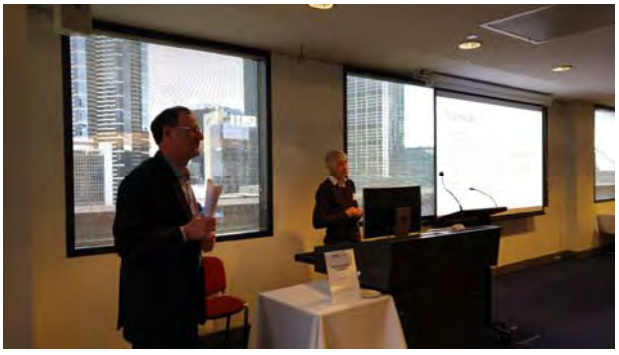
National CGE Workshop 2017

Monday August 7, 2017

Victoria University



Slides and abstracts

2017 National CGE Workshop

Monday August 7, 2017

Victoria University Convention Centre
Level 12, 300 Flinders St, Melbourne

8:15 **Registrations open. Barista now serving.**

8:55 **Welcome** ***Dr Janine Dixon, CoPS, VU***

9:00 **Keynote lecture** ***Chair: Professor John Madden, CoPS, VU***

Professor John Freebairn, University of Melbourne
Opportunities and Challenges for CGE Models in Analysing Taxation

10:00 – 10.15 **Morning tea**

10:15 – 12:15 **Session 1 – Data for CGE Modellers** ***Chair: Dr Xiujian Peng, CoPS, VU***

10:15 Khanh Hoang, ABS
Modernising the Input Output Tables: The way forward

10:45 Dr Geoffrey Brent, ABS
Optimisation balancing work at the ABS

11:15 Carl Obst, IDEEA Group
Using the SEEA Experimental Ecosystem Accounting framework to extend environmental-economic modelling

11:45 Professor James Giesecke, CoPS, VU
Modelling the GST in VURM

12:15 – 13:00: **Lunch**

13:00 – 15:00: **Session 2 – Issues in international economics** ***Chair: Dr Hom Pant, Deloitte Access Economics***

13:00 Dr Jason Nassios, CoPS, VU
Comparing the impact of bank regulation in Australia and the U.S.

13:30 Sigit Perdana, UWA
Global Climate Change Mitigation: Strategic Interactions or Unilateral Gains?

14:00 Gabrielle McGrath, Deloitte Access Economics
Minimising aggregation bias in regional models

14:30 Paul Gretton, Crawford School, ANU
Achieving longer-run equilibrium in the dynamic GTAP model

15:00 – 15:15: **Afternoon tea**

15:15 – 17:15: **Session 3 – Issues in domestic economics** ***Chair: Paul Gretton, Crawford School, ANU***

15:15 Raymond Mi, BAEconomics
The Effects of Trade Openness on Food Prices and Welfare: A Monte Carlo Approach

15:45 Philip Norman, Philip Norman and Associates Pty Ltd
Six CGE opportunities (and possible threats) in Subterranean Freight

16:15 Nathan Brierley and Cedric Hodges, Deloitte Access Economics
Firm closures in small regional economies

16:45 Dr James Lennox, CoPS, VU
Housing and employment growth in Melbourne: a Spatial General Equilibrium analysis

17:15 **Workshop end**

18:30 **Informal dinner, La Camera Southbank** **http://www.lacamerasouthgate.com/**

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Opportunities and Challenges for CGE Models in Analysing Taxation

John Freebairn, University of Melbourne

We analyse taxation to: understand and explain the current system; forecast the future; and evaluate reform options. CGE models are a complement to other modes of assessment, and in particular partial equilibrium models. Partial equilibrium models provide key building blocks for the effective tax burdens on decision choices and then the first round effects on market outcomes, redistribution and efficiency. Where second-round effects on other markets are important, including taxes initially levied on business, CGE models can trace through the general equilibrium effects in a logical and consistent fashion. In the many cases where the interest is in the interaction of several taxes a CGE is appropriate. Some of the manageable challenges in applying current Australian CGE models to the analysis of taxation include model additions: disaggregation of households to provide required pictures of distribution effects of taxes; disaggregation of households and businesses to reflect exemptions and deductions from comprehensive tax bases, and progressive rates; inclusion of external costs and benefits important in evaluating selective product taxes.

Modernising the Input Output Tables: The way forward

Khanh Hoang, ABS

The Input-Output (I-O) tables produced by the ABS are changing. This presentation will explain the modifications to the structure of the I-O tables brought about by changes to classifications meant to enhance their relevance to contemporary issues and the incorporation of updated source data and improvements in estimation methods.

Optimisation balancing work at the ABS

Geoffrey Brent, ABS

The Australian Bureau of Statistics is moving to adopt modern optimisation tools for Supply-Use balancing and other applications. I'll discuss this process, some of the methods and tools involved, and the expected benefits.

