C Estimating the contribution of yield changes to mining MFP

This appendix contains a description of the methodology used to derive estimates of the extent to which changes in ‘yield’ – ore grades in metal mining, the saleable to raw coal ratio in coal mining, and the implicit rate of oil and gas flow in oil and gas extraction – contribute to year on year changes in multifactor productivity (MFP).

It is assumed that the contribution of yield changes to MFP can be calculated directly by measuring the extent to which gross output changes are attributable to changes in yield alone. For example, if the average ore grade in a metal mining industry falls from one year to the next, the contribution of the yield decline to the change in gross output can be measured directly. However, the output measure used in MFP studies is real value added (gross output less intermediate inputs), and hence the effect of a yield change on value added is also influenced by the relative size of intermediate inputs. As a result, the calculation of the extent to which yield changes contribute to MFP changes involves first estimating the extent to which yield changes influence changes in value added.

The formula used to measure the extent to which yield changes affect MFP is derived below. Note that yield effects are estimated separately for each of the eight mining subdivisions or classes analysed in this study, as well as for the ABS mining industry classification as a whole. Each parameter therefore has two subscripts: *i*, indicating mining subdivision or class, or the mining industry as a whole; and *t*,., designating the time period measured in fiscal years. Thus for $i \in \{1,2,...,9\}$ where 1 represents coal mining, 2 oil and gas extraction and so on with 9 representing the ABS classification in its entirety. The time subscript runs from 1974-75 to 2006-07.

Define Y_{it} as gross output (that is, metal content in metal ore mining, saleable coal in coal mining, crude, condensate, LPG, and LNG in the oil and gas extraction sector) of industry *i* at time *t*, which is equal to $s_{it}\gamma_{it}$, where:

s_{it} = Raw production (for example, ore production in metal mining, raw coal production in coal mining, and the amount of time spent extracting oil & gas in the oil and gas sector) for industry *i* at time *t*.

γ_{it} = Yield (ore grade/saleable to raw coal ratio/oil & gas flow rate) for industry i at time t.

J_{it} = Intermediate inputs for industry i at time t.

I_{it} = Labour and capital inputs of industry i at time t.

VA_{it} = Value added $= Y_{it} - J_{it}$

$MFP_{it} = \frac{Y_{it} - J_{it}}{I_{it}} \equiv \left[\frac{s_{it}\gamma_{it} - J_{it}}{I_{it}}\right]$ = Multifactor productivity of industry i in period t.

We define multifactor productivity exclusive of resource depletion (yield) effects to be:

$$M\hat{F}P_{it} = \frac{s_{it} - J_{it}}{I_{it}}$$

that is, set $\gamma_{it} = 1$ for all t to represent no depletion effect.

Therefore,

$$\frac{M\hat{F}P_{it}}{MFP_{it}} = \frac{(s_{it} - J_{it})}{(s_{it}\gamma_{it} - J_{it})}$$

$$M\hat{F}P_{it} = MFP_{it} \cdot \frac{(s_{it} - J_{it})}{(s_{it}\gamma_{it} - J_{it})}$$

$$or,$$

$$M\hat{F}P_{it} = MFP_{it} \cdot \frac{(Y_{it} - J_{it}\gamma_{it})}{(Y_{it} - J_{it})\gamma_{it}}$$

Hence, changes in the ratio $\frac{Y_{it} - J_{it}\gamma_{it}}{(Y_{it} - J_{it})\gamma_{it}}$ over time indicate the extent to which MFP changes over time as a consequence of changes in average yields. Decreases in the average yield over time imply that $\frac{Y_{it} - J_{it}\gamma_{it}}{(Y_{it} - J_{it})\gamma_{it}}$ will be increasing over time (ceteris paribus), and $M\hat{F}P_{it}$ growth will be greater than MFP_{it} growth, and conversely.