Problem Set #2 Suggested Solutions

1. (1 point) What is the time frequency of the data: annual, quarterly, monthly, weekly, or daily? (3 answers each for each of the next 4 questions): Leading into the Great Depression, when did each of the three measures of output achieve its peak value? What was that maximum value? In what month did each of the three measures hit its minimum value? What was that minimum value?

The data are monthly, as indicated by the heading of column B.

	Producer Goods Output	Consumer Goods Output	Consumer Goods Excluding Autos
Month hit maximum	May-29	Mar-29	Jun-29
Maximum value	128	125.7	119.5
Month hit minimum	Jun-32	Mar-33	Mar-33
Minimum value	44.5	75.6	84.7

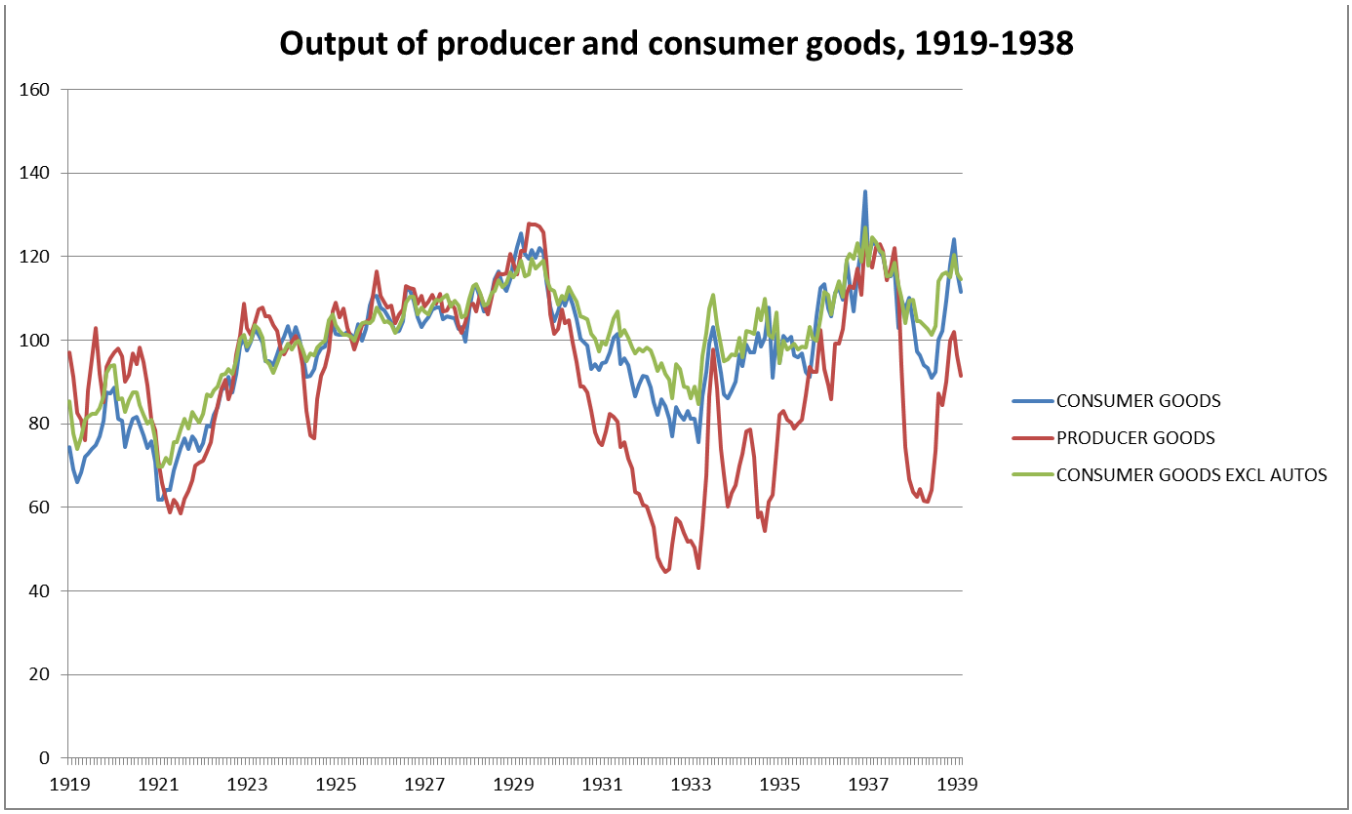
2. (1 point) For each of the three measures of output, what is the total percentage decline in output from its peak to its trough? Express your answer as a percentage (-20%), not a decimal (-0.20). Round to nearest tenth (-20.3%). Write down the formula you used to calculate your answers.

To compute the total percentage decline, use the formula $\frac{trough\ value - peak\ value}{peak\ value}$. This is equivalent to $\frac{trough\ value}{peak\ value} - 1$.