Using the SEEA Experimental Ecosystem Accounting framework to extend environmental-economic modelling

Carl Obst, Melbourne Sustainable Society Institute, University of Melbourne and Institute for Development of Environmental-Economic Accounting (IDEEA) and Mark Eigenraam, Institute for Development of Environmental-Economic Accounting (IDEEA)

Detailed analysis of the implications of economic policy options and economic shocks relies heavily on comprehensive economic models. Increasingly it is recognized that establishing a comprehensive picture requires incorporation of environmental factors that relate directly to economic production and consumption behavior and outcomes. Recent papers by Banerjee et al highlight the potential to incorporate environmental information into CGE models. Also, while there has been investigation of the impacts of ecosystem activity on biodiversity and ecosystems, for example in terms of modeling land use change, there is an emerging interest in understanding the dependency of economic activity on these complex environmental assets.

This presentation articulates a conceptual approach by which data on ecosystem services and ecosystem assets can be integrated into standard input-output tables, and hence CGE models; and describes potential applications of the approach in underpinning further advances in integrated environmental-economic modeling.

The approach involves applying the important recent advances in accounting for natural capital and environmental assets, as encapsulated in the UN System of Environmental-Economic Accounting (SEEA). Since the SEEA uses national accounting principles for the organization of environmental data, the information can be readily linked to the standard input-output dataset that underpin CGE models.

In 2013, as part of the SEEA framework, an additional perspective was introduced to apply national accounting principles to the integration of information on ecosystem condition, biodiversity and ecosystem services. This advance is referred to as ecosystem accounting.

The approach described here harks back to early work on linking environment and input-output but formulates an alternative path that overcomes some limiting features of those approaches while also ensuring standard accounting identities (e.g. supply and use of products) are maintained and that there is coherence between measurement boundaries for production and assets. The presentation notes a number of conceptual and measurement issues, including those concerning the pricing of ecosystem services that remain to be further explored.

Modelling the consequences of GST reform for state and territory economies

J.A. Giesecke and N.H. Tran, Centre of Policy Studies, Victoria University

Previous modelling of the Australian GST has: (a) used models of the national economy; and (b) modelled the GST as an indirect tax on various tax bases (like consumption and investment) without taking explicit account of the complex details of the operations of the GST system as they relate to its legislated features and its interactions with the structure of economic activity. In this paper we improve on previous modelling by: (a) modelling the GST within a multi-regional framework that allows for the identification of the commodity-, source-, user-, and region-specific details of

economic transactions; (b) modelling the legislated details of the GST as it relates to the commodity-, source-, user-, and region-specific details of legislated GST rates, legislated GST exemptions, agent- and region-specific details of entities registered for GST, multiproduct detail as it relates to the capacity of agents to reclaim GST paid on inputs, informal economic activity, the low value import threshold, transaction-specific compliance rates, and taxation of on-shore purchases by non-residents. In a model like this, when we change any individual element of the GST (for example, by raising existing rates, taxing currently GST-free goods like basic foods, removing exemptions such as finance, removing the low value import threshold) the economic effects are informed by regional differences in economic structure and their interactions with the commodity- user- and source-specific details of our GST theory.

Comparing the impacts of bank regulation in Australia and the United States using country-specific financial CGE models

Jason Nassios, James Giesecke, Peter Dixon, Maureen Rimmer, Centre of Policy Studies, Victoria University

Jurisdiction-specific differences exist in the implementation of the Basel III capital adequacy requirements. In this presentation, we highlight one reason inhomogeneous cross-country capital regulations may materialise, by illustrating how the impacts of regulatory change [in this case, a rise in bank capital adequacy ratios (CARs)] can be affected by jurisdiction-specific differences in the structure of the financial sector. To this end, we begin by summarising the structure of a new financial computable general equilibrium (financial CGE) model of the U.S. called USAGE2F. We then illustrate how explicit recognition of financial stocks and flows can broaden the scope of CGE analyses to include the effects of changes in CARs of financial agents, e.g., the commercial banks. Finally, our results are compared to findings of a similar policy scenario in Australia, with differences in the results largely attributable to cross-country differences in financial structure.

Global Climate Change Mitigation: Strategic Interactions or Unilateral Gains?

Sigit Perdana and Rod Tyers, UWA

Global agreements designed to slow global warming are being weakened by unilateral concerns over growth performance and debates over burden sharing. Since all approaches to emission control imply carbon pricing, in this paper the national policy choice is standardised as between implementing an effective carbon tax or free riding, to determine whether the incentive structure is a coordination game in which collective gains require that all, or most, countries participate. The potential economic costs of ignoring climate change are first surveyed, linking economic growth to carbon concentrations, global temperature changes and, finally, to the scale of global economic benefits from mitigation. Second, modelling of global economic performance is used to measure the costs of carbon tax implementation. Finally, multi-player, normal form games with pay-offs derived from both the survey and the modelling reveal that the large economies are net gainers from unilateral implementation, while the dominant strategy for small countries is to free ride. Yet there exist side payments that result in universal adoption and collective welfare gains.

