

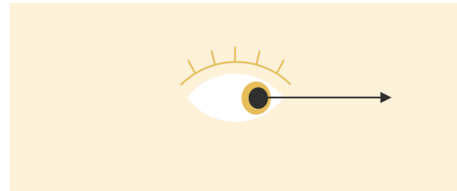
THE BOYNE ISLAND SMELTER:

A CASE STUDY

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Economic Modelling
with
Sector-specific Euler Equations

“emsee” model overview



CGE model with forward-looking dynamics:

General equilibrium: supply = demand at each region, sector, time, ...

Capital is optimally replenished using inputs from all sectors

Balanced growth paths: each sector grows in range 1% to 2%

Computation: sequence of overlapping nonlinear dynamic programs (Cai–Judd; Na et al.; 2021)

Sector-specific Euler Eq'ns:

When the SEE hold, capital is optimally allocated across sectors

Testable: “value capital today” = “expected value of capital in the future”

Absent: in intersectoral models such as CoPS; Atalay; Cesa-Bianchi et al; Baqaee and Farhi

Transition to net zero: lots of rapid change and uncertainty

Behavioural economics: decisions are hard in such settings, so **some of the SEE will fail to hold.**

When some of the SEE fail to hold:

- Sector-specific shocks lead to corrections that spill over to other sectors
- **more capacity for adaptation:** more opportunities to nudge economy to new equilibria

Aluminium Industry and Boyne Smelters Limited (**BSL**)

Australia: energy-abundant with a fully integrated Aluminium supply chain

- One of only three countries in the world along with Brazil and Venezuela.

Qld: Weipa Bauxite 50% to Gladstone; AlOx refining; Al smelting at BSL

- Gladstone AlOx (Alumina) refineries sell 15% to BSL
- Recent investment in Weipa and increase in capacity in Gladstone
- *No obvious threat to overall supply chain as Rio Tinto is majority owner*

BSL: consumes 1/8 of Qld's electricity; large energy subsidy (\$250m+)

One of four smelters in Australia NSW, Victoria and Tasmania

- Kurri Kurri, NSW closed in 2012
- Tiwai Point, New Zealand, Rio Tinto nearly closed in 2020-2021

- Qld Energy and Jobs Plan:

- Sustaining heavy industry in Qld is a key part of the transition

Gladstone, Central Queensland

Gladstone (2018-19 economy, SA3/LGA):

\$15.5bn **output**: approx. 25% of Central Qld, 2% Qld

29k FTE: approx. 28% of Central Qld, 1.3% of Qld



Gladstone is Qld's regional  manufacturing hub:

Other Heavy industry: Ammonia, Cement, LNG, Oil refinery

Growth industries: ag-tech, AlOx batteries, aquaculture, Mining Serv., green {...}

BSL represents approx. ¼ of Manufacturing activity (large energy consumption)

Data sources

Regionalisation to a 19-sector (ANZSIC divisions) Gladstone economy

Investment flows between sectors: method of Atalay (2017)

- Adapt investment flows tables from US data

BLADE (*and Remplan*): for output per sector for Gladstone 2019

Jobs in Australia ABS data: labour per sector for Gladstone 2019.

Input-output flows between sectors: ABS tables 5 and 8 for Australia

Gross Fixed Capital Formation by Industry by type of Asset: ABS for Australia

Gladstone Port data for Bauxite, Alumina, Aluminium and Coal

Rio Tinto accounts

Studies on aluminium production e.g.

- Gagne and Nappi 2000
- Best Available Techniques 2017

Experiments and shocks

Experiment (1) *all 19 SEE hold*

1st phase: tune/regionalise parameters

2nd phase: capital evolves towards a balanced growth path;

3rd phase: continue and generate

- ``status quo'' path
- ``shock'' (BSL closure) path

Experiment (2) *not all 19 SEE hold*

1st phase: tune/regionalise parameters;

2nd phase: capital evolves towards a balanced growth path;

3rd phase: continue and generate

- ``status quo'' path
- ``shock'' (BSL closure) path

Shock Type (a): one-off ``MIT shock'' agents don't see coming

- 1/4 decrease in Manufacturing productivity, capital and exports
- 5/6 decrease in Utilities (energy + water) purchases by Manufacturing
- No **exogenous** decommissioning or replacement activity

