Measuring Natural Resources for Australia’s Mining Industry

Derek Burnell, Ken Ren, Larissa Argento

statistics for informed decision making
Outline

• Framework & recent improvements to valuation

• Relationship between income and capital in the SNA & SEEA

• Addressing the separation of ownership issue

• Some preliminary results
The model

- The ABS has measured the value of the stock of subsoil assets for nearly 20 years using NPV approach.
- For each mineral type:

\[
NPV = \sum_{t=1}^{T} \left( \frac{[Price_t - Cost_t] \times Quantity\ extracted_t}{[1 + r]^t} \right)
\]

\[
NPV = \sum_{t=1}^{T} \left( \frac{Economic\ rent_t}{[1 + r]^t} \right)
\]

Over a mine life of \( T \) with real discount rate of \( r \)
5 year moving averages for Price, Cost and \( r \)
International standards

- Aligns with SNA 08 & SEEA 2012 standards:
Recent Improvements

• Updated mineral extraction costs provided by a private consulting firm, based on company reported information and industry trends
• Mineral extraction cost is a **key** variable and reflects a variety of factors that characterise the quality including:
  - ore grade (metal per tonne of ore)
  - ore quality (impurities, milling characteristics)
  - reservoir pressure (flow rates of crude oil or gas)
  - overburden/strip ratio (waste material to ore or coal production)
  - mine or well depth
  - distance from infrastructure (port and rail facilities).
• Mineral costs components are not itemised sufficiently to identify the ore grade component
Recent Improvements...

• Real NPV:

\[
real \ NPV = \sum_{t=1}^{T} \left( \frac{[Price_{RY} - Cost_{RY}] \times Quantity \ extracted_t}{[1 + r_{RY}]^t} \right)
\]

• Where Price, Cost and r are fixed in reference year RY
• So real growth is driven by changes in quantity extracted
• Quantity extracted is before refining and processing so is not adjusted for variations in purity
• The numerator, real economic rent, is the indicator of subsoil service flows in the production function
Recent Improvements…

• Applies guidance in the new SNA08 Chapter 20 on Theory of Capital Services
• GOS is the return to capital (if no natural resource)
• Mining GOS can be allocated to both capital and subsoil natural resources
• ABS implemented improved allocation of economic rent
• The *return to produced assets* is now based on a mark up of costs using cost of extraction data, mining industry capital stock and an appropriate discount rate
Recent Improvements...

SEEA 2012 further elaborates on estimating resource rents from natural resources in mining:

- "Resource rent is thus derived from standard SNA measures of gross operating surplus by deducting specific subsidies, adding back specific taxes and deducting the user costs of produced assets (itself composed of consumption of fixed capital and the return to produced assets). As noted above, resource rent is composed of depletion and the net return to environmental assets." (SEEA 2012, para 5.120)
Relationship between income and capital

<table>
<thead>
<tr>
<th>Gross operating surplus</th>
<th>Consumption of fixed capital</th>
<th>Capital services of produced assets</th>
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<tr>
<td></td>
<td>Net operating surplus</td>
<td>Economic rents</td>
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<td>Return to produced assets</td>
<td>Services of subsoil “resource rents”</td>
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<td>Depletion</td>
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## Relationship between income and capital

<table>
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<tr>
<th>Gross operating surplus $95532m*</th>
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<td>Services of subsoil “resource rents” $42174m</td>
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Model allocation as at 2011-12 (current prices)
* Modelled “subsoil natural resources GOS”, not actual GOS
Validation of results

- Recent improvements have ensured greater consistency between the subsoil valuation model and other ABS data.

Mining GOS comparison ($billion), 1989-90 to 2011-12.
Net rate of return (subsoil) % = return to subsoil/subsoil NPV
Net rate of return (produced) % = return to produced/Mining NKS
GG Royalty income return = Rent on natural assets/subsoil NPV
Separation of ownership issue

SNA framework states that economic assets must have

- Ownership rights enforced, and
- Economic benefits derived
- The same business that owns the asset derives the capital services in the productive process
- Capital hired on operational leases is recorded as intermediate inputs of the lessee and the lessor retains the asset
Does ASNA meet SNA conditions?

