

How to calculate the autocorrelation (ACF) and partial autocorrelation (PACF) coefficients in Excel with a single formula?

The purpose of this tutorial is not to explain the meaning, use and purpose of autocorrelation (ACF) and partial autocorrelation (PACF) coefficients, but just to show you how to calculate them in Excel. If you need to learn more about these tools, check some other resources on the web. Once you understand them and assuming that you would like to use Excel to calculate them, return to this tutorial.

What is so special about this tutorial? First of all, we want to use Excel. Secondly, we do not want to create Macros or write a VBA program to calculate these coefficients. Our ambition is to use standard Excel functions to execute this task.

How are we going to do it? We will use a time series that is given in cells B2:B51 in Figure 1. To make things easier, in cells A2:A51 we have used sequential numbers 1, 2, ..., 50 that represent n number of observations and which will also represent k number of ACF and PACF. In this tutorial, we will do the following calculations:

1. Calculate ACF
2. Calculate the standard errors (SE) for ACF using two different methods
3. Extract the time-lagged autocorrelation matrix
4. Calculate PACF and SE
5. Show both ACF and PACF functions with their respective standard errors in a graph

That is all we intend to do. We will show the equations so that you can see how the Excel functions were constructed, but we will not explain them. This tutorial just translates the equations into Excel syntax.

Let's press on with the tasks.

1. Calculate ACF

Figure 1 below shows the time series in cells B2:B51 (rows 10:40 hidden). To calculate the ACF coefficients we must first calculate deviations from the mean for the time series. Column C2:C51 in Figure 1 contains the deviations of every observation in the time series from their mean.

Deviations from the mean are calculated using the equation:

$$d_i = y_i - \bar{y} \quad (1)$$

Where d_i is the deviation, y_i is the observation and \bar{y} is the mean value of all the observations.

In Figure 1 in cell C2 we have a formula: =B2-(AVERAGE(\$B\$2:\$B\$51)), which is copied down to cell C51. This is the series of deviations from the mean for every observation in the time series.

	A	B	C
1	k	y	Dev
2	1	17409.7	-974.74
3	2	17694.7	-689.78
4	3	17930	-454.47
5	4	17949.4	-435.09
6	5	17840.6	-543.84
7	6	17918.6	-465.84
8	7	17895.9	-488.58
9	8	18146.7	-237.72
41	40	18547.3	162.84
42	41	18481.5	97.02
43	42	18448.4	63.95
44	43	18395.4	10.94
45	44	18503	118.53
46	45	18454.3	69.84
47	46	18400.9	16.42
48	47	18419.3	34.84
49	48	18492	107.50
50	49	18538.1	153.66
51	50	18526.1	141.68

Figure 1

The autocorrelation coefficients are calculated as:

$$r_k = \frac{\sum_{i=1}^{n-k} (y_i - \bar{y})(y_{i+k} - \bar{y})}{\sum_{i=1}^k (y_i - \bar{y})^2} \quad (2)$$

This equation is translated into Excel syntax as:

=SUMPRODUCT(\$C\$2:INDEX(\$C\$2:\$C\$51,ROWS(C3:C\$51)),\$C3:C\$51)/DEVSQ(\$C\$2:\$C\$51).

This is the function from cell D2 in Figure 2. If we copy this cell down to D22, we have all the autocorrelation coefficients calculated. That is all that is needed to have ACFs done in Excel.

2. Calculate standard errors for ACF using two different methods

In Figure 2, you can also see that columns E and F contain the values for the standard error for every autocorrelation coefficient. Column E contains the conventional equation for the autocorrelation standard errors (SE) and this is:

$$SE1_k = \sqrt{\frac{1}{n} \left(\frac{n-k}{n+2} \right)} \quad (3)$$

Where n is the total number of observations and k changes and corresponds to the ACF coefficient.

This formula is translated in cell E2, Figure 2 into:

=SQRT((1/COUNT(\$B\$2:\$B\$51))*((COUNT(\$B\$2:\$B\$51)-A2)/(COUNT(\$B\$2:\$B\$51)+2))). This cell is copied down to E22.

