Solving simultaneous equations using matrix functions in Excel

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There are occasions in solving Finance problems when we face a situation that requires solving several equations at one time, whether that isa portfolio optimization, an analysis of economic systems, or making decisions under bond indenture constraints.

Microsoft Excel Matrix functions

Microsoft Excel provides matrix functions for calculation purposes:

MINVERSE   Invert a matrix

MMULT   Multiply two matrices together

MDTERM   Calculate the determinant of a specified array

When solving simultaneous equations, we can use these functions to solve for the unknown values. For example, if you are faced with the following system of equations:

$$a + 2b + 3c = 1$$

$$a - c = 0$$

$$2a + b = 1.25$$

Using matrix Algebra,

$$\begin{bmatrix} 1 & 2 & 3 \\ 1 & 0 & -1 \\ 2 & 1 & 0 \end{bmatrix} \times \begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 1.25 \end{bmatrix}$$

To solve for the vector $\begin{bmatrix} a \\ b \\ c \end{bmatrix}$, we bring the first matrix over to the right-hand side by dividing both sides by the matrix, and then multiply the two matrices:

$$\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 1.25 \end{bmatrix} \begin{bmatrix} 1 & 2 & 3 \\ 1 & 0 & -1 \\ 2 & 1 & 0 \end{bmatrix}^{-1}$$

$$\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 1.25 \end{bmatrix} \begin{bmatrix} 1 & 2 & 3 \\ 1 & 0 & -1 \\ 2 & 1 & 0 \end{bmatrix}^{-1} = \begin{bmatrix} 1.0 \\ -0.75 \\ 0.5 \end{bmatrix}$$

Matrix Algebra using Excel

So how do we accomplish this in Excel?

Step 1: Create matrices

	A	B	C	D	E	F
1						
2						
3	1	2	3		1	
4	1	0	-2		0	
5	2	1	0		1.25	
6						
7						

Step 2: Invert first matrix

Select cells for the inverted matrix result for a matrix the same size as the original matrix. The use the function MMINVERSE to invert it. Once you specify the array to invert, use CTRL-CHIFT-ENTER instead of closing out the function:
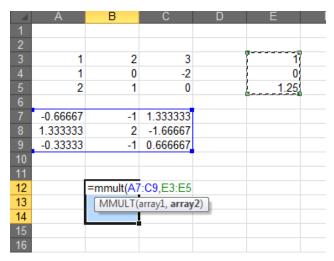
	A	B	C	D
1				
2				
3	1	2	3	
4	1	0	-2	
5	2	1	0	
6				
7	=minverse(A3:C5			
8	MINVERSE(**array**)			
9				
10				
11				
12				

This produces:

	A	B	C	D
1				
2				
3	1	2	3	
4	1	0	-2	
5	2	1	0	
6				
7	-0.66667	-1	1.333333	
8	1.333333	2	-1.66667	
9	-0.33333	-1	0.666667	
10				
11				

Step 3: Multiply matrices

You multiply matrices using the MMULTI function, selecting the cells that you want the results (in this example, cells B12, B13 and B14:

	A	B	C	D	E	
1						
2						
3	1	2	3		1	
4	1	0	-2		0	
5	2	1	0		1.25	
6						
7	-0.66667		-1 1.333333			
8	1.333333		2 -1.66667			
9	-0.33333		-1 0.666667			
10						
11						
12		=mmult(A7:C9,E3:E5				
13		MMULT(array1, **array2**)				
14						
15						
16						

As with the MINVERSE function, use CTRL-SHIFT-ENTER to produce the results:

	A	B	C	D	E	F
1						
2						
3	1	2	3		1	
4	1	0	-2		0	
5	2	1	0		1.25	
6						
7	-0.66667		-1 1.333333			
8	1.333333		2 -1.66667			
9	-0.33333		-1 0.666667			
10						
11						
12		1				
13		-0.75				
14		0.5				
15						
16						
17						