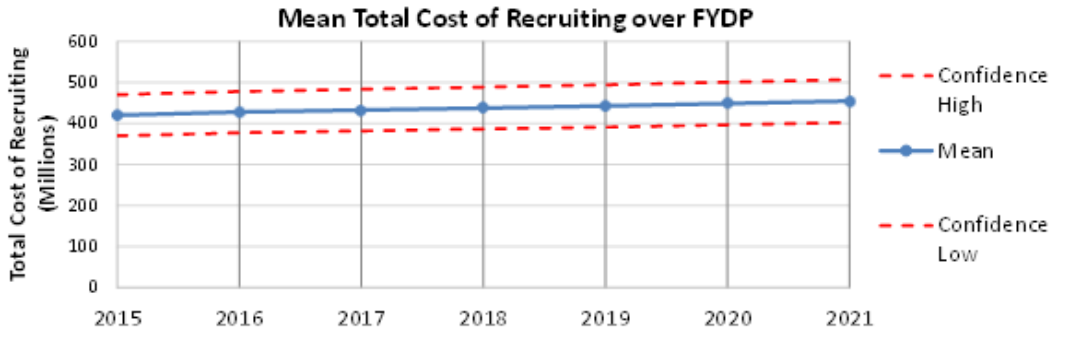
A. Automatically Generated Analysis

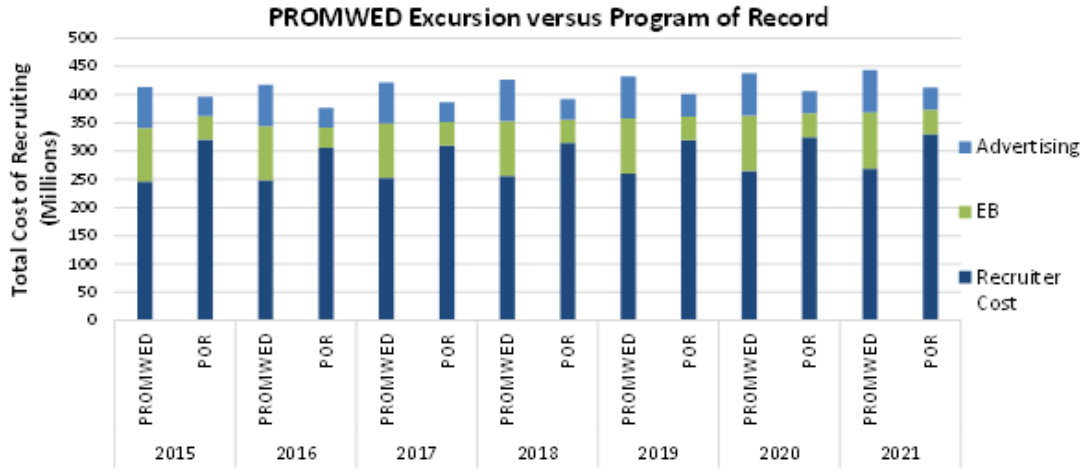
PROM-WED's "Decision Support Analysis" for the traditional run option provides users with a broad understanding of how variability in decision variables, controllable policy changes, and uncontrollable market factors affect the total cost of recruiting. This type of analysis would be appropriate for testing excursions during a time constrained meeting, working group, or whenever basic analysis needs to be generated quickly.

An example of PROM-WED's automatically generated analysis follows.

PROM-WED
Decision Support Analysis

Traditional Run: 33 Design Points





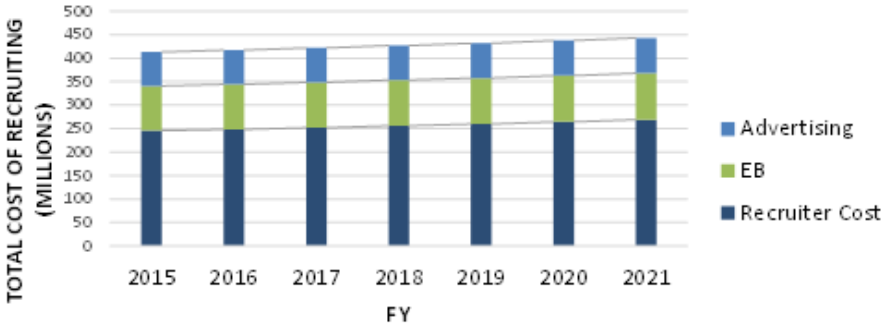
Scenario

		2015	2016	2017	2018	2019	2020	2021
NCO	high	40000	40000	40000	40000	40000	40000	40000
	low	30000	30000	30000	30000	30000	30000	30000
LRP	high	7.44	11.22	11.28	11.38	11.43	11.46	11.67
	low	7.44	11.22	11.28	11.38	11.43	11.46	11.67
HSDG	high	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	low	0.95	0.95	0.95	0.95	0.95	0.95	0.95
TSC	high	0.85	0.85	0.85	0.85	0.85	0.85	0.85
	low	0.7	0.7	0.7	0.7	0.7	0.7	0.7
UE	high	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	low	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Rel Pay	high	1.2	1.2	1.2	1.2	1.2	1.2	1.2
	low	0.8	0.8	0.8	0.8	0.8	0.8	0.8
QMA	high	1883304	1873304	1863304	1853304	1843304	1833304	1823304
	low	1873304	1863304	1853304	1843304	1833304	1823304	1813304

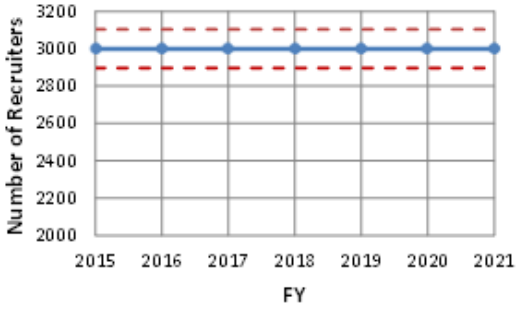
PROM-WED
Decision Support Analysis

Decision Variables

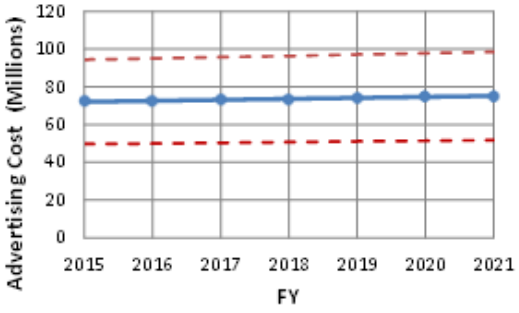
Total Cost of Recruiting



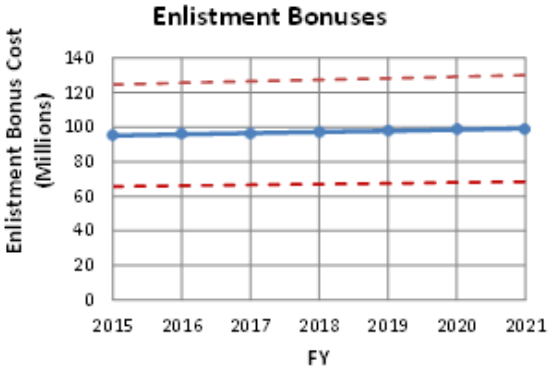
Total Recruiters



Advertising



Enlistment Bonuses

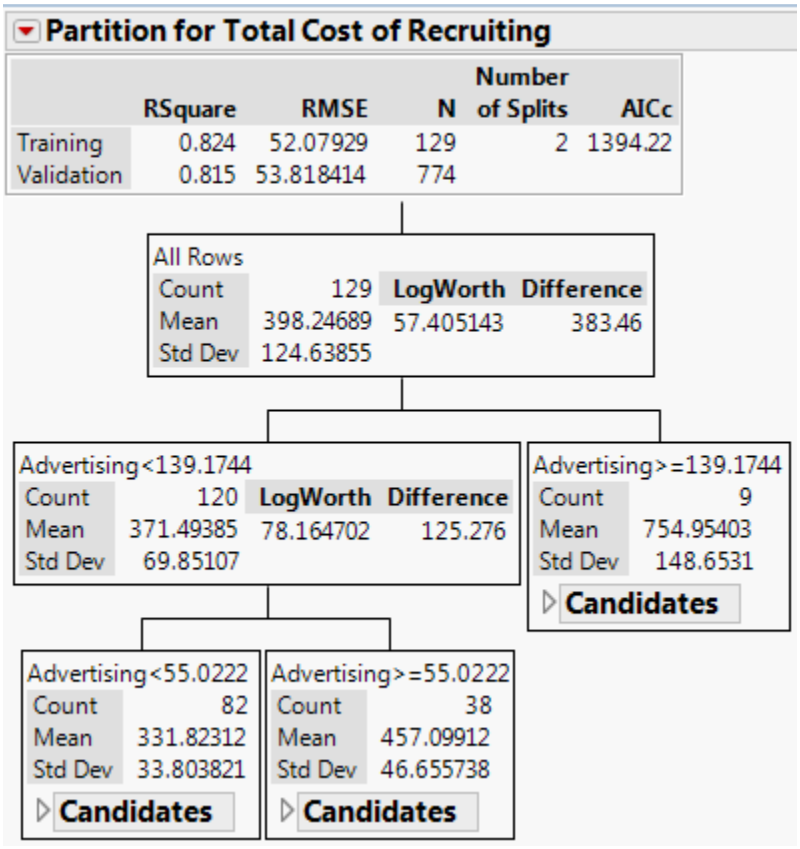


B. JMP Analysis

Analysts will need to use a statistical software package to take full advantage of the data grown by PROM-WED. Therefore, data produced by PROM-WED is designed to be easily uploaded into a software package, such as JMP.

The following are examples of insights gained through analysis of PROM-WED data in JMP.

1. Partition Tree



Over 80 percent of variance in the total cost of recruiting is explained by the amount of funds allocated to advertising.

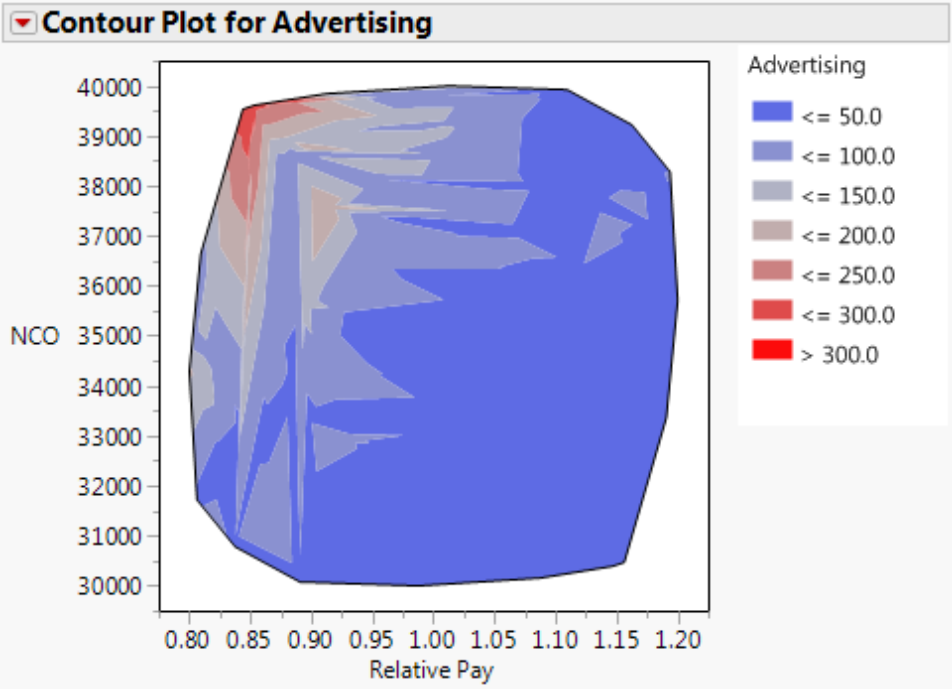
2. Stepwise Regression

The total cost of recruiting can be formulated into a stepwise regression model:

Prediction Expression

150.980052850998
+ 0.02553596931337 * NCO
+ -24.593679044673 * Unemployment
+ -550.34801858165 * Relative Pay
+ (NCO - 35000.0620155039) * ((Relative Pay - 1) * -0.1270005027034)
+ (NCO - 35000.0620155039) * ((NCO - 35000.0620155039) * 0.00000304992539)
+ (Relative Pay - 1) * ((Relative Pay - 1) * 1882.37625427676)

3. Contour Plots

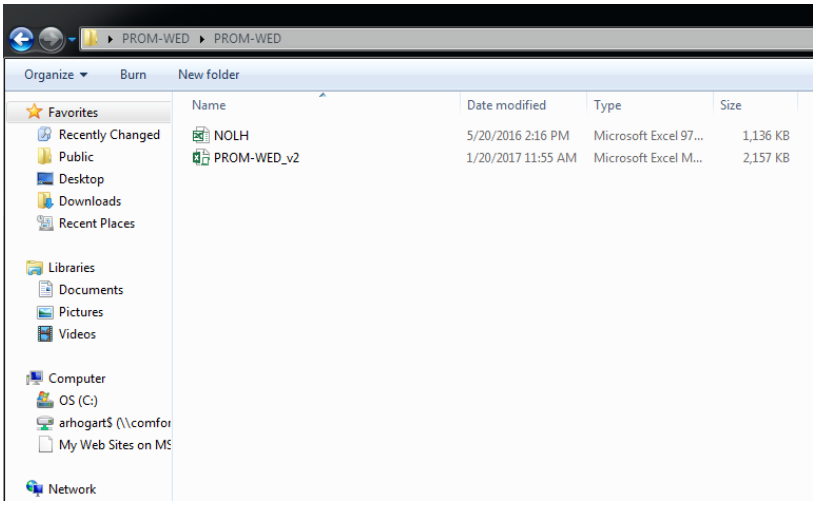


The contour plot indicates that nearly half of the solution space supports a low advertising budget, represented by the dark blue region. The cost of advertising substantially increases when relative pay favors the civilian sector and the accession mission is high, represented by the red region. Once relative pay exceeds approximately

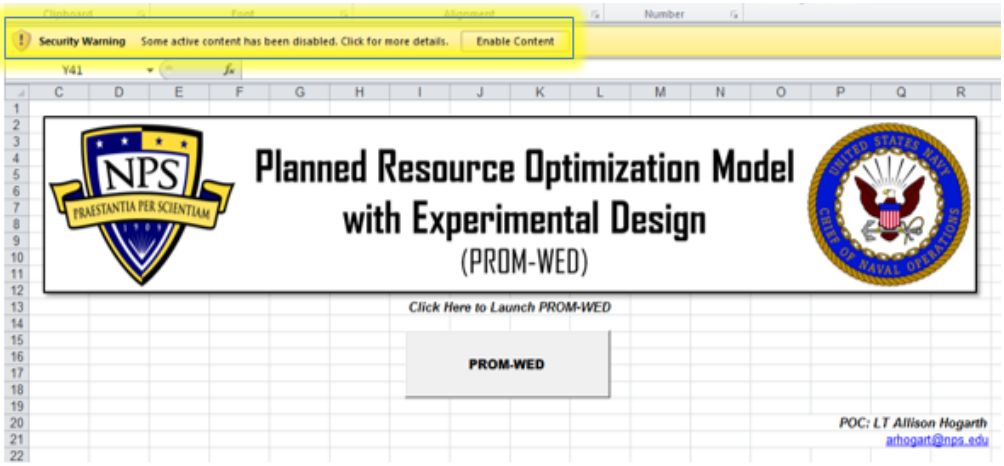
1.00, changes in the new accession mission have little to no effect on the amount of resources allocated to advertising.

III. STEP-BY-STEP INSTRUCTIONS TO RUN PROM-WED

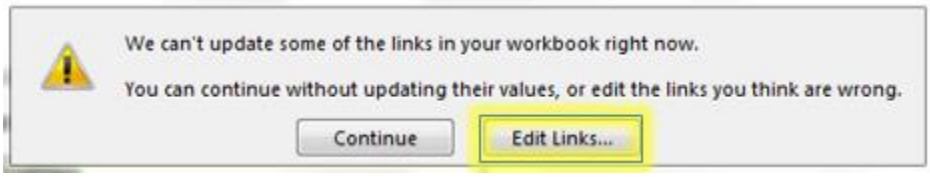
Step 1: Unzip the "PROM-WED.zip" file, and save the "PROM-WED.xlsm" file and "NOLH.xls" file in the same folder. This folder is where the output file generated by PROM-WED will be saved following the PROM-WED excursion.



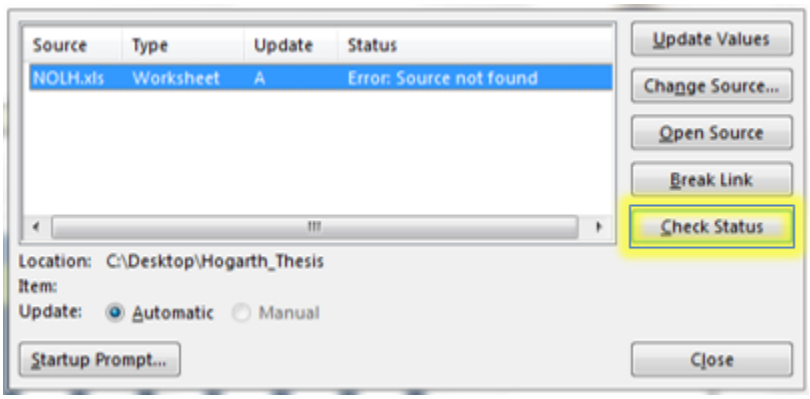
Step 2: Open the PROM-WED file, and ensure the "Enable Content" button is selected.



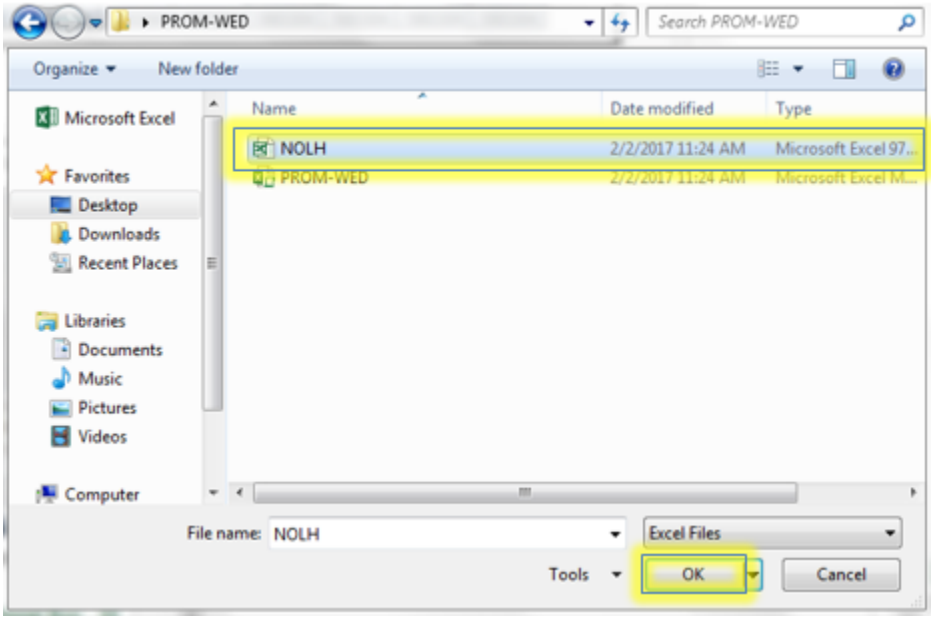
The first time you open PROM-WED, the NOLH.xls file link needs to be updated. To do this, select the “Edit Links...” button.



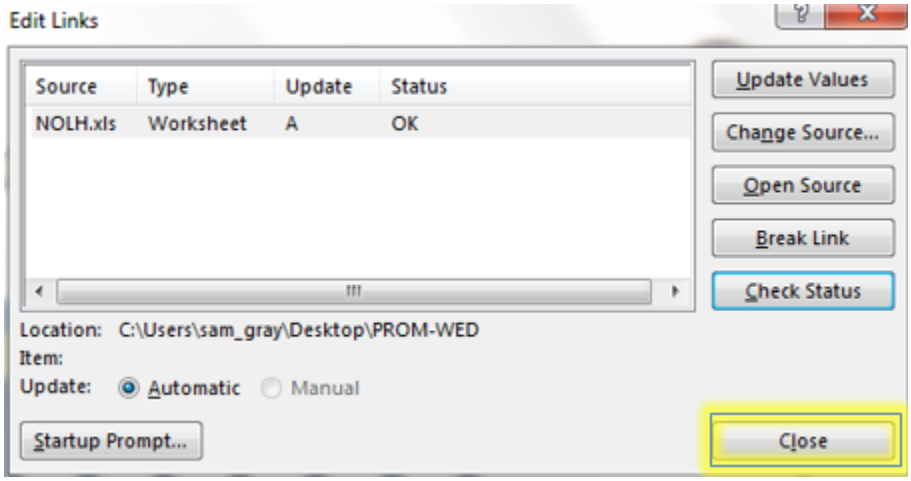
To update the NOLH.xls file, click on the “Change Source…” button.



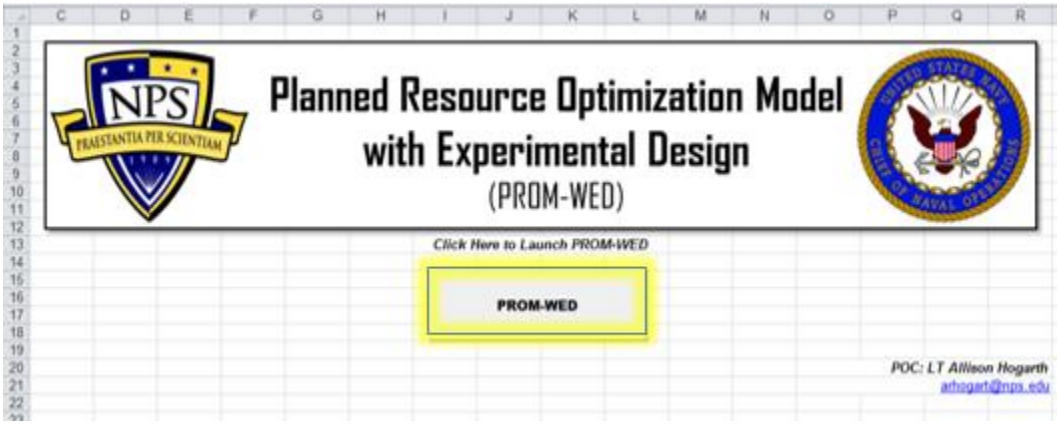
A file search window will pop-up. Navigate to the folder where you saved the files after unzipping them. Select the “NOLH.xls” file, and click on the “OK” button.



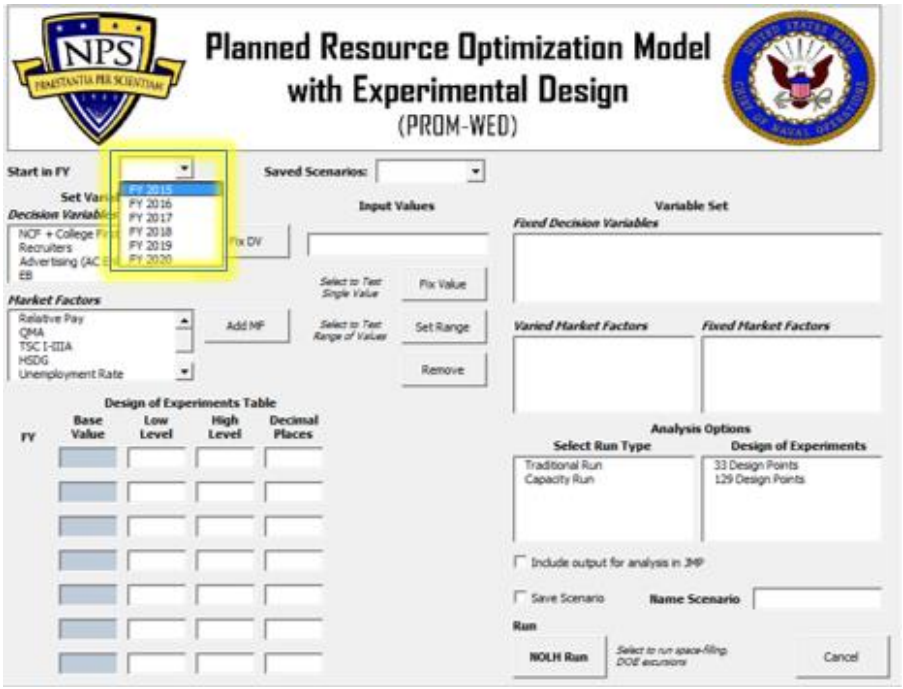
The “Edit Links” window will pop-up. Once the “NOLH.xls” worksheet’s status updates to “OK,” click on the “Close” button.