Summary of Results

Experiment (1a) Results

Shock is sector-specific

Aggregate Output -\$1.7bn	
Manufacturing	Others
-\$1.59bn	-\$0.1bn

Utilities prices fall:

Increasing Agriculture and Consumption

Economy *preserves* the status quo:

Manufacturing employment actually rises
(Compensation of Employees does indeed fall)

Experiment (2a) An example of Results

Shock is more dispersed

Aggregate Output -\$0.85bn	
Manufacturing	Others
-\$1.14bn	+\$0.29bn

Utilities and Manufacturing prices fall

Increasing Agriculture, Mining, ..., Consumption

Economy *departs from* the status quo:

Agriculture and Mining employment rise
(Manufacturing employment falls)

Graphical comparison of experiments

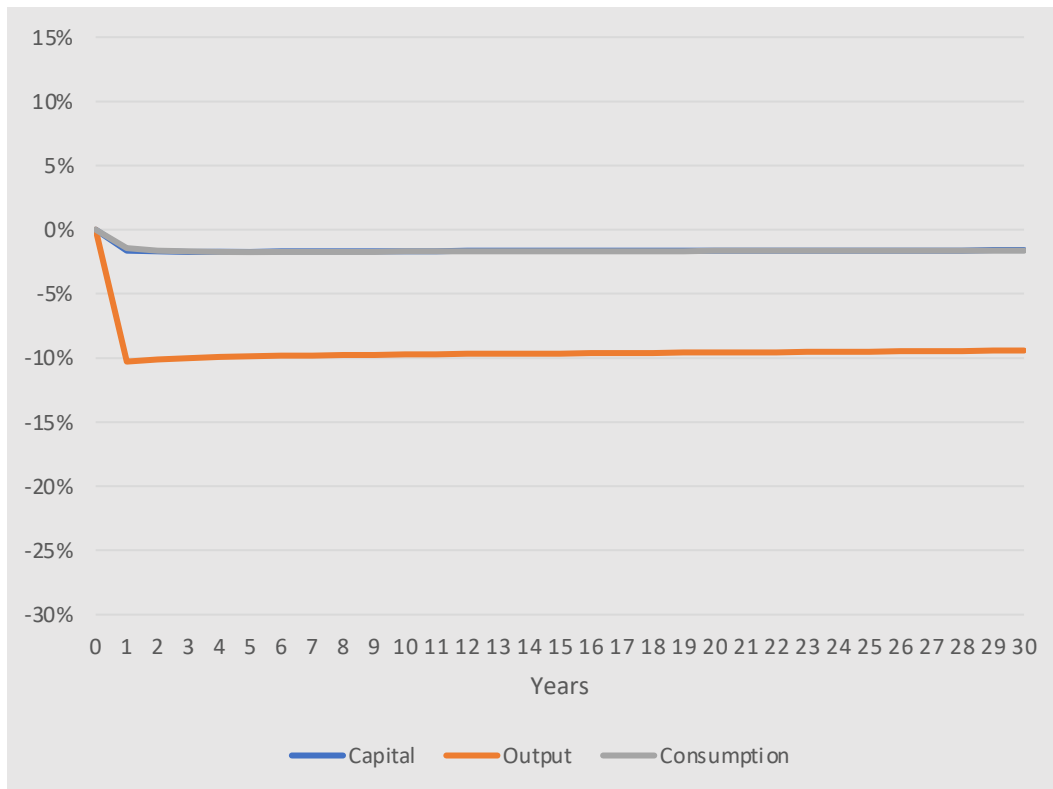
(1a)

All 19 SEE hold

(2a)

