

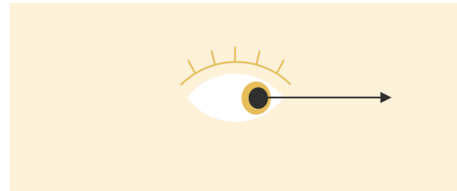
# THE BOYNE ISLAND SMELTER:

## A CASE STUDY

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Economic Modelling  
with  
Sector-specific Euler Equations

“emsee” model overview



## CGE model with forward-looking dynamics:

**Supply = Demand** (equilibrium where output = med + con + inv + xpo) at each time

**Capital** is optimally replenished using inputs from other sectors

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

**Solve as a sequence of overlapping nonlinear dynamic programs** (Cai–Judd; Na et al.; 2021)

**Sector-specific Euler Eq'ns:** *when they hold, capital is optimally allocated across sectors*

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

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

**With transition to net zero, some SEE may fail to hold, thus:**

- sectoral shocks are more likely to spill over/propagate to other sectors
- the economy has more capacity for adaptation: chance to nudge economy to new equilibria

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

## Australia: energy-abundant and fully integrated Aluminium supply chain

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

## Qld: Weipa Bauxite Gladstone for AlOx refining and Al smelting at BSL

- Gladstone Bauxite imports less than half of Weipa production
- QAL and Yarwun: Alumina sales to BSL is 15% of total output

*No obvious major threats to overall supply chain: Rio Tinto is majority owner*

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

- Like other smelters it is in close proximity of energy resources
- Recent smelter closures:
  - Kurri Kurri, NSW closed in 2012
  - Tiwai Point, New Zealand *almost* 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 aggregate output: approx. 25% of Central Qld, 2% Qld

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

63k population: highly skilled, but aging with 0.7% growth

- Multi-commodity deep-water port plus rail and road infrastructure



## Gladstone is Qld's regional manufacturing hub:

\$5.5bn to \$6bn Manufacturing output: of which approx. \$1bn is BSL

4k to 4.5k Manufacturing FTE employees: of which 1k at **BSL**

- **BSL represents approx. ¼ of Manufacturing activity except in energy consumption**

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

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



# Data sources



## **We specialise the model to the Gladstone region with 19 ANZSIC divisions:**

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

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

**Investment flows** between sectors: following Atalay (2017)

- Adapt investment flows tables from the US Bureau of Economic Analysis
- ABS Gross Fixed Capital Formation by Industry by type of Asset

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

*Gladstone Port* data for Bauxite, Alumina, Aluminium and Coal

- Eg. Bauxite imports

*Rio Tinto* accounts

*Studies* on aluminium production e.g.

- Gagne and Nappi 2000
- Best Available Techniques 2017

# Experiments and shocks

## Experiment Type (1):

**1st phase:** tune parameters to regionalise, *all 19 SEE hold*

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

**3rd phase:** continue along same path and generate

- “status quo” path
- “shock” (BSL closure) path

## Experiment Type (2):

**1st phase:** tune parameters to regionalise; *not all 19 SEE hold*

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

**3rd phase:** continue along same path 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

## Experiment (1a) Summary of Results

### Shock is sector-specific

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

Utilities prices ↓ by 4%

Agriculture, Consumption ↑

\* But Gladstone is connected to NEM ...

Manufacturing employment ↑ 6%:

- At 32% lower pay as economy strives to preserve **current equilibrium**.

## Experiment (2a) *an example* of Results

### Shock is more dispersed

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

Prices: Utilities ↓ 10%, Manuf. ↓ 3%

Agriculture, Mining, ... ↑ Consumption ↑

\* But Gladstone is connected to NEM ...