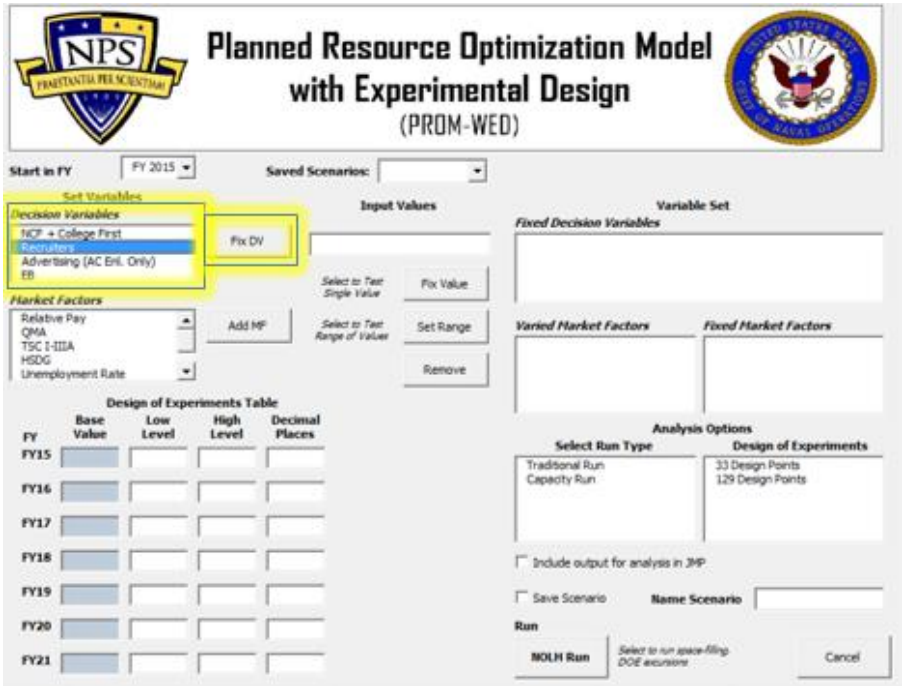
Step 3: Open the PROM-WED file, and select the “PROM-WED” button to open the GUI.



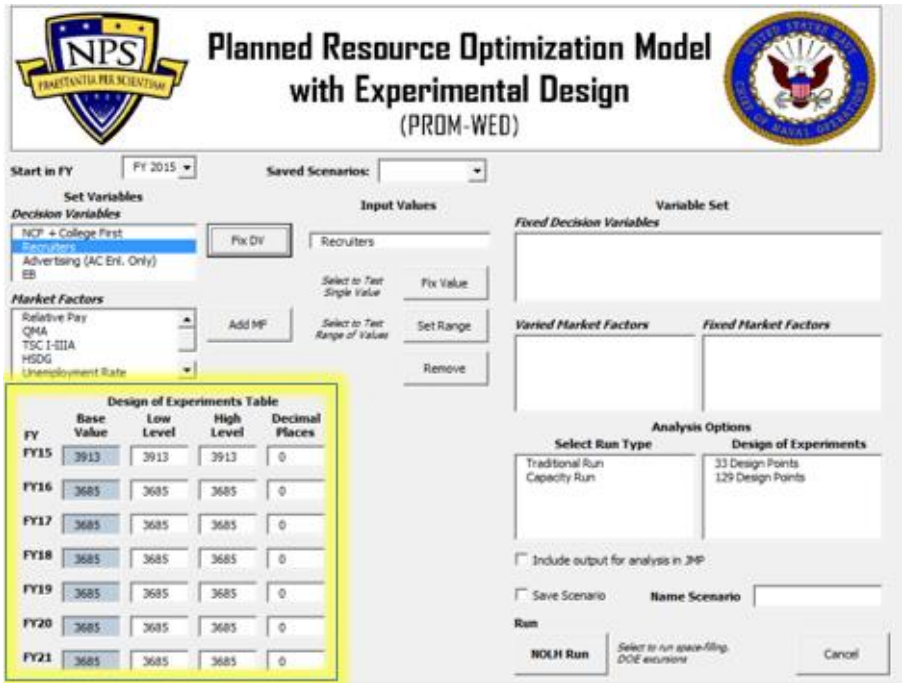
Step 4: Select the appropriate starting fiscal year (FY) from the drop-down list. The current version of the legacy PRO model is set at a FY 2015 start.



Step 5: To constrain a decision variable, select it from the list, and click “Fix DV” button.



The default data from the legacy PRO Model will automatically populate the “Design of Experiments Table.”

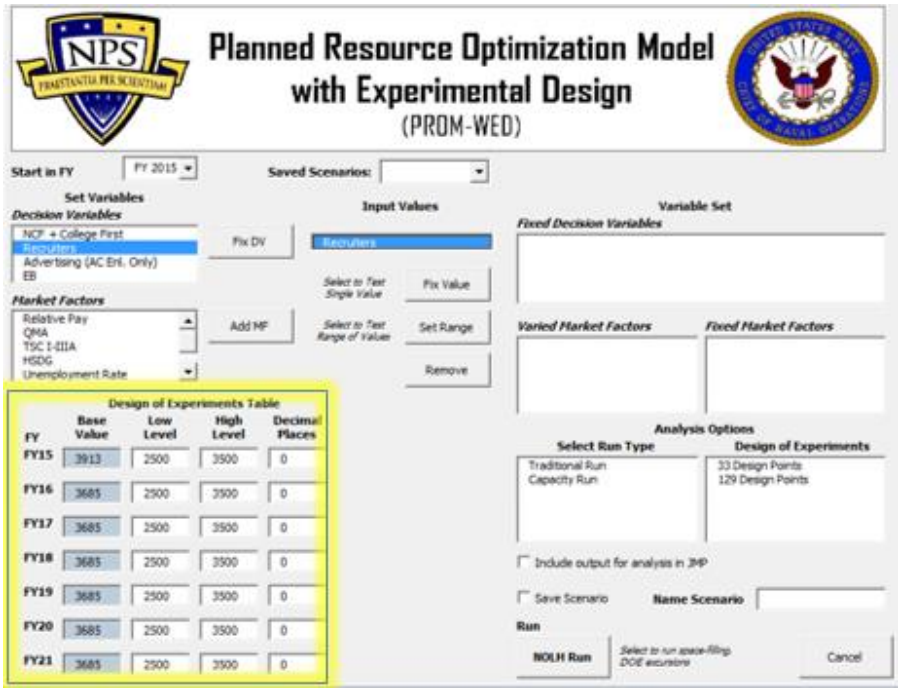


Step 6: Input the range of values for the decision variable in the “Design of Experiments Table.” Input the low value of the range in the “Low Level” text box for each FY, and the high value of the range in the “High Level” text box for each FY. In this example, the number of recruiters is tested from 2,500 to 3,500 for each FY.

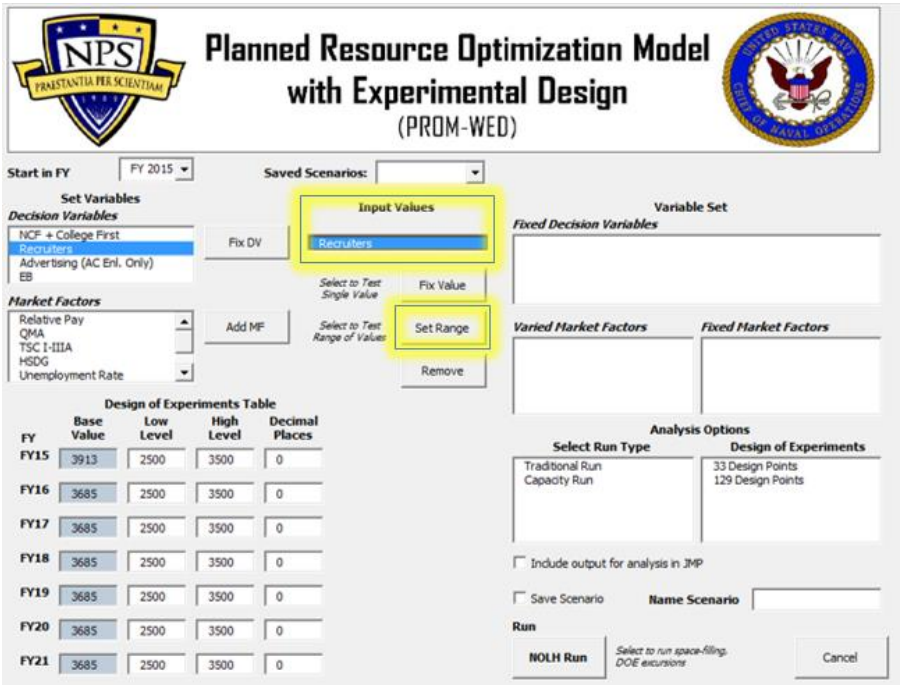
Each year can be tested using different ranges. For example, to represent a smaller recruiter force in FY 2021, the range could be inputted as 2,000 to 2,700.

If you want to constrain the decision variable at the default value populated by the legacy PRO model, select the “Fix Value” button. By selecting “Fix Value,” the default values for the decision variable in the “Design of Experiments Table” are deposited into the NOLH worksheet for each FY. This decision variable is now moved to the “Fixed Decision Variables” list, and the “Design of Experiments Table” is cleared. (If this is your course of action, continue to Step 8.)

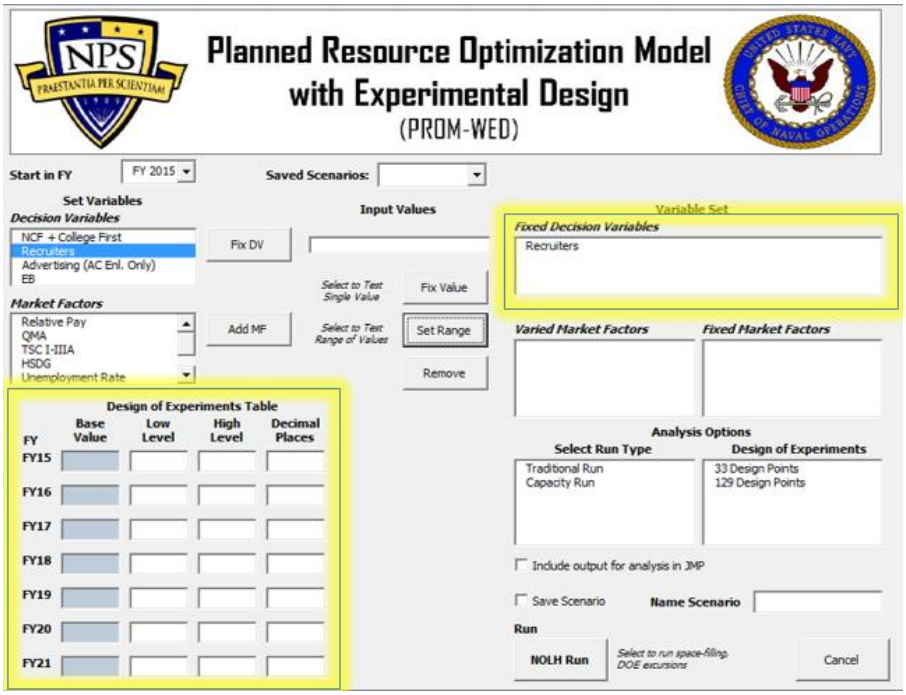
If you want to constrain the decision variable at one number that is different than the default value populated by the legacy PRO model, the same number has to be inputted into the “Low Level” and “High Level” text boxes. For example, if you want to constrain the number of recruiters in FY 2021 to 2700, then you would enter 2700 in both the “Low Level,” and “High Level” text boxes.



Step 7: Once the “Design of Experiments Table” is fully populated with the low and high levels for each FY, select the decision variable from the “Input Values” box, and click on the “Set Range” button.



By selecting “Set Range,” the low and high values entered for this decision variable in the “Design of Experiments Table” are deposited into the NOLH worksheet for each FY. This decision variable is now moved to the “Fixed Decision Variables” list, and the “Design of Experiments Table” is cleared.



Step 8: Follow Steps 5-7 to fix any other decision variables.

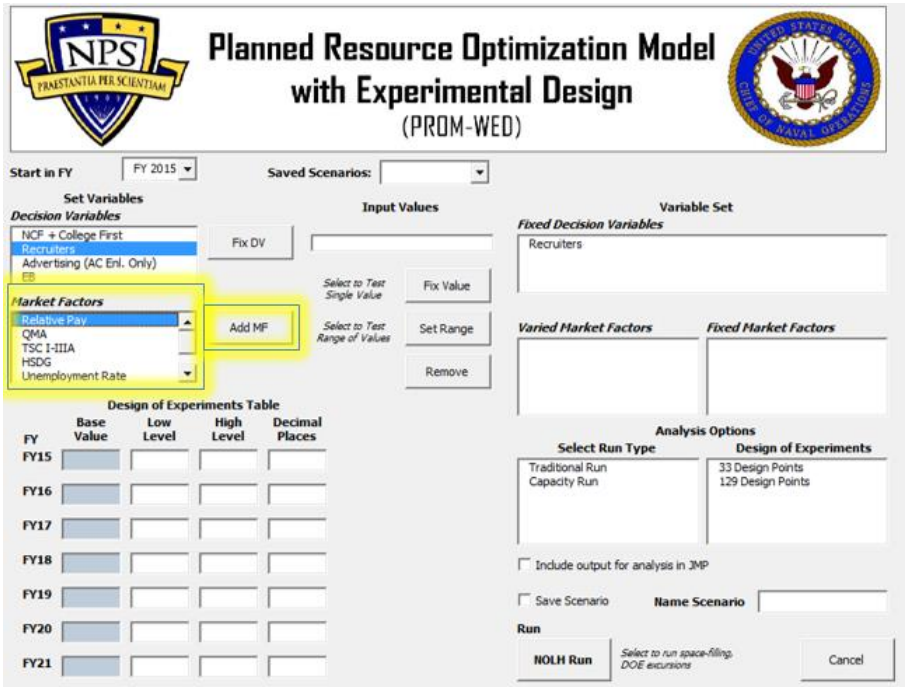
Reminders:

- If you constrain a decision variable to a number other than the default values populated from the legacy PRO model, as mentioned earlier enter the same number into the low and high level text boxes, and select the “Set Range” button when complete.

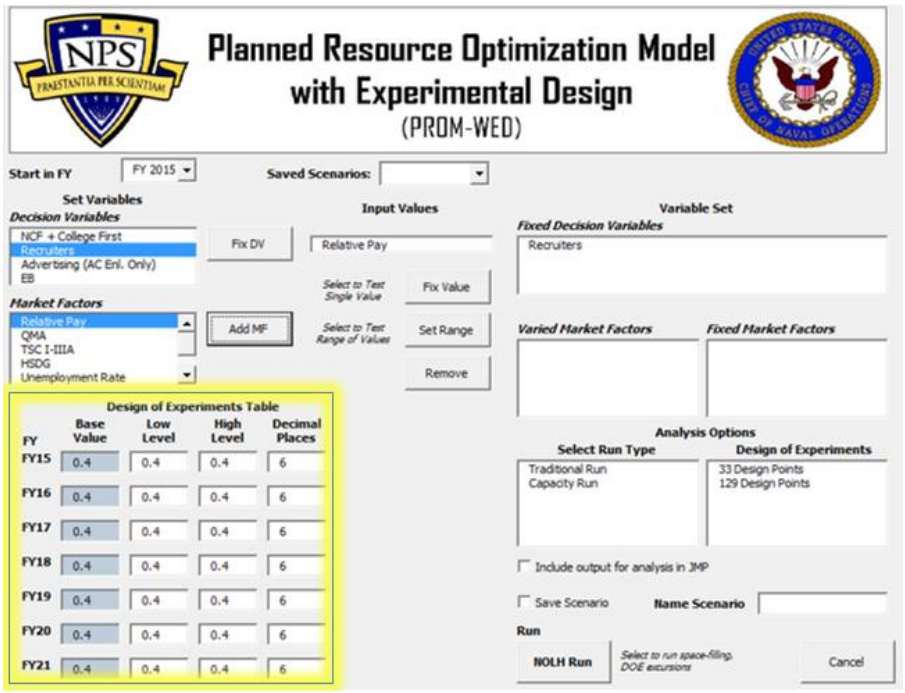
- Since the PRO model solves an optimization problem, ensure that at least one of the following decision variables: Recruiters, Advertising or Enlistment Bonus (EB) remain in a “float” status. In this example, only the number of recruiters are fixed.

Step 9: Once all decision variables that need to be fixed are fixed, gears shift to the market factors. The “Market Factors” list includes all market factors (relative pay, QMA and unemployment rate) and policy factors (percentage of high quality recruits (TSC I-IIIA), percentage of recruits with a high school diploma (HSDG), and NCO). Each market factor, from relative pay to NCO, must either be fixed at one value, or a range of values needs to be entered.

Similar to how decision variables are fixed, select “Relative Pay” from the list of market factors, and select the “Add MF” button.

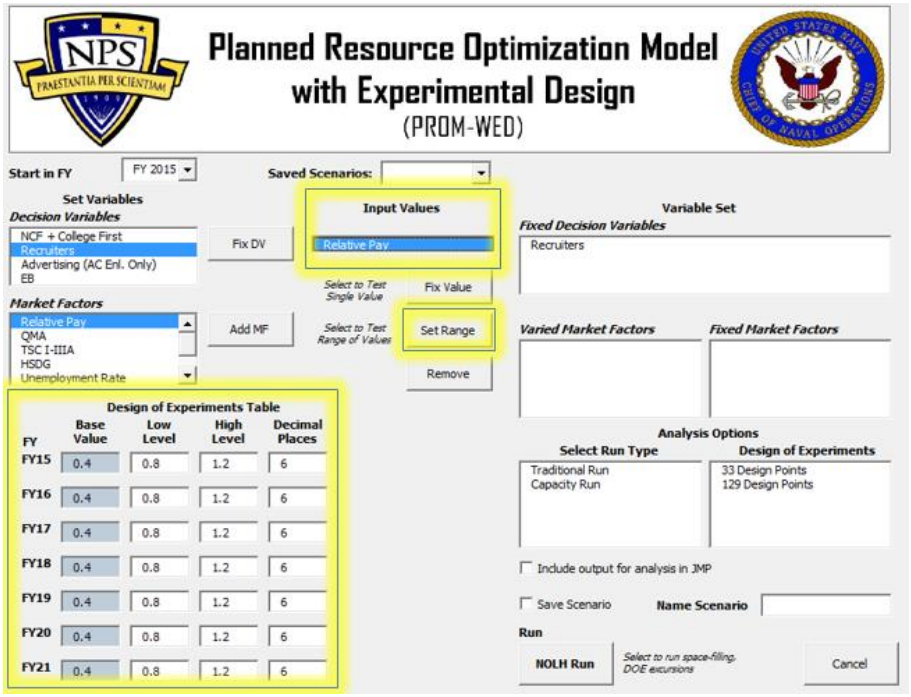


The default data from the legacy PRO Model automatically populates in the “Design of Experiments Table.”

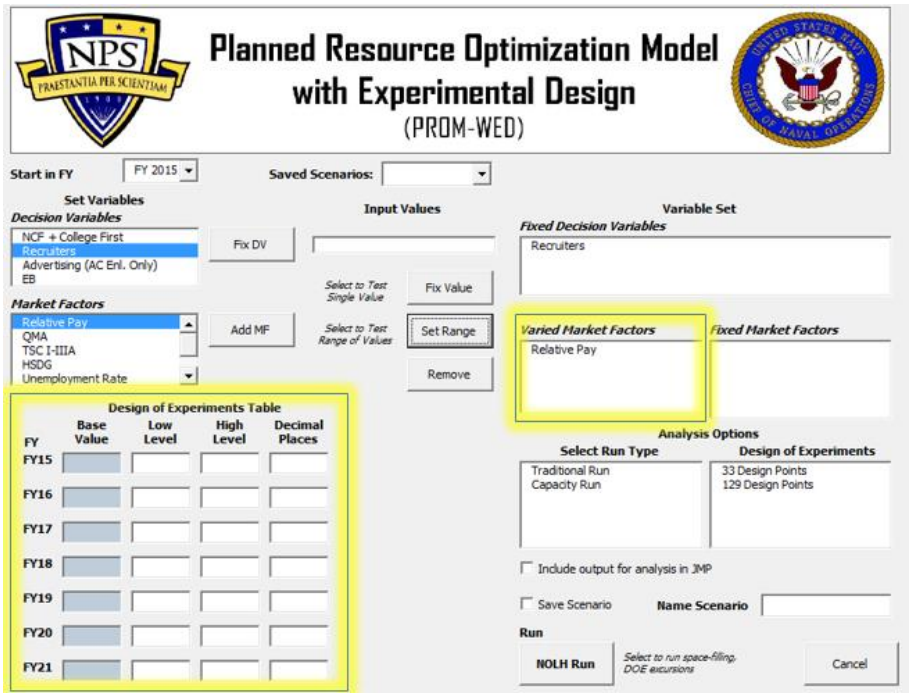


Step 10: Input the range values for the market factor in the “Design of Experiments Table.” Input the low value of the range in the “Low Level” text box for each FY, and the high value of the range in the “High Level” text box for each FY.

In this example, the relative pay is tested from 0.8 to 1.2 for each FY. Clicking the “Set Range” button deposits the low and high values entered for this market factor into the NOLH worksheet for each FY.

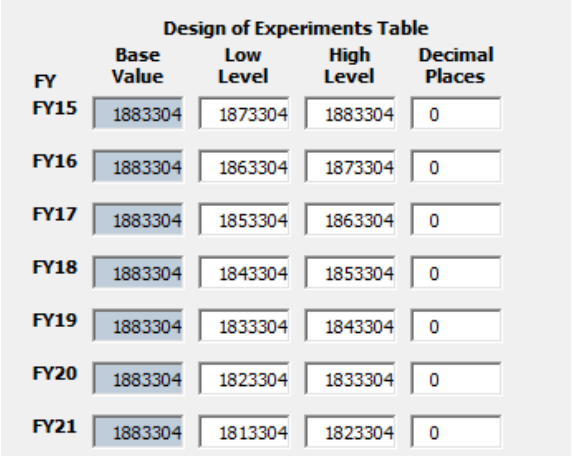


This market factor is now moved to the “Varied Market Factors” list, and the “Design of Experiments Table” is cleared.



