THE BOYNE ISLAND SMELTER:
ECONOMIC IMPACT ON THE GLADSTONE REGION

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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

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**

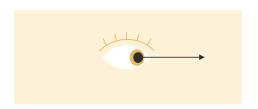- **BSL represents approx. ¼ of Manufacturing** activity except in energy consumption

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

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

Economic Modelling
with
Sector-specific Euler Equations

``emsee'' model overview

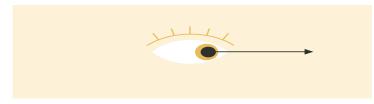*CGE model with forward-looking dynamics*: 19 ANZSIC divisions, Gladstone region:

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

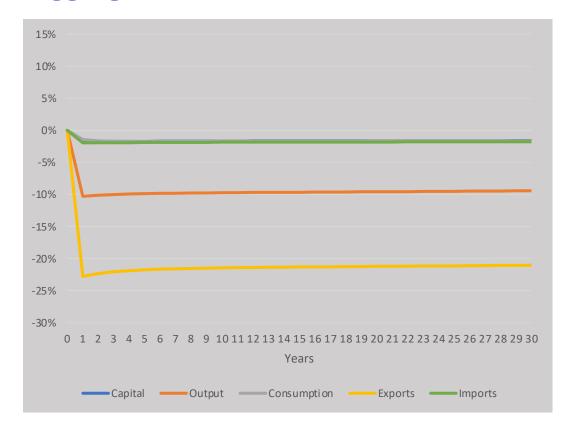| Sectoral breakdown of initial -$1.56bn drop in Aggregate Output				
Manufacturing	Utilities	Construction	Transport	Others
-$1.47bn	-$45m	-$23m	-$4m	-$17.5m

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:
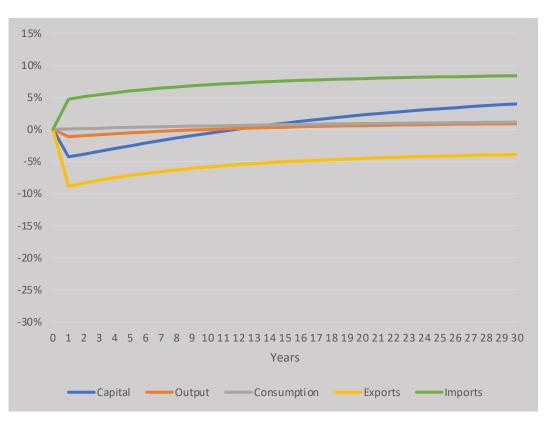
(1a)   (2a)

All 20 SEE hold   ***Not** all 20 SEE hold*
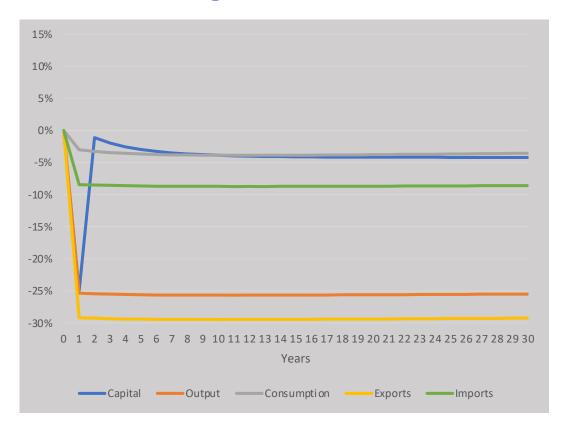
Experiment-shock (1a): **% change relative to status quo,** **Aggregates**

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

Aggregate Output permanently down by 10% or $1.5bn in accordance with productivity shock

Aggregate Capital permanently down by 1.6-1.7%
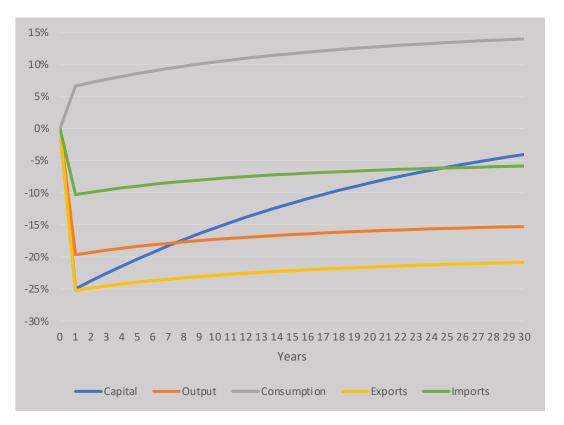
Output falls by 1% or $0.15bn before converging to 0; impact is transitory (unlike the productivity shock).

Consumption is up by 1% in the long run

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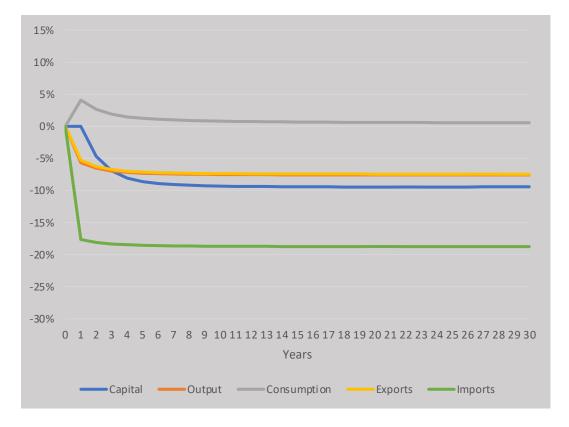**Manufacturing**

Manufacturing capital immediately returns back to previous no-shock levels: a quick response is optimal.

