SAM Multipliers: Exercises

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1. Introduction

The SAM exercises are formulated to help you develop your understanding of SAMs; the exercises are not exhaustive and they are not a substitution for more extensive study of SAMs.

This set of exercises involves the generation of income and price multipliers using a SAM for South Africa.[1] You will carry out four simple experiments; two income multiplier experiments and two price multiplier experiments. The theory is provided in the document 'SAM Multipliers cgemod.pdf'

The data required for this set of exercises and all the SAM based exercises are in a WinZip archive ('intro sams.zip') on the cgemod site.

The first thing you need to do, if you have not done it already, is create a directory and call this directory/folder 'intro sam' (this is the name we assume you have chosen when referring to the directory in all the SAM exercise documents). Now download the file 'intro sams.zip' to this directory and extract all the Excel files into this directory. You will use the workbook 'SAM multiplier exercises.xlsx' for these exercises. This workbook has templates for each stage of the process; the workbook 'SAM multiplier solutions.xlsx' has worked solutions so that you can check your calculations.

[1] This is an aggregated version of the PROVIDE SAM for South Africa. The original SAM had some 900 accounts.

2. South Africa SAM Income Multiplier Exercises

The income multiplier exercise using the South African SAM involves three stages. First, you need to decide which accounts will be endogenous and which will be exogenous; for this exercise, we will specify those accounts that are exogenous. Second, having made that decision you need to calculate the multiplier matrix. And third, you need to use the multiplier matrix to carry out two simple experiments. There are two template worksheets for these exercises 'RSA Inc Mult' and 'RSA Inc Mult Expt.'

The exogenous accounts will be the government, include tax accounts, the capital accounts, including stock changes, the enterprise account and the rest of the world account.

Deriving the Multiplier Matrix

The following are instructions for the stages you need to follow.

1. Populate the endogenous accounts in the matrix C7:AV52.
2. Calculate the totals for the row sums (recorded in AX7:AX52) and the column sums (recorded in vector C54:AV54) for the exogenous accounts.
3. Calculate the matrix [**I** – **A**] using the matrix C64:AV109) to record the result. (NB: An appropriately dimensioned identity matrix has been created for you in the worksheet 'RSA SAM Identity Matrix'.)
4. Calculate the inverse of the [**I - A**] matrix using the matrix C116:AV161 to record the result. This needs the Excel function MINVERSE.

Excel's function library contains a wide range of matrix operations. Select `Formulas>Math&Trig` and select the function `MINVERSE`; you will need to scroll down. This will open the function arguments box shown below. This tells you what to do and there is a help system.

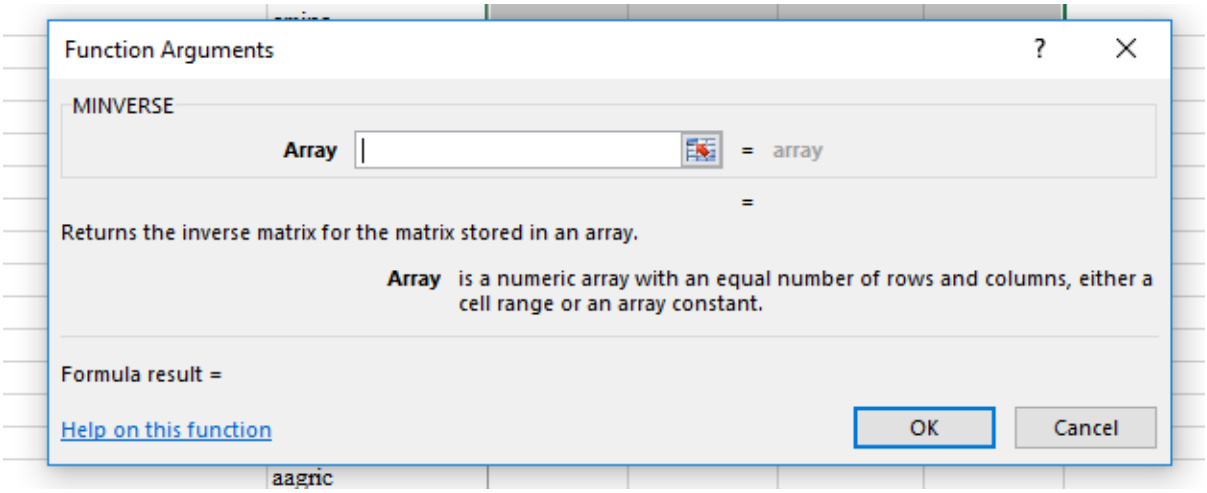
There are a few things worth knowing that may save you time:

1. You must select/highlight the into which the result will be recorded **BEFORE** selecting the function. This must be of the correct dimensions, i.e., to invert an *n***n*

matrix you must select an *n***n* matrix for the result. Excel may not provide a meaningful error message if the dimensionality is wrong.

2. The array referred to in the Function Arguments box is the array/matrix that is to be inverted.

3. For ALL array operation hold down the `Ctrl` and `Shift` keys when pressing `OK`. (Experienced users may insert the formula in other ways; in those cases, hold down the `Ctrl` and `Shift` keys when pressing `Enter`.)



Simple Income Multiplier Experiments

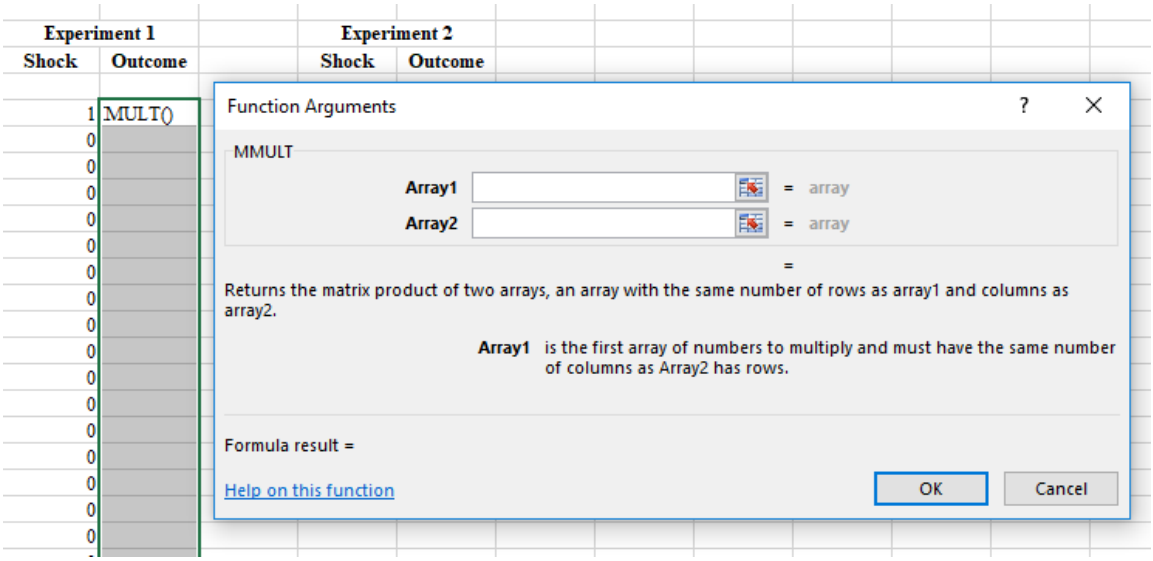
A very simple approach to multiplier experiments is to evaluate the implications of a one unit shock in exogenous demand for different accounts. In matrix algebra terms this effects a summation that picks out the column of the multiplier matrix that is paired with the respective row of the shock. Economically, such an experiment tells the analyst by how the outputs for every endogenous account must increase to satisfy the increased exogenous demand, e.g., export demand.