Minimising aggregation bias in regional models

Cedric Hodges, Gabrielle McGrath, Hom Pant, Deloitte Access Economics

Despite evidence that aggregation bias exists in CGE modelling, computational efficiency requires some level of database aggregation. This paper explores practical ways of minimising regional aggregation bias in global CGE models. The methodology is illustrated with the example of a mining boom in an Australian region, New South Wales, propelled by a demand surge from a specific global region, China.

We apply a given export demand shock (in dollar value) to the model, with Australia as the domestic economy and different specifications of Rest of World. At one extreme we define Rest of World as one region and interpret the increase in export demand as coming from this single foreign region. At the other extreme we identify all countries in the Global Trade Analysis Project database separately and interpret the export demand surge as originating from China. The difference between these two specifications shows the extent of the regional aggregation bias in this exercise, and informs whether this bias is important for Australian policy analysis or not.

We then run alternative aggregations, guided by economic theory, to find a regional aggregation that practically minimises the aggregation bias. We look for a regional aggregation that gives results closer to that of the full database disaggregation without significantly increasing the computational burden. We then discuss how our findings can be generalised to reduce bias from regional aggregation in the broader context of policy analysis done using CGE models.

Achieving longer-run equilibrium in the dynamic GTAP model – Gdyn

Paul Gretton, Crawford School, ANU

A dynamic version of the well-known GTAP model became available in 2012. The dynamic version known as GDyn, introduced partial adjustment mechanisms for capital accumulation and a dynamic accounting of capital-finance and related income flows between regional households and firms, and a global trust. In long run equilibrium, the model rates of return are to be equal and constant over time. In practice, illustrative results presented with the release of GDyn show the equilibrium conditions are only partially satisfied. This paper confirms this model property. It finds that this gives rise to model instability which limits the use GDyn for the analysis of economic growth within a neoclassical framework. To achieve model stability and overcome this limitation, modelling of rates of return and capital-finance flows is further developed within the GDyn framework to satisfy the stated longer-run neoclassical equilibrium conditions. Results of the revised model demonstrating a stable, longer-run equilibrium are reported. Some key areas for further research are noted.

The Effects of Trade Openness on Food Prices and Welfare: A Monte Carlo Approach

Raymond Mi and Brian Fisher, BAEconomics - CIE

The effects of trade openness on food prices and its consequence on national welfare are extremely complex. The findings are subject to different circumstances and they cannot be oversimplified by the neoclassical theory of comparative advantage. The aim of this paper is to examine the effects of trade openness on global food prices and national welfare in the light of the uncertainties of climate variability. Given that the net global agricultural productivity impact and the variation from one economy to another economy under a global climate event are highly unpredictable, a Monte Carlo method is used to simulate the wide range of productivity and geographical variations.

By assuming the percentage change of factor productivity shock around the globe is normally distributed under a climate event, the current version of GTAP model 6.2 plus the latest GTAP database 9.0 is run for 18,000 times by three sets of productivity shocks. Each productivity shock has 16 randomly drawn elements. Each element corresponds to an agricultural factor productivity disturbance to one of the 16 economies aggregated from the GTAP 9.0 database.

One reference case and two alternative scenarios are considered in this paper. The reference case represents the current form of trade openness specified in the GTAP 9.0 database. Scenario A represents an increase in trade openness by allowing more flexible substitutions between domestic agricultural production and imports. Scenario B represents further increase in trade openness by reducing 10 per cent of the current tariff levels on agricultural products, on top of the flexible institutional measures introduced in Scenario A.

Our results found that trade openness can contribute to reducing the volatility of world food prices. It also has an impact to some degree on the level of world food prices, but the direction depends on the impacts of the climate events. In respect of national welfare, it is found that while greater trade openness in the agricultural sector could increase welfare at the global scale, it does not automatically increase welfare for every economy.

Six CGE opportunities (and possible threats) in Subterranean Freight

Philip Norman, Philip Norman and Associates Pty Ltd

Moving international shipping containers below ground has economic benefits in large cities compared to current practice of large trucks on congested roads.

Presentations to the *Australian Conferences of Economists* 2016 and 2017 explain progress that Philip Norman and Associates Pty Ltd www.philipeconomist.com.au and many helpers are making in the engineering and economics of Subterranean Freight.

Single containers move slowly10kph in tight tunnels of 2.25m internal radius using mechanical, automotive and electrical engineering that is confidential while Intellectual Property IP is protected. Civil engineering is more public.