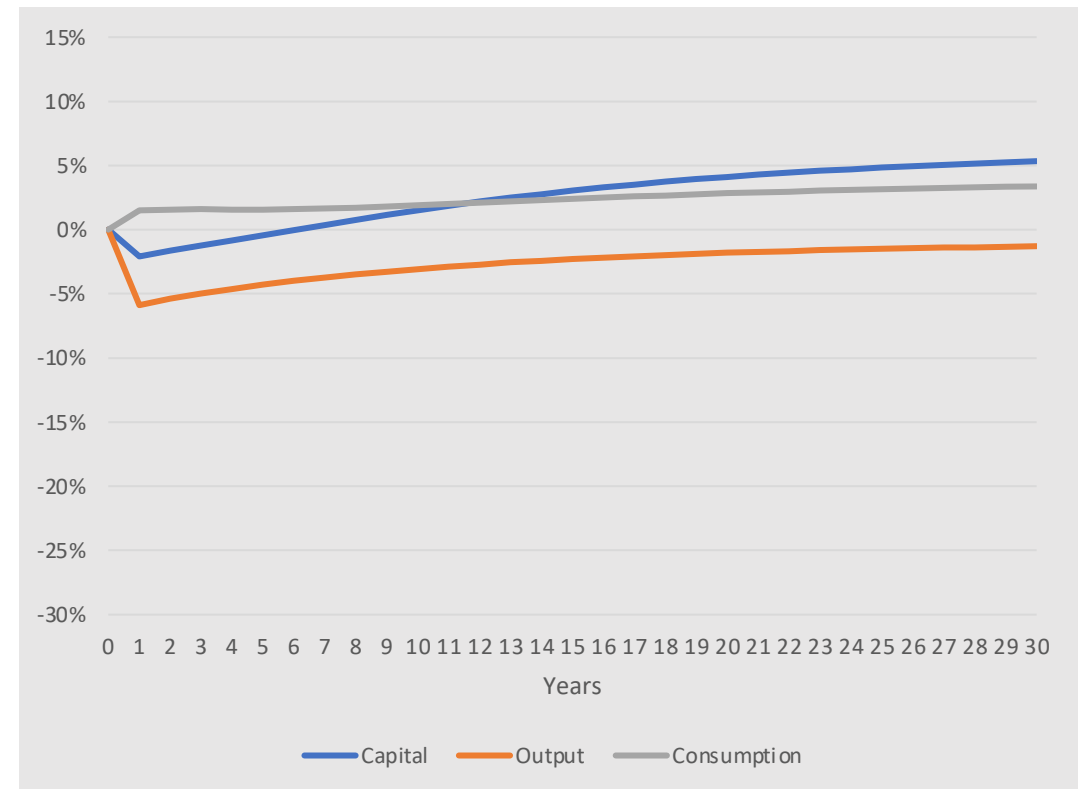
Not all 19 SEE hold

Experiment-shock (1a): % change relative to status quo, Aggregates



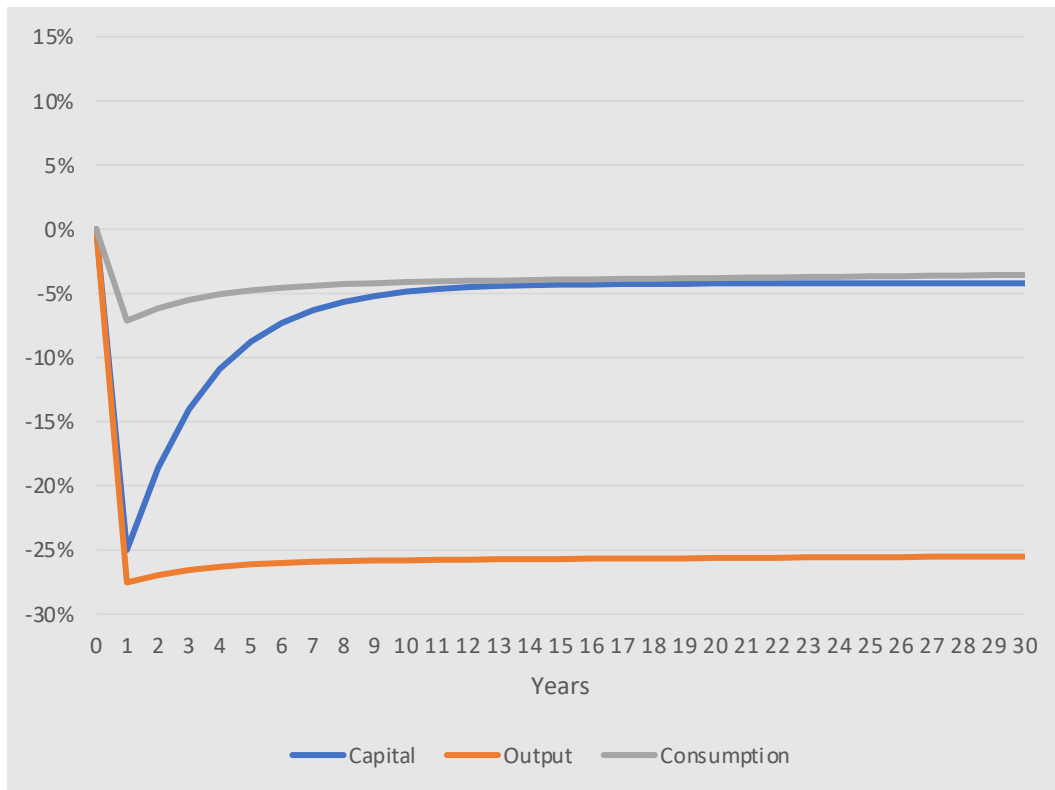
Aggregate Capital permanently down;
Aggregate Output permanently down by 10%;
Consumption falls as aggregate price levels rise