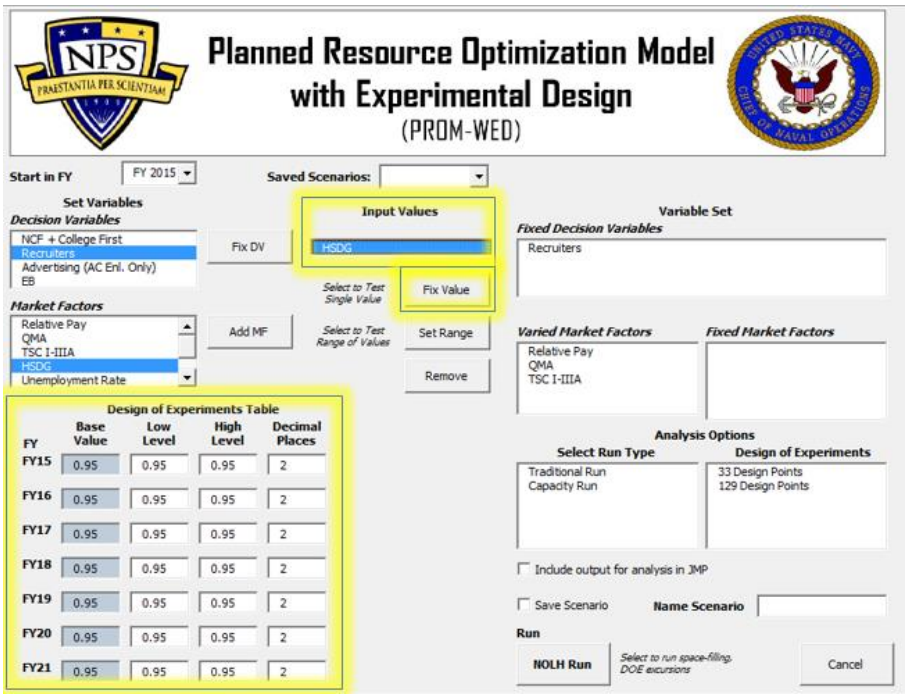
Step 11: Work through each “Market Factor” in the list, from “Relative Pay” to “NCO” following Steps 9-10.

Note that each year can be tested using a different range of values for the market factors. For example, an annual decrease of 10,000 QMA can be entered as shown in the figure below.

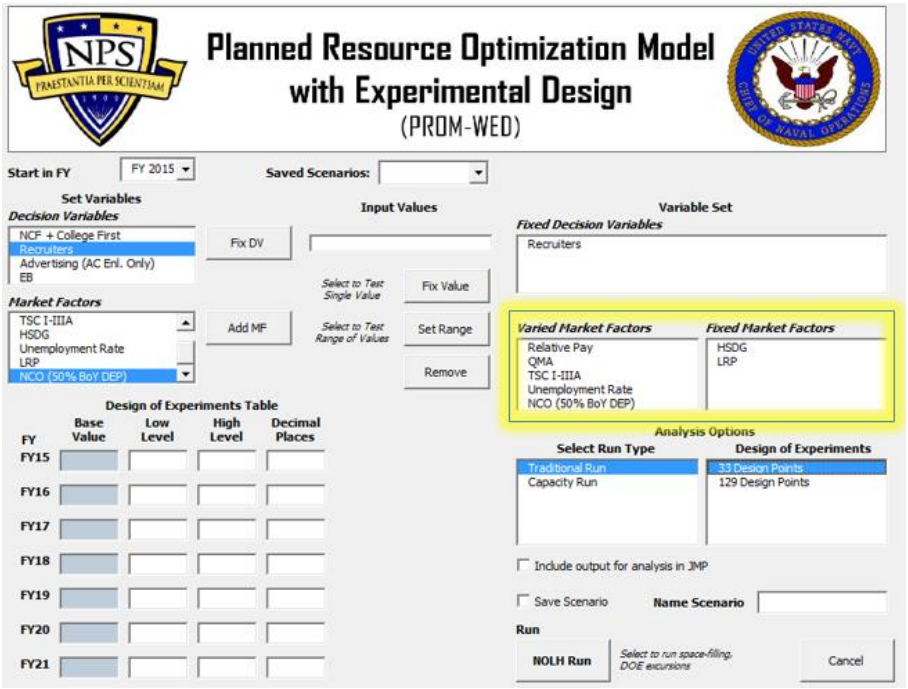


If you want to constrain the market factor at one number different than what is populated by the legacy PRO model, the same number has to be inputted into the “Low Level” and “High Level” text boxes. Then select the “Set Range” button.

To constrain the market factor at the value automatically populated in the “Design of Experiments Table,” select the market factor from the “Input Values” box, and click on the “Fix Value” button.



Step 12: Work through all seven market factors until they are all accounted for. A market factor is accounted for once it appears in either the “Varied Market Factors,” or “Fixed Market Factors” lists.



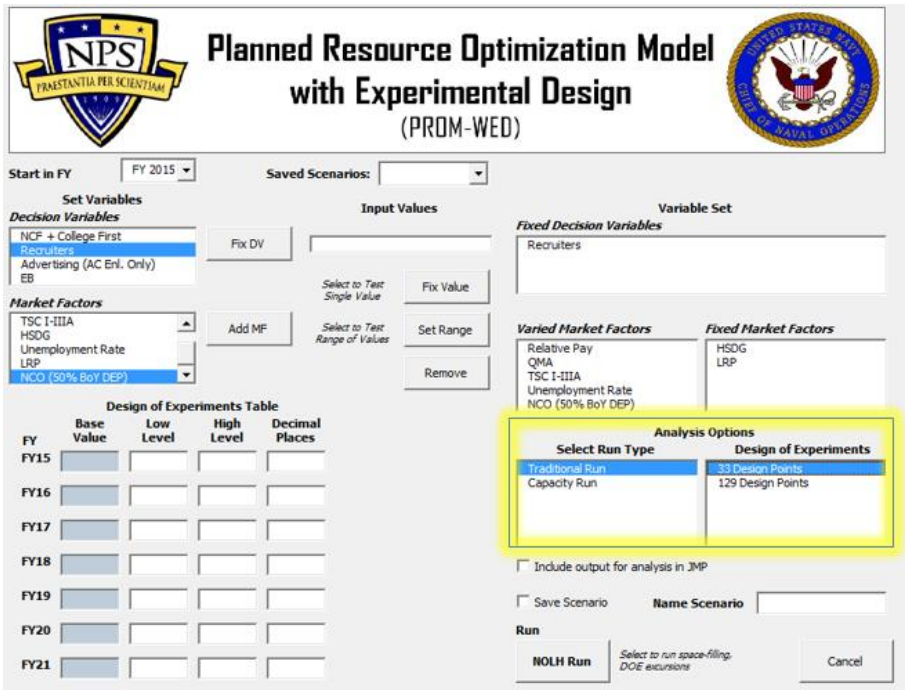
Step 13: Select “Traditional Run” under “Select Run Type.” (Currently, only the Traditional Run option is operational).

Automatically Generated Decision Support:

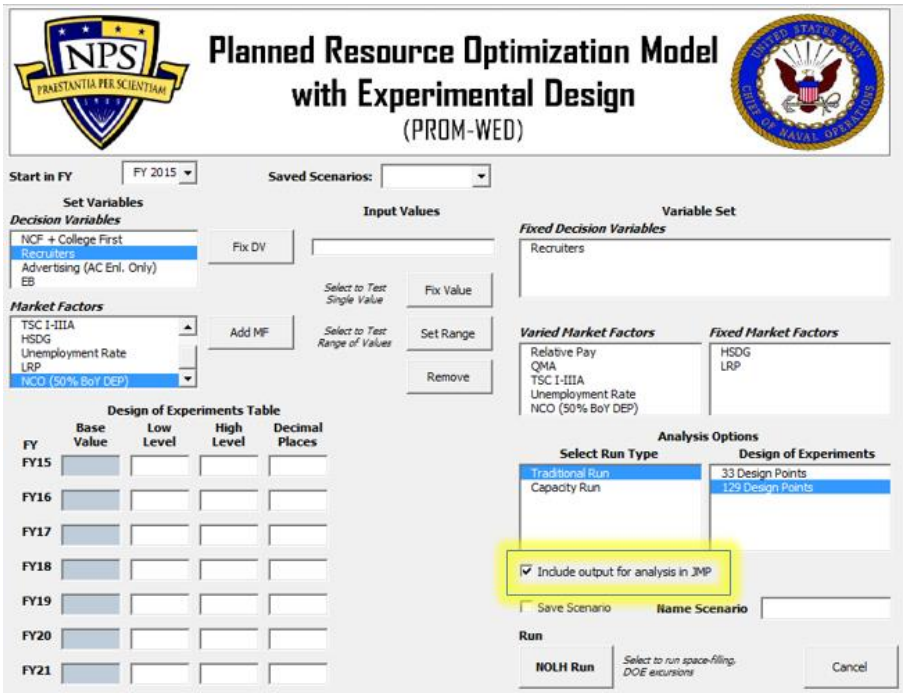
The “33 Design Points” option is well suited for the automatically generated decision support analysis. The “129 Design Points” option can also be used, but it will take additional time to run (approximately 10 minutes versus 2-3 minutes). The “129 Design Points” option grows more data, resulting in a narrower 95% confidence interval.

Analysis in JMP:

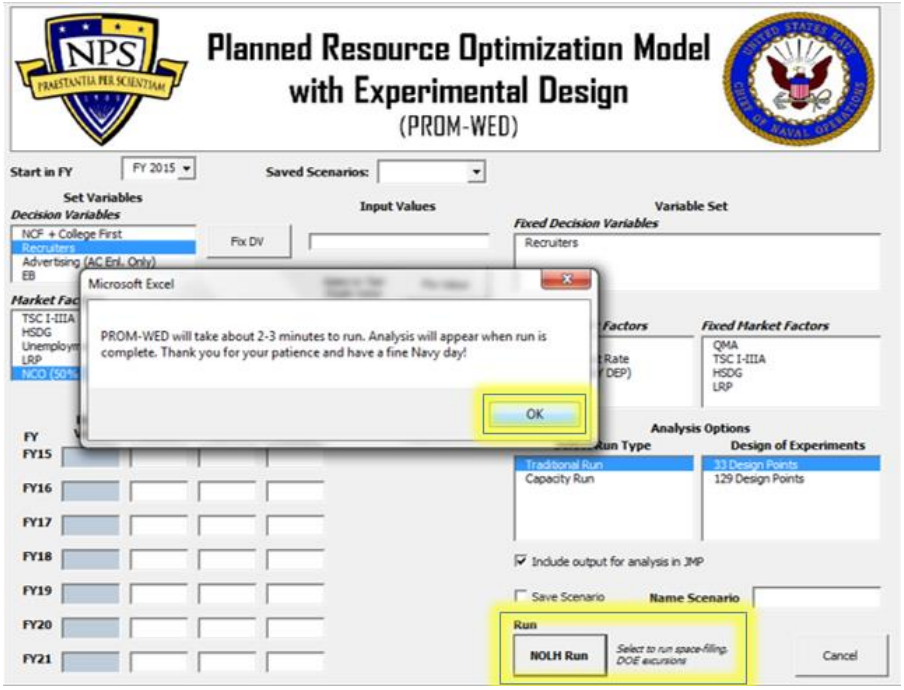
The “129 Design Points” option is intended to be used for further analysis in a commercial statistical software package, such as JMP.



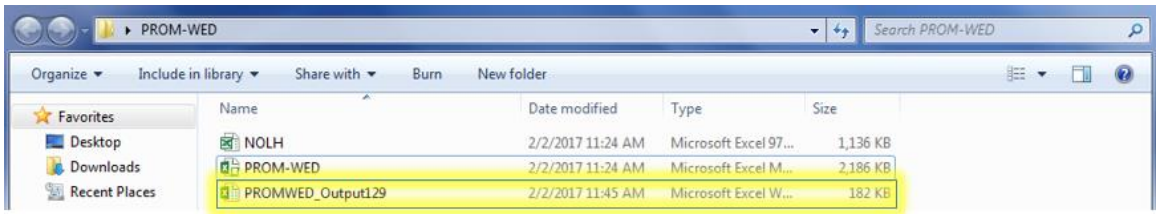
Step 14: To save PROM-WED output to a separate .xls file for analysis in JMP, select the “Include output for analysis in JMP” box. This will save the PROM-WED output as a .xls file in the same folder that the PROM-WED model was saved in.



Step 15: Once the run options are set, select the “NOLH Run” button. A message will pop-up providing an estimated wait time for the PROM-WED excursion. Click “OK.”



Step 16: When the PROM-WED excursion is complete, the automatically generated decision support analysis will appear (this is true for both the 33 and 129 point designs). If you selected the option to output PROM-WED data for analysis in JMP, the .xls file named “PROMWED_Output129.xls” will appear in the folder that your PROM-WED model is saved in.



Please be aware that each 129 design point output file will be named “PROMWED_Output129.xls.” It is recommended that you rename the file before running another PROM-WED excursion.

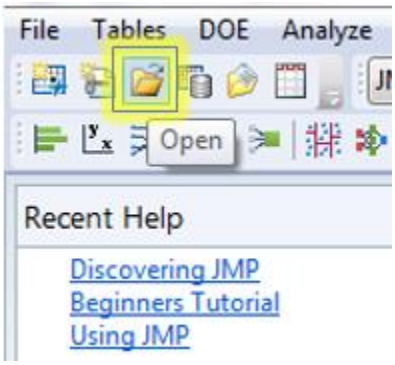
IV. GUIDELINES FOR ANALYSIS OF PROM-WED DATA IN JMP

Using JMP Pro 12, the following section provides a tutorial on analysis techniques for PROM-WED output. Steps 1-5 explain how to upload and prepare the data for analysis in JMP, followed by guidance on how to conduct various analysis techniques.

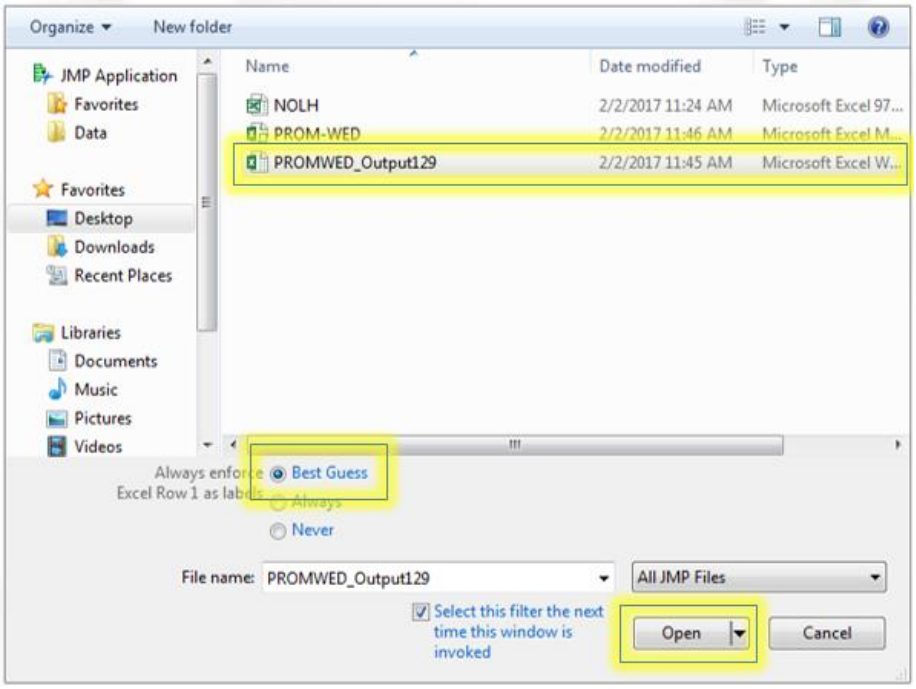
Analysis Techniques:

A. Oneway Analysis of Total Cost of Recruiting by FY
B. Explore Outliers from the Oneway Analysis Graph
C. Select one FY to Analyze
D. Distribution
E. Partition Trees
F. Stepwise Regression Model
G. Scatterplot Matrix
H. Contour Plot

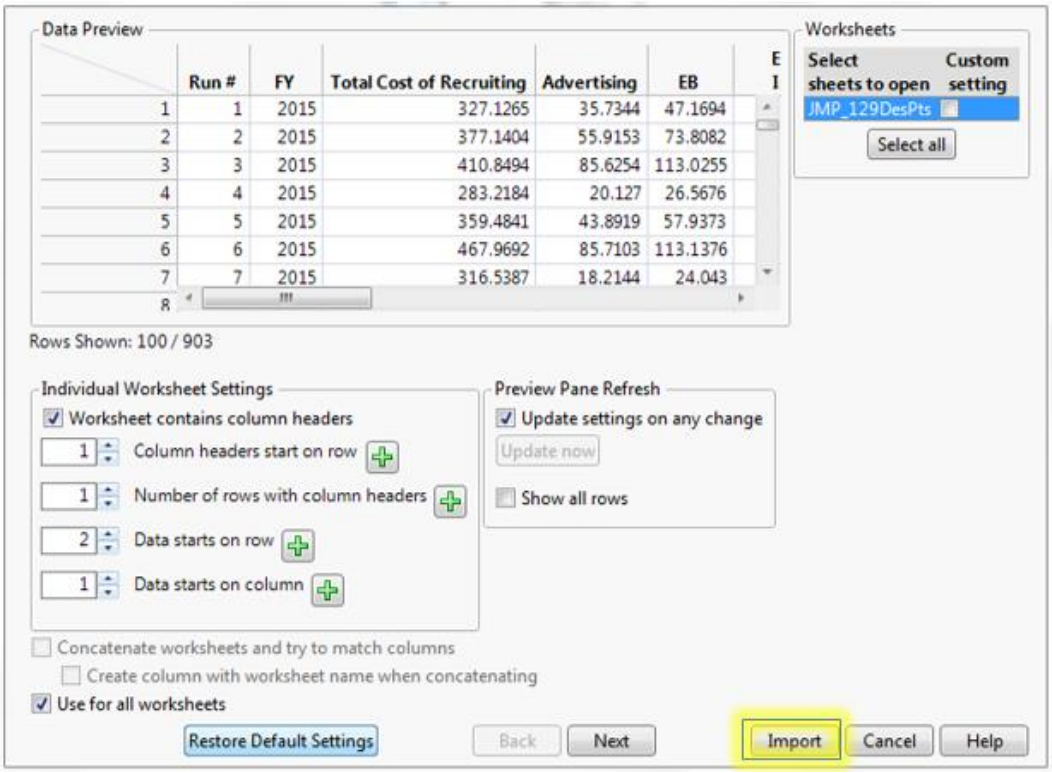
Step 1: To load the PROM-WED data into JMP, select the folder icon.



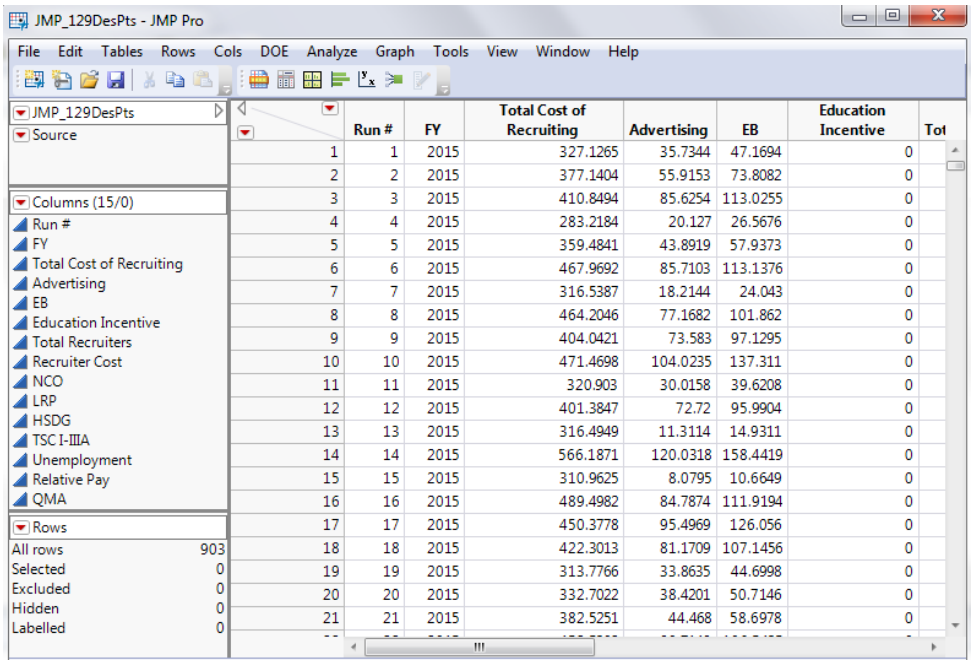
Step 2: Select the output data of interest, select the “Best Guess” option, and click “Open.”



Step 3: Select the “Import” button.

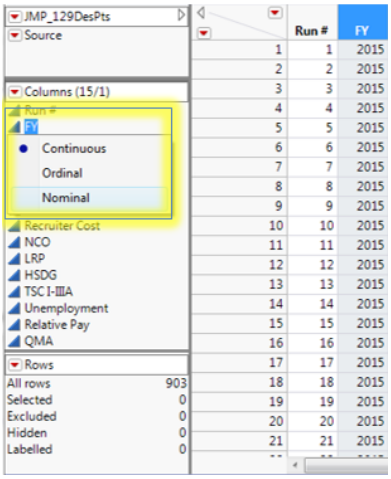


The PROM-WED output data should appear in a table, as shown below:



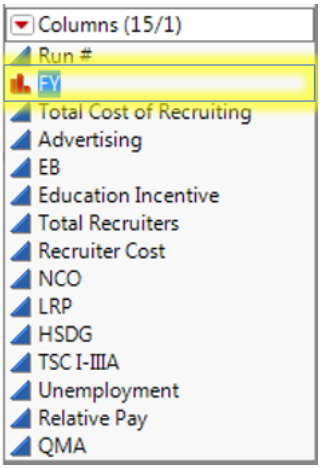
	Run #	FY	Total Cost of Recruiting	Advertising	EB	Education Incentive	Tot
1	1	2015	327.1265	35.7344	47.1694	0	
2	2	2015	377.1404	55.9153	73.8082	0	
3	3	2015	410.8494	85.6254	113.0255	0	
4	4	2015	283.2184	20.127	26.5676	0	
5	5	2015	359.4841	43.8919	57.9373	0	
6	6	2015	467.9692	85.7103	113.1376	0	
7	7	2015	316.5387	18.2144	24.043	0	
8	8	2015	464.2046	77.1682	101.862	0	
9	9	2015	404.0421	73.583	97.1295	0	
10	10	2015	471.4698	104.0235	137.311	0	
11	11	2015	320.903	30.0158	39.6208	0	
12	12	2015	401.3847	72.72	95.9904	0	
13	13	2015	316.4949	11.3114	14.9311	0	
14	14	2015	566.1871	120.0318	158.4419	0	
15	15	2015	310.9625	8.0795	10.6649	0	
16	16	2015	489.4982	84.7874	111.9194	0	
17	17	2015	450.3778	95.4969	126.056	0	
18	18	2015	422.3013	81.1709	107.1456	0	
19	19	2015	313.7766	33.8635	44.6998	0	
20	20	2015	332.7022	38.4201	50.7146	0	
21	21	2015	382.5251	44.468	58.6978	0	

Step 4: Change the FY column from “continuous” to “nominal” data, by right-clicking on the blue triangle next to “FY,” and select “nominal” from the drop-down menu.