Focus for the first two years has been on economic costs. Now is the time to seek CGE help in estimating benefits beyond economic cost benefit defined narrowly. Six CGE calculations of wider economic benefits are:

Kewdale rail freight terminal to the sea Port of Fremantle, WA

Land-side access to the Indian ocean Gateway, Kwinana WA

http://indianoceangateway.com.au/

Land-side access to the sea Port of Brisbane from the Melbourne to Brisbane inland rail link.

Land-side access to the sea Port of Melbourne

Land-side access to the future sea Port of Hastings, Victoria.

All of the above – somehow using proposed Transport Satellite accounts to the *ABS System of National Accounts* including travel time.

Possible A* journal article topics include

Some mathematical economics optimisation of 6 above

Well-insured analyses of loss of producer surplus if market power exists.

Disruptive technology may threaten existing producers who may not be happy.

Firm closures in small regional economies

Nathan Brierley, Wilma Gillies, Hugh Green, Cedric Hodges, Christine Ma, Hom Pant

Regional economies tend to be less diversified compared to the national economy, with many reliant on one or two major industries or firms. Consequently, the closure of a firm, which is a major employer, can have profound effects on a regional economy. This paper analyses the potential economic impact of a large firm closure in a small regional economy using a Computable General Equilibrium (CGE) framework. Specifically, the closure of a large manufacturing firm, accounting for 25 percent of local employment in a hypothetical small region which accounts for 1 percent of Australias GDP, is simulated.

We first produce a central estimate of the impact on real Gross Regional Product (GRP) and on Full Time Equivalent (FTE) employment. Both are expressed as ratios, where the lost output from the firm's closure serves as the denominator. These ratios provide a simple snapshot of what is important to policy makers and allow easy comparison between the different scenarios. We then determine plausible upper and lower bounds for the impact by altering the values of critical parameters to their logical extremes.

With a central estimate and plausible range of impacts identified, we conduct sensitivity analysis to determine how several observable factors influence the projected impact. These include the size of the regional economy, the state of the labour market, the relative factor intensity of the sector being shut-down and the level of import penetration.

Results indicate that the impact could plausibly vary by a factor of three, depending on how mobile factors are within the region and the substitutability of products in interregional trade within Australia. In addition to this, we examine how significant the variations in other factors, like the degree of import penetration, are to the resulting deviation.

Policy makers are understandably apprehensive in the face of a large local firm closing. In particular, the focus is typically on what it may mean for employment and regional output, with a loss of both being weighed against the cost of providing industry assistance. This analysis shows that, by using tailored and rigorous analysis, policy makers can better understand how a firms closure will impact the regional economy.

Housing and employment growth in Melbourne, Australia: a spatial general equilibrium analysis.

James Lennox, Centre of Policy Studies, Victoria University

We present a spatial computable general equilibrium (SCGE) model of Melbourne, Australia featuring commuting between over three hundred residential and employment zones. The `VU Cities{Melbourne' model, is designed to simulate the impacts of policies, planning and public investments in the urban and transport sectors. These can be represented for example as changes in taxes, transport costs, productivity or amenity. The model allows for positive externalities of density affecting both productivity and amenity. We have calibrated the model to data for the Melbourne region and illustrate its application to three scenarios of population growth. We consider scenarios featuring rezoning for residential densification or transport taxes as two alternatives to a scenario of continuing heavy reliance on peripheral greenfield developments and `urban sprawl'. Both rezoning and transport taxes are effective in increasing residential densities, but the transport tax has much stronger impacts employment densities and also reduces aggregate travel demand substantially. The densification policy alleviates pressure on housing costs but has small productivity benefits, whereas both housing costs and productivity increase with the transport tax. These two types of policies are thus potentially complementary.

Opportunities and Challenges for CGE Models in Analysing Taxation

John Freebairn
University of Melbourne
2017 National CGE Workshop, Victoria University, 7 August 2017

Issues to be covered

- Research questions involving taxation
- Potential additional information provided with a CGE model
- Suggestions on some areas of further development of Australian CGE models to assess taxation questions

Why analyse taxation?

- Describe and understand the current taxation system
- Forecasts or projections involving taxation
- Analysis of taxation reform options

Description of current taxation in terms of:

- What is been taxed and how
  - Tax unit and tax base
  - Tax rate schedule
- Decisions affected by tax
  - Importance of effective tax wedge = pre-tax return to buyer – after-tax return received by seller
- Market outcomes
- Distribution effects
- Distortions to decisions and efficiency costs
- Complexity, and costs of administration and compliance

Taxation in the economy

- Purposes of taxation include:
  - Redirect limited national resources from private sector for use by governments
  - A component of government redistribution policy to meet society equity objectives
- Current taxation, 2013-14
  - $437 billion, or 27% of GDP
  - Main taxes
    - Personal income, 39%
    - Company income, 16%
    - GST, 13%
    - Payroll, 5%
    - Municipal rates, 4%
    - Land, 2%
    - Excises, gambling, motor vehicles, 8%
    - Transaction taxes, 5%