	A	B	C	D	E	F
1	k	y	Dev	ACF r_k	SE1	SE2 Bart
2	1	17409.7	-974.74	0.7995	0.137	0.141
3	2	17694.7	-689.78	0.6631	0.136	0.213
4	3	17930	-454.47	0.5752	0.134	0.251
5	4	17949.4	-435.09	0.5114	0.133	0.276
6	5	17840.6	-543.84	0.3876	0.132	0.295
7	6	17918.6	-465.84	0.2759	0.130	0.305
8	7	17895.9	-488.58	0.1184	0.129	0.310
9	8	18146.7	-237.72	0.0404	0.127	0.311
10	9	18226.9	-157.53	-0.0367	0.126	0.311
11	10	18347.7	-36.79	-0.0695	0.124	0.311
12	11	18372.1	-12.34	-0.1154	0.122	0.311
13	12	18506.4	121.95	-0.1052	0.121	0.312
14	13	18516.6	132.09	-0.1046	0.119	0.313
15	14	18533.1	148.59	-0.0888	0.118	0.313
16	15	18559	174.55	-0.0649	0.116	0.314
17	16	18595	210.57	-0.0148	0.114	0.314
18	17	18517.2	132.77	-0.0083	0.113	0.314
19	18	18570.8	186.39	0.0328	0.111	0.314
20	19	18493.1	108.60	0.0389	0.109	0.314
21	20	18473.8	89.29	0.0456	0.107	0.314
22	21	18472.2	87.71	0.0281	0.106	0.314

Figure 2

However, it is more customary to use the Bartlett's formula for autocorrelation standard errors, which is:

$$SE2_k = \sqrt{\frac{1}{n} \left(1 + 2 \sum_{l=1}^{k-1} r_l^2 \right)} \quad (4)$$

Where, as before n is the number of observations, k is the lag for the ACF and r_l is the ACF coefficient for the same lag as ACF.

We need three steps to apply this formula in column F. First, in cell F1 we enter a formula: =SQRT(1/COUNT(\$B\$2:\$B\$51)).

Then in cell F2 we enter the formula: =SQRT((1/COUNT(\$B\$2:\$B\$51))*(1+(2*SUMSQ(\$D\$2))))).

And finally, in cell F3 we enter: =SQRT((1/COUNT(\$B\$2:\$B\$51))*(1+(2*SUMSQ(\$D\$2:D3)))). Now we can copy this cell F3 down to F22 to cover the rest of the standard errors.

This completes step 2 and we have two versions of calculating the standard errors (SE) for the autocorrelation (ACF) coefficients. The second version (Bartlett) is a much more often used version of calculating ACF SE and we recommend that you use this method.

3. Extract the time-lagged autocorrelation matrix

To calculate the partial autocorrelation coefficients, we need an intermediate step, which is to create a matrix with the lagged autocorrelation coefficients. How do we do this?

Our autocorrelation coefficients are calculated in cells D2:D22. We'll first just copy the range D2:D22 into G2:G22 (see Figure 3). We will then type number 1 in cell G1 (this implies that the correlation with the series of data with itself is 1). So, our full autocorrelation set is now in cells G1:G22.

	A	B	C	D	E	F	G
1	k	y	Dev	ACF r_k	SE1	SE2 Bart	1
2	1	17409.7	-974.74	0.7995	0.137	0.141	0.7995
3	2	17694.7	-689.78	0.6631	0.136	0.213	0.6631
4	3	17930	-454.47	0.5752	0.134	0.251	0.5752
5	4	17949.4	-435.09	0.5114	0.133	0.276	0.5114
6	5	17840.6	-543.84	0.3876	0.132	0.295	0.3876
7	6	17918.6	-465.84	0.2759	0.130	0.305	0.2759
8	7	17895.9	-488.58	0.1184	0.129	0.310	0.1184
9	8	18146.7	-237.72	0.0404	0.127	0.311	0.0404
10	9	18226.9	-157.53	-0.0367	0.126	0.311	-0.0367
11	10	18347.7	-36.79	-0.0695	0.124	0.311	-0.0695
12	11	18372.1	-12.34	-0.1154	0.122	0.311	-0.1154
13	12	18506.4	121.95	-0.1052	0.121	0.312	-0.1052
14	13	18516.6	132.09	-0.1046	0.119	0.313	-0.1046
15	14	18533.1	148.59	-0.0888	0.118	0.313	-0.0888
16	15	18559	174.55	-0.0649	0.116	0.314	-0.0649
17	16	18595	210.57	-0.0148	0.114	0.314	-0.0148
18	17	18517.2	132.77	-0.0083	0.113	0.314	-0.0083
19	18	18570.8	186.39	0.0328	0.111	0.314	0.0328
20	19	18493.1	108.60	0.0389	0.109	0.314	0.0389
21	20	18473.8	89.29	0.0456	0.107	0.314	0.0456
22	21	18472.2	87.71	0.0281	0.106	0.314	0.0281

Figure 3

Now copy D2:D22 (or G2:G22) and Paste Special as transposed values into cells H1:AB1. See Figure 4 below if you are unsure how to use Paste Special function and if you are not familiar with transposing values in Excel. Essentially, you copy the range G2:G22, then select Paste Special option and then tick the Values and Transpose options, as in Figure 4.