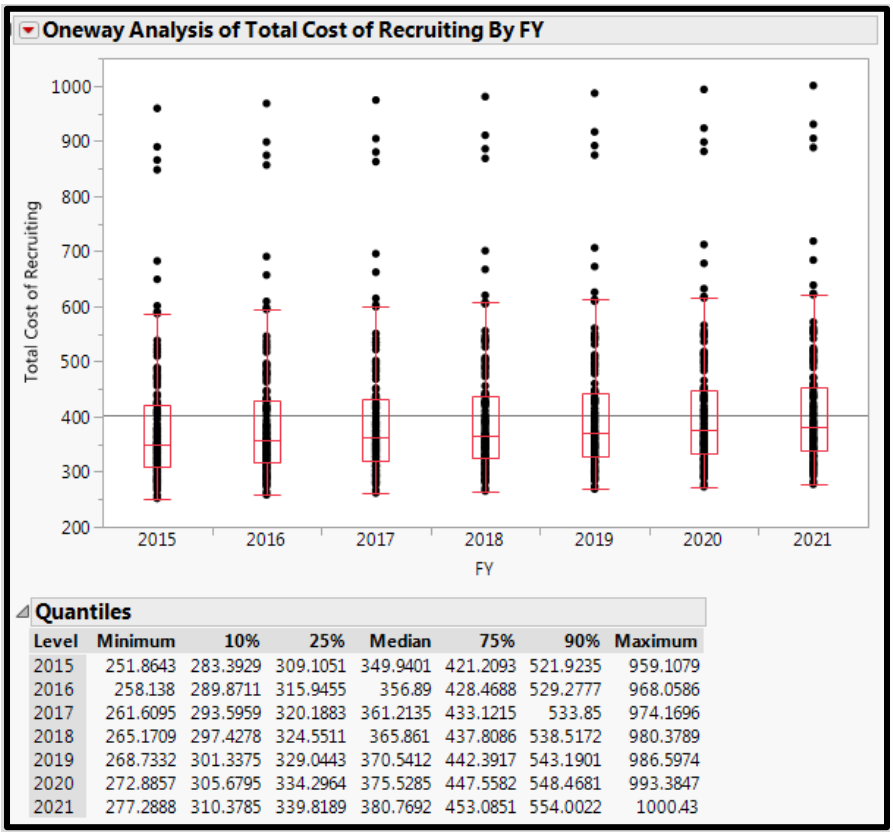
	Run #	FY
1	1	2015
2	2	2015
3	3	2015
4	4	2015
5	5	2015
6	6	2015
7	7	2015
8	8	2015
9	9	2015
10	10	2015
11	11	2015
12	12	2015
13	13	2015
14	14	2015
15	15	2015
16	16	2015
17	17	2015
18	18	2015
19	19	2015
20	20	2015
21	21	2015

The blue triangle next to FY will change to a red bar chart icon when JMP changes its classification to nominal data.



The data is now ready to be analyzed.

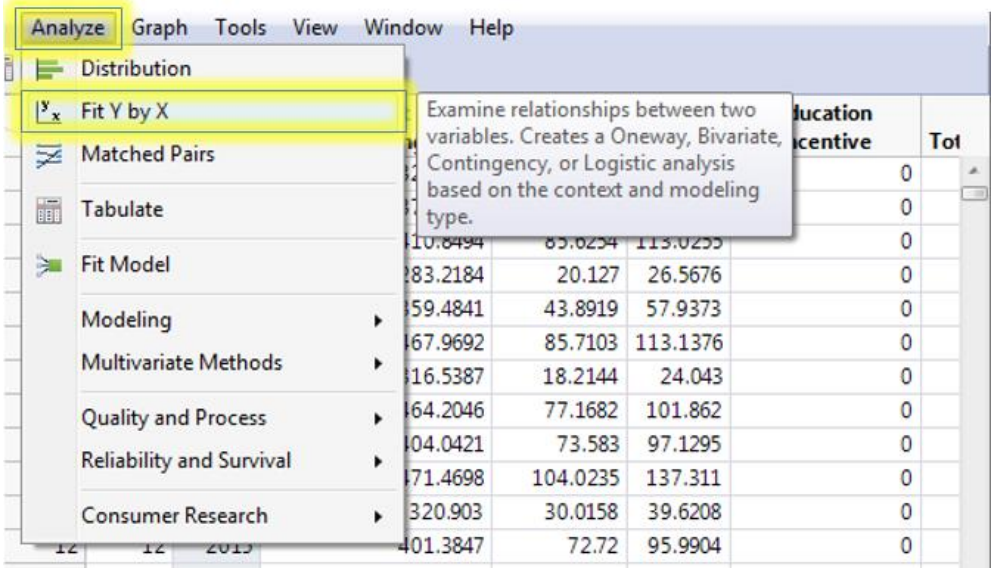
A. Oneway Analysis of Total Cost of Recruiting by FY



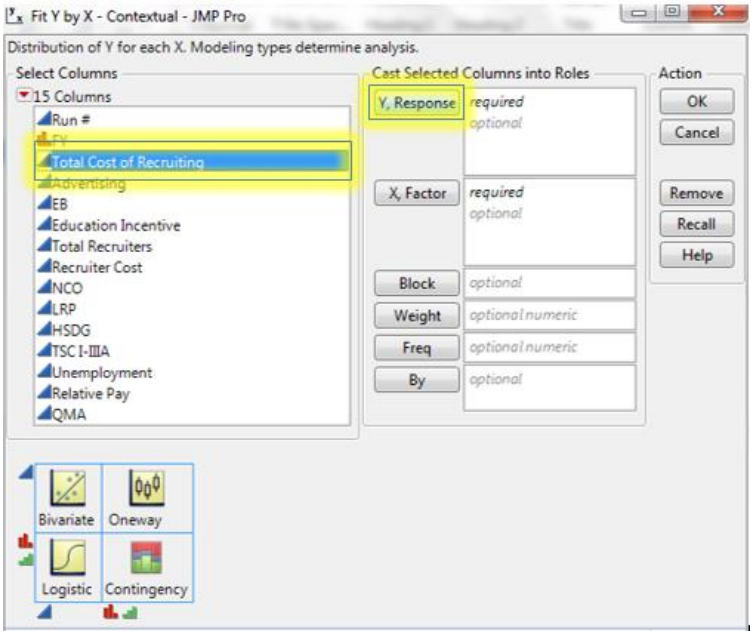
Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
2015	251.8643	283.3929	309.1051	349.9401	421.2093	521.9235	959.1079
2016	258.138	289.8711	315.9455	356.89	428.4688	529.2777	968.0586
2017	261.6095	293.5959	320.1883	361.2135	433.1215	533.85	974.1696
2018	265.1709	297.4278	324.5511	365.861	437.8086	538.5172	980.3789
2019	268.7332	301.3375	329.0443	370.5412	442.3917	543.1901	986.5974
2020	272.8857	305.6795	334.2964	375.5285	447.5582	548.4681	993.3847
2021	277.2888	310.3785	339.8189	380.7692	453.0851	554.0022	1000.43

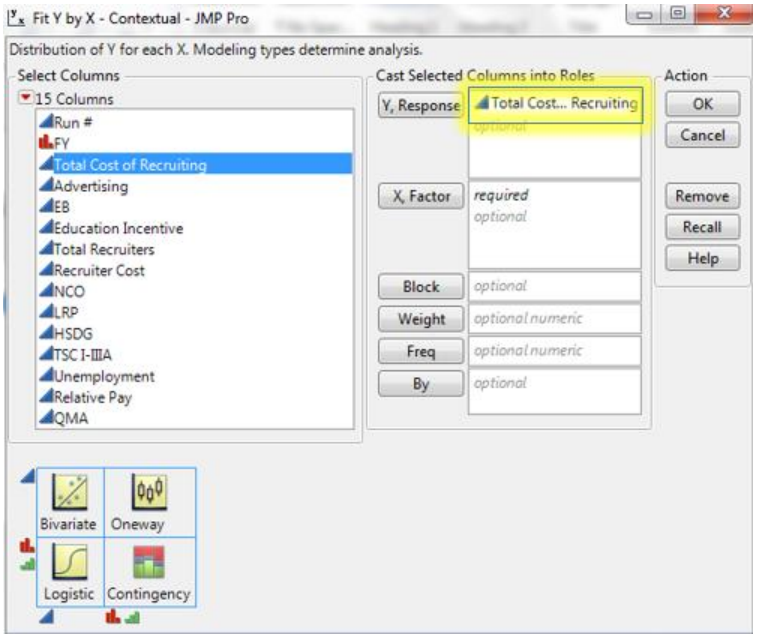
Step 1: To create an oneway analysis of total cost of recruiting by FY graph, select "Analyze" from the ribbon, and select "Fit Y by X."



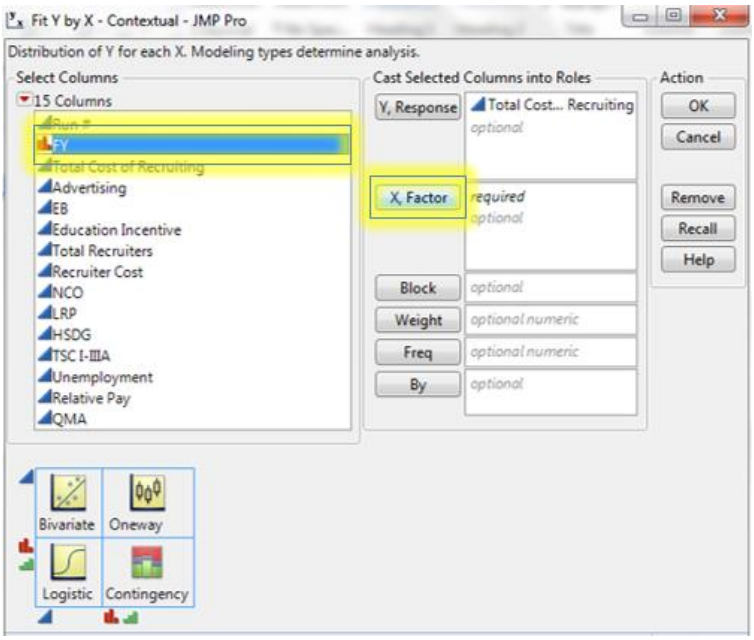
Step 2: Select “Total Cost of Recruiting” from the list of columns, and select the “Y, Response” button.



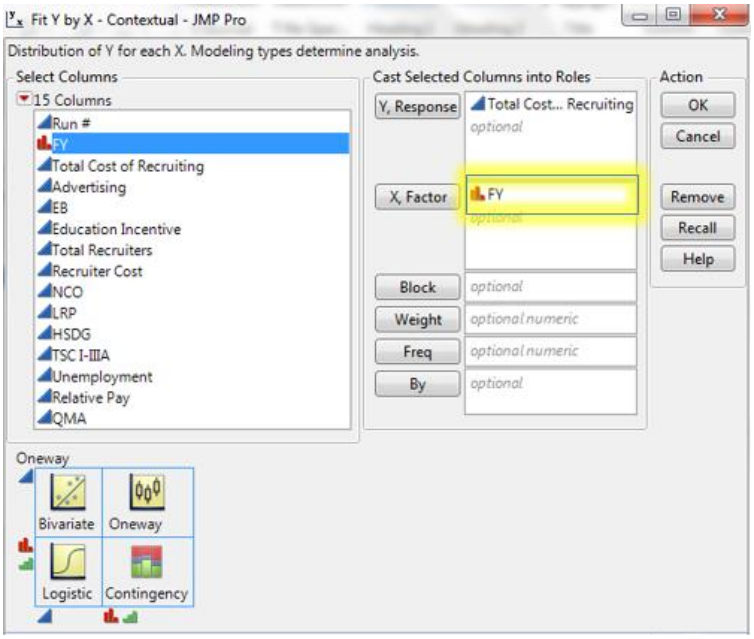
“Total Cost of Recruiting” should now appear in the “Y, Response” box.



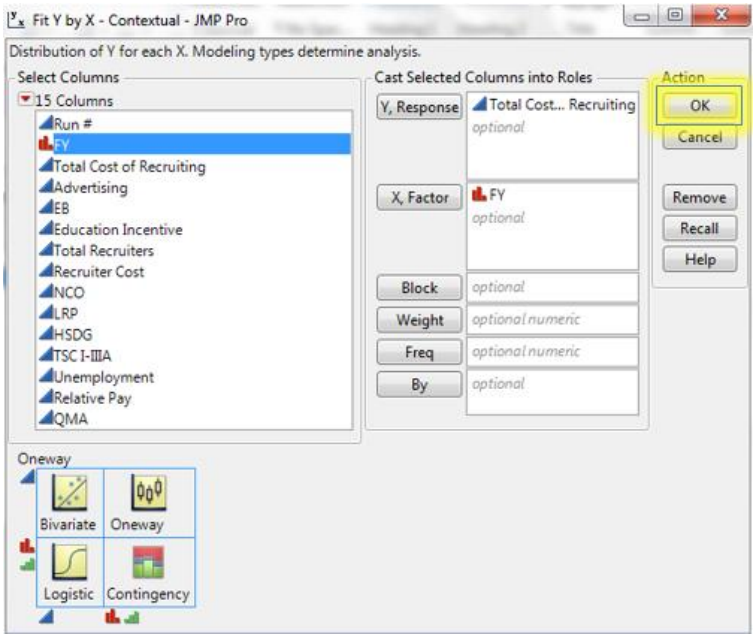
Step 3: Select “FY” from the list of columns, and select the “X, Factor” button.



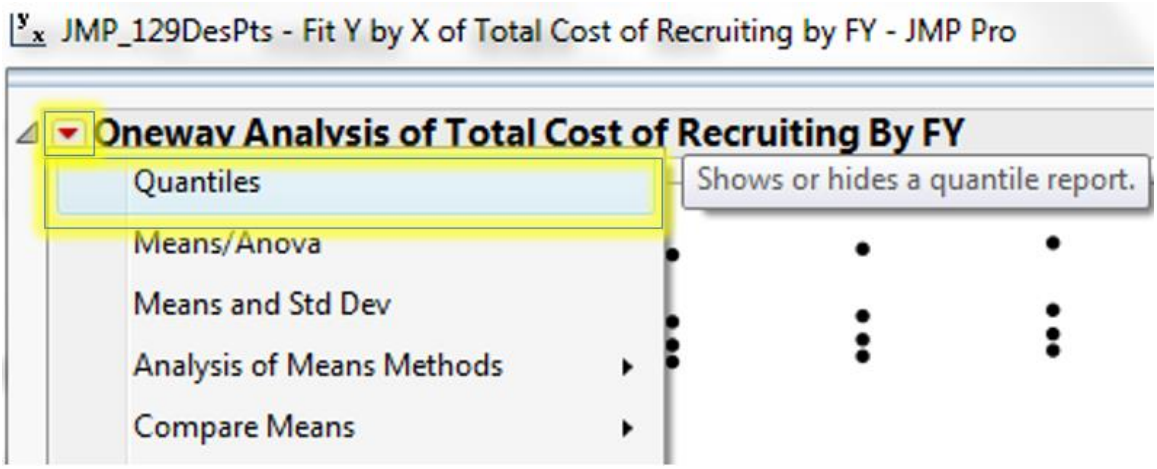
“FY” should now appear in the “X, Factor” box.



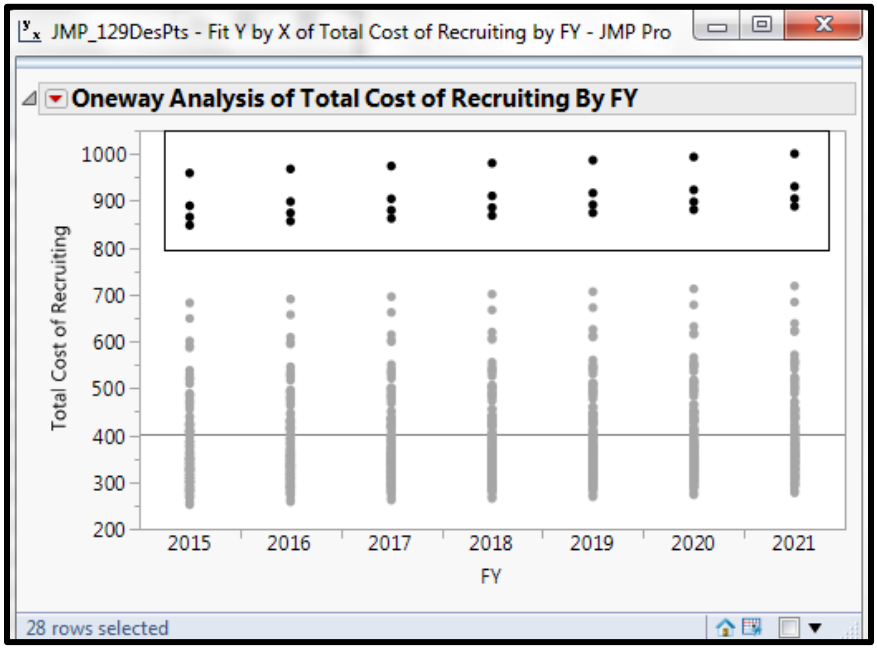
Step 4: Click-on the “OK” button to generate the graph of FY by total cost of recruiting.



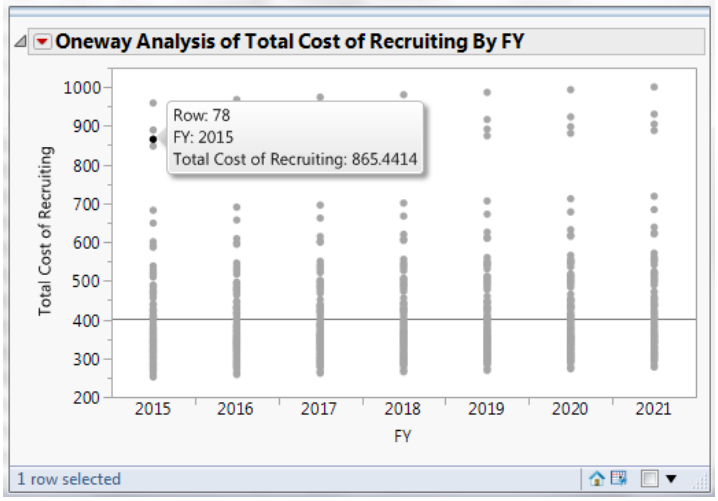
Step 5: To add boxplots on the data for each FY, select the red triangle in the upper left hand corner of the graph. From the drop-down menu, select “Quantiles.”



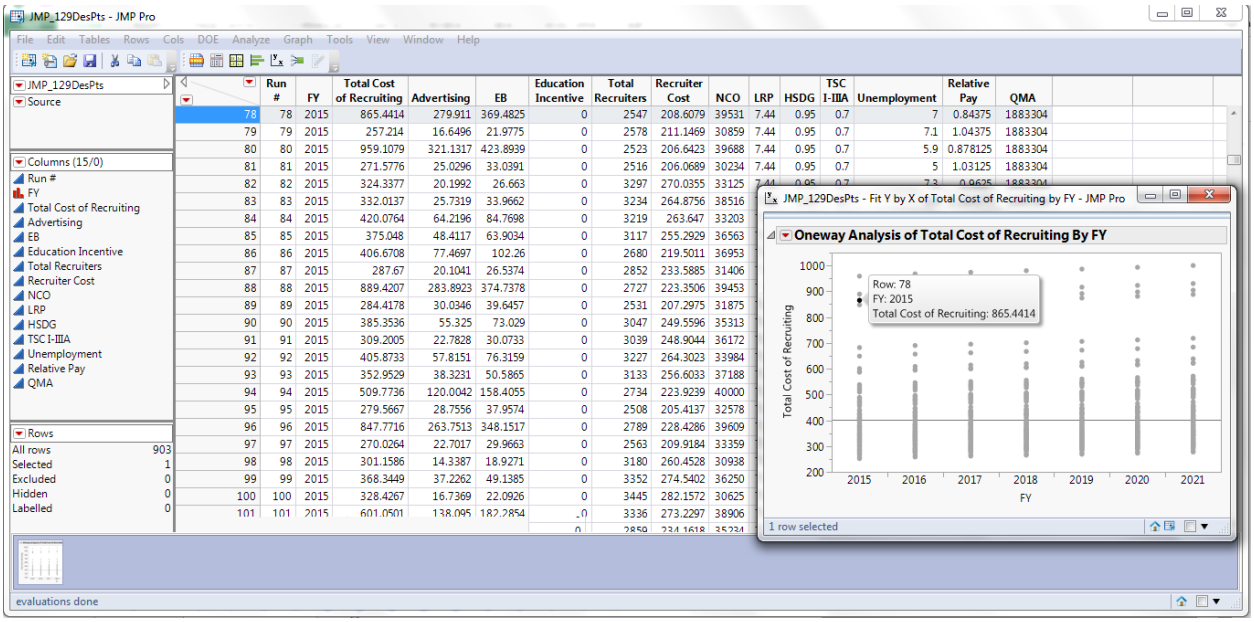
B. Explore Outliers from the Oneway Analysis Graph



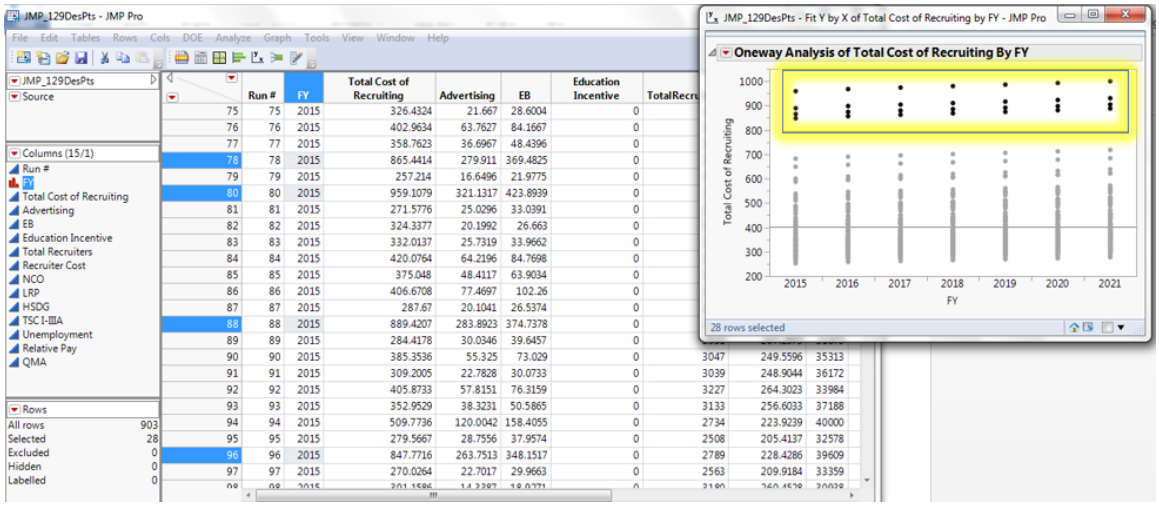
Step 1: Hover your mouse over a data point of interest to retrieve information regarding that point.



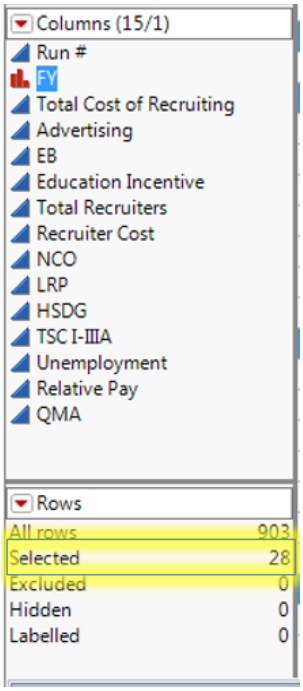
Clicking on the data point on the graph will highlight it within the greater data set. Understanding the input variables can help explain why the total cost of recruiting was unusually high for this data point.



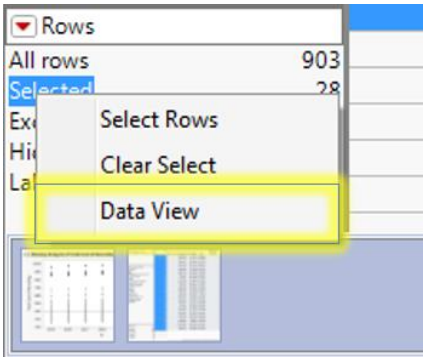
Step 2: To explore a group of outliers, lasso the data points of interest by creating a box around the data points with your mouse. Lassoing the data points will automatically select these data points within the greater data set.