Employment: Manuf. ↓ 1.5%:

- At 19% lower pay.
- Agric. employment ↑ 5%, Mining more

# Comparison of experiments:

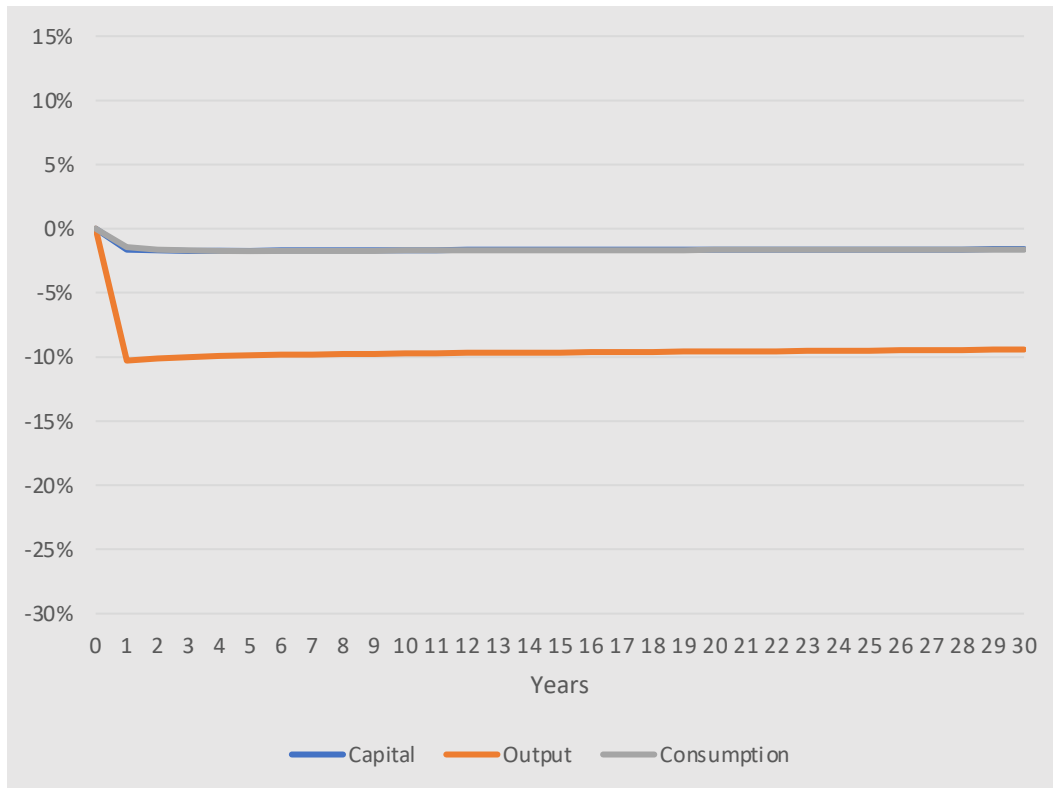
(1a)

*All 20 SEE hold*

(2a)

