## THE BOYNE ISLAND SMELTER:

A CASE STUDY

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# 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 closure: Kurri Kurri smelter, closed in 2012
- Tiwai Point smelter, 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



\$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

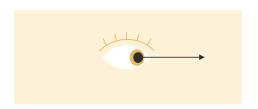
Other Heavy industry: Ammonia, Cement, LNG, Oil refinery

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



# Economic Modelling with Sector-specific Euler Equations

## "'emsee" model overview



#### CGE model with forward-looking dynamics: 19 ANZSIC divisions, Gladstone region:

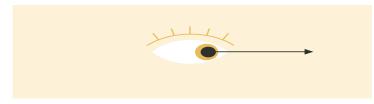
Solve as a sequence of overlapping nonlinear dynamic programs

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

**Output** is a function of capital, labour, inter**med**iates (with imports) and a fixed factor.

Capital depreciates and is optimally replenished to grow the economy.

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



#### **Sector-specific Euler Eq'ns:**

Testable condition: "value capital today" = "expected value of capital in the future" When the SEE hold, capital is optimally allocated across sectors

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

#### Transition to net zero: some SEE may fail to hold and, in this case:

- 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

## The data

#### Data sources:

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:

- 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 20 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 20 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) Results Summary

## When the SEE hold, the shock is sector-specific

Sectoral breakdown of initial -\$1.7bn drop in Aggregate Output				
Manufacturing	Utilities	Construction	Transport	Others
-\$1.59bn	-\$47m	-\$24m	-\$8m	-\$27m

## Closure causes Utilities (energy and water) prices to fall

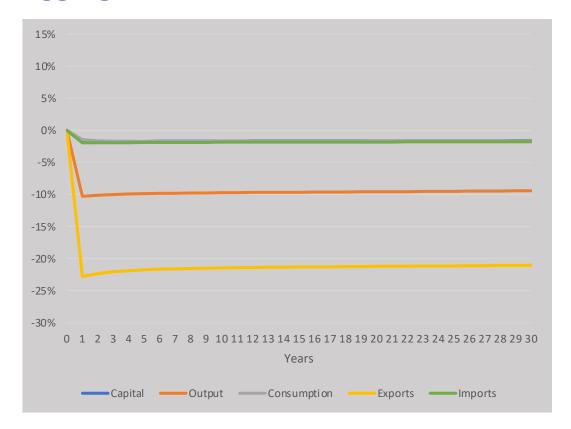
- This stimulates Agriculture, Mining and Consumption.
- In practice, Gladstone is connected to NEM, so actual fall in energy prices would be less significant as benefits are spread over a much larger region.

## Comparison of experiments:

(1a) (2a)

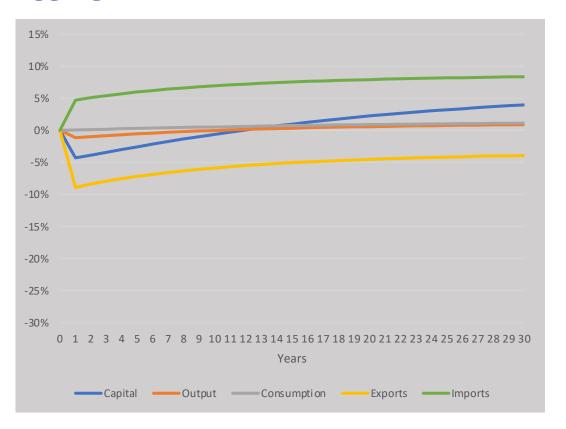
All 20 SEE hold Not all 20 SEE hold

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



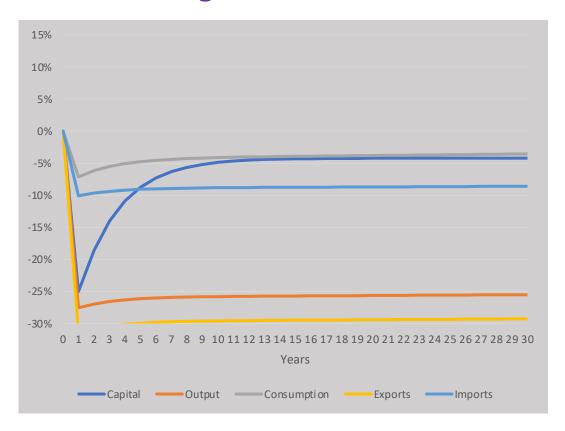
Aggregate Output permanently down by 11% or \$1.7bn in accordance with productivity shock
Aggregate Capital permanently down by 1.6-1.7%

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



Output falls by 1% or \$0.15bn before converging to 0; impact is transitory (unlike the productivity shock). Consumption is up by 1% in the long run.

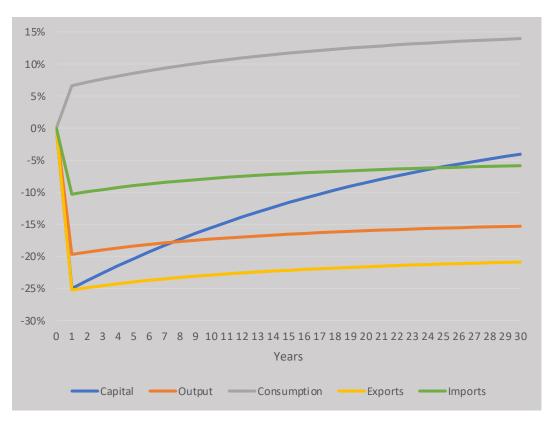
# Experiment-shock (1a): % change relative to status quo, Manufacturing



Aggregate Output permanently down by 27% or \$1.5bn (slightly more than productivity shock)

Manufacturing capital quickly recovers: a quick response is optimal.