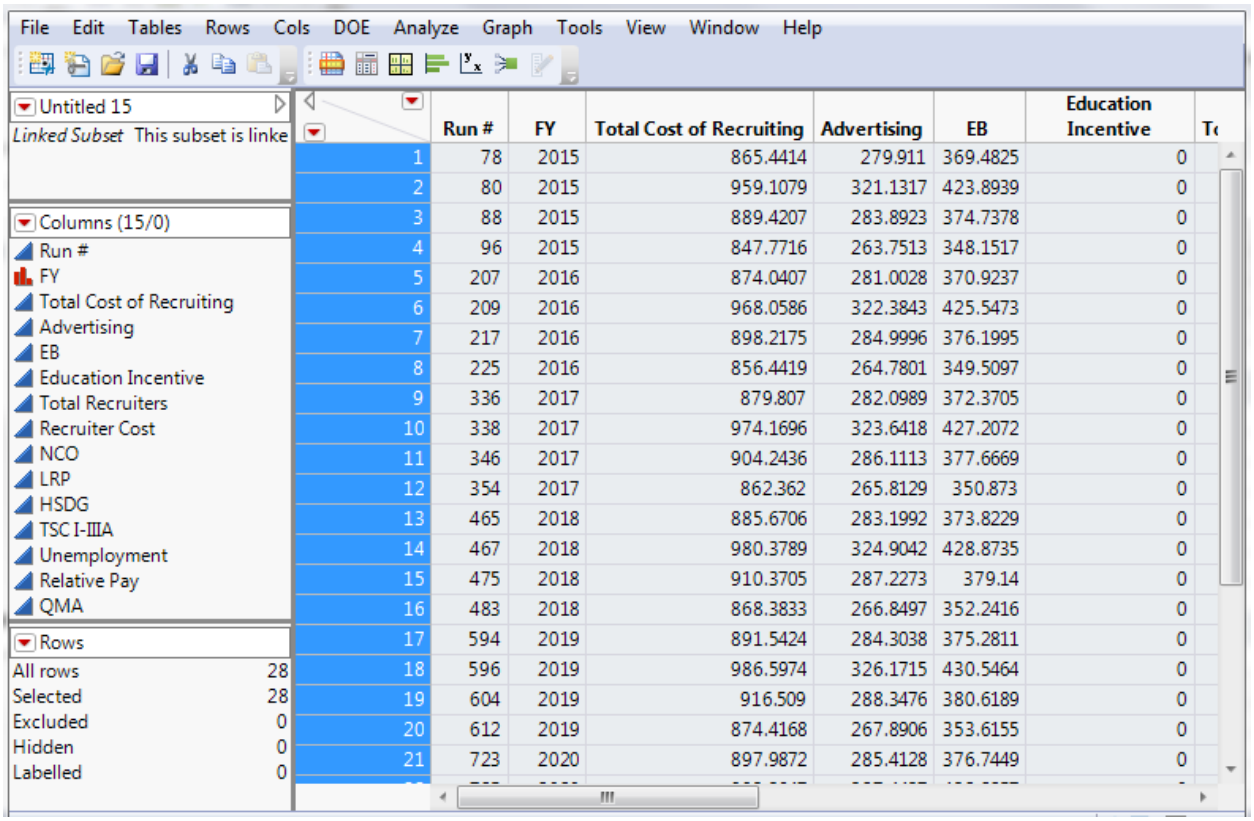
Step 3: The selected data points can be further analyzed on their own. Right-click on "Selected."



Then choose "Data View" from the drop down menu.



This will create a separate data table with just the outliers.

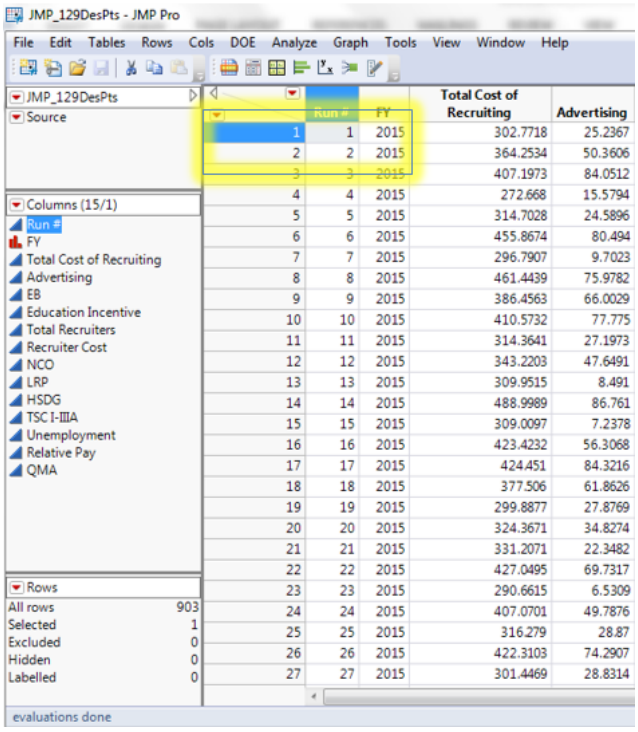


	Run #	FY	Total Cost of Recruiting	Advertising	EB	Education Incentive	T
1	78	2015	865.4414	279.911	369.4825	0	
2	80	2015	959.1079	321.1317	423.8939	0	
3	88	2015	889.4207	283.8923	374.7378	0	
4	96	2015	847.7716	263.7513	348.1517	0	
5	207	2016	874.0407	281.0028	370.9237	0	
6	209	2016	968.0586	322.3843	425.5473	0	
7	217	2016	898.2175	284.9996	376.1995	0	
8	225	2016	856.4419	264.7801	349.5097	0	
9	336	2017	879.807	282.0989	372.3705	0	
10	338	2017	974.1696	323.6418	427.2072	0	
11	346	2017	904.2436	286.1113	377.6669	0	
12	354	2017	862.362	265.8129	350.873	0	
13	465	2018	885.6706	283.1992	373.8229	0	
14	467	2018	980.3789	324.9042	428.8735	0	
15	475	2018	910.3705	287.2273	379.14	0	
16	483	2018	868.3833	266.8497	352.2416	0	
17	594	2019	891.5424	284.3038	375.2811	0	
18	596	2019	986.5974	326.1715	430.5464	0	
19	604	2019	916.509	288.3476	380.6189	0	
20	612	2019	874.4168	267.8906	353.6155	0	
21	723	2020	897.9872	285.4128	376.7449	0	

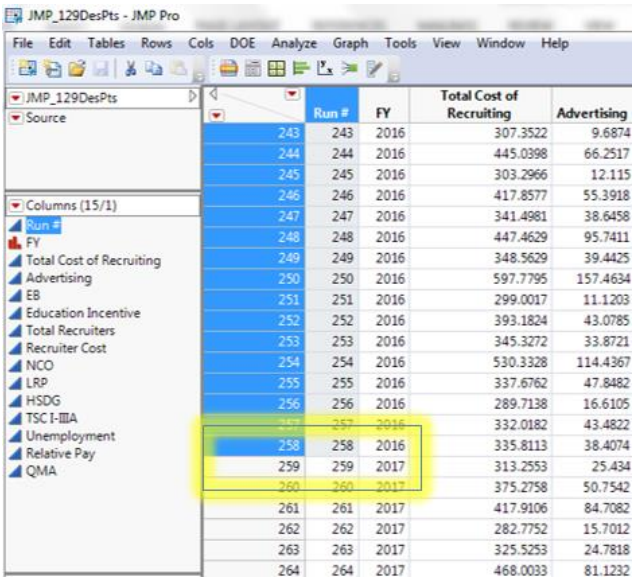
C. Select one FY to Analyze

To focus analysis on one specific FY, the other six FYs must be hidden and excluded. In this example, FY 2017 is the FY of interest. FYs 2015, 2016, 2018, 2019, 2020, and 2021 will be hidden and excluded.

Step 1: To exclude FY 2015 and 2016, select on the first row of FY 2015 data in the furthest column to the left. Hold the “shift” keyboard button.

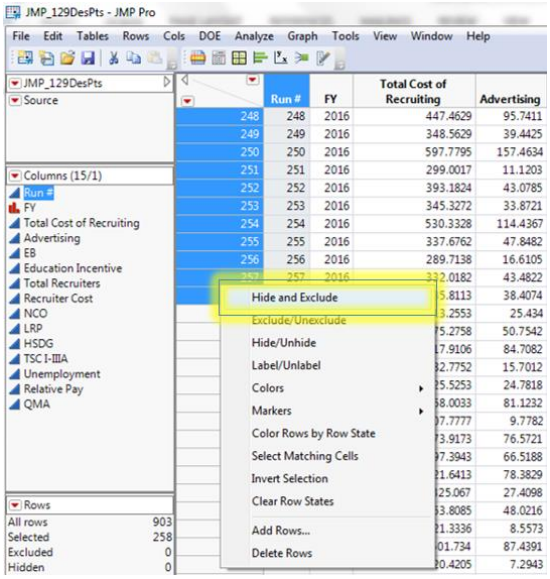


Step 2: Scroll down to the last row of FY 2016 data (which appears in row “258”). Click on the “258” cell in the furthest column to the left.



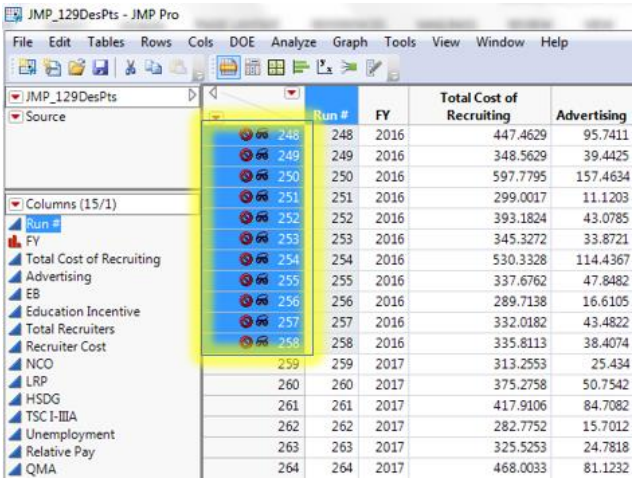
	Run #	FY	Total Cost of Recruiting	Advertising
243	243	2016	307.3522	9.6874
244	244	2016	445.0398	66.2517
245	245	2016	303.2966	12.115
246	246	2016	417.8577	55.3918
247	247	2016	341.4981	38.6458
248	248	2016	447.4629	95.7411
249	249	2016	348.5629	39.4425
250	250	2016	597.7795	157.4634
251	251	2016	299.0017	11.1203
252	252	2016	393.1824	43.0785
253	253	2016	345.3272	33.8721
254	254	2016	530.3328	114.4367
255	255	2016	337.6762	47.8482
256	256	2016	289.7138	16.6105
257	257	2016	332.0182	43.4822
258	258	2016	335.8113	38.4074
259	259	2017	313.2553	25.434
260	260	2017	375.2758	50.7542
261	261	2017	417.9106	84.7082
262	262	2017	282.7752	15.7012
263	263	2017	325.5253	24.7818
264	264	2017	468.0033	81.1232

Step 3: Right-click on the selected rows, and choose “Hide and Exclude” from the drop down menu.



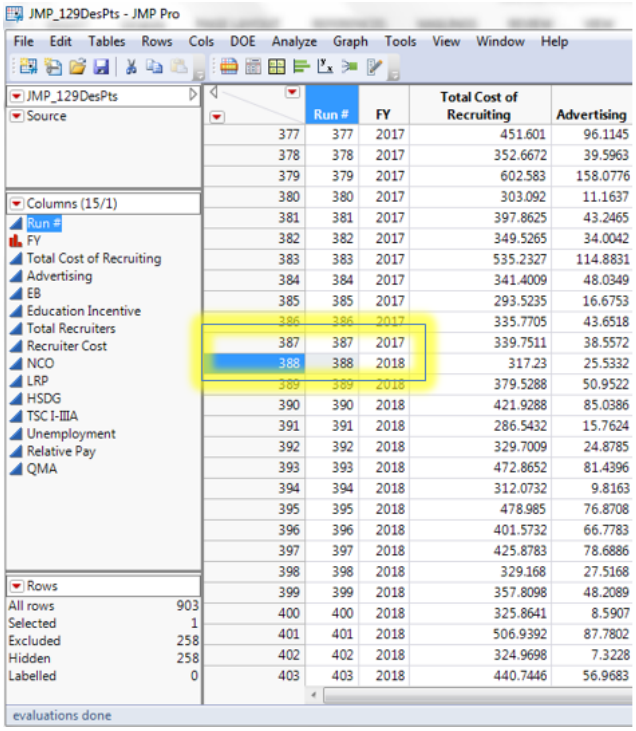
	Run #	FY	Total Cost of Recruiting	Advertising
248	248	2016	447.4629	95.7411
249	249	2016	348.5629	39.4425
250	250	2016	597.7795	157.4634
251	251	2016	299.0017	11.1203
252	252	2016	393.1824	43.0785
253	253	2016	345.3272	33.8721
254	254	2016	530.3328	114.4367
255	255	2016	337.6762	47.8482
256	256	2016	289.7138	16.6105
257	257	2016	332.0182	43.4822
258	258	2016	335.8113	38.4074
259	259	2017	313.2553	25.434
260	260	2017	375.2758	50.7542
261	261	2017	417.9106	84.7082
262	262	2017	282.7752	15.7012
263	263	2017	325.5253	24.7818
264	264	2017	468.0033	81.1232

You should now see  next to each row of data from FY 2015 and 2016.



Run #	FY	Total Cost of Recruiting	Advertising
248	2016	447.4629	95.7411
249	2016	348.5629	39.4425
250	2016	597.7795	157.4634
251	2016	299.0017	11.1203
252	2016	393.1824	43.0785
253	2016	345.3272	33.8721
254	2016	530.3328	114.4367
255	2016	337.6762	47.8482
256	2016	289.7138	16.6105
257	2016	332.0182	43.4822
258	2016	335.8113	38.4074
259	2017	313.2553	25.434
260	2017	375.2758	50.7542
261	2017	417.9106	84.7082
262	2017	282.7752	15.7012
263	2017	325.5253	24.7818
264	2017	468.0033	81.1232

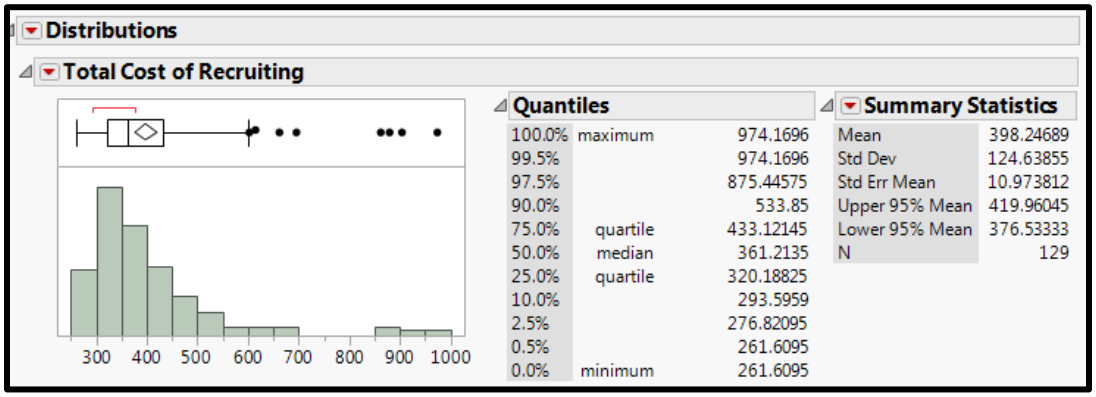
Step 4: Follow steps 1-3 to hide and exclude data from FY 2018, 2019, 2020 and 2021. Row 388 is the first row of data for FY 2018.



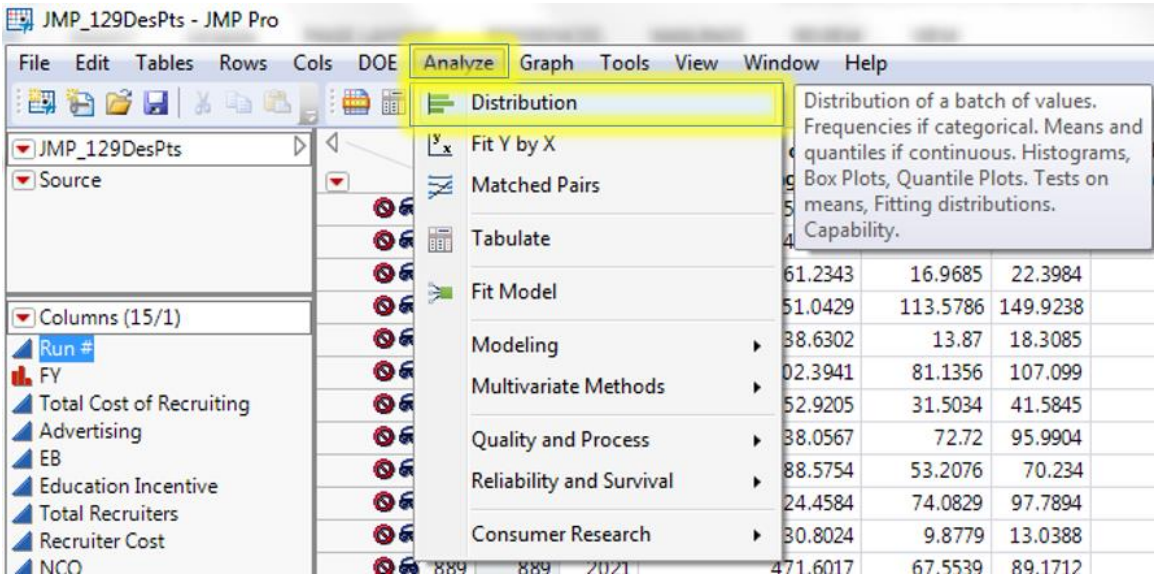
Run #	FY	Total Cost of Recruiting	Advertising
377	2017	451.601	96.1145
378	2017	352.6672	39.5963
379	2017	602.583	158.0776
380	2017	303.092	11.1637
381	2017	397.8625	43.2465
382	2017	349.5265	34.0042
383	2017	535.2327	114.8831
384	2017	341.4009	48.0349
385	2017	293.5235	16.6753
386	2017	335.7705	43.6518
387	2017	339.7511	38.5572
388	2018	317.23	25.5332
389	2018	379.5288	50.9522
390	2018	421.9288	85.0386
391	2018	286.5432	15.7624
392	2018	329.7009	24.8785
393	2018	472.8652	81.4396
394	2018	312.0732	9.8163
395	2018	478.985	76.8708
396	2018	401.5732	66.7783
397	2018	425.8783	78.6886
398	2018	329.168	27.5168
399	2018	357.8098	48.2089
400	2018	325.8641	8.5907
401	2018	506.9392	87.7802
402	2018	324.9698	7.3228
403	2018	440.7446	56.9683

D. Distribution

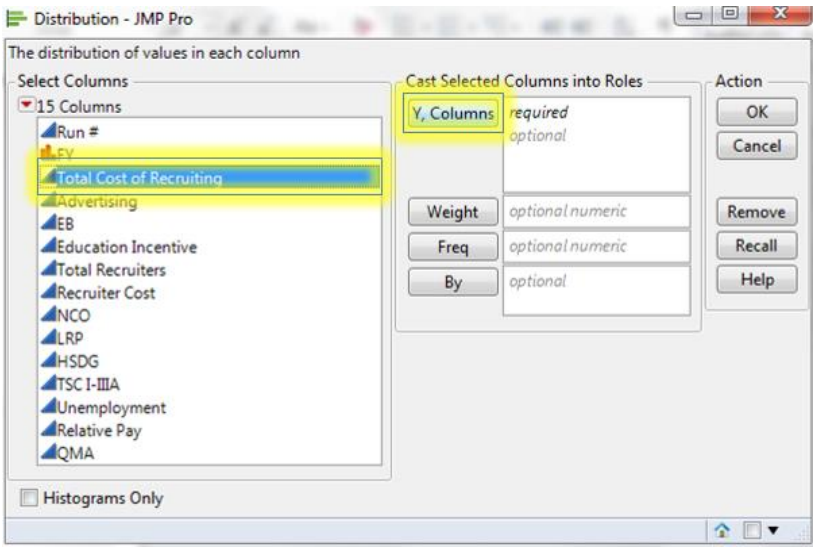
The distribution of the total cost of recruiting for FY 2017 is explored. This technique can be applied to any of the output variables to better understand its distribution and possible spread values.



Step 1: Select “Analyze” from the ribbon, and select “Distribution” from the drop down menu.

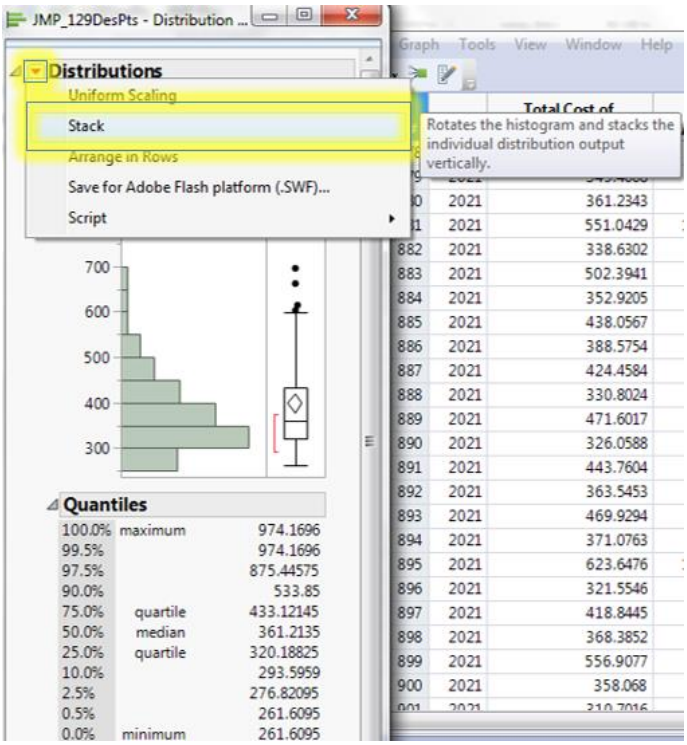


Step 2: Select “Total Cost of Recruiting” from the list of columns, and click on the “Y, Columns” button.



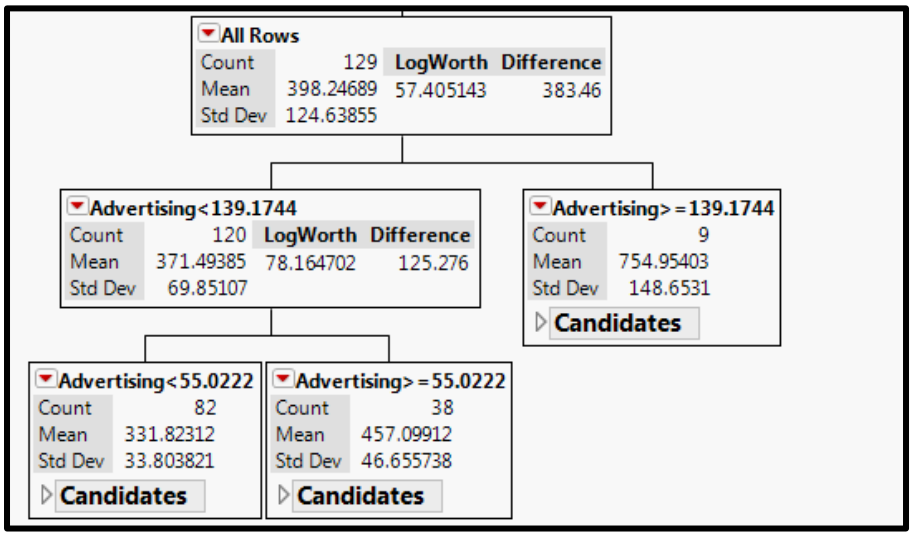
The distribution for Total Cost of Recruiting will appear.

Step 3: To rotate the distribution to appear horizontal, click on the red triangle in the upper left hand corner of the graph, and select “Stack” from the drop down menu.