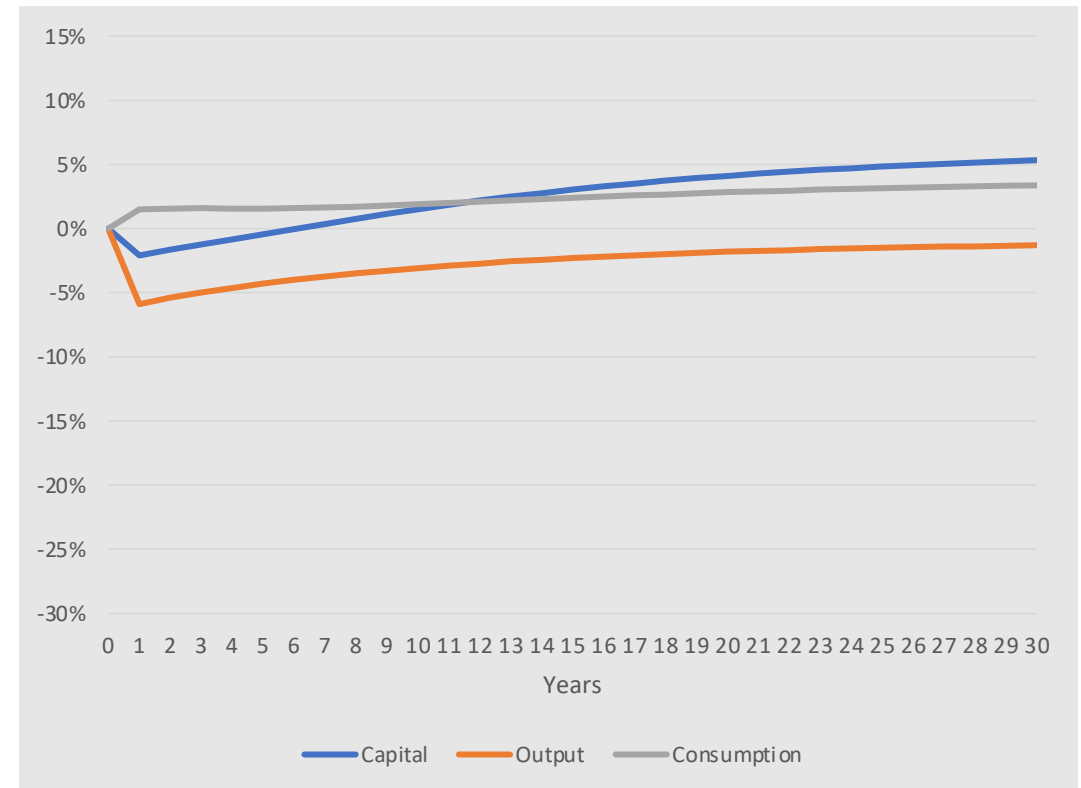
*Not all 20 SEE hold*

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



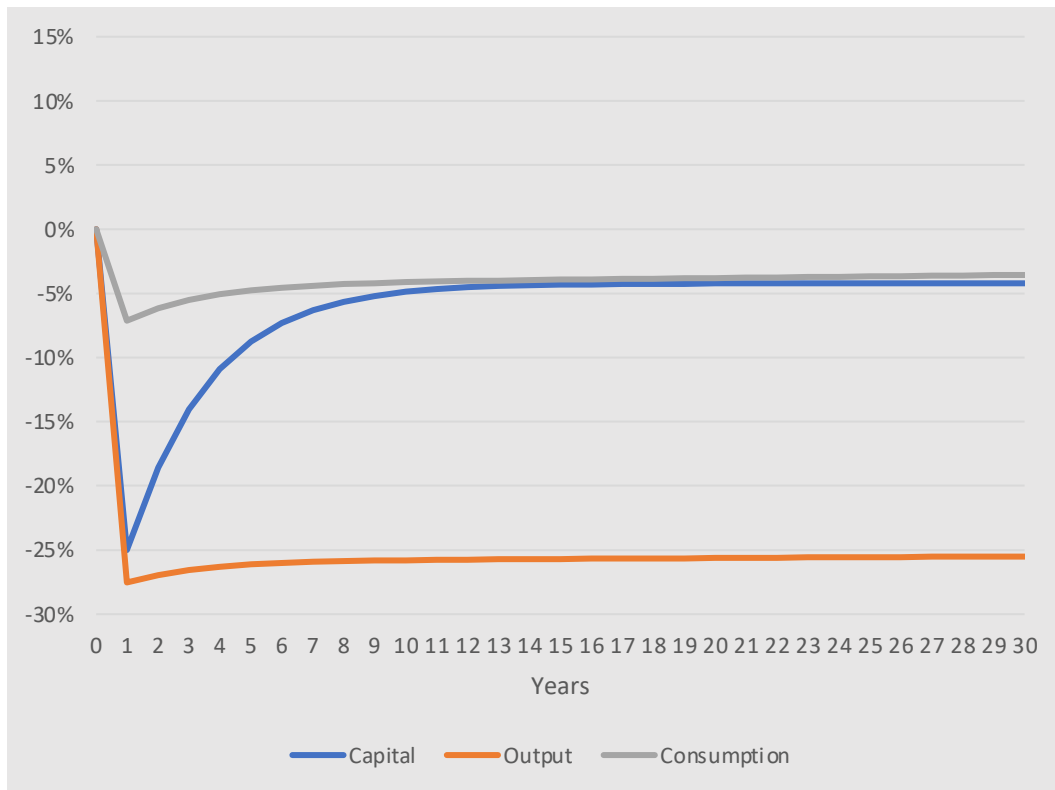
Aggregate Capital permanently down by 1.6-1.7%  
Aggregate Output permanently down by 11% or \$1.7bn  
Consumption falls as aggregate price levels rise