Experiment-shock (2a): % change relative to status quo, Aggregates



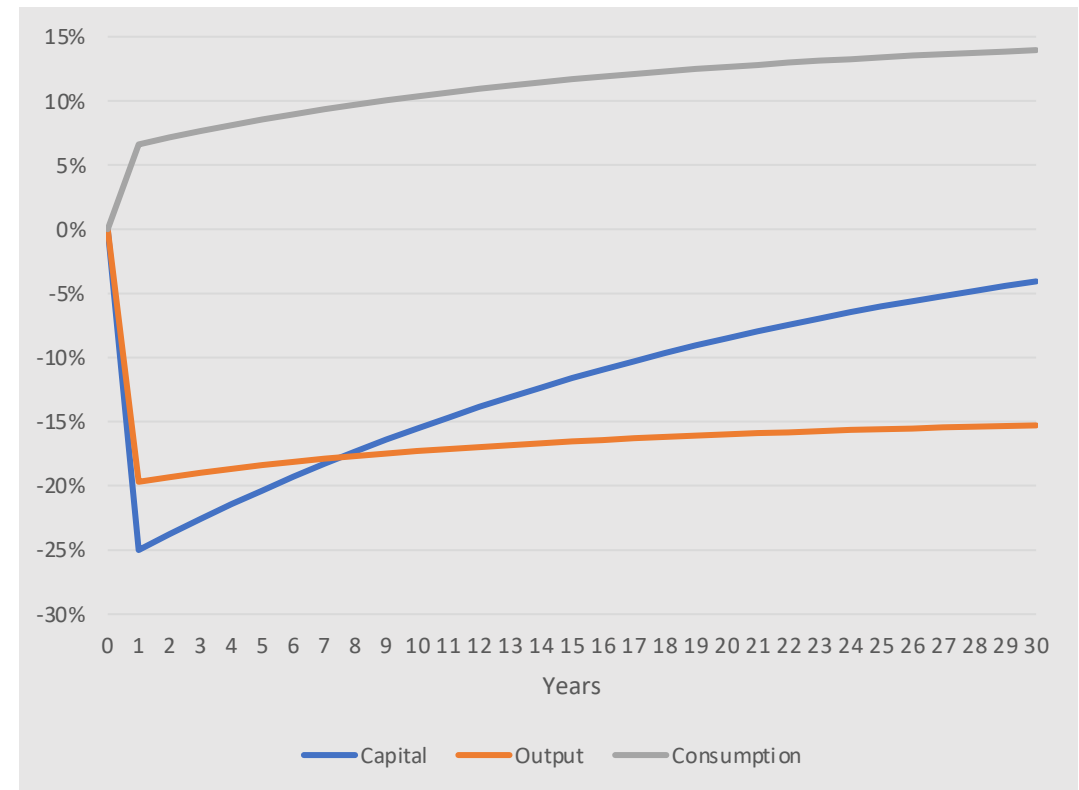
Aggregate Capital falls, but then rises above status quo;
Output initially falls by 6% before rising;
Consumption is 3.5% higher in the long run