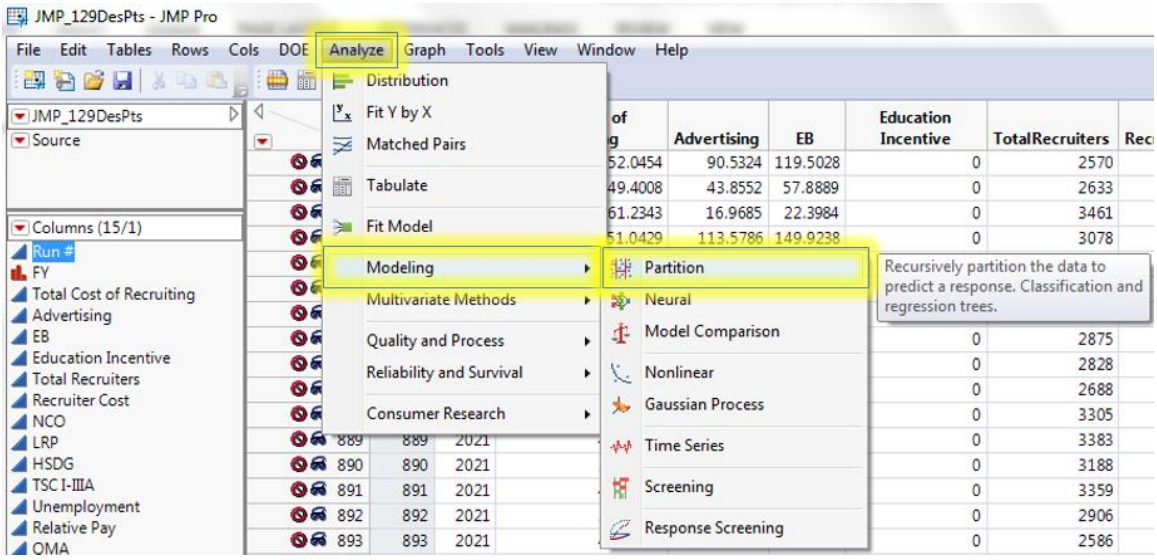


E. Partition Trees

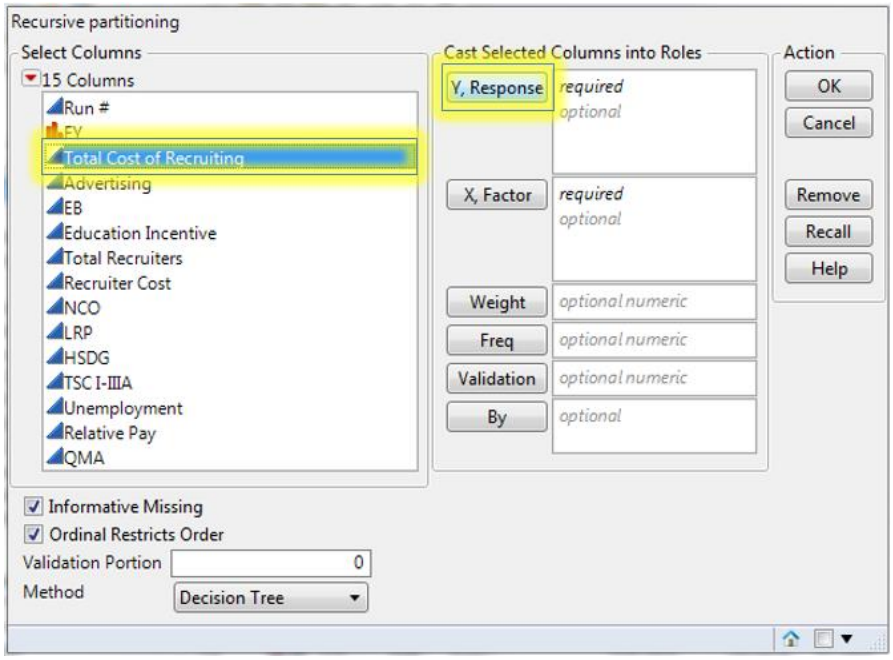
The partition tree on total cost of recruiting will be explored. The partition tree is a useful method that can help provide insights into variable interactions.



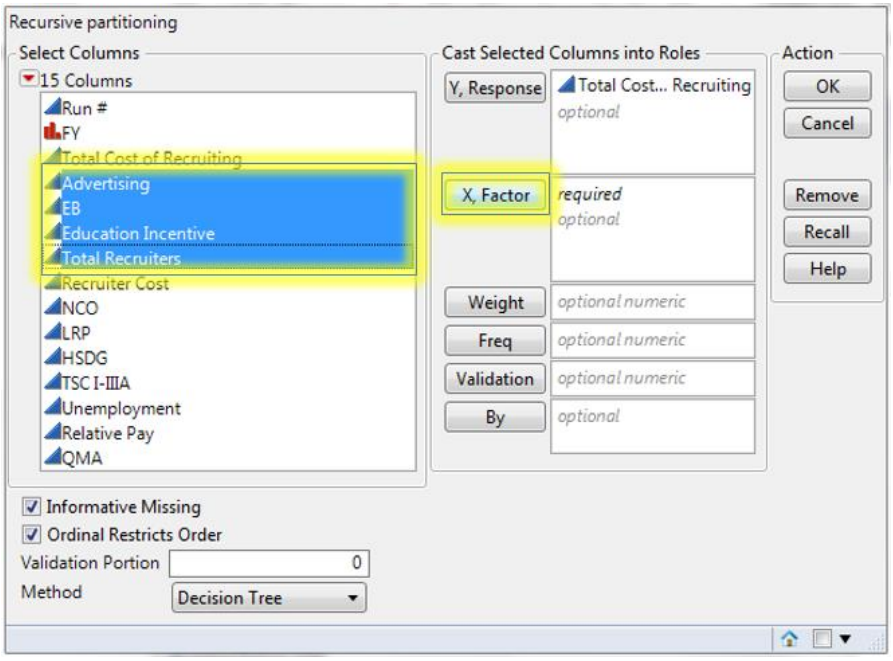
Step 1: To create a partition tree, select "Analyze" from the ribbon. Then choose "Modeling," and "Partition" from the drop down menus.



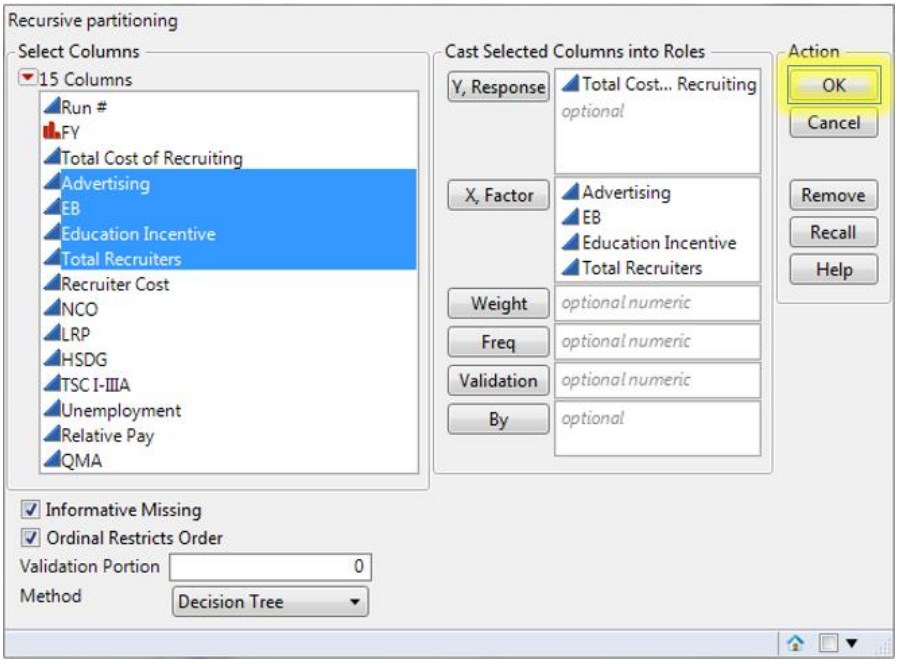
Step 2: Select “Total Cost of Recruiting” from the list of columns, and click on the “Y, Response” button.



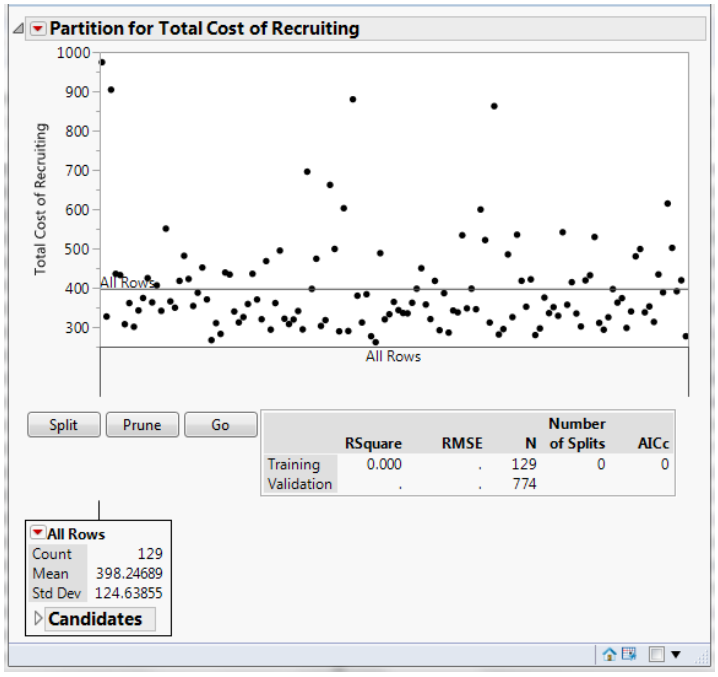
Step 3: Select each decision variable (Advertising, EB, Education Incentive, Total Recruiters) from the list of columns, then click on the “X, Factor” button.



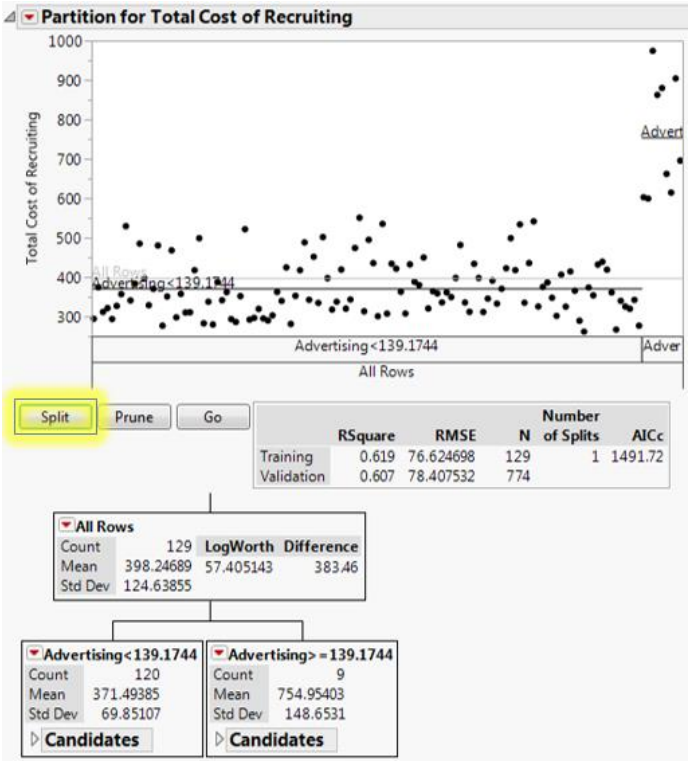
Step 4: Click on the “OK” button.



The partition tree window will pop-up with just the parent node.



Step 5: To make the first split on “Total Cost of Recruiting,” click on the “Split” button.

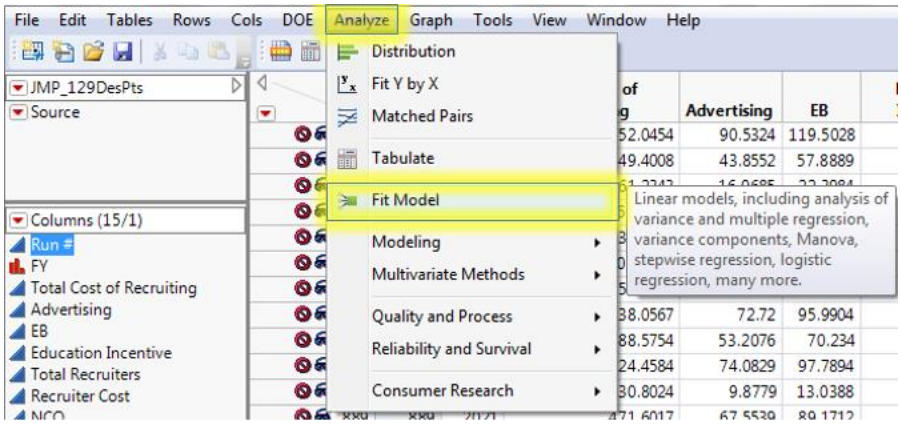


Continue to split, by clicking the “Split” button. If you want to undo a split, click on the “Prune” button. A “Training” R^2 value of 0.80 is an adequate threshold to achieve. In this case, disregard the “Validation” R^2 value.

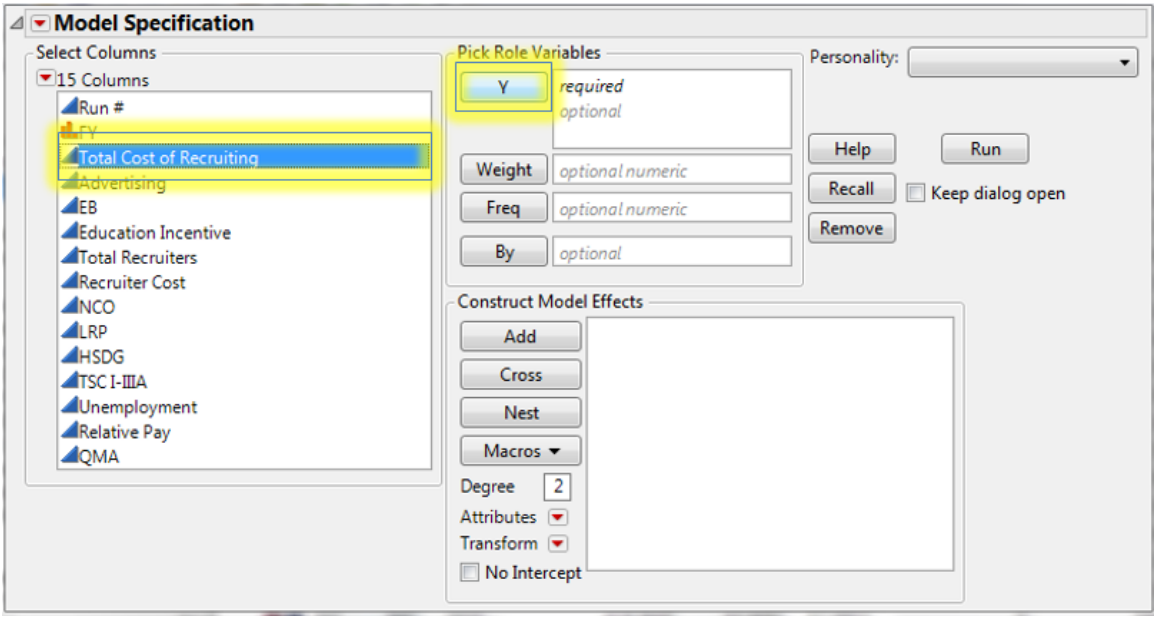
F. Stepwise Regression Model

To develop a model for the total cost of recruiting, stepwise regression is used to determine the beta estimates to fit a model.

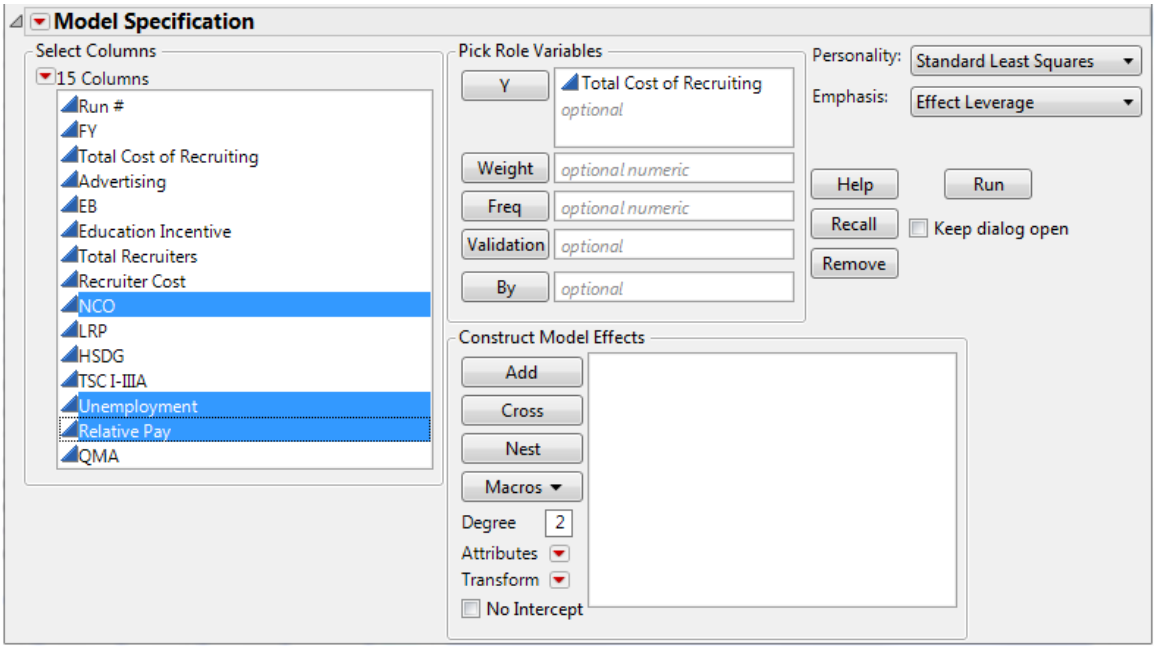
Step 1: Select “Analyze” from the ribbon, then “Fit Model” from the drop down menu.



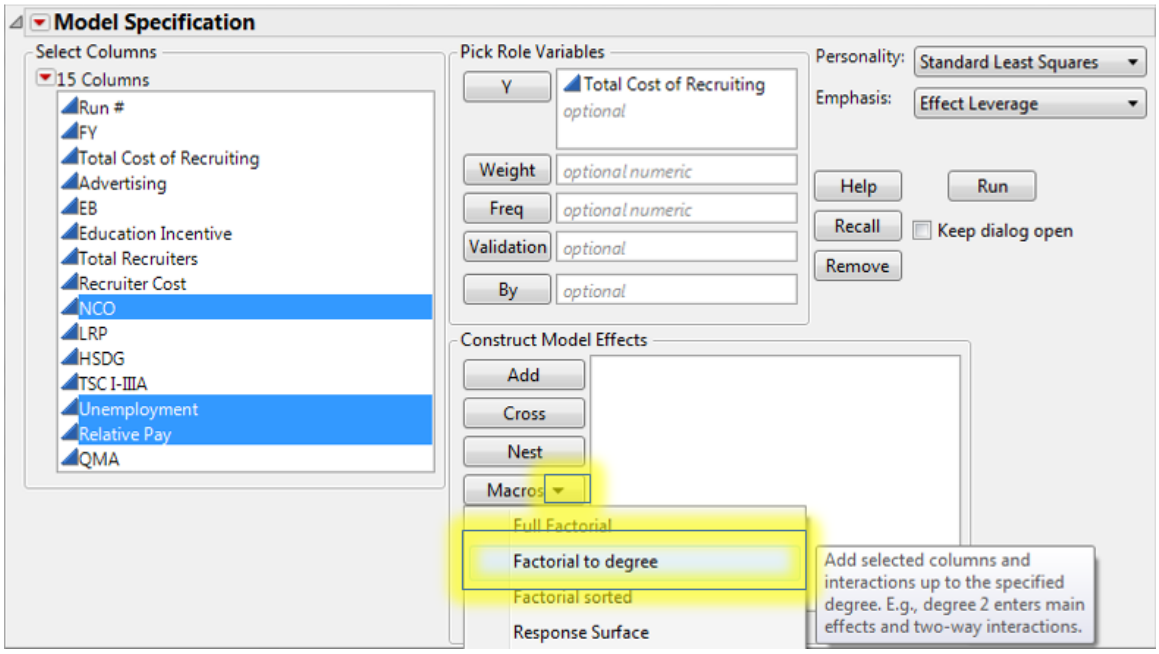
Step 2: Select “Total Cost of Recruiting” from the list of columns, and click on the “Y” button.



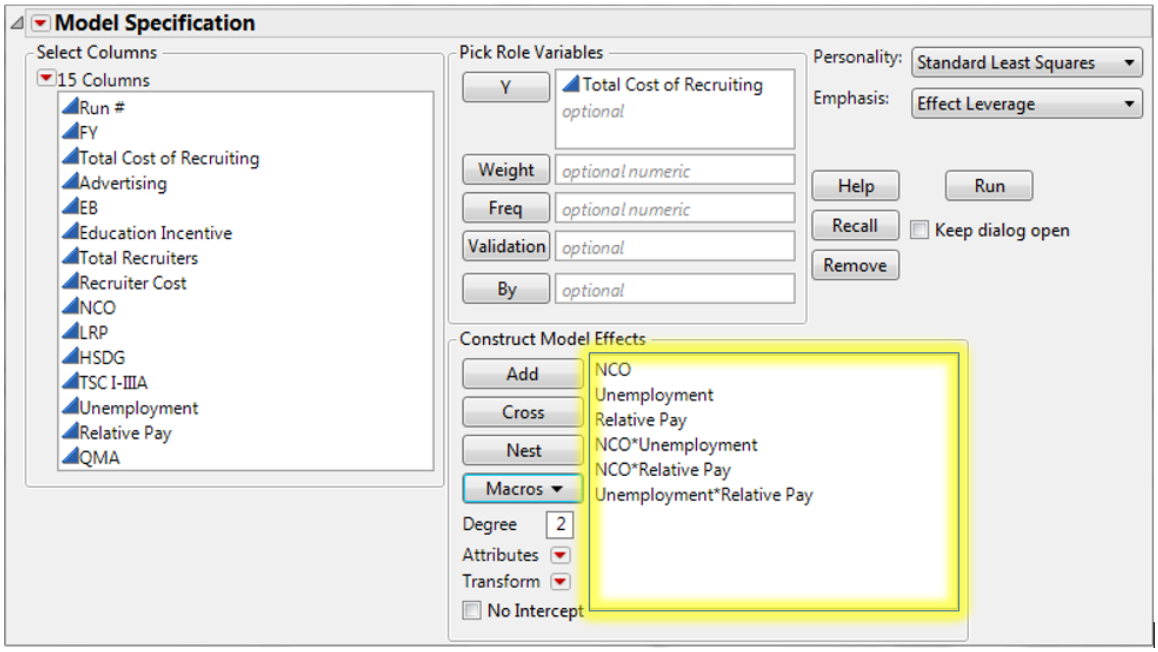
Step 3: While holding the Ctrl key, select each market factor that was varied in the PROM-WED excursion.