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



Aggregate Capital is higher than status quo after 7 years  
Output initially falls by 6% or \$0.85bn before rising;  
Consumption is 3.5% higher in the long run.

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

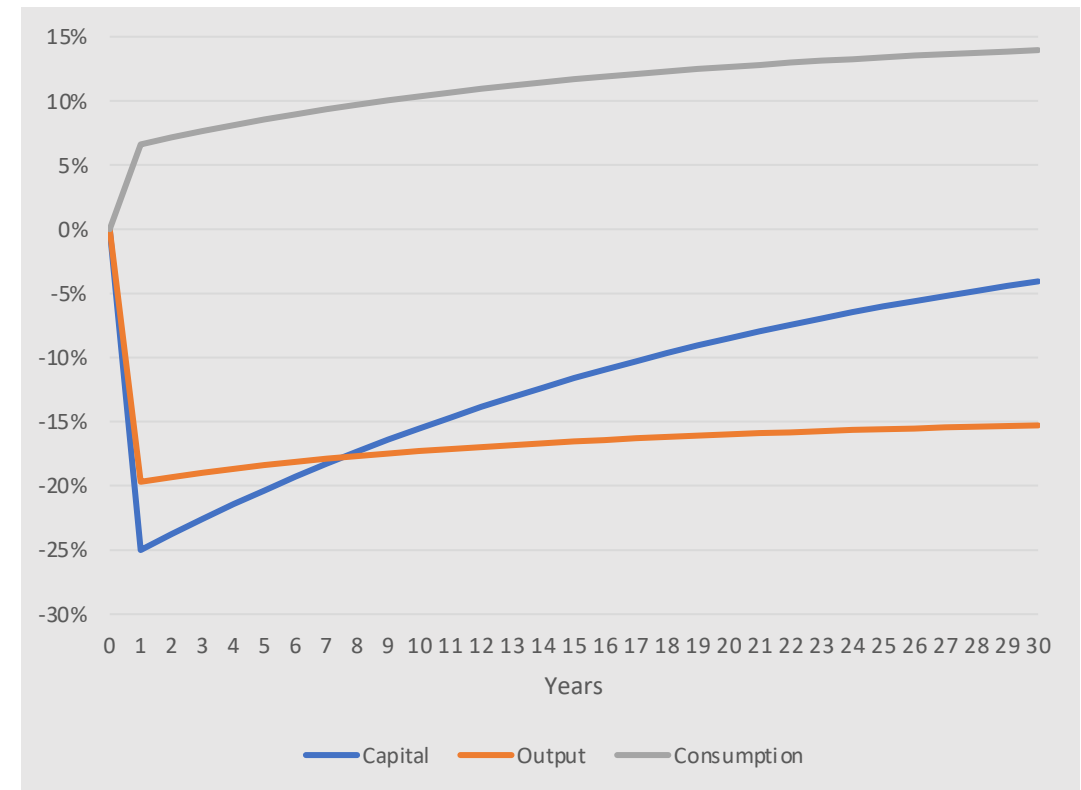


Manufacturing capital quickly recovers

Manufacturing output down by 27% or \$1.5bn

Consumption falls as Manufacturing prices rise.