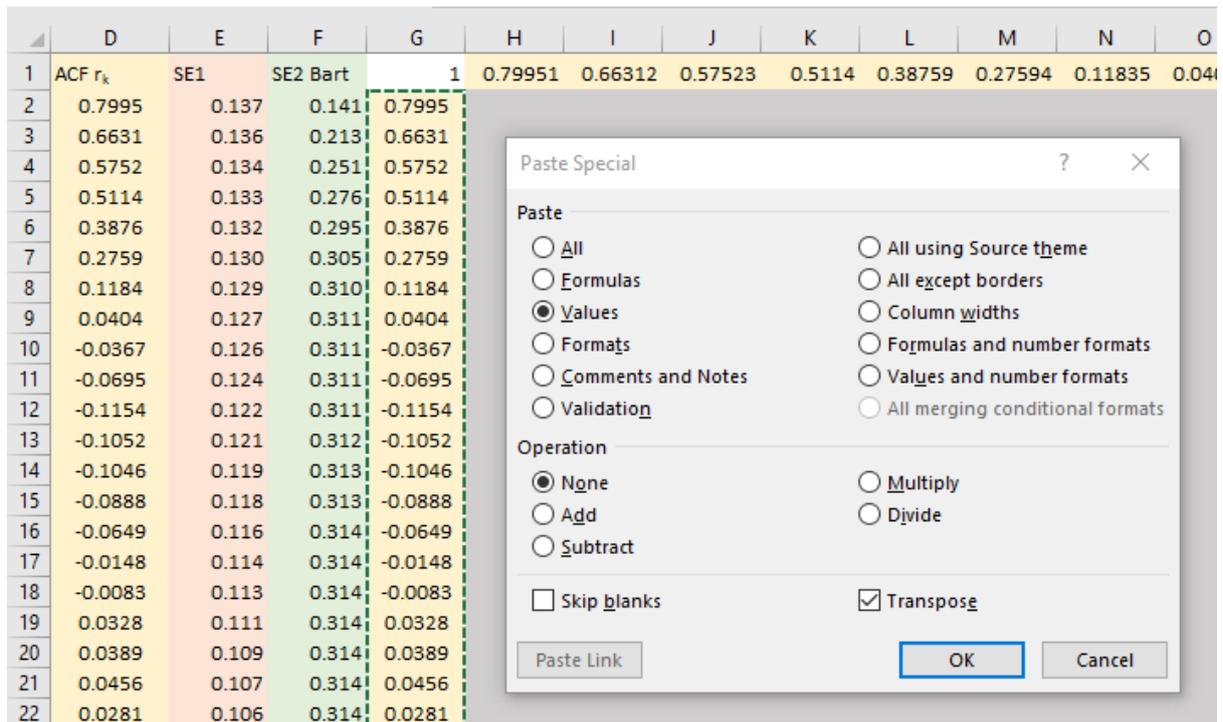


Figure 4

Now we have the frame (the first row and the first column) for our autocorrelation matrix that is going to be time-lagged. What is the next step? We need to fill in the cells H2:AB22 to have the full matrix completed.

In cell H2 we insert function `=INDEX(G1:G$22,ROWS($A3))`, as shown in Figure 5. The result is 1.

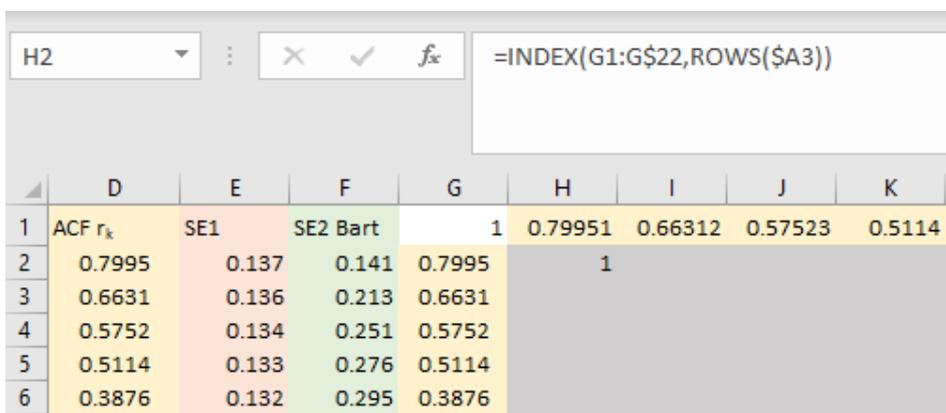


Figure 5

The formula from cell H2 needs to be copied across to AB2.