Forecasting and projections

- To support and facilitate decision making by
  - Governments
  - Business
  - Households

Analyses of taxation reform options

- Potential tax reforms include
  - Henry Review (2009), Re:Think (2015), state reviews, lobby groups, etc
  - Single changes and packages of changes
- Relative to a base case, usually current situation**, assess changes to**
  - Tax bases and rates, then to effective tax rates
  - Decisions affected, and changes induced
  - Market prices and quantities, taxation revenue, GDP, etc
  - Redistribution effects
  - Efficiency effects, or gains in national productivity and incomes
  - Simplicity and operating costs

Economic tools for analysing taxation

- Night-after effects. Assumes no behaviour responses
- Partial equilibrium models. Usually for a single product, factor or asset
- General equilibrium models, including CGE

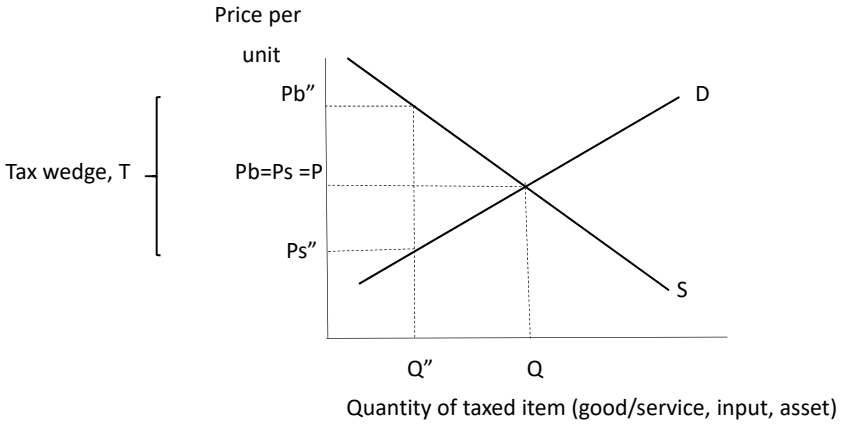
I see

- the different tools as complements rather than as substitutes
- Often a CGE study will draw heavily on PE in setting up the model and in interpreting the results

Why a CGE rather than, or in addition to, a partial equilibrium model?

- Important second round effects assumed away with PE
- Need to assess the interaction of and the collective effects of several taxes and tax reform packages
- Assess time path of responses to tax changes
- Assess macroeconomic effects, such as GDP, GNI, government budget

Partial equilibrium model



Examples of **significant second round effects** to warrant a general equilibrium assessment

- Taxation of business income and the flow through to individuals
  - Market effects of, and final incidence of, corporate tax
  - Transaction tax reducing productivity of input or asset, then demand
  - Different tax bases
  - Interplay of imputation system for residents and withholding tax for non-residents
- Tax bases with significant exemptions, including payroll, land, GST
- Special taxes to correct market failures and the "double dividend" debate
- Analysing the hybrid of different tax systems and effective tax rates for different avenues of household saving and investment
- The flow-through of changes in taxes on capital income to asset prices

Other reasons to use a CGE to analyse taxation

- Assess the effects of multiple taxes
  - Labour market effects of labour income plus payroll plus GST in driving effective tax wedge between labour cost to employer and effective purchasing power for employee
  - Overall redistribution and efficiency effects of several taxes
    - Current tax system
    - Reform packages, e.g. land tax for conveyance, larger GST for smaller income
- Assess dynamics and time pattern of responses in addition to comparative static equilibrium. Associated with: adjustment costs, sticky prices, other than model rational expectations

Some challenges in developing CGE models for the analysis of taxation

- A range of different households/individuals
- Current narrow tax bases and reform proposals with comprehensive tax bases
- Taxation of wealth and capital income
- Adding finance
- Taxation of decisions involving external costs/benefits and changing non-market values
- Model closure
- How to assess and report effects of imperfect information

Clearly, an omnibus large model for all questions is neither feasible nor appropriate

Modelling households

- A key concern of most tax studies is the distribution effects across a range of different households. Options for disaggregation include
  - Capacities to pay tax assessed in terms of one or more of: income, assets, expenditure, employment endowment, age or generation
  - Different response elasticities, and especially labour supply, but perhaps savings
- Desirable to include formal utility maximisation models, and use EV or CV measures of welfare changes
- Rather than snapshot pictures, include information on individual/household transitions across states over time.