Experiment-shock (1a): % change relative to status quo, Manufacturing



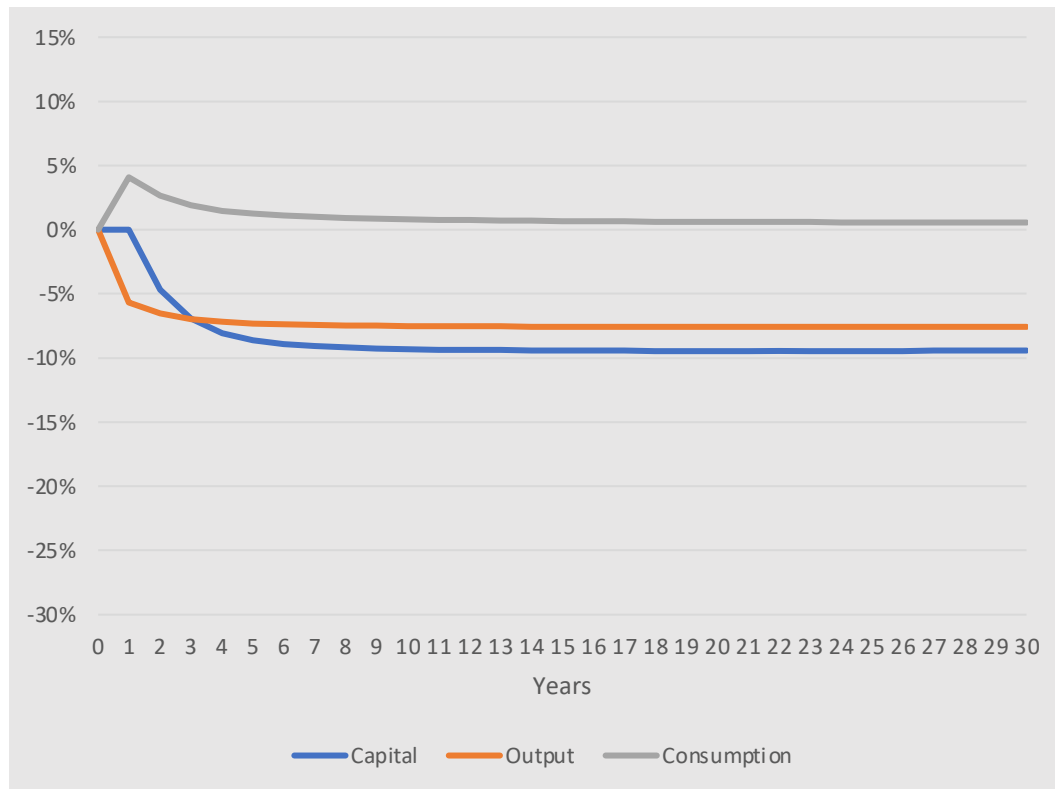
Manufacturing capital quickly recovers;
Consumption falls (prices rise)

