

Measurement Technical Change in Practice

Manual

This manual, which assumes knowledge of the paper *A Reappraisal of Ricardo's Principles - On the Measurement of technical Change*, shows how to use the Excel file *Reappraisal Ricardo's Principles* that explains by means of input-output models how technical change can be measured using fluctuating market prices.

ALL WORKSHEETS

For all worksheets of the file, the user can change the contents of the green marked cells. These cells per firm or sector concern per period the input of labour, the input of commodities supplied by other sectors and output of commodities produced with the input of both direct and indirect labour. In addition to the randomly selected price that must be paid for the commodities produced, the user must also indicate in which commodities these prices are expressed. For this chosen commodity the price is always equal to 1.

In the first three worksheets, the columns have a similar structure. Column C shows the direct labour that the five distinct sectors use for their production. Columns D through H indicate the input of commodities supplied by other sectors. Column I shows how many commodities each sector produces, while column K shows the price at which these commodities are sold. In column L the user can choose the sector producing the commodity in which price the other prices should be expressed, with the result immediately visible in the column.

Columns N through Q show the basic elements of the twofold valuation method, with columns N and O providing intermediate steps to determine the necessary totals of all sectors:

- N Result of each sector which is equal to the market value of the sold production minus the market value of input derived from other sectors. In period 1 this result will be corrected by a factor equal to the total labour used in period 2 divided by its use in period 1. This correction is necessary to implement the condition of a constant use of labour over time. The total result of all sectors follows by summation.
- O Result of each sector divided by its use of direct labour. The total results for all sectors together follows from the total of column 4 divided by the total use of labour.

Columns P and Q determine the two basic elements of the twofold valuation method:

- P Relative exchange value of each commodity (column L) divided by the total result of all sectors (column N)
- Q relative result per unit of labour of each sector (column O) divided by the total result per unit labour (also column O).

Below the unit matrices of the input-output tables with the green marked cells are copies of these matrices of intermediate deliveries in which the additional elements of the twofold valuation method are included. In addition to these matrices, column L contains the basis of the twofold valuation method derived from the columns P and Q and applied to the transition from period 1 to period 2. Column O gives the results after processing the additional elements. The labour saving *rho* as a result of technical change is determined in column Q. The labour saving derived directly from the production techniques is stated in column S (red figures). The development of the index of labour worked up in commodities starts in column V.

As soon as the development over more than two periods has to be described, a varying total of labour employed must be taken into account. This requires new calculations for each new transition. For the transition from period 2 to period 3, the results are shown in the columns K and N.

SEPARATE WORKSHEETS

The following information applies to the separate worksheets:

- 1 Direct labour only
The instructions and the results are briefly described again in the explanatory notes. Attention is also drawn to the restriction that only positive numbers may be entered in the green marked cells.
- 2 Intermediate step
This worksheet is only of interest to users who want to gain more insight into the individual elements of the twofold valuation method. It provides insight into the constraints that must be observed so that only the formulas of the main diagonal of the matrices suffice to obtain results that are consistent with the technical change directly derived from the production processes
- 3 Direct and indirect labour
Because three periods are distinguished in this worksheet, the correction for achieving a constant amount of labour must be made at each period transition. To make this possible, the basic elements of the twofold valuation in columns N to Q are repeated in columns S to V, except that in the second set of columns the amount of labour is corrected to equal the amount in the next period. At each transition, the U and V columns of the first period are then compared with the P and Q columns of the next period
But as you will see, there is initially no technical change, except in sector D. This sector consists of three firms, each of which produces one commodity after two periods. This leads to two commodities being produced in one year and only one in the following year,

and so on. The twofold valuation method then shows a fluctuating technical change even if there is no change in the production conditions. The worksheet also shows that this fluctuation is repeated in sectors that need the commodities of sector D in their production processes. With this knowledge, the user is prompted to change the cells marked in green as he sees fit.

4 Malthus' table

Here the twofold valuation method is applied to Malthus' table.

5 Overview

This worksheet summarizes the treatment of investments in the twofold valuation method. In the first approach, investments are treated in the same way as intermediate supplies; in the second as consumer commodities. In the first approach, there is often a sharp rise in the index of worked up labour in commodities, whereby it remains to be seen whether the investments in later periods lead on balance to labour savings. In the second approach, it immediately becomes clear to what extent the investments lead to labour savings.

There are three sectors A, B and C. Sector B consists of three firms that replace their machines every three years. The machines are produced by sector C. To provide insight into the replacement of machines, five periods are distinguished.

The user can choose from 4 options:

- A. There is no technical change. The summary tables (included in row 9 to 17) for both approaches show no change, except for the individual firms of sector B. They show, only in the first approach, every three year an increase in the labour worked up in commodities, which is reversed in the next period.
- B. Sector C starts to produce new machines in period 2 that enable firms of sector B to produce 50 per cent more. Sector C needs to expand its workforce by one-off 10 per cent. The summary tables show how the labour required in sector B to produce one of its commodities gradually decreases.
- C. The same as option B, but here the workforce of sector C remains after period 2 at the level of period 2.
- D. When choosing option D, the user can change the green marked cells in columns N through V at will. The summary tables then provide direct insight into the pattern of technical change

The red marked cells show the implication of the selected option. These cells are the input for the calculations made in the last two worksheets, which are then summarized in the tables in rows 9 through 17.

6 First approach investment

Provides insight into the calculations of the first approach.

7 Second approach investment

Provides insight into the calculations of the second approach.