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

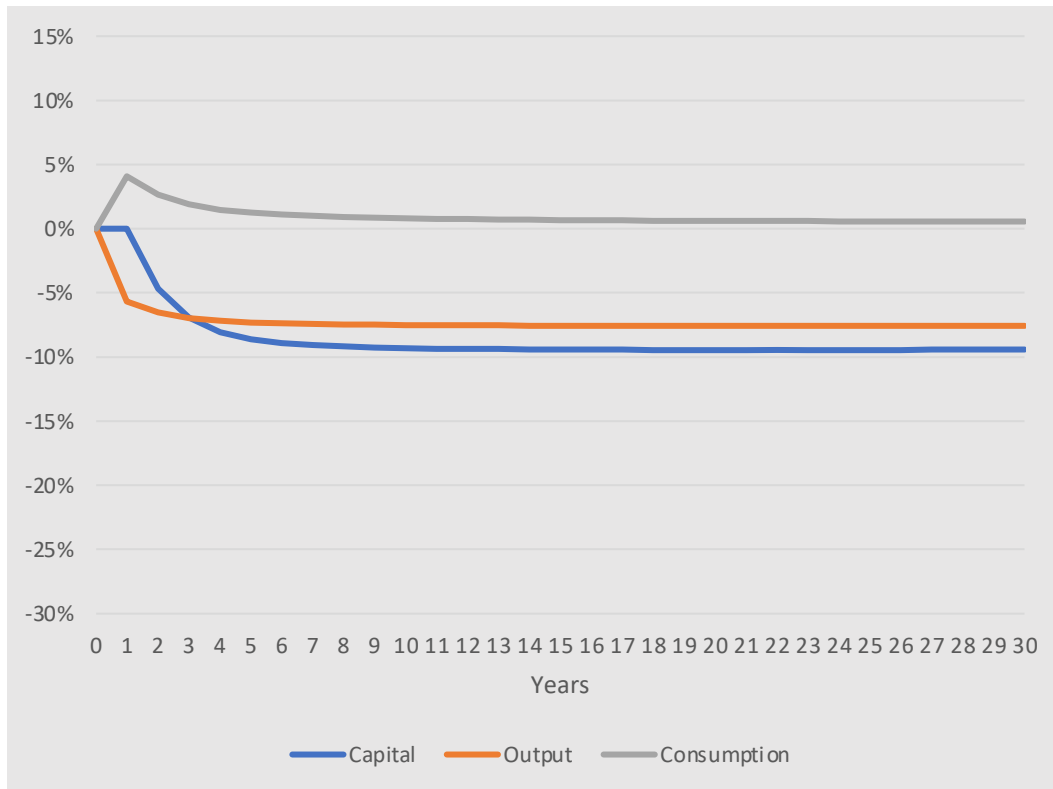


Manufacturing capital slowly recovers

Manufacturing output down by 20% or \$1.1bn

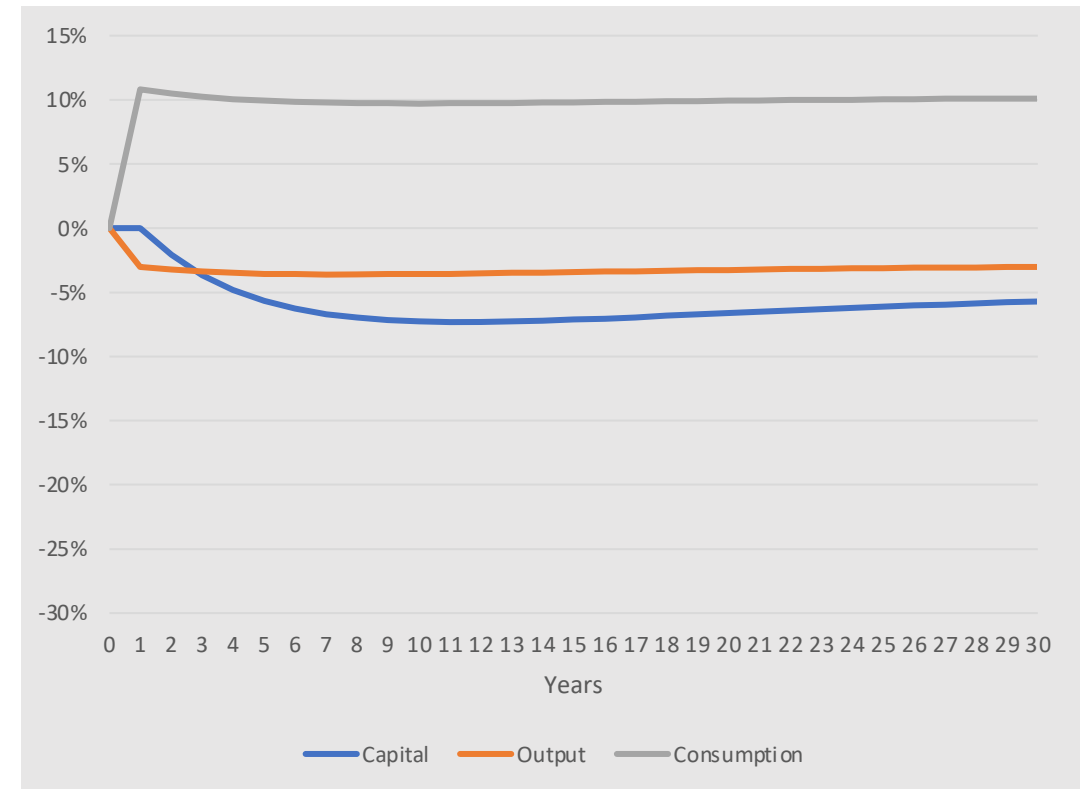
Consumption rises as Manufacturing prices fall.