	Producer Goods Output	Consumer Goods Output	Consumer Goods Excluding Autos
maximum value (peak)	128	125.7	119.5
minimum value (trough)	44.5	75.6	84.7
% decline	-65.2 %	-39.9 %	- 29.1 %

3a. (2 points) Prepare one graph that contains all three measures of output from 1919:1 to 1938:12. When your graph is done, copy and paste it into your paper. Be sure you follow these guidelines.

- Your horizontal axis should show the years. Format your axis so that your interval between labels is 24.
- You should have a title on your graph. The title should tell the reader what's in the graph & the time period.
- There should be a legend that shows which line is which. The titles in the legend should be "Producer Goods," "Consumer Goods," and "Consumer Goods Excl Autos."



3b. (2 points) Below your graph, write one paragraph in which you describe the patterns you see in the data.

Answers will vary. Your paragraph should address the pattern over time (rising after the post-WWI downturn, hitting a peak in 1929, falling until 1933, then increasing in fits and starts to 1937, before output dips again in the 1937-38 recession). You will probably also point out that producer goods fluctuates much more than consumer goods, and that consumer goods excluding autos fluctuates least of all. You might also discuss the obvious seasonality of the data: the month-to-month fluctuations in the data reflect at least in part the influence of the seasons – summer, fall, winter, spring – on production.

4. (2 points) Write down the formula you will use to calculate the average annual rate of change between two dates. Use "t" to stand for the amount of time in years between the two dates.

To calculate the annual rate of change use the usual formula: $\frac{new\ value - old\ value}{old\ value} = \frac{new\ value}{old\ value} - 1$. You can ignore the values for the months in between the end dates. So the rate of change between 1933:3 and 1934:3 would use just those two values – the index value for 1933:3 is the "old value" and the index value for 1934:3 is the "new value."

Then to calculate the average annual rate of change between two dates, you can use either an arithmetic average or a geometric average. When the growth rates are small, there are no differences between the two averages. But when the growth rates are large, there can be differences.

An arithmetic average is just a mean – add up the values and divide by the number of values. In excel, you can use the =AVERAGE( ) formula where the values you are averaging are the annual rates of change you already calculated.

A geometric average assumes annual compounding of the growth rate. The formula for a geometric average is not embedded in Excel. (The GEOMEAN command is not what you want.) The formula for a geometric average with annual compounding is $\left(\frac{new\ value}{old\ value}\right)^{\frac{1}{t}} - 1$. When the values are one year apart, this formula is the same as the formula used to

calculate the annual rate of change: $\frac{new\ value}{old\ value} - 1$. When the values are more than one year apart, the formula calculates an annual rate of change and assumes the changes are compounded.

For each of the three series, calculate the average annual rate of change of output over these time periods:

1933:3 - 1934:3
1933:3 - 1935:3 1934:3 - 1935:3
1933:3 - 1936:3 1935:3 - 1936:3
1933:3 - 1937:3 1936:3 - 1937:3
1933:3 - 1938:3 1937:3 - 1938:3

Present your answers in a table. The column headings should be the names of each of the three measures of output. The row headings should be these nine time periods. The entry in each cell should be the average annual rate of change of output for that time period & measure of output.

Rates of Growth of Output, 1933-1938				
		producer goods output	consumer goods output	consumer goods output excl autos
Annual Rates of Change	1933-34	60.0%	24.1%	13.3%
	1934-35	11.4%	6.6%	2.0%
	1935-36	6.0%	5.8%	8.5%
	1936-37	42.2%	16.4%	16.2%
	1937-38	-47.3%	-21.8%	-15.2%
Average Annual Rates of Change (Geometric average)	1933-34	60.0%	24.1%	13.3%
	1933-35	33.5%	15.0%	7.5%
	1933-36	23.6%	11.9%	7.8%
	1933-37	28.0%	13.0%	9.9%
	1933-38	7.2%	5.0%	4.3%
Average Annual Rates of Change (Arithmetic average)	1933-34	60.0%	24.1%	13.3%
	1933-35	35.7%	15.3%	7.7%
	1933-36	25.8%	12.2%	7.9%
	1933-37	29.9%	13.2%	10.0%
	1933-38	14.5%	6.2%	5.0%
Total Growth / Number of Years	1933-34	60.0%	24.1%	13.3%
	1933-35	39.1%	16.1%	7.8%
	1933-36	29.7%	13.3%	8.5%
	1933-37	42.2%	15.7%	11.4%
	1933-38	8.4%	5.5%	4.7%

5. (1 point) If you wanted to present data that supported an argument that the recovery from the Great Depression was astoundingly rapid, which of the values in your table in #4 would you cite? Why?

Rapid rates of growth are evident if you focus on producer goods output, and on the average annual values for periods from 1933 to 1934, 1935, 1936, or 1937. The average annual values up to 1937 are also quite impressive for consumer

goods output. In all these cases, output is growing well over 20 % per year (producer goods) or 10 % per year (consumer goods). That's pretty astoundingly rapid.