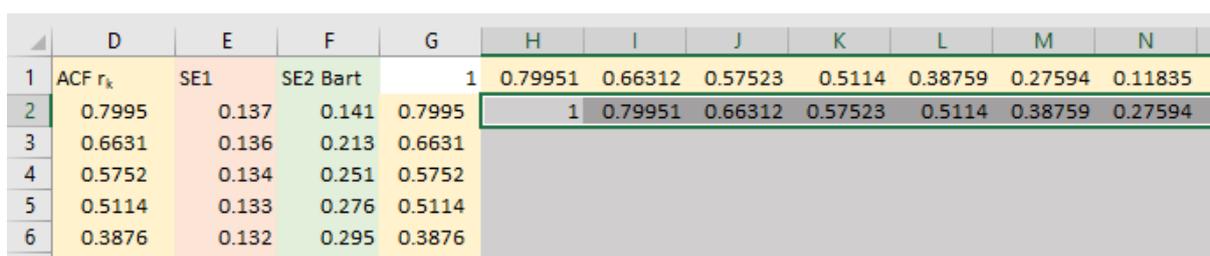


Figure 6

After we have the formula copied across row 2 from H2:AB2, we highlight this whole row H2:AB2 and copy it down to AB22. The result is shown in Figure 7.

	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673	-0.06952	-0.11538	-0.10519	-0.10458	-0.08879	-0.06491	-0.01481	-0.00829	0.03281	0.03891	0.04565	0.02811
2	0.7995	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673	-0.06952	-0.11538	-0.10519	-0.10458	-0.08879	-0.06491	-0.01481	-0.00829	0.03281	0.03891	0.04565
3	0.6631	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673	-0.06952	-0.11538	-0.10519	-0.10458	-0.08879	-0.06491	-0.01481	-0.00829	0.03281	0.03891
4	0.5752	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673	-0.06952	-0.11538	-0.10519	-0.10458	-0.08879	-0.06491	-0.01481	-0.00829	0.03281
5	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673	-0.06952	-0.11538	-0.10519	-0.10458	-0.08879	-0.06491	-0.01481	-0.00829
6	0.3876	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673	-0.06952	-0.11538	-0.10519	-0.10458	-0.08879	-0.06491	-0.01481
7	0.2759	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673	-0.06952	-0.11538	-0.10519	-0.10458	-0.08879	-0.06491
8	0.1184	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673	-0.06952	-0.11538	-0.10519	-0.10458	-0.08879
9	0.0404	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673	-0.06952	-0.11538	-0.10519	-0.10458
10	-0.0367	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673	-0.06952	-0.11538	-0.10519
11	-0.0695	-0.03673	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673	-0.06952	-0.11538
12	-0.1154	-0.06952	-0.03673	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673	-0.06952
13	-0.1052	-0.11538	-0.06952	-0.03673	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044	-0.03673
14	-0.1046	-0.10519	-0.11538	-0.06952	-0.03673	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835	0.04044
15	-0.0888	-0.10458	-0.10519	-0.11538	-0.06952	-0.03673	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594	0.11835
16	-0.0649	-0.08879	-0.10458	-0.10519	-0.11538	-0.06952	-0.03673	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759	0.27594
17	-0.0148	-0.06491	-0.08879	-0.10458	-0.10519	-0.11538	-0.06952	-0.03673	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114	0.38759
18	-0.0083	-0.01481	-0.06491	-0.08879	-0.10458	-0.10519	-0.11538	-0.06952	-0.03673	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523	0.5114
19	0.0328	-0.00829	-0.01481	-0.06491	-0.08879	-0.10458	-0.10519	-0.11538	-0.06952	-0.03673	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312	0.57523
20	0.0389	0.03281	-0.00829	-0.01481	-0.06491	-0.08879	-0.10458	-0.10519	-0.11538	-0.06952	-0.03673	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951	0.66312
21	0.0456	0.03891	0.03281	-0.00829	-0.01481	-0.06491	-0.08879	-0.10458	-0.10519	-0.11538	-0.06952	-0.03673	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1	0.79951
22	0.0281	0.04565	0.03891	0.03281	-0.00829	-0.01481	-0.06491	-0.08879	-0.10458	-0.10519	-0.11538	-0.06952	-0.03673	0.04044	0.11835	0.27594	0.38759	0.5114	0.57523	0.66312	0.79951	1

Figure 7

This creates a matrix of all autocorrelations lagged by one period at a time. This matrix will be the basis for calculating the partial autocorrelation coefficients. Without it, we would not be able to calculate the PACF using a single formula.