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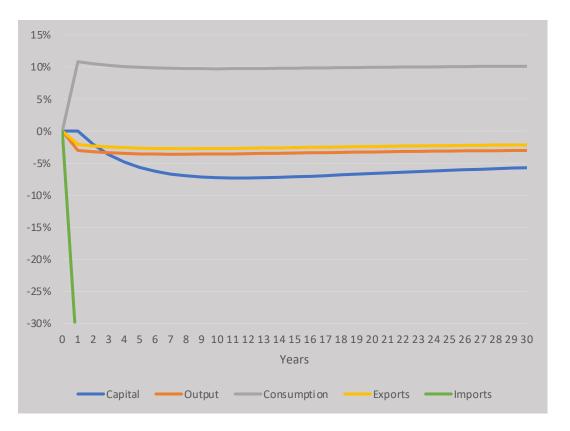**Manufacturing**

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

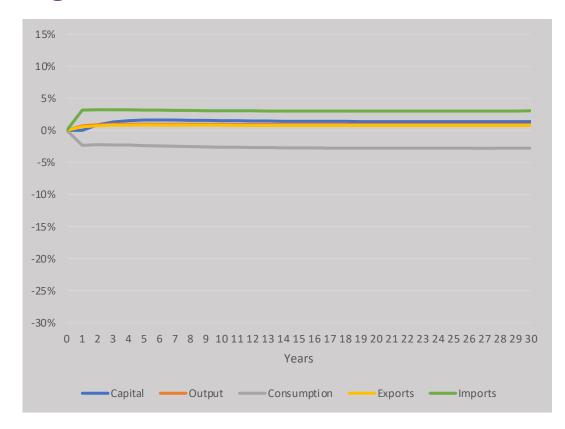Experiment-shock (1a): **% change relative to status quo,**
Utilities

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;
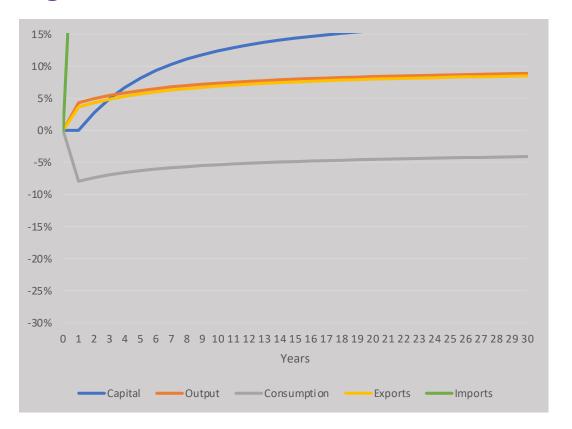As prop'n of output: imports down from 12.5% to 8%

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 the SEE:
- The SEE are testable conditions with a long history in macroeconomics and finance
- 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
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

References

Short list of Articles:

- Atalay, E. (2017). How important are sectoral shocks?. *American Economic Journal: Macroeconomics*, *9*(4), 254-80.

- Baqaee, D. R., & Farhi, E. (2019). The macroeconomic impact of microeconomic shocks: Beyond Hulten's theorem. *Econometrica*, *87*(4), 1155-1203.

- Cai, Y., & Judd, K. L. (2021). A Simple but Powerful Simulated Certainty Equivalent Approximation Method for Dynamic Stochastic Problems (No. w28502). National Bureau of Economic Research.

- Cusano, G., Rodrigo Gonzalo, M., Farrell, F., Remus, R., Roudier, S., Delgado Sancho, L. (2017). *Best Available Techniques (BAT) Reference Document for the Non-Ferrous Metals Industries. Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control)* (No. JRC107041). Joint Research Centre (Seville site).

- Dixon, P., & Rimmer, M. T. (2020). *Developing a DSGE consumption function for a CGE model*. Centre of Policy Studies (CoPS), Victoria University.

- Gagné, R., & Nappi, C. (2000). The cost and technological structure of aluminium smelters worldwide. *Journal of Applied Econometrics*, *15*(4), 417-432.

- Na, S., Anitescu, M., & Kolar, M. (2021). A fast temporal decomposition procedure for long-horizon nonlinear dynamic programming. *arXiv preprint arXiv:2107.11560*.

Data:

- Australian Bureau of Statistics (ABS), 2018-2019. *Tables 5 and 8: Industry by Industry Flow Table*. Released May 2021.

- Australian Bureau of Statistics, Business Longitudinal Analysis Data Environment (BLADE), 2018-2019, https://www.abs.gov.au/about/data-services/data-integration/integrated-data/business-longitudinal-analysis-data-environment-blade

- Bureau of Economic Analysis (2003). *Capital flow data for 1997*. https://www.bea.gov/news/2003/capital-flows-us-economy-1997

- Gladstone Regional Council. https://www.gladstone.qld.gov.au/downloads/file/3466/gladstone-region-investment-prospectus . Retrieved October 2022

- Queensland Government (2022). *Energy and Jobs Plan*. https://www.epw.qld.gov.au/energyandjobsplan . Retrieved October 2022

- Queensland Government. https://yoursayhpw.engagementhq.com/understand-qrez/news_feed/central . Retrieved October 2022

- Port of Gladstone, "Trade Statistics Data," https://www.gpcl.com.au/trade-statistics . Retrieved April 2020

- Rio Tinto, (2019). *Annual Report Production, Reserves and Operations*. Retrieved in April 2020.