- Ownership rights enforced? No
- Economic benefits to miners? Yes
- The government owns the stock of subsoil recorded on the balance sheet
- Miners have long term permits issued by the government
- Miners pay royalties to government, recorded in the government income account as *rent on natural assets*
The problem & possible solution

PROBLEM
• Separation of ownership of the asset owned by Govt and the extractor
• No asset miners own from which the capital services are derived

SOLUTION
• Create a separate asset for miners that is distinct from the resource itself
• This asset representing the right to extract minerals is 'permission to use natural resources' will satisfy the SNA08 'ownership rights enforced' condition
• Link the asset 'permission to use natural resources' to the capital services derived
Linking ownership & capital services

- SNA provides:
  17.314 ... (2) The owner may allow the resource to be used for an extended period of time in such a way that in effect the user controls the use of the resource during this time with little if any intervention from the legal owner.

- If Australian mining leases meet the above description SNA recommends:
  17.315 The second option leads to the creation of an asset for the user, distinct from the resource itself but where the value of the resource and the asset allowing use of it are linked.

- And the separation of ownership issue in the ASNA is resolved by creating an asset 'permission to use natural resources'
Relationship between owner & extractor

OWNER

Government on behalf of the community recorded in the Balance sheet

STOCKS

Permits issued by GG SNA 17.314

MINERAL EXTRACTION

INCOME FLOWS (GOS)

CAPITAL: Stock of subsoil NPV
INCOME: Flow of rent

CAPITAL: none
INCOME: Flow GOS

Rent on natural assets SNA 29.112
Relationship between owner & extractor

CAPITAL: Stock of subsoil NPV
INCOME: Flow of rent

OWNER

Government on behalf of the community recorded in the Balance sheet

STOCKS

Permission to use natural resources

MINERAL EXTRACTION

INCOME FLOWS (GOS)

Permission to extract

INCOME: Flow GOS

CAPITAL: Stock of subsoil NPV

Rent on natural assets

SNA 29.112

SNA 17.315
MFP Estimation

- New Mining value added $V_t$ production function with subsoil $N_t$, capital $K_t$ and labour $L_t$:

$$V_t = A_t F(K_t, N_t, L_t)$$

- Growth in mining MFP can be written as:

$$\ln \left( \frac{A_t}{A_{t-1}} \right) = \ln \left( \frac{V_t}{V_{t-1}} \right) - \bar{S}_{K,t} \ln \left( \frac{K_t}{K_{t-1}} \right) - \bar{S}_{N,t} \ln \left( \frac{N_t}{N_{t-1}} \right) - \bar{S}_{L,t} \ln \left( \frac{L_t}{L_{t-1}} \right)$$

- And $N_t$ is an index of real economic rent:

$$N_t = (Price_{RY} - Cost_{RY}) \times \text{Quantity extracted}_t$$
Growth accounting shares

• Use two period income shares in the usual way. Subsoil share is the \textit{return to subsoil} + \textit{resource depletion} share of modelled $GOS + COE$:

\[
\tilde{S}_{N,t} = \frac{\text{return to non produced assets + depletion}}{\text{Mining GOS + compensation of employees}}
\]

\[
\tilde{S}_{K,t} = \frac{\text{return to produced assets + consumption of fixed capital}}{\text{Mining GOS + compensation of employees}}
\]

\[
\tilde{S}_{L,t} = \frac{\text{compensation of employees}}{\text{Mining GOS + compensation of employees}}
\]
Capital services & subsoil shares 1989-90 to 2011-12.

- Subsoil natural resources
- Mineral and petroleum exploration
- Non-dwelling construction
- Machinery and equipment
- Research and development
- Inventories
- Land
## Mining productivity growth accounts

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<td>2.75</td>
<td>-9.60</td>
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<td>-2.93</td>
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Growth in natural log x 100
Impact of subsoil on MFP aggregates (growth)

- Proposed12
- Proposed16
- Current12
- Current16

Years: 1995-96 to 2011-12

Values range from -3.00 to 4.00.
### REVISION TO AGGREGATE VALUE ADDED MFP GROWTH FROM INCLUSION OF SUBSOIL

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Conclusions

• Recent improvements to the cost of extraction and normal returns to capital have ensured consistency between subsoil valuation model & other ABS mining industry statistics.
• The improved subsoil natural resources estimates are available for inclusion in MFP estimates if SNA ownership principles are satisfied.
• Mining MFP decline is significantly moderated when subsoil natural resources is included.
• Direction of revisions consistent with previous studies by Loughton (ABS, 2011), Zheng (2009), and Topp et al (2008) (but spread between various models is quite large).
• Potentially much better specification of production function in as far as the MFP residual has been reduced.
• Extending growth accounts to industry is beneficial as we can clearly see the contribution to growth of subsoil.
• But may need to maintain without subsoil estimates as well.