4. Calculate PACF and SE

The formulae for partial autocorrelation coefficients look scary, so let's just show them here without necessarily going into them.

The first partial autocorrelation coefficient $\hat{\phi}_{11}$ is the same as the first autocorrelation coefficient r_1 :

$$\hat{\phi}_{11} = r_1 \quad (5)$$

That's easy. The second one is:

$$\hat{\phi}_{22} = (r_2 - r_1^2)/(1 - r_1^2) \quad (6)$$

Still easy. From there, we generalise for $\hat{\phi}_{kj}$ and calculate the intermediate values of $\hat{\phi}_{kj}$:

$$\hat{\phi}_{kj} = \hat{\phi}_{k-1,j} - \hat{\phi}_{kk}\hat{\phi}_{k-1,k-j} \quad (7)$$

Where $k = 2, \dots, j$ and $j = 1, 2, \dots, k-1$

This enables us to calculate all the higher $\hat{\phi}_{kk}$ that are defined by the equation:

$$\hat{\phi}_{kk} = \left(r_k - \sum_{j=1}^{k-1} \hat{\phi}_{k-1,j} r_{k-j} \right) / \left(1 - \sum_{j=1}^{k-1} \hat{\phi}_{k-1,j} r_j \right) \quad (8)$$

Where $k = 3, \dots$

Sounds complicated. Right? Well, with the use of Excel, we can "squeeze" everything into a single function: =INDEX(MMULT(MINVERSE(OFFSET(\$G\$1,0,0,A2,A2)),OFFSET(\$G\$1,1,0,A2,1)),A2). This is the function in cell AC2 in Figure 8. This cell was copied down to AC22 and these are our partial autocorrelation (PACF) coefficients.

	A	B	C	D	E	F	AC	AD
1	k	y	Dev	ACF r _k	SE1	SE2 Bart	PACF r _{k,k}	SE PACF
2	1	17409.7	-974.74	0.7995	0.137	0.141	0.800	0.141
3	2	17694.7	-689.78	0.6631	0.136	0.213	0.066	0.141
4	3	17930	-454.47	0.5752	0.134	0.251	0.076	0.141
5	4	17949.4	-435.09	0.5114	0.133	0.276	0.050	0.141
6	5	17840.6	-543.84	0.3876	0.132	0.295	-0.170	0.141
7	6	17918.6	-465.84	0.2759	0.130	0.305	-0.072	0.141
8	7	17895.9	-488.58	0.1184	0.129	0.310	-0.245	0.141
9	8	18146.7	-237.72	0.0404	0.127	0.311	0.042	0.141
10	9	18226.9	-157.53	-0.0367	0.126	0.311	-0.049	0.141
11	10	18347.7	-36.79	-0.0695	0.124	0.311	0.085	0.141
12	11	18372.1	-12.34	-0.1154	0.122	0.311	0.012	0.141
13	12	18506.4	121.95	-0.1052	0.121	0.312	0.105	0.141
14	13	18516.6	132.09	-0.1046	0.119	0.313	0.016	0.141
15	14	18533.1	148.59	-0.0888	0.118	0.313	-0.026	0.141
16	15	18559	174.55	-0.0649	0.116	0.314	0.035	0.141
17	16	18595	210.57	-0.0148	0.114	0.314	0.013	0.141
18	17	18517.2	132.77	-0.0083	0.113	0.314	-0.063	0.141
19	18	18570.8	186.39	0.0328	0.111	0.314	0.051	0.141
20	19	18493.1	108.60	0.0389	0.109	0.314	-0.050	0.141
21	20	18473.8	89.29	0.0456	0.107	0.314	-0.016	0.141
22	21	18472.2	87.71	0.0281	0.106	0.314	-0.051	0.141

Figure 8

The reason why we were able to use one single formula using standard Excel functions comes from matrix algebra. The autocorrelation function can be expressed as the following equation:

$$\rho_k = \phi_{k1}\rho_{j-1} + \dots + \phi_{k(k-1)}\rho_{j-k+1} + \phi_{kk}\rho_{j-k} \quad (9)$$