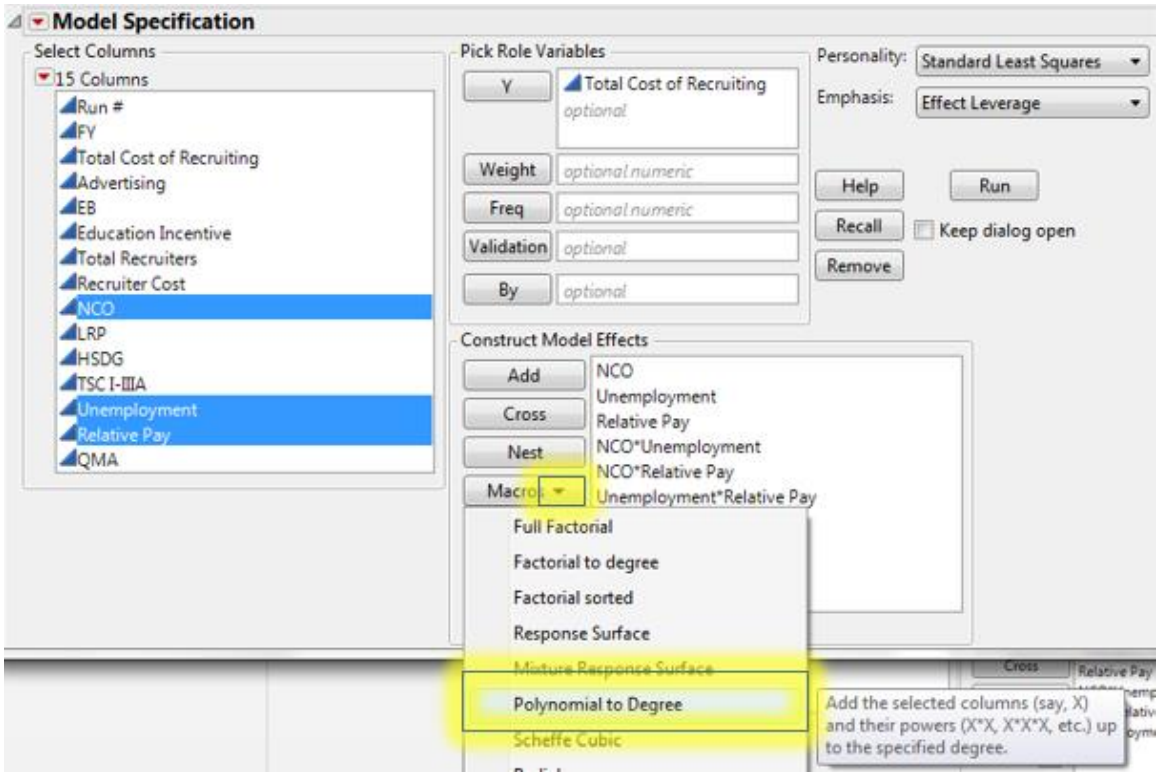
Select the right corner of the “Macros” button (i.e. the arrow), and select “Factorial to degree” from the drop-down menu.



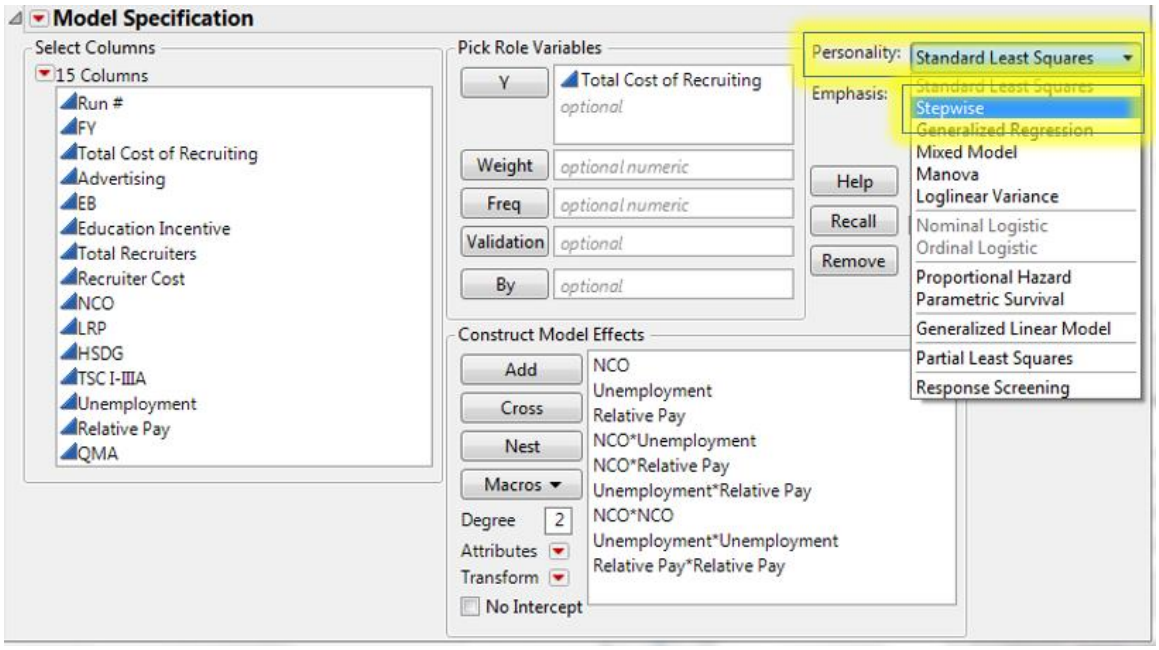
This will add all main effect and two-way interactions.



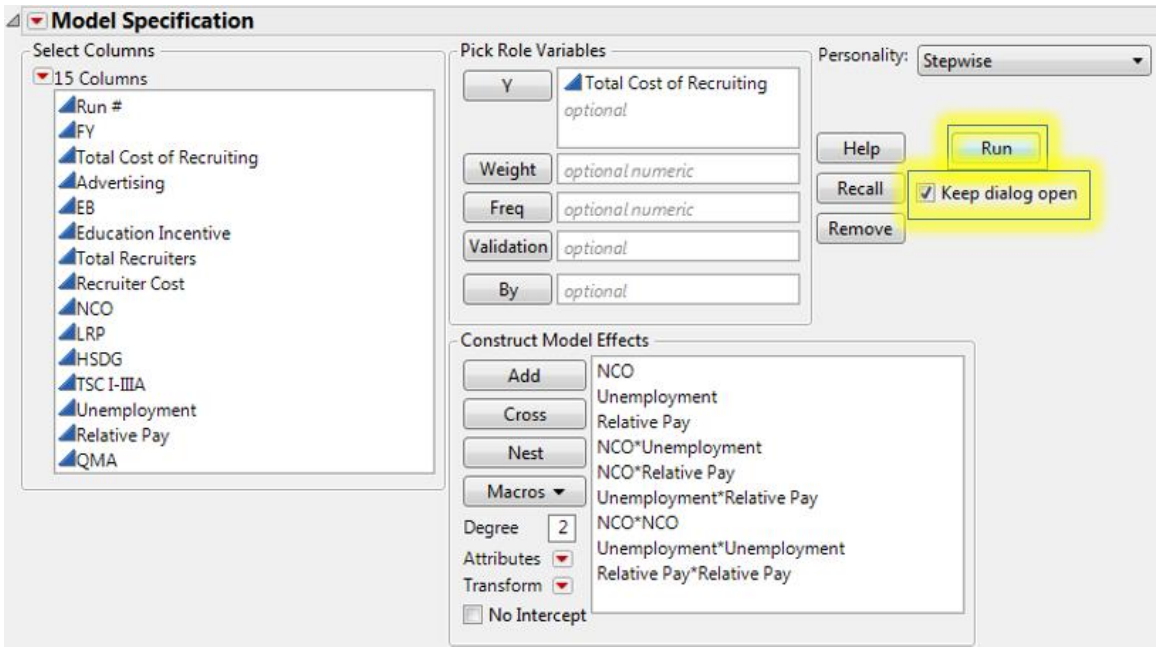
Again, while holding the Ctrl key, select each market factor that was varied in the PROM-WED excursion. Select the right corner of the “Macros” button (i.e. the arrow), and select “Polynomial to degree” from the drop-down menu. This will add all second degree polynomial interactions.



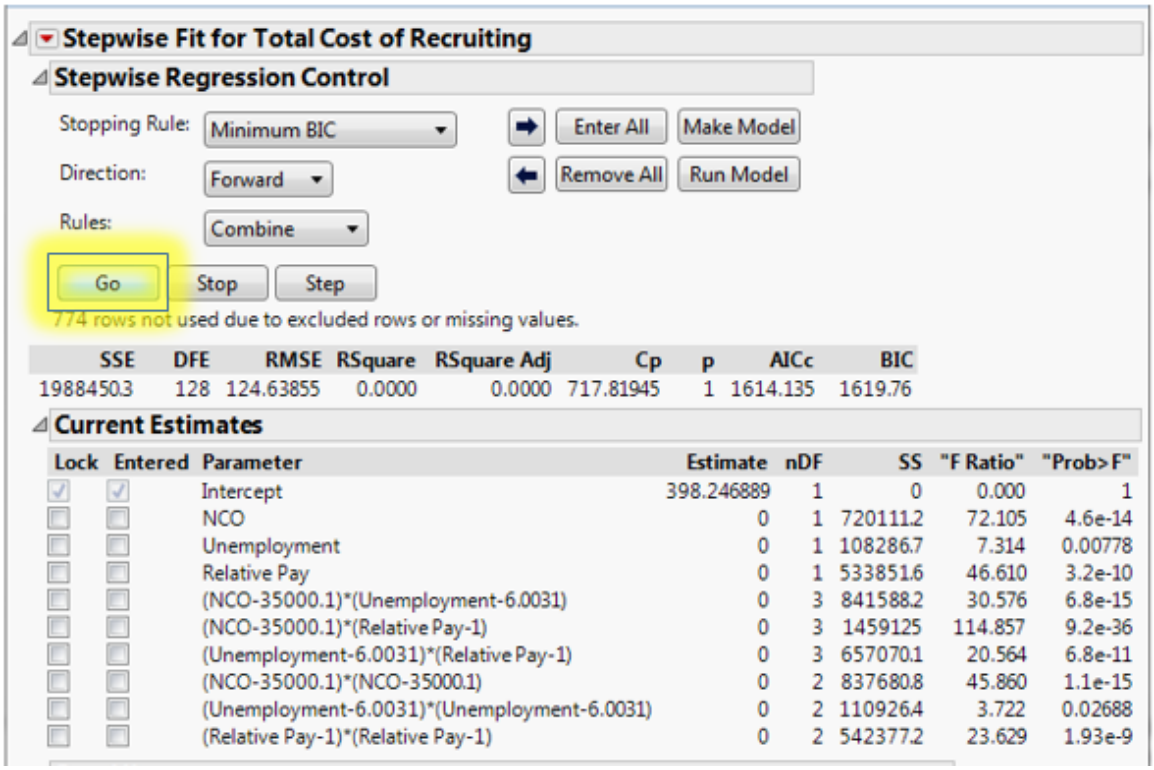
Step 4: From the “Personality” drop-down menu, select “Stepwise.”



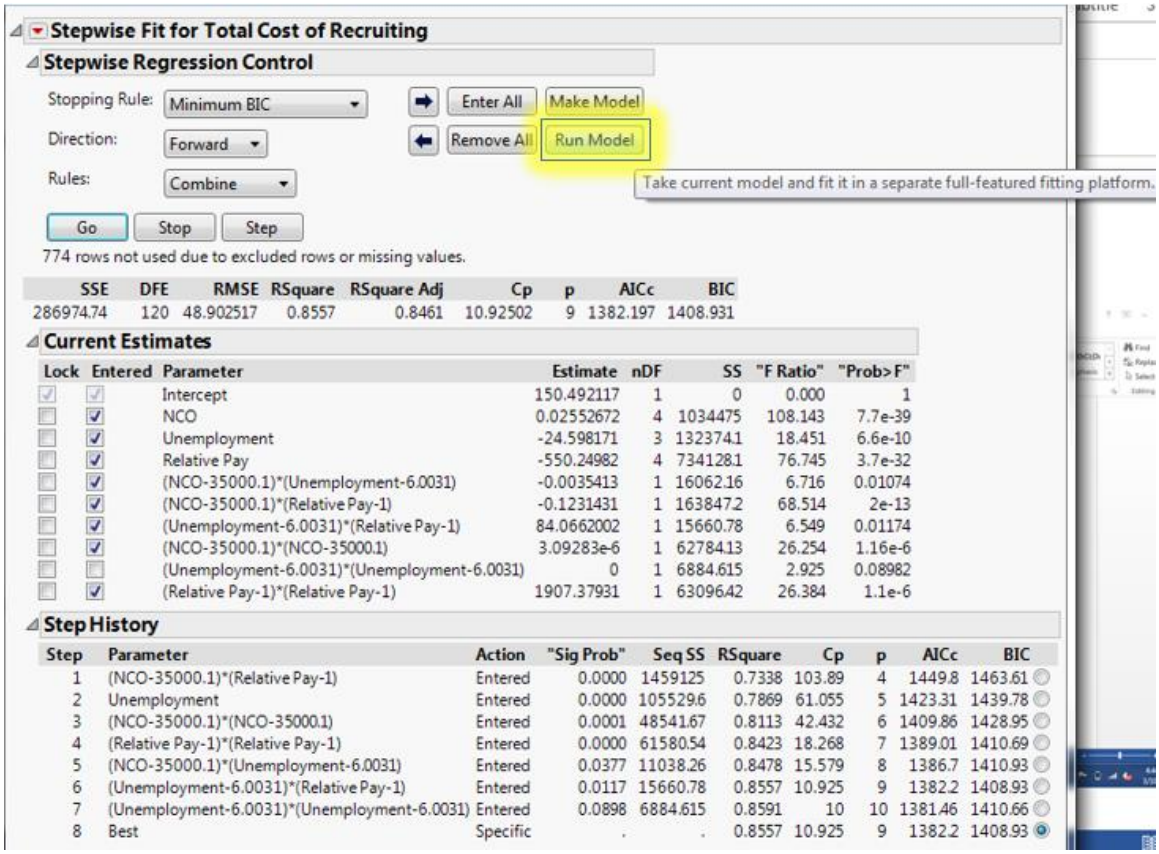
Step 5: Ensure that the “Keep dialog open” box is checked, and click the “Run” button.



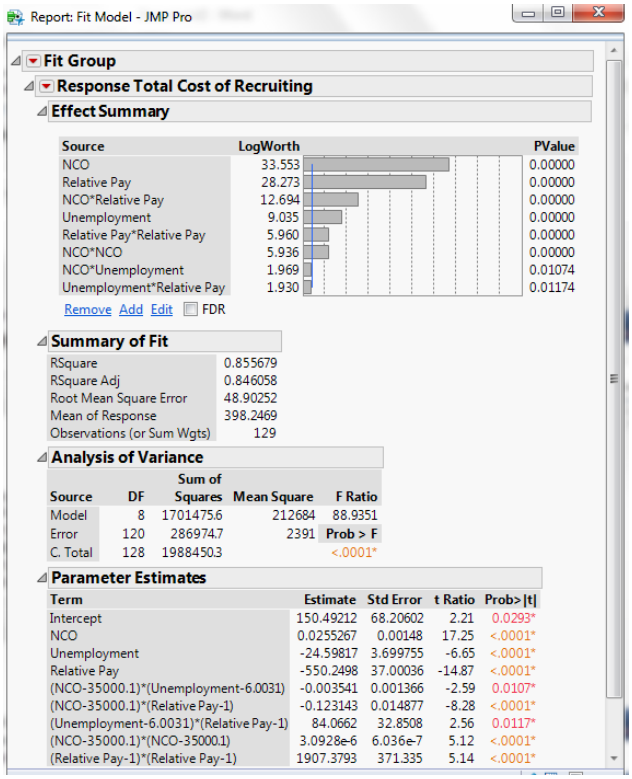
Step 6: The “Stepwise Regression Control” window will appear. Press the “Go” button.



Step 7: Once settled, select the “Run Model” button.

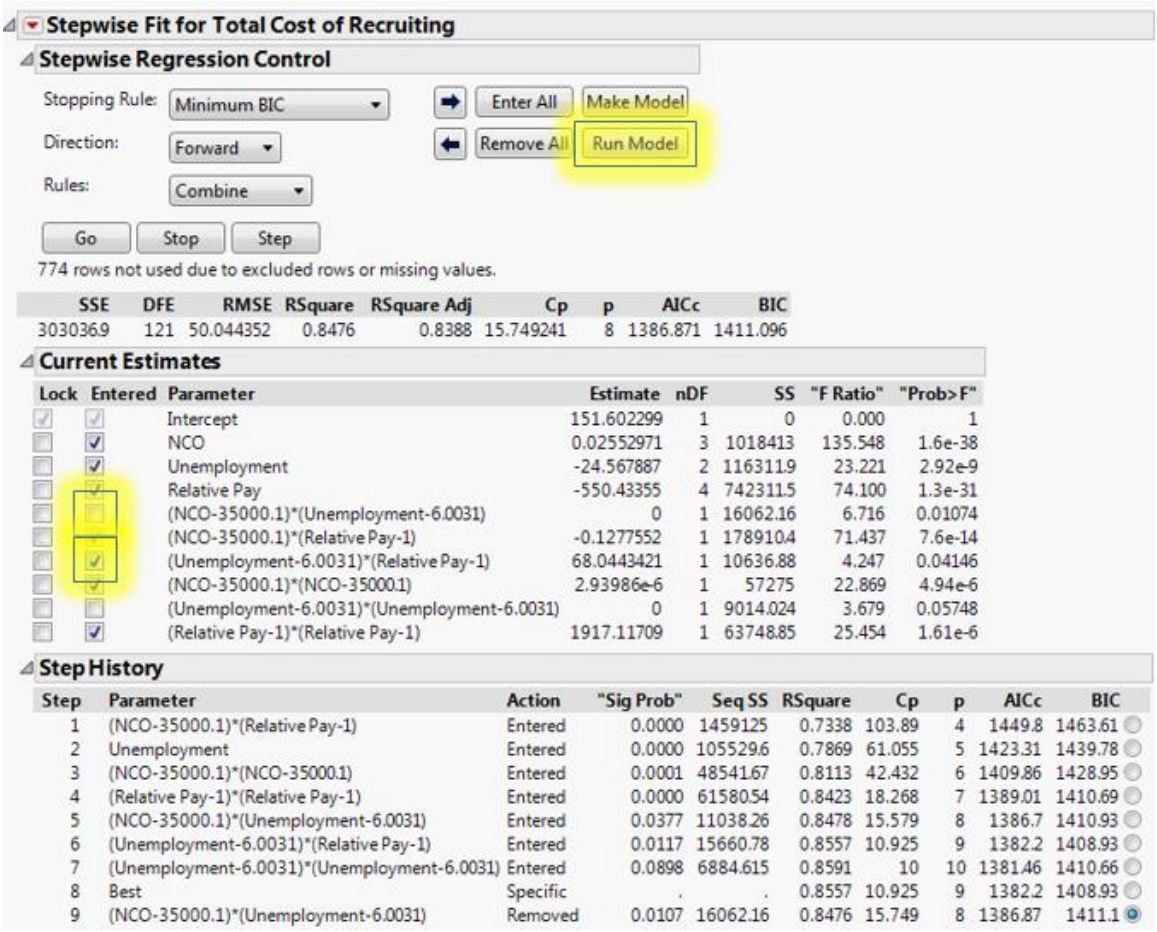


The “Report: Fit Model” window will appear.

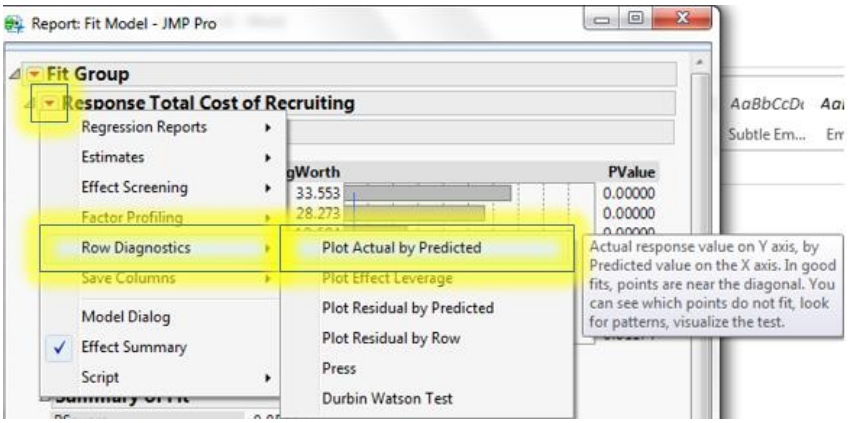


At this point, you can decide if you would like to make manual adjustments to the stepwise regression. For example, the interactions between unemployment rate and relative pay, and the new accession mission and unemployment in this example both exhibit low “t Ratio” values.

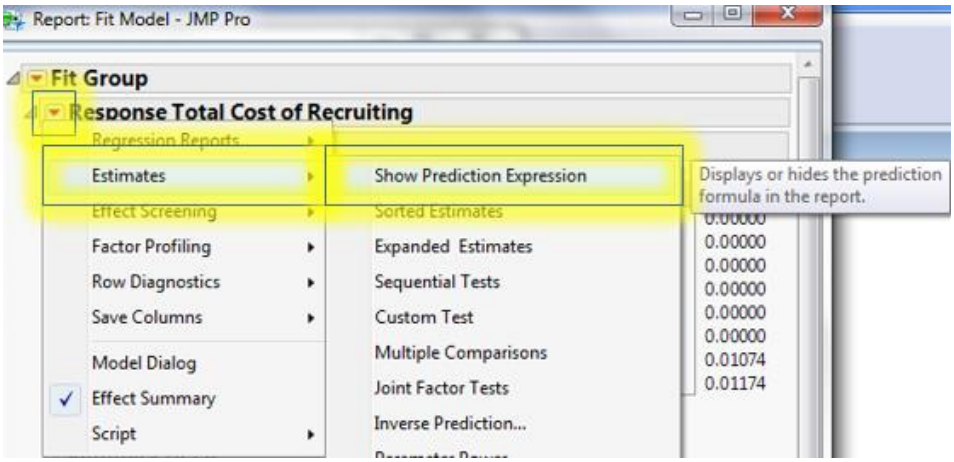
To remove these terms from the model, return to the “Stepwise Fit” window, and uncheck the terms in the “Entered” column that you would like to remove. Select “Run Model” to fit the new model.



Step 8: To graph the “Actual by Predicted” plot, select the red triangle next to “Response Total Cost of Recruiting.” From the drop-down menu, select “Row Diagnostics” and “Plot Actual by Predicted.”

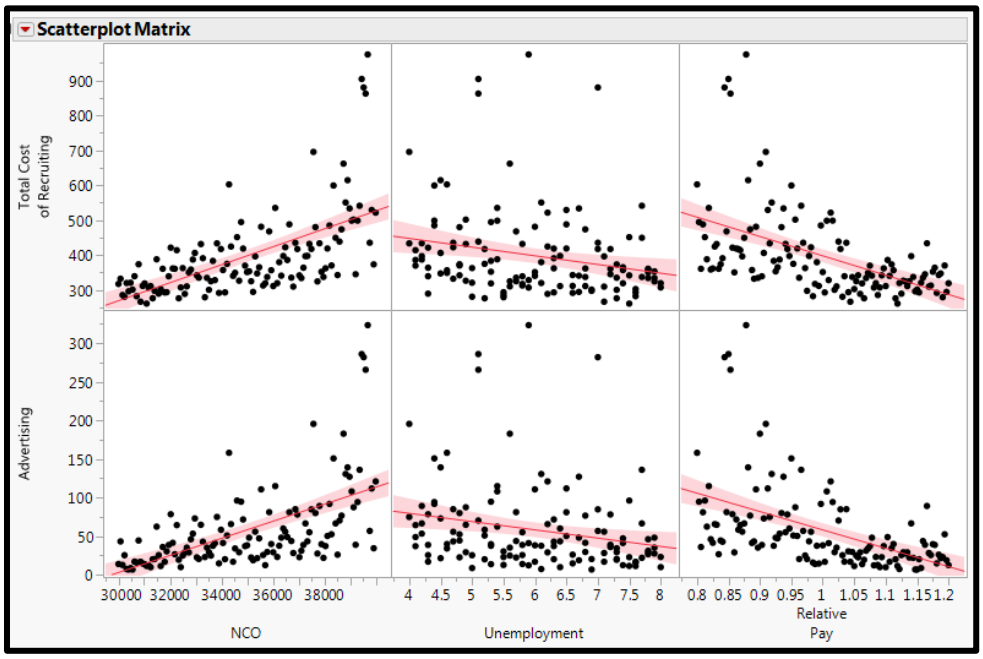


Step 9: To fit the prediction model, select the red triangle next to “Response Total Cost of Recruiting.” From the drop-down menu, select “Estimates” then “Show Prediction Expression.”