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



Capital down by 9% in the long run.  
Utilities (Energy and Water) price initially fall by 4%;  
Consumption up compensating for falls elsewhere;

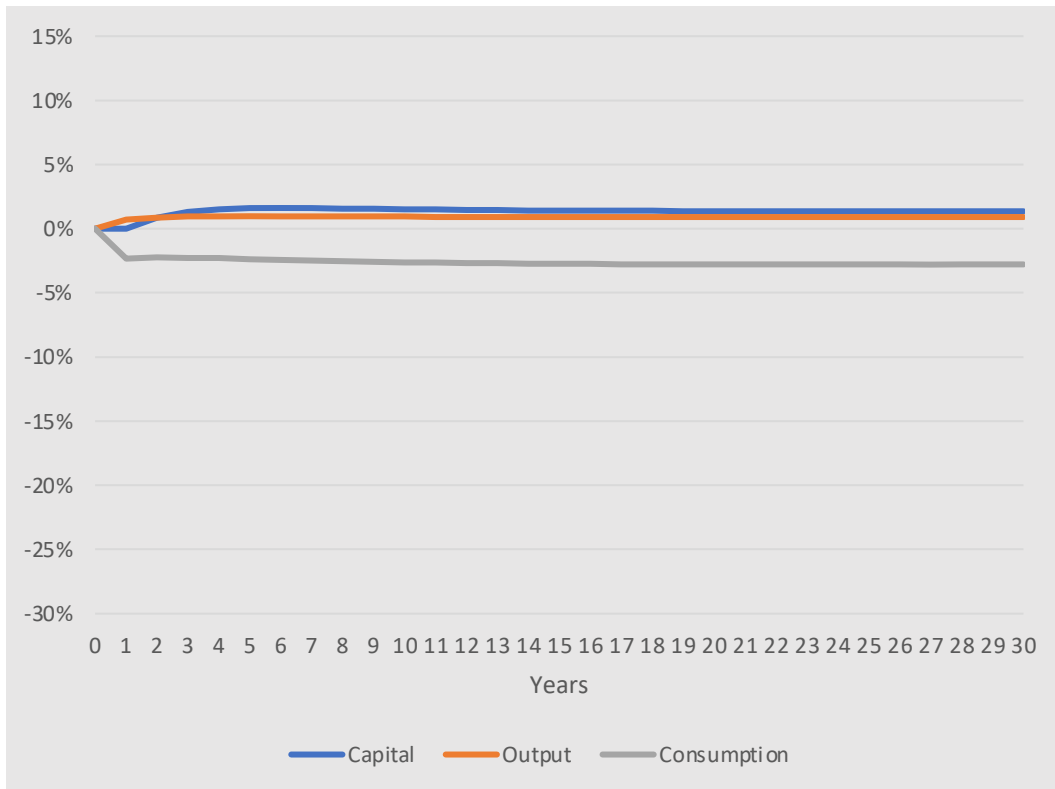
## Experiment-shock (2a): % change relative to status quo, Utilities