Equation (9) can also be represented as a matrix:

$$\begin{bmatrix} \rho_1 \\ \rho_2 \\ \vdots \\ \rho_k \end{bmatrix} = \begin{bmatrix} 1 & \rho_1 & \rho_2 & \dots & \rho_{k-1} \\ \rho_2 & 1 & \rho_1 & \dots & \rho_{k-2} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \rho_{k-1} & \rho_{k-2} & \rho_{k-3} & \dots & 1 \end{bmatrix} \begin{bmatrix} \phi_{k1} \\ \phi_{k2} \\ \vdots \\ \phi_{kk} \end{bmatrix} \quad (10)$$

The alternative expression for (10) is matrix notation:

$$\boldsymbol{\rho}_k = \mathbf{P}_k \boldsymbol{\Phi}_k \quad (11)$$

This means that we can solve (11) for Φ_k :

$$\boldsymbol{\Phi}_k = \frac{\boldsymbol{\rho}_k}{\mathbf{P}_k} = \mathbf{P}_k^{-1} \boldsymbol{\rho}_k \quad (12)$$

It might sound very complicated, but in terms of Excel functions this means that to calculate the partial autocorrelations, we need only two standard Excel functions, =MMULT() and =MINVERSE(). The first function is used to multiply two matrices and the second one returns an inverse of the matrix, which is exactly what we need, as per equation (12). This is exactly what we have done in cell AC2 in Figure 8: =INDEX(MMULT(MINVERSE(OFFSET(\$G\$1,0,0,A2,A2)),OFFSET(\$G\$1,1,0,A2,1)),A2). Easy, isn't it!

We now have to calculate the standard errors (SE) for the partial autocorrelation (PACF) coefficients. Unlike the autocorrelation standard errors, the ones for partial autocorrelations are much easier to calculate. They are simply for all values of PACF:

$$SE = \sqrt{\frac{1}{n}} \quad (13)$$

Column AD2:AD22 contain the values of the partial autocorrelation coefficients standard errors and they are calculated in Excel as: =1/SQRT(COUNT(\$B\$2:\$B\$51)).

5. Show both ACF and PACF functions with their respective standard errors in a graph

We can now construct two graphs, one for ACF and the corresponding standard errors and the other one for PCF and its standard errors. For ACF standard errors, we will only use the Bartlett formula values from column F in Figure 2.

We copied the values of ACF and their SE and PACF and their SE in columns AL:AM and AP:AQ respectively. Columns AN and AR contain the negative values of ASF SE and PACF respectively. The only reason why we are doing this is to make it easier to create the charts. Otherwise, there is no need to do it. See Figure 9 for the final result.

	AL	AM	AN	AO	AP	AQ	AR
1	ACF r _k	SE2+ Bart	SE2- Bart		PACF rk,j	SE+	SE-
2	0.7995	0.141	-0.141		0.800	0.141	-0.141
3	0.6631	0.213	-0.213		0.066	0.141	-0.141
4	0.5752	0.251	-0.251		0.076	0.141	-0.141
5	0.5114	0.276	-0.276		0.050	0.141	-0.141
6	0.3876	0.295	-0.295		-0.170	0.141	-0.141
7	0.2759	0.305	-0.305		-0.072	0.141	-0.141
8	0.1184	0.310	-0.310		-0.245	0.141	-0.141
9	0.0404	0.311	-0.311		0.042	0.141	-0.141
10	-0.0367	0.311	-0.311		-0.049	0.141	-0.141
11	-0.0695	0.311	-0.311		0.085	0.141	-0.141
12	-0.1154	0.311	-0.311		0.012	0.141	-0.141
13	-0.1052	0.312	-0.312		0.105	0.141	-0.141
14	-0.1046	0.313	-0.313		0.016	0.141	-0.141
15	-0.0888	0.313	-0.313		-0.026	0.141	-0.141
16	-0.0649	0.314	-0.314		0.035	0.141	-0.141
17	-0.0148	0.314	-0.314		0.013	0.141	-0.141
18	-0.0083	0.314	-0.314		-0.063	0.141	-0.141
19	0.0328	0.314	-0.314		0.051	0.141	-0.141
20	0.0389	0.314	-0.314		-0.050	0.141	-0.141
21	0.0456	0.314	-0.314		-0.016	0.141	-0.141
22	0.0281	0.314	-0.314		-0.051	0.141	-0.141

Figure 9

Now we'll create the ACF graph from columns AL:AN. We highlight these three variables (ranges) and create a line graph as in Figure 10.

