

## Computing cross-correlation functions with Minitab

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You have a choice of software for computing cross-correlation functions, one with low fixed cost and high variable cost, the other the reverse. The former is Excel (or other spreadsheet program). It's familiar, and we can see exactly what the program is doing. But it's cumbersome if you want to compute several cross-correlation functions (high variable cost). The latter is something like Minitab (or any other statistical software package you're familiar with). Typically the startup costs are higher, but once you have it running it's relatively easy to use. Feel free to use either one. There's a template for Excel on Blackboard if you choose that route. But if you'd prefer to use Minitab, here are the steps you'll need to follow. On the off-chance that you'd prefer to use Stata (another statistical package), let me know and I'll give you my template for that.

Steps to follow using Minitab:

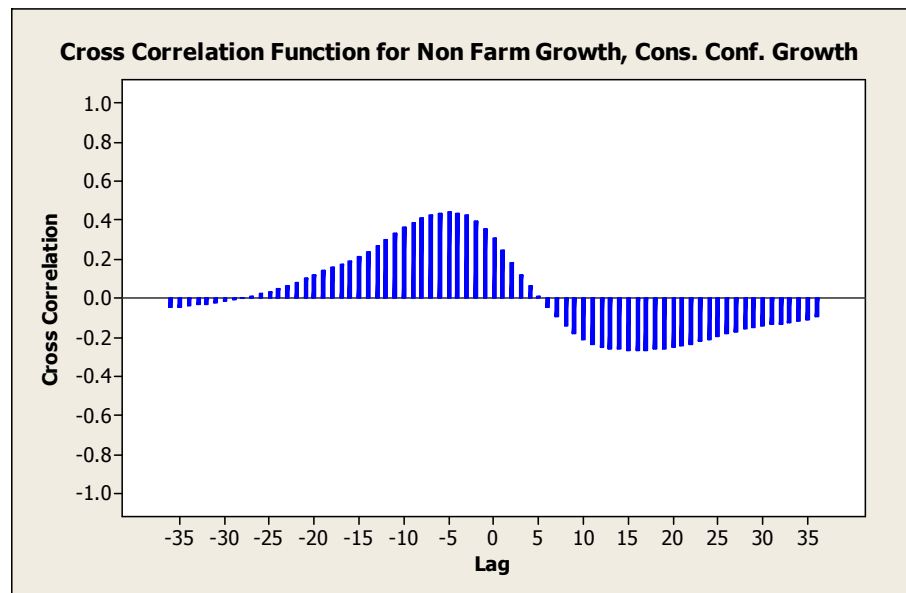
1. **Clean up the data:** Any time there is any text in a column (including a % sign or a "#NA"), Minitab will make the whole column "text" and therefore unusable. Thus, in any column that you want to use, you'll need to make sure that any data point is either a number or a completely blank cell. Even the column headings must be numeric.
2. **Convert to "growth rates":** You are interested not in comparing absolute numbers, but rather the growth from period to period or some other convenient "transformation." Therefore, for any column you are interested in, you'll need to convert it to a "growth" figure. This can be month-over-month growth, or the more smoothed year-over-year.
3. **Paste to Minitab:** Similar to copying and pasting within Excel. You can copy the whole worksheet from Excel and simply select the top left white cell in Minitab to paste. Once the data is clean and you have columns of growth then you can begin Minitab. You can enter column labels once you've copied the data into Minitab.
4. **Cross Correlation:** Choose Stat > Time Series > Cross Correlation. Then you need to put the production proxy (like GDP, or Production) in First Series, and the indicator in the Second Series. You can leave the "number of lags" as default since it basically uses the number of data points to advise the overall graph. Then click "OK."
5. **Reading the Output:** Focus on the two numerical columns on the left. The first is the number of lead/lag months, and the second is the correlation of the two series at that lead/lag point. Say you have "-20, 0.378" ... this means that if you run a correlation of

the two series with the Second Series shifted 20 months in front of First Series, they have a 0.378 correlation. You are looking for the highest correlation number, and then the lead/lag at that correlation is the "best" correlated data...or alternatively you could say, the second series appears to lead/lag the first series by the "best" correlated number of months. (See example output below)

### Sample Output from Minitab:

CCF - correlates Non Farm Growth(t) and Cons. Conf. Growth(t+k)

| Lag | CCF       |
|-----|-----------|
| -36 | -0.050808 |
| -35 | -0.045276 |
| -34 | -0.038685 |
| -33 | -0.033775 |
| -32 | -0.029789 |
| -31 | -0.022706 |
| -30 | -0.014723 |
| -29 | -0.005555 |
| -28 | 0.002898  |
| -27 | 0.010159  |
| -26 | 0.021847  |
| -25 | 0.035043  |
| -24 | 0.047935  |
| -23 | 0.063352  |
| -22 | 0.081049  |
| -21 | 0.102538  |
| -20 | 0.121894  |
| -19 | 0.139665  |
| -18 | 0.157123  |
| -17 | 0.173371  |
| -16 | 0.193180  |
| -15 | 0.214449  |
| -14 | 0.239976  |
| -13 | 0.269227  |
| -12 | 0.301594  |
| -11 | 0.334145  |
| -10 | 0.364263  |
| -9  | 0.387342  |
| -8  | 0.408520  |
| -7  | 0.424168  |
| -6  | 0.435348  |
| -5  | 0.439884  |
| -4  | 0.435920  |
| -3  | 0.423789  |
| -2  | 0.397544  |
| -1  | 0.358661  |
| 0   | 0.306066  |
| 1   | 0.246077  |
| 2   | 0.182969  |
| 3   | 0.121178  |
| 4   | 0.060671  |
| 5   | 0.005158  |
| 6   | -0.047574 |
| 7   | -0.094798 |
| 8   | -0.140389 |
| 9   | -0.179707 |
| 10  | -0.211431 |
| 11  | -0.235483 |



|    |           |
|----|-----------|
| 12 | -0.249866 |
| 13 | -0.257837 |
| 14 | -0.263330 |
| 15 | -0.264492 |
| 16 | -0.265359 |
| 17 | -0.265520 |
| 18 | -0.264192 |
| 19 | -0.260582 |
| 20 | -0.252132 |
| 21 | -0.244030 |
| 22 | -0.234917 |
| 23 | -0.224277 |
| 24 | -0.212530 |
| 25 | -0.198557 |
| 26 | -0.184372 |
| 27 | -0.171916 |
| 28 | -0.159440 |
| 29 | -0.150071 |
| 30 | -0.141481 |
| 31 | -0.137116 |
| 32 | -0.133142 |
| 33 | -0.125554 |
| 34 | -0.116888 |
| 35 | -0.107395 |
| 36 | -0.097253 |