Household wealth and capital income

- Considerable heterogeneity of different saving and investment options in terms of
  - Income characteristics such as variability and distribution of returns, liquidity, personal preferences
  - Tax systems and effective tax rates on different forms of capital income, and then of reform options
- Suggest portfolio models for allocation of saving to the different options to reflect different characteristics and preferences
- Very important for both horizontal and vertical equity

Taxation reforms to remove special exemptions and deductions

- Examples include: payroll tax, land tax, measures of business income, GST
- Modelling requires disaggregation of taxed and tax-exempt sectors, e.g.
  - Small and large business for payroll
  - Owner occupied and other property for land
  - Small companies with lower rate and accelerated depreciation versus large
- Assessment of GST reforms to consider snapshot ABS data with C/Y > 1 for first two quintiles versus a sustainable long run C/Y ≤ 1. Mix of households may be required according to mix of C spent on GST taxed and exempt (and also for special externality correction taxes)

Adding finance

- Most current models focus on real decisions with seamless movement of funds
- For example, in practice debt and equity
  - Have different characteristics to both lenders and borrowers, which with portfolio preferences, mean they are imperfect substitutes
  - Face different tax treatments, and then different between resident and non-resident
- Suggest disaggregate some financial flows as imperfect substitutes and portfolio preferences along the lines of treatment of different types of labour and physical capital

Model closure assumptions

- For prices need to distinguish between pre-tax price paid by buyer and after-tax price received by seller, with difference equal to tax wedge
- Treatment of tax changes and government budgets. Options include
  - Leave budget outcome endogenous
  - Unchanged budget with lump sum transfer
  - Revenue offset via other tax changes

Challenge of imperfect knowledge

- Clearly, there is available a wide range of estimates for key parameters affecting tax incidence, market outcomes, efficiency and redistribution.
- So, necessary to test for robustness, run scenarios, etc
- Some suggest provide matrices of effects for key uncertain parameters rather than just independent variations
- How to concisely present masses of information?

Final thoughts

- Clearly there is a very important role for CGE in the analysis of taxation
  - In many cases second round effects are important
  - Often the combined effects of numerous taxes are to be assessed
- Compelling micro foundations of the links from changes in taxation to changes in decisions should underlie the model and interpretation of the results
- Developing CGE models for taxation is another version of well-established extended detail and sector disaggregation of parts of a generic model required for specific questions. And then, model for purpose rather than a universal model.
- Suggested priority areas include
  - Disaggregation of households
  - Taking longer term average pictures rather than snapshot pictures
  - Presentation of results to recognise imperfect numbers

Modernising the Input – Output Tables

A way forward

Khanh Hoang
7 August 2017

www.abs.gov.au

Input-Output tables are changing….

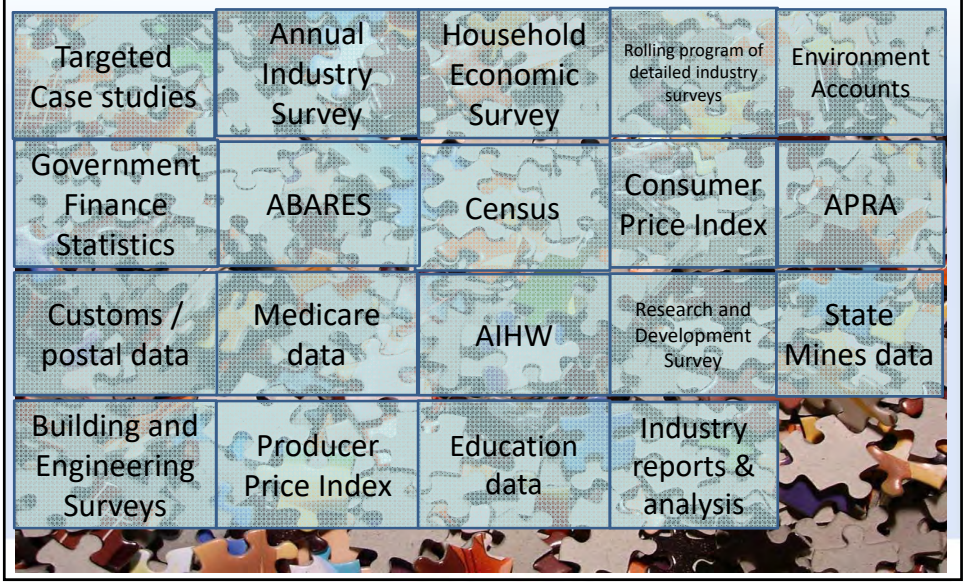
Input Data	Incorporating updated source data and methods
Classification Systems	Updating IOPCs and IOIGs
Systems and processes	Implementing constrained optimisation to balance tables

Incorporating updated data sources and methods

DATA INPUTS

Supply, Use and Input-Output Tables

Data inputs



Supply, Use and Input-Output Tables

Interrelationships

The starting point for Input- Output tables (IOTs) are the balanced Supply and Use tables (SUTs) underlying the benchmarks of GDP in the national accounts

The SUTs for each year are compile three times: 1st preliminary, 2nd preliminary and final

Up to and including 2009-10 IOTs, the IOTs were based on the 2nd prelim SUTs, and released 40 months after the reference period

Since the 2012-13 release, the IOTs are based on the 1st prelim SUTs, and released 24 months after the reference period

IOTs are compiled only at current price and are **NOT** revised once finalised

SUTs and the GDP accounts are a consistent time series and may be revised for all periods whenever a historical revision occurs

Revising the SUTs

National Accounts apply regular annual revisions to Supply Use Benchmarks, limited to the previous three years (t-1, t-2, t-3).