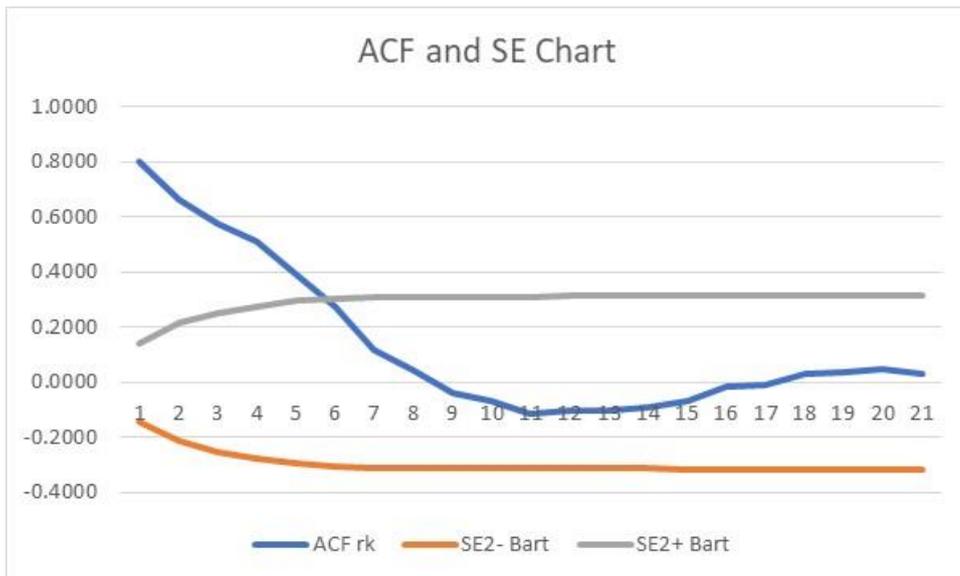


Figure 10

We would like to present ACF (blue line) as bars, as it is customary, and change the colour for two SE lines to be identical.

We right-click on the blue line and then select Change Series Chart Type as in Figure 11.

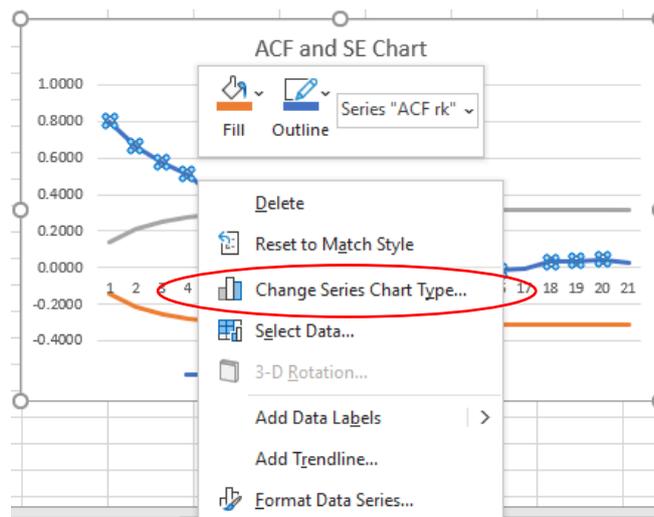


Figure 11

This produces another dialogue box as in Figure 12. We change ACF from line to clustered columns.