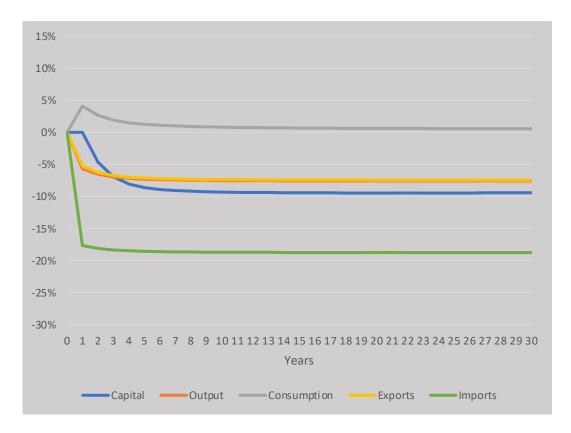
# Experiment-shock (2a): % change relative to status quo, Manufacturing



Manufacturing capital slowly returns to no-shock levels as they were not entirely efficient.

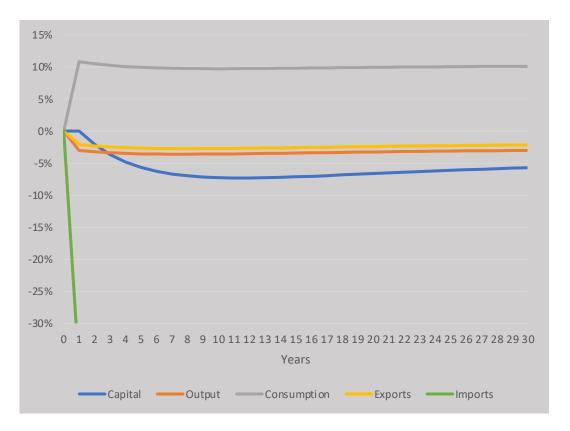
Consumption rises as Manufacturing prices fall.

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



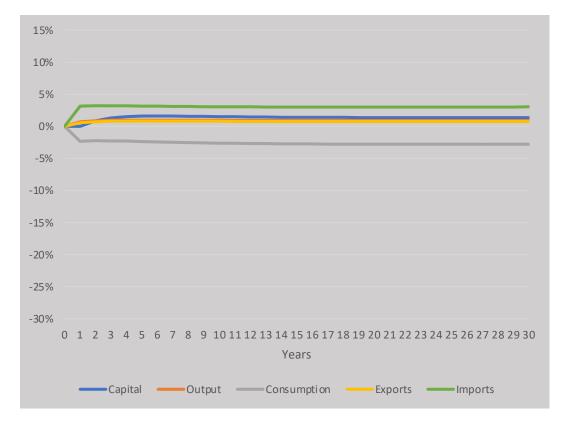
Utilities (Energy and Water) price initially fall by 4%; Consumption up compensating for falls elsewhere; Capital down by 9% in the long run.

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



Utilities price down by 10% and remains there; Capital down by 6% in the long run; As prop'n of output: imports down from 12.5% to 8%

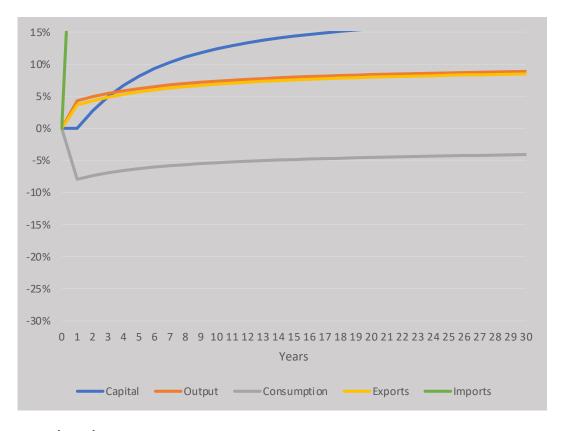
# Experiment-shock (1a): % change relative to status quo, Agriculture (Similar pictures for Mining.)



Cheaper energy and water prices cause Capital, Output, Exports and Imports to rise.

Consumption falls due to increases in other demand.

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



Similar, but more extreme:

Capital up by over 15% in the long run.

As prop'n of output: imports up from 10% to 15%

## Key takeaways

#### Economic modelling with SEE:

- The SEE are testable conditions with long history in macroeconomics and finance: absent in CGE
- If the SEE hold, then the shock is more sector-specific (less macroeconomic).

#### Transition: uncertainty and out-of-date capital, so the SEE are unlikely to hold

greater propagation of shocks, but also opportunity for change

#### Policy implications: by estimating how the SEE fail to hold, we can

• identify paths of least resistance for transforming the economy

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

- Transition needs to be handled with care as it is a major consumer of energy
- Needs a large backup supply of energy (currently Gladstone Power Station)
- Quick decisions are valuable: e.g. Kurri Kurri closure 2012; power station approval 2021

With right energy transition, Gladstone Aluminium can be internationally competitive <u>June 2022</u>: Rio Tinto calls for clean Gladstone Aluminium by 2030. September 2022, Qld Energy Plan: supergrid can keep Gladstone in proximity of power supply

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