6. (1 point) If instead you wanted to present data that supported an argument that recovery from the Great Depression proceeded unevenly, which of the values in your table in #4 would you cite? Why?

The unevenness of the recovery is apparent from the annual figures. Producer goods output grew 60 percent from March 1993 to March 1934. But then grew only 11 percent the following year and 6 percent the year after that. The average annual growth from 1933-1937 masks very uneven progress through the recovery.

Indeed the average annual growth rate for 1933-1938 is positive for each of the three measures of output. But the economy went into a second recession (the "double dip") in 1937, with output falling substantially. Looking at the average annual figures masks that second dip entirely.

Extra credit for 5 points

(extra credit points will be added to your midterm 1 score)

7. From Table Cb45-51, copy and paste Series Cb45 "Number Employed, Not Seasonally Adjusted" into your original worksheet. From Table Cb64-70, copy and paste Series Cb64 "Money Supply Total" into that same worksheet.

In Excel, install the "analysis tool pak" add-in. (If you don't know how to do this, google "Load or unload add-in programs.") Now go to the "data" tab of Excel. At the far right you should see the "data analysis" icon. Click on the icon and you'll be offered a number of analysis tools. Choose the "regression" tool.

Regress Producer Goods Output (Cb35, the Y variable) on Employment (Cb45, the X variable), using the data from 1919:1 to 1938:12. **Copy and paste** the regression output table into your paper. **Put a title** above the output table.

Producer Goods Output regressed on Employment, 1919:1 - 1938:12

Regression Statistics	
Multiple R	0.830
R Square	0.689
Adjusted R Square	0.687
Standard Error	11.455
Observations	240

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	69054.137	69054.1374	526.300468	0.0000
Residual	238	31227.19	131.206681		
Total	239	100281.33			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-39.487	5.718	-6.906	0.000	-50.7503	-28.2235	-50.7503	-28.2235
X variable (employment)	0.017	0.001	22.941	0.000	0.0157	0.0186	0.0157	0.0186

Highlight the number in the table that tells you the relationship between output and employment is statistically significant.

Does the statistical significance of the relationship between output and employment tell you anything about what caused changes in the total amount of producer output produced? **Explain**.

Even though the relationship is statistically significant, we don't learn anything from this regression. Employment and output go hand-in-hand – to produce more output requires more workers. Regressing output on employment is

somewhat like regressing the number of left shoes sold on the number of right shoes sold. There will be a strong correlation between the two variables, a very statistically significant result, but the result has no economic or practical significance because it simply tells us these two things (output & employment; left shoes & right shoes) rise and fall together. We haven't learned anything about what is causing these two things to rise or fall over time.

Another way to think of it is to use the concepts "endogenous" and "exogenous." Employment is not an exogenous variable. Its value is not determined independently of the factors that determine output. Employment and output, that is, are both endogenous variables in this regression. The values of employment and output are both determined by some other factor that we haven't yet looked at.

Now, regress Producer Goods Output (Cb35, the Y variable) on money supply (Cb64, the X variable), using the data from 1919:1 to 1938:12. **Copy and paste** the regression output table into your paper. **Put a title** above the output table.

Producer Goods Output regressed on Money Supply, 1919:1 - 1938:12

Regression Statistics	
Multiple R	0.578
R Square	0.334
Adjusted R Square	0.331
Standard Error	16.749
Observations	240

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	33511.63	33511.63	119.4519	0.0000
Residual	238	66769.7	280.545		
Total	239	100281.3			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-2.633	8.597	-0.306	0.760	-19.569	14.302	-19.569	14.302
X variable (money supply)	0.004	0.000	10.929	0.000	0.003	0.004	0.003	0.004

Highlight the number in the table that tells you the relationship between output and money supply is statistically significant.

Does the statistical significance of the relationship between output and money supply tell you anything about what caused changes in the total amount of producer output produced? **Explain**.

Yes, the statistical significance here has economic or practical significance and actually tells us something. Changes in the money supply are correlated with changes in output, and the correlation is statistically significant. Money supply is (at least to a reasonable extent) an exogenous variable. Its value is not itself determined by the same factors that determine the value of output. So this regression actually tells us something. The money supply and output are positively related (the coefficient >0): an increase variable in one occurs simultaneous with an increase in the other.

Be careful, though! Even though economists will often then assert there is a causal relationship – an increase in the money supply **causes** an increase in output – econometricians will drill into your brain an important phrase: "Correlation is not causation." It is still possible that we are picking up "spurious correlation" – two variables that happen to increase together but aren't causally related. That's why the economic theory is important. We need to have a good story that connects the exogenous variable (here, money supply) with the endogenous variable (here, output). Why might it be reasonable to believe that an increase in the money supply would cause an increase in output? The answer to that question is not found in a table. That answer is found in the courses in which you learn economic theory.