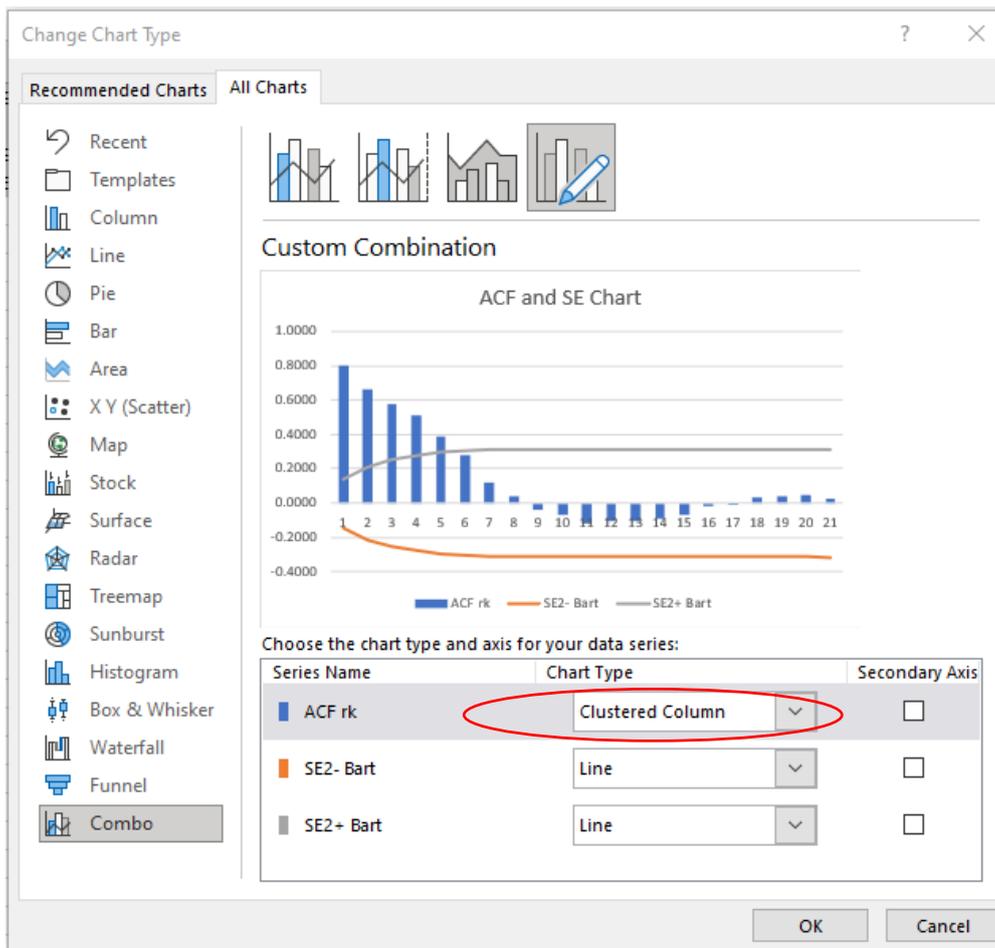


Figure 12

After that, we just change the colour of the two SE lines to make them the same colour. We get a proper ACF chart as in Figure 13.



Figure 13

We repeat the same procedure for PACF and their SE using data from AP:AR in Figure 9 and the final graph is as in Figure 14.

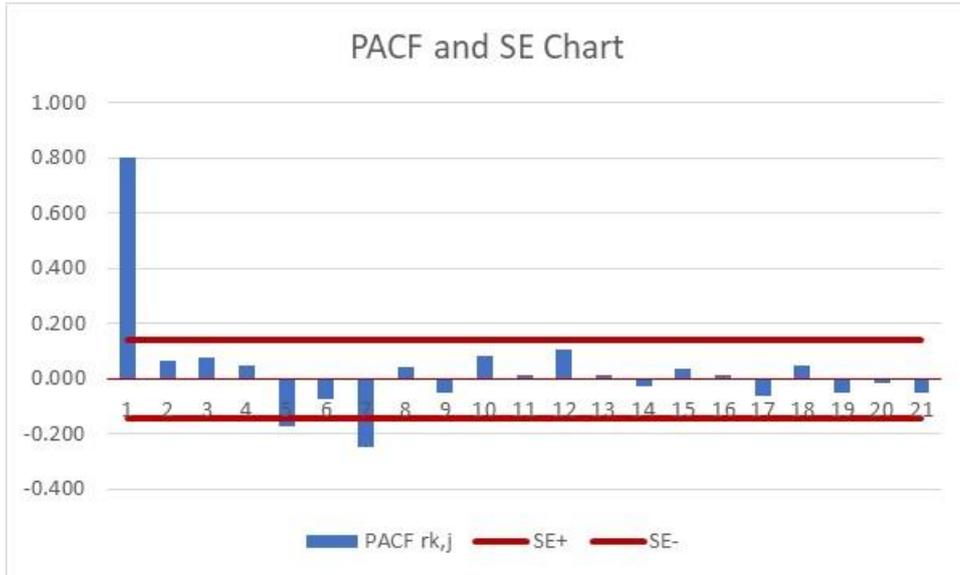


Figure 14

The graphs show 5 significant ACFs and 1 significant PACF. You could try to model this time series using a simple AR(1) model, but this is a subject for completely different tutorial.

To download the spreadsheet with all the calculations, go to http://pecar-uk.com/acf_pacf.html. This completes the tutorial dedicated to calculating ACF and PACF using Excel.

Branko Pecar
Spring 2021