Experiment-shock (2a): % change relative to status quo, Manufacturing



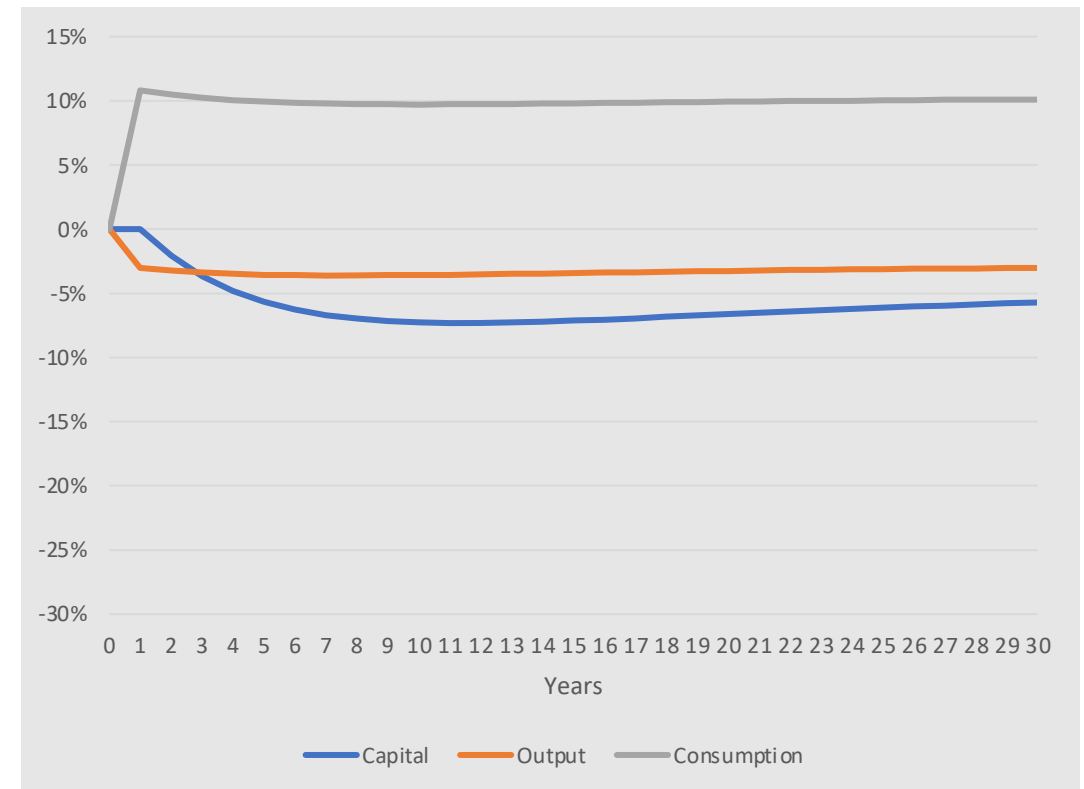
Manufacturing capital slowly recovers;
Consumption rises (prices fall)

Experiment-shock (1a): % change relative to status quo, Utilities



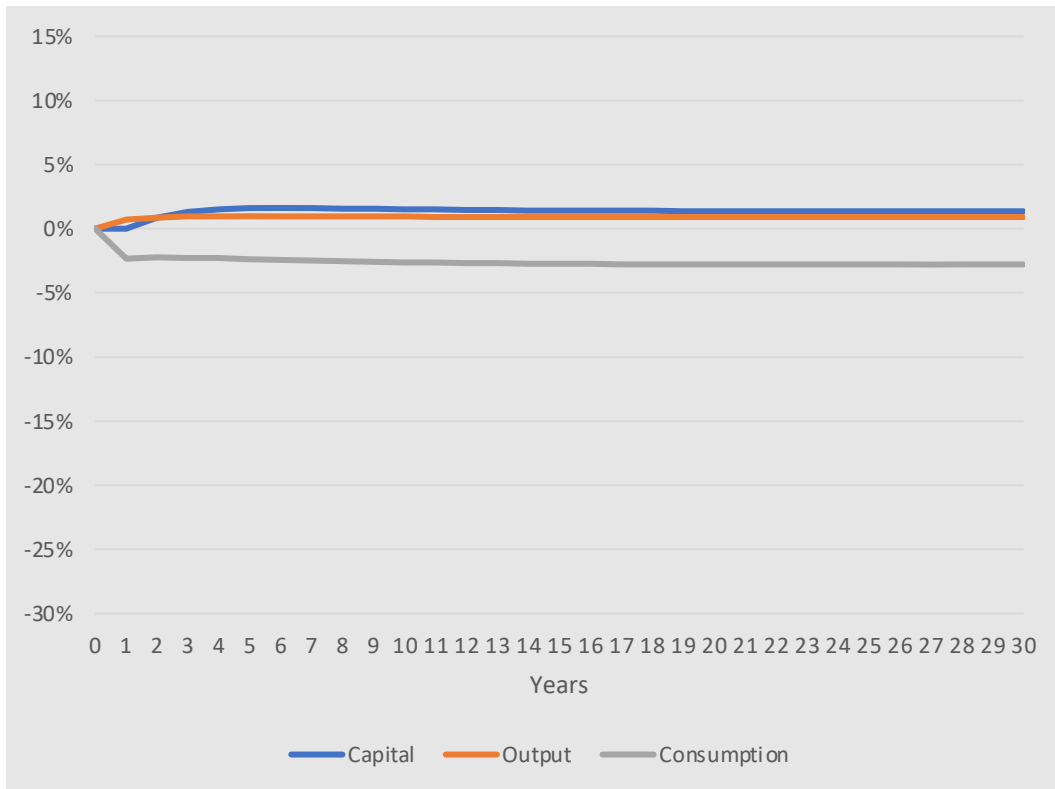
Consumption up (price down) temporarily
* Gladstone is connected to NEM ...