We will consider and compare two such unit shocks. The first, is an increase in the exogenous demand of the commodity agriculture ('*cagric'*) and the second for the commodity minerals ('*cmins*'). The template worksheet for this exercise is 'RSA Inc Mult Expt'. The steps to follow are:

1. In the worksheet 'RSA Inc Mult Expt.' Enter 1 (one) in the cell C8, and enter 0 (zero) in the cells C9:C53 for the experiment for '*cagric'*. For the experiment for '*cmins*', enter 1 (one) in the cell F9 and 0 (zeros) in the other cells of column F.

2. In the cells D8:D53 calculate the value of [**I** - **A**] * Δ**d** where Δ**d** is the shock vector (C8:C53). This needs the Excel function MMULT. Select `Formulas>Math&Trig` and select the function `MMULT` (see below for an illustration; note there is a help function).

3. Note that the operation `MMULT` requires two arrays. These must be entered in the correct order and have correct dimensions. The same operation of holding down the `Ctrl` and `Shift` keys when pressing `OK` is required.



Having computed the outcomes for both experiments you can compare the results.

1. Why is the total increase in outputs so much greater for '*cagric*' than for '*cmins*'. (HINT: remember the Keynesian injections = leakages in the new equilibrium.)

2. What are the shares of exogenous transactions in the columns of the SAM for '*cagric*' than for '*cmins*'?

3. South Africa SAM Price Multiplier Exercises

The price multiplier exercise using the South African SAM involves three stages. First, you need to decide which accounts will be endogenous and which will be exogenous; for this exercise, we will assume these accounts are the same as for the income multipliers (this will reduce the number of calculations needed). Second, having made that decision you need to calculate the multiplier matrix; this will only need us to transpose the income multiplier matrix. And third, you need to use the multiplier matrix to carry out two simple experiments. There are two template worksheets for these exercises 'RSA Price Mult' and 'RSA Price Mult Expt.'

Deriving the Multiplier Matrix

This only requires that we transpose the multiplier matrix derived for the income multiplier case. Check out the mathematics in the SAM Multiplier document and PPTs. We will use the worksheet 'RSA Price Mult'.

Select the matrix C66:AV111.

1. Use the array function TRANSPOSE. Select `Formulas>Lookup & Reference` and select the function `TRANSPOSE`. And then follow the instructions noting that this is an array function.

This ensures that we have a correctly dimension price multiplier matrix. The alternative would be to transpose the shock vector, but this would produce the outcomes as a row in Excel, which is less easily read.

Simple Price Multiplier Experiments

A very simple approach to multiplier experiments is to evaluate the implications of a one unit shock in exogenous **costs** for different accounts. In matrix algebra terms this effects a summation that picks out the column of the transposed multiplier matrix that is paired with the respective row of the shock. Economically, such an experiment tells the analyst by how the costs for every endogenous account must increase to satisfy the increased exogenous costs, e.g, an increase in commodity taxes.

We will consider and compare two such unit shocks. The first, is an increase in the exogenous cost of the commodity agriculture ('*cagric'*) and the second for the commodity minerals ('*cmins*'). The template worksheet for this exercise is 'RSA Price Mult Expt'. The steps to follow are:

1. In the worksheet 'RSA Price Mult Expt.' Enter 1 (one) in the cell C8, and enter 0 (zero) in the cells C9:C53 for the experiment for '*cagric'*. For the experiment for '*cmins*', enter 1 (one) in the cell F9 and 0 (zeros) in the other cells of column F.
2. In the cells D8:D53 calculate the value of [**I** - **A**]′ * Δ**v** where Δ**v** is the shock vector (C8:C53), using Excel's matrix multiplication function.

Having computed the outcomes for both experiments you can compare the results.

1. What are the differences in the implications for the costs faced by the different accounts from the differences in the two shocks?
2. How much have the costs of living gone up for different households because of the two shocks?
3. Explain why the changes in the cost of living for the households '*hafflow'* and '*hwhhigh'* differ. Are these differences consistent with expectations?