Periodically, the national accounts undergo a 'major' historical revision.

Usually coincides with updates to major data sources (e.g. Census, HES) which occur less frequently than the three years standard annual benchmark revisions window.

Typically coincide with major changes in statistical methods and changes in concepts, definitions, and classifications.

National Accounts are currently in the process of incorporating revisions which will impact on a broad range of macroeconomic series and encompass the entire time series.

Key Revisions
Australian Industry Survey Program

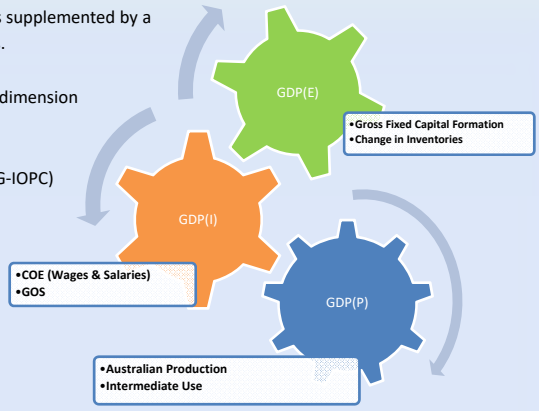
The Key data source for balancing SU tables is the annual Economic Activity Survey (EAS).

Producing quality benchmark level estimates at the ANZSIC Subdivision classification level.

To capture product level dimensions the EAS is supplemented by a program of periodic targeted industry surveys.

Targeted Industry Surveys add a product level dimension to the annual EAS program.

- Run periodically
- Industry and product level estimates (IOIG-IOPC)



Key Revisions
Australian Industry Survey Program

Opportune time to incorporate targeted Industry surveys in the Historical Revisions year as they are:

- Run periodically outside standard annual revision period
- Likely to significantly impact the composition of product level estimates
- Unlikely to change Industry level estimates

Targeted Industry Surveys

Manufacturing Industry Survey (2015-16)
Film, Television & Digital Games (2015-16)
Information, Media and Telecommunication (2013-14)
Survey of Major Labour Costs (2015-16)
Arts & Recreation Services Industry Survey (2014-15)
Retail & Wholesale Industry Survey (2012-13)
Professional, Scientific and Technical Services (2015-16)
Not for Profit Institutions (NPIs) satellite account (2012-13)
Construction Industry Survey (2010-11)

Updated source data

Household Final Consumption Expenditure (HFCE)

Key updated data sources contributing to HFCE

- Retail Wholesale Industry Survey, 2012-13 (8622.0)
- Household Expenditure Survey, 2015-16 (6530.0)
- Non-Profit Institutions Satellite Account, 2012-13 (5256.0)
- 2016 Census of Population & Housing

New Australian Government Financial Statistics (AGFS) Standards

Australian Government Finance Statistics (AGFS) measures financial activities of Governments.

From 1 July 2017, the ABS is updating from AFGS05 to AGFS15 – the new international standard set by the International Monetary Fund (IMF).

Benefits:

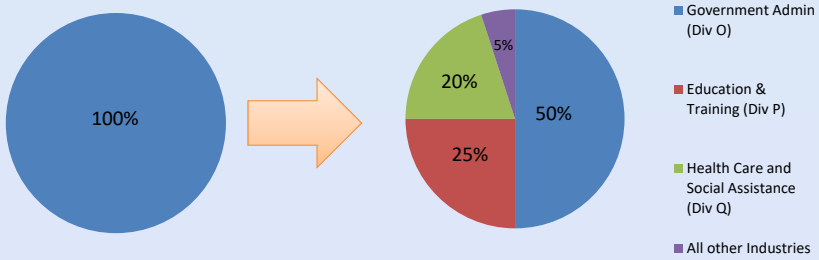
- Increased classification detail which allowed improved product and industry concordances
- Strengthen and modernise the AGFS framework
  - Enable closer alignment with SNA08
  - Consistency with international reporting

The introduction of AGFS15 will necessitate revisions to the time series

New Australian Government Financial Statistics (AGFS) Standards

Impacts of AGFS15?