Experiment-shock (2a): % change relative to status quo, Utilities



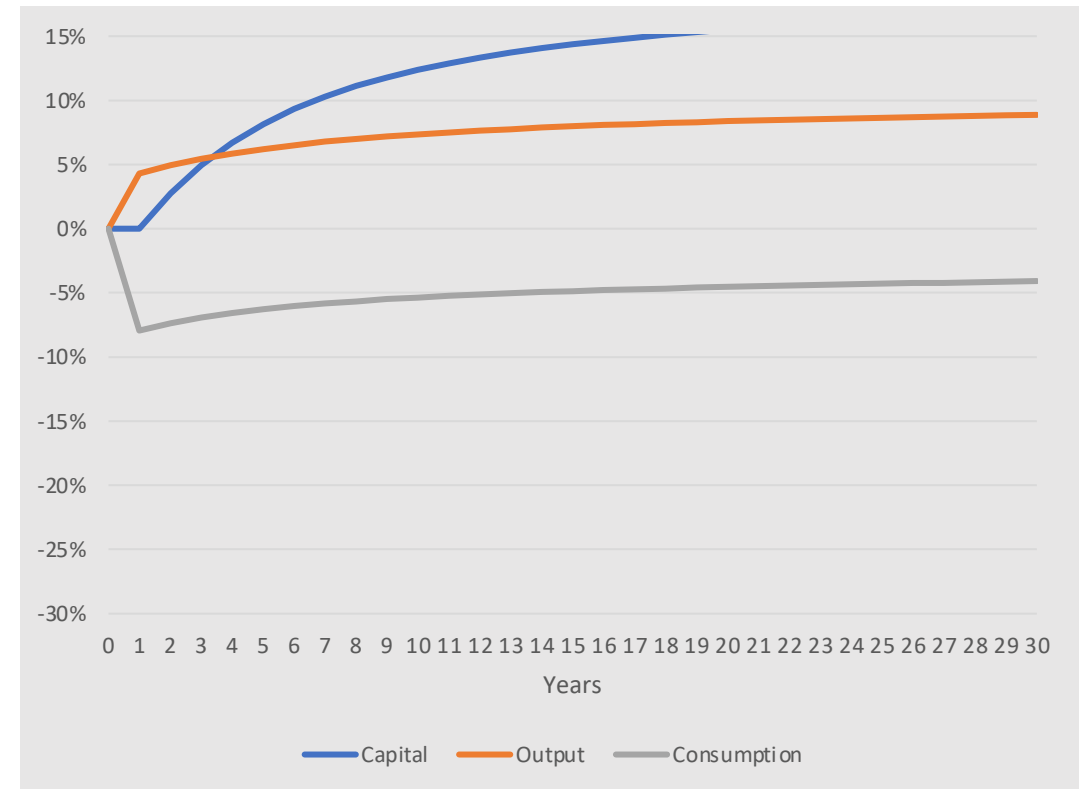
Consumption up (price down) 10% and permanently
* Gladstone is connected to NEM ...

Experiment-shock (1a): % change relative to status quo, **Agriculture** (Similar pictures for Mining.)



Capital up, Output up and consumption down

Experiment-shock (2a): % change relative to status quo, **Agriculture**



Capital up by over 15% in the long run.

Key takeaways

BSL is important to Gladstone's economy and the overall supply chain

Transition needs to be handled with care: BSL needs to be in close proximity of energy supply

Gladstone Aluminium: internationally competitive (given right energy transition)

[June 2022](#): Rio Tinto calls for clean Gladstone Aluminium by 2030.

[September 2022](#), Qld Energy Plan: supergrid can keep Gladstone in proximity of energy supply

Economic modelling with SEE:

Testable equations with long history in macroeconomics / finance (absent in CGE)

- If the SEE hold, then the shock is more sector-specific (less macroeconomic)

Transition to net zero:

Some SEE will not hold (given high uncertainty and out-of-date capital)

Greater **propagation of shocks**, but also greater **opportunity for change**

Policy implications:

We can estimate how the SEE fail and identify paths of least resistance for economic transformation.

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