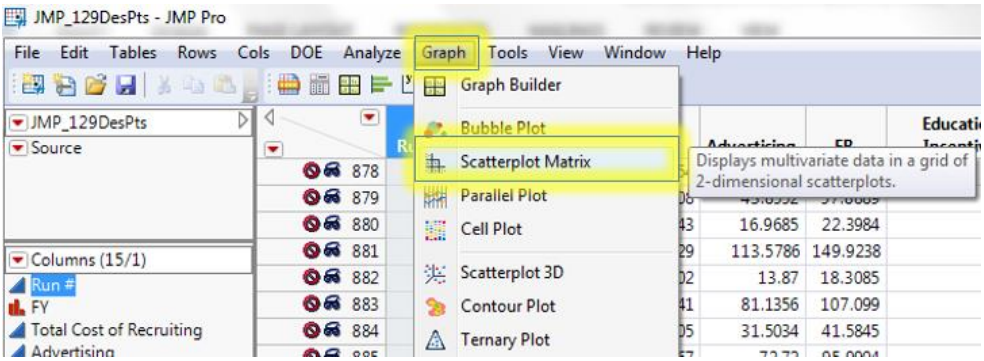


G. Scatterplot Matrix

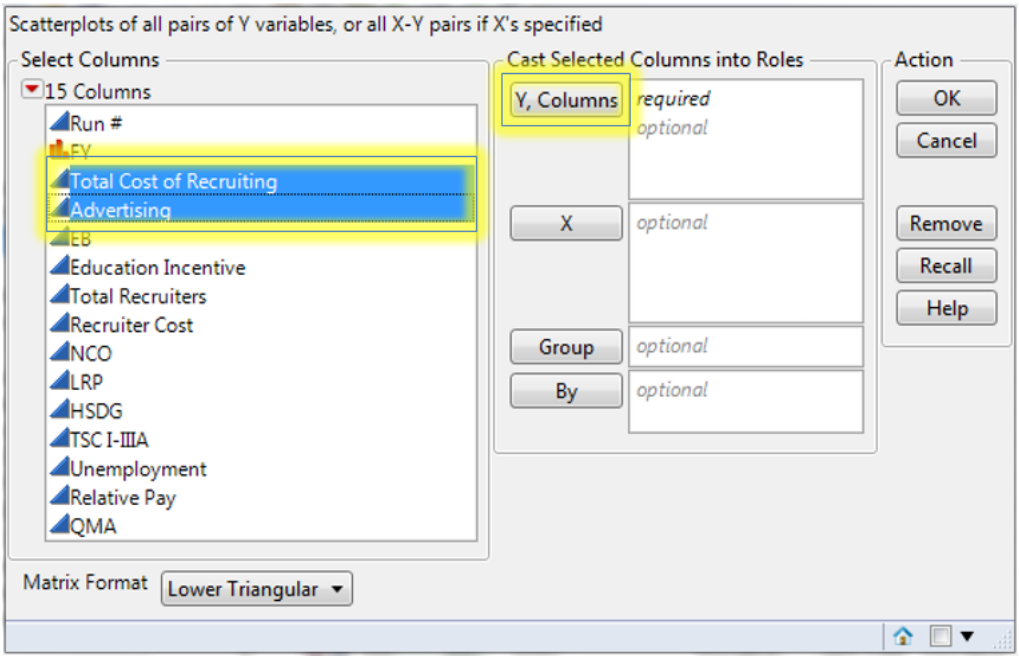
Scatterplot matrices can be used to visualize trends when multiple variables are changing.



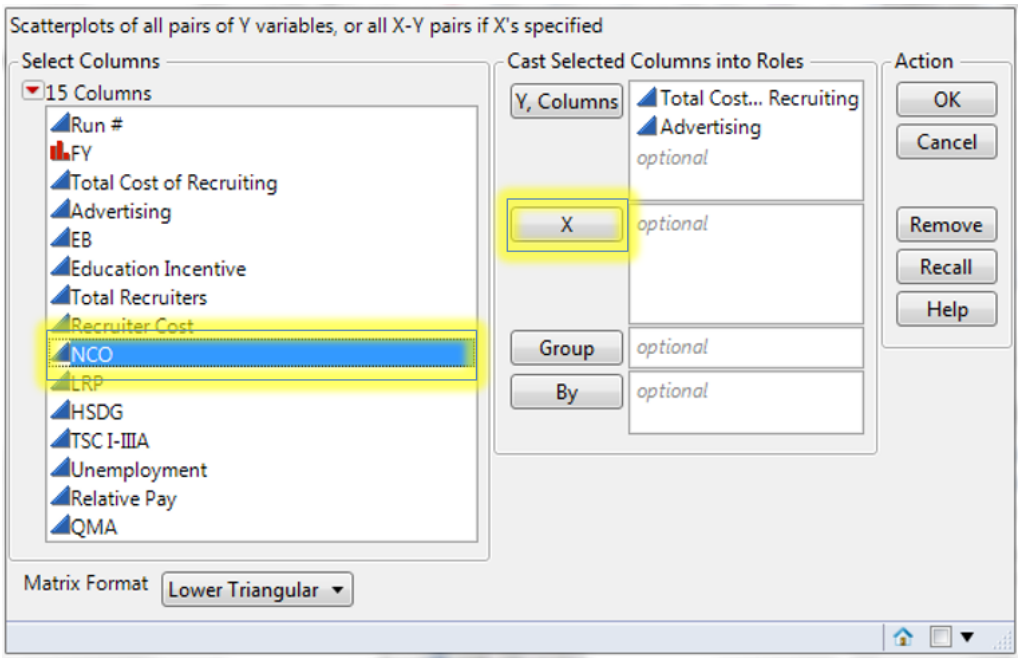
Step 1: Select “Graph” from the ribbon, then “Scatterplot Matrix” from the drop down menu.



Step 2: To set the Y-axis variables, select “Total Cost of Recruiting” and “Advertising” from the list of columns, and click on the “Y, Columns” button.

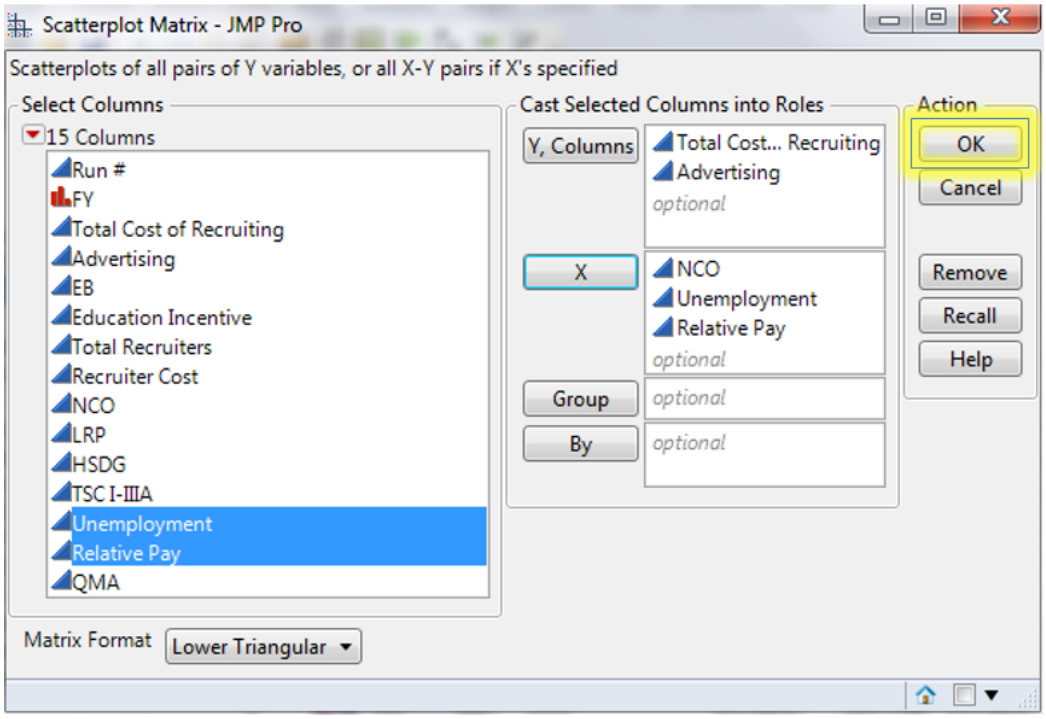


Step 3: To set the X-axis variables, select the variables of interest (NCO, Unemployment Rate and Relative Pay in this case), and click on the “X” button.

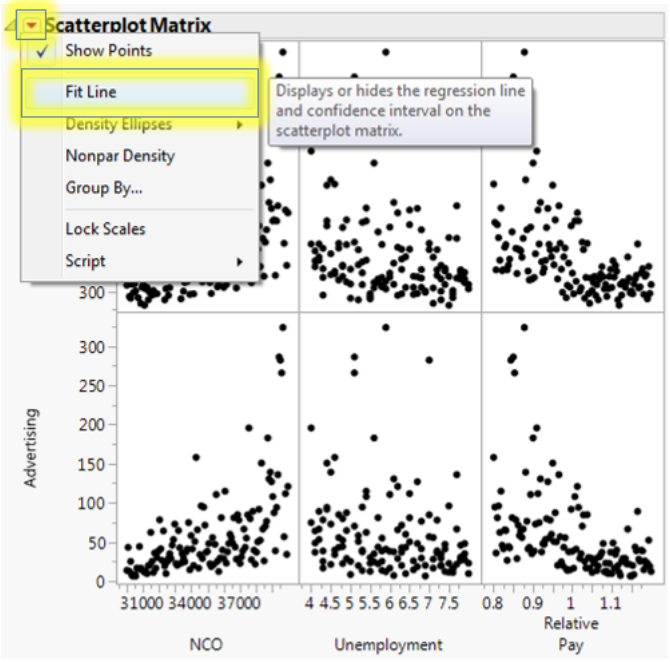


Step 4: Repeat Step 3 for Unemployment Rate and Relative Pay.

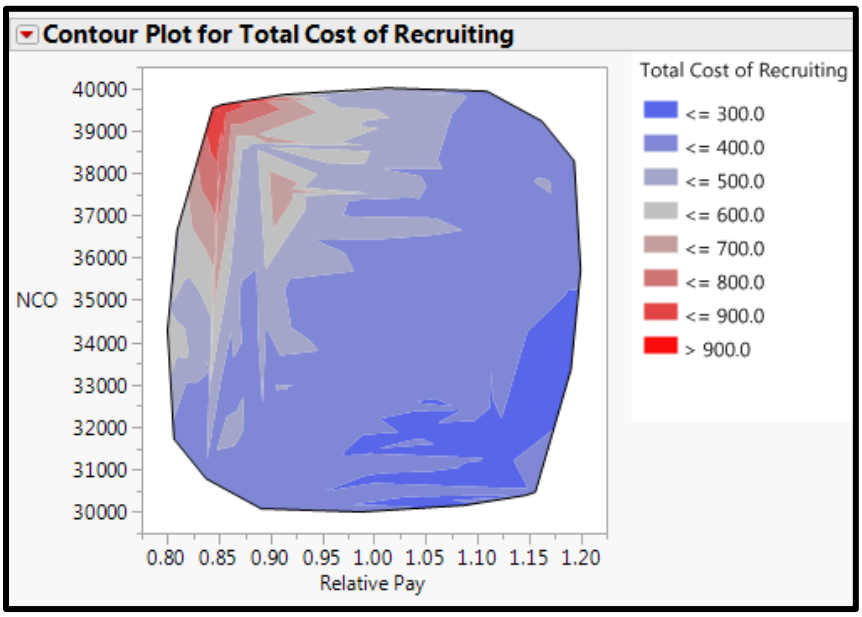
Step 5: To generate the scatterplot matrix, click the “OK” button.



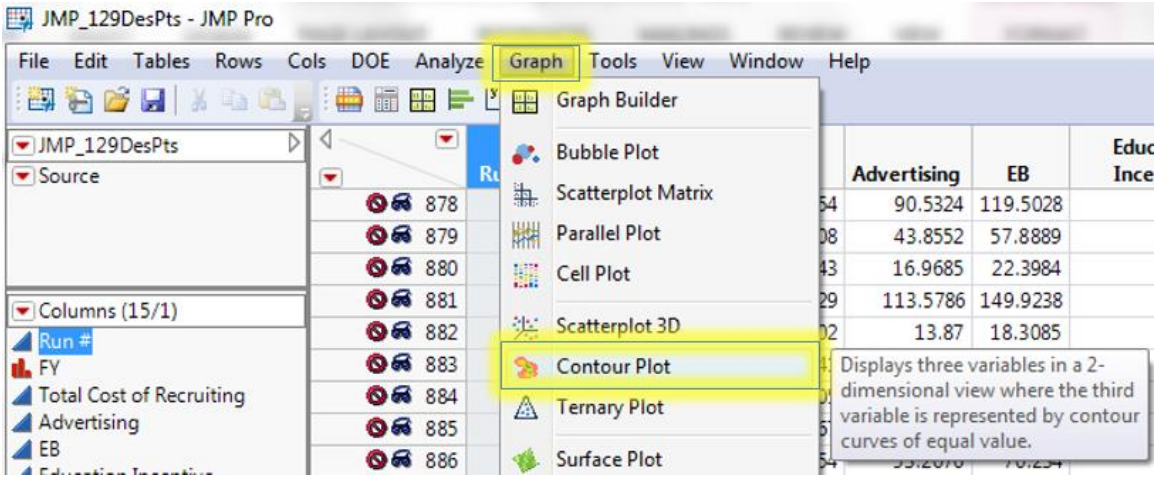
Step 5: To fit a trend line on the plots, click the red triangle, and select “Fit Line” from the drop down menu.



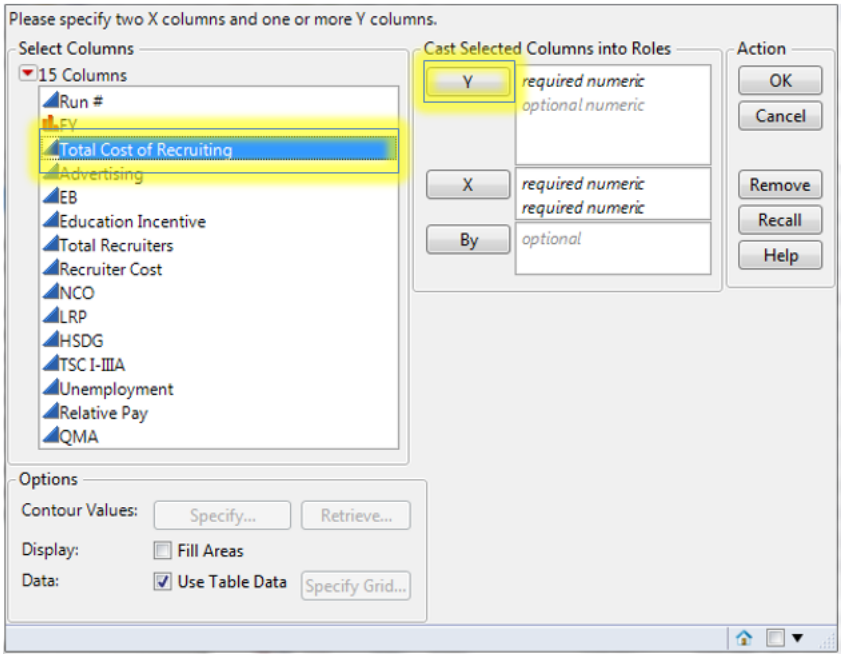
H. Contour Plots



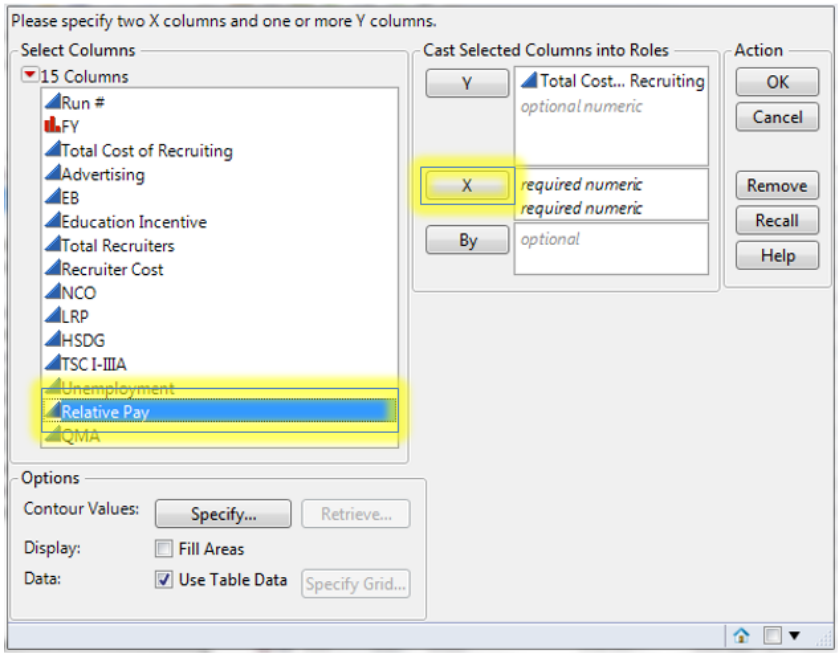
Step 1: Select “Graph” from the ribbon, then “Contour Plot” from the drop down menu.



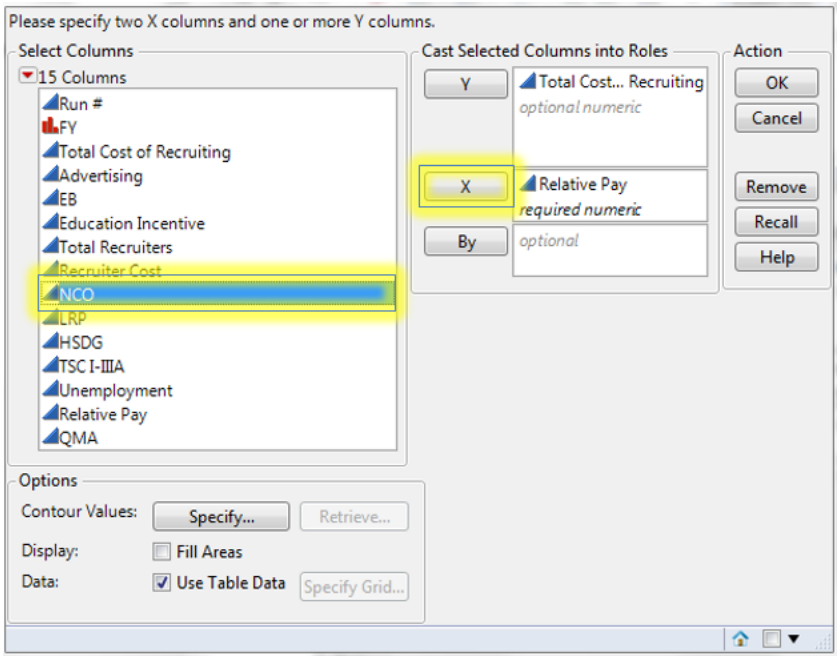
Step 2: To set “Total Cost of Recruiting” as the variable represented by the color scale, select “Total Cost of Recruiting” from the list of columns, and click the “Y” button.



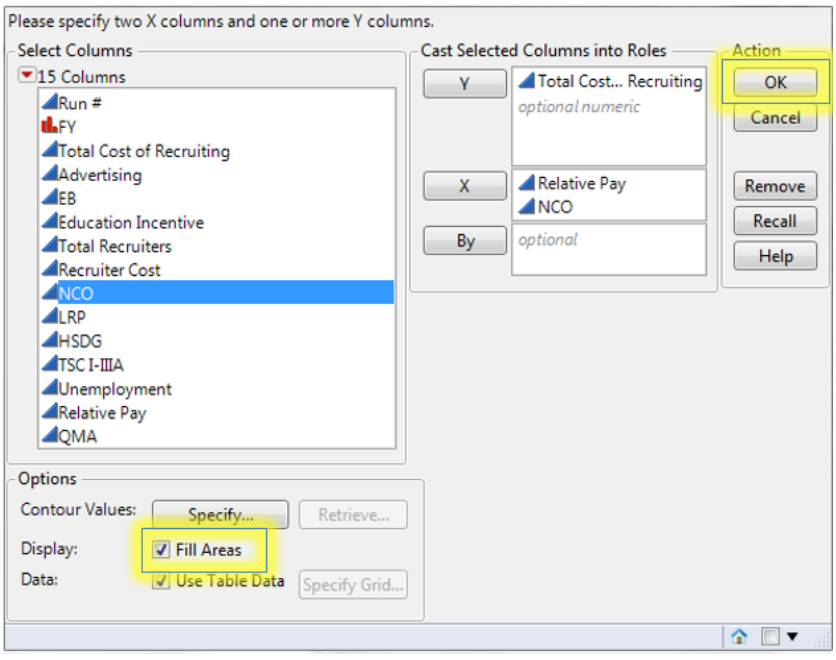
Step 3: To set “Relative Pay” as the x-axis, select “Relative Pay” from the list of columns, and click the “X” button.



Step 3: To set the new accession mission (NCO) as the y-axis, select “NCO” from the list of columns, and click the “X” button.



Step 4: Select the “Fill Areas” box, then click the “OK” button to generate the contour plot.



V. EXAMPLE TEST CASES

Two test case examples are provided to demonstrate PROM-WED's capabilities.

A. Effect of Economic Uncertainties

What is the optimal allocation of recruiting resources that is robust to a broad range of economic uncertainties?

Variable Type	Variable Name	Value Low	Value High
Decision Variable	Recruiters	2,500 recruiters	3,500 recruiters
Market Factor	Unemployment Rate	4.0%	8.0%
Market Factor	Relative Pay	0.80	1.20
Policy Factor	Recruiting Mission (NCO)	30,000 recruits	40,000 recruits

B. Effect of Legalization of Marijuana Test Case:

What is the optimal allocation of recruiting resources if the Navy desires to increase the percentage of high quality recruits from 70 percent to 85 percent? Due to uncertainties in the current fiscal environment, the unemployment rate may fluctuate between 4 to 8 percent and the ratio of relative pay may vary between 0.8 and 1.2. In addition, since marijuana has been legalized for recreational use in many states nationwide, drug-use amongst 18-24 year-olds is expected to increase. An increase in drug-use means less young adults qualify for military service. This test case models the effect of an annual decrease of 10,000 qualified military available due to pre-service drug-use.

Variable Type	Variable Name	Value Low	Value High
Decision Variable	Production Recruiters	2,500 recruiters	3,500 recruiters
Market Factor	Unemployment Rate (UE)	4.0%	8.0%
Market Factor	Percentage of High Quality Recruits (TSC I-III)	70%	85%
Market Factor	Relative Pay	0.8	1.2
Market Factor	Qualified Military Available (QMA)	*See Table 13	
Policy Factor	Recruiting Mission (NCO)	30,000 recruits	40,000 recruits

Cumulative Effect of Decrease in QMA

FY	QMA Value Low	QMA Value High
2015	1,873,304	1,883,304
2016	1,863,304	1,873,304
2017	1,853,304	1,863,304
2018	1,843,304	1,853,304
2019	1,833,304	1,843,304
2020	1,823,304	1,833,304
2021	1,813,304	1,823,304