Capital down by 6% in the long run;  
Utilities price down by 10% and remains there;  
Consumption up and remains there

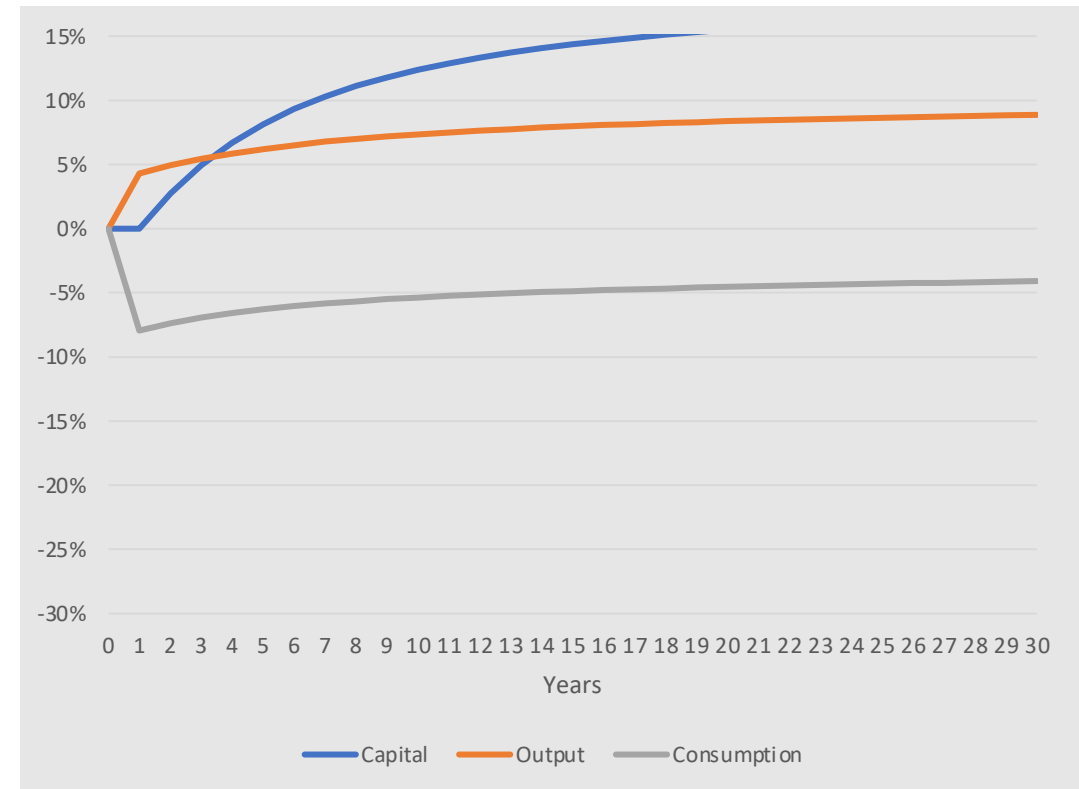


Experiment-shock (1a): % change relative to status quo, **Agriculture** (Similar pictures for Mining.)



Cheaper energy and water prices cause  
Capital up, Output up and consumption down

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



Similar, but more extreme:  
Capital up by over 15% in the long run.

# Key takeaways

**BSL is important to Gladstone's economy** and Qld's Al/AlOx supply chain

Transition needs to be handled with care: **major consumer of energy and energy prices ↑**

**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 power 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: some** SEE will not hold (given 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 transforming the economy

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