Superannuation redistribution (General Government Output, Government Final Consumption Expenditure)



Revised International Travel Services Model

Education-related services	• Tourism Research Australia (TRA) - National Visitor Survey (NVS) & International Visitor Survey (IVS) will replace current outdated and no longer available data.
Remove Young Persons Adjustment Factor	• An adjustment is made for non-reporting young persons spending. • Research identified their spending has been implicitly included in NVS/IVS.
Commission on travel and transport services	• International Standard - Commissions on packaged tours and International airfares to be reported as Transport Services. • Deducted from Travel Services, not re-allocated to Transport Services • Significantly underestimating Exports and Imports of Trade in services (particularly imports)
Removal of motor vehicle expenditure	• To adhere to the international standard for International Trade Statistics (MSITS 2010)

Expected schedule of releases

Oct 2017
- **5204.0** Australian System of National Accounts, 2016-17
- **5368.0** International Trade in Goods and Services, Aug 2017

Nov 2017
- **5220.0** Australian National Accounts: State Accounts, 2016-17
- **5368.0** International Trade in Goods and Services, Sept 2017
- **5368.0.55.003** International Trade: Supplementary Information, 2016-17

Dec 2017
- **5260.0.55.002** – Estimates of Industry Multifactor Productivity, 2016-17
- **5206.0** –Australian National Accounts: National Income, Expenditure and Product, Sept 2017
- **5302.0** – Balance of Payments and International Investment Position, Sept 2017
- **5232.0** – Australian National Accounts: Finance and Wealth, Sept 2017

Jun 2018
- **5209.0.55.001** - Australian National Accounts: Input-Output Tables, 2016-17

Nov 2018
- **5215.0.55.001** - Australian National Accounts: Input-Output Tables (Product Details), 2016-17

Updating IOPCs and IOIGs

CLASSIFICATIONS

Classifications

Industry Classification

- SUTs – 67 industries (SUIC)
- IOTs – 115 industries (IOIG)

Product Classification

- SUTs – 301 products (SUPC)
- IOTs – 917 products (IOPC)

Changes to the IOPC

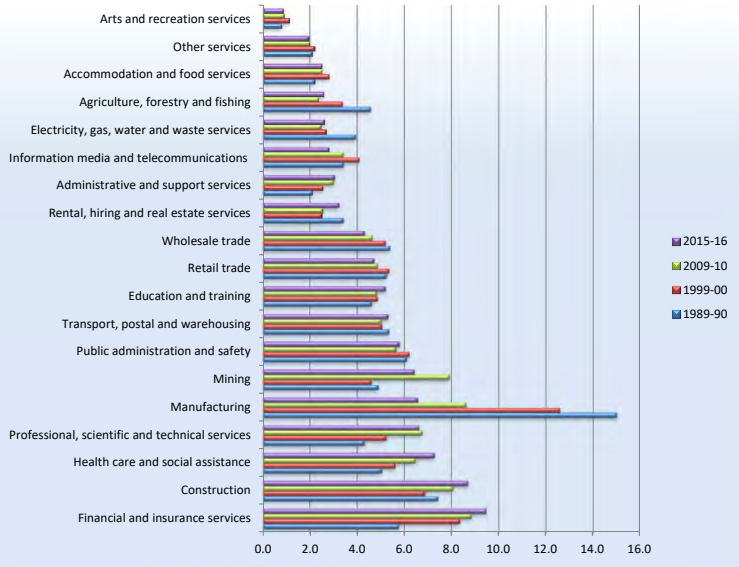
ANZSIC Division	IOPCs in 2016	Current IOPCs	Change
A Agriculture, Forestry and Fishing	106	101	5
B Mining	42	39	3
C Manufacturing	805	471	334
D Electricity, Gas, Water and Waste Services	11	11	0
E Construction	15	15	0
F Whole Trade	6	6	0
G Retail Trade	4	4	0
H Accommodation and Food Services	7	7	0
I Transport, Postal and Warehousing	46	43	3
J Information Media and Telecommunications	45	43	2
K Financial and Insurance Services	25	25	0
L Rental, Hiring and Real Estate Services	16	16	0
M Professional, Scientific and Technical Services	26	26	0
N Administrative and Support Services	18	18	0
O Public Administration and Safety	12	12	0
P Education and Training	13	13	0
Q Health Care and Social Assistance	19	19	0
R Arts and Recreation Services	24	23	1
S Other Services	27	25	2
Total	**1,267**	**917**	**350**

Potential I-O products disaggregation

Current IOPC Classification	Proposed IOPC Classification	Will Proposed Split Be Implemented?
Water, sewerage and drainage services	Water services Sewerage and drainage services	Yes Yes
Electricity generated from fossil fuels	Electricity generation from coal Electricity generation from natural gas Electricity generation from other fossil fuels	Possibly Possibly Possibly
Electricity generation nec	Electricity generation from large scale solar power Electricity generation from large scale wind power Electricity generation nec	Possibly Possibly Possibly

Changes to IOIG

26 years: Industry contributions to GVA (data from 5204.0 2016)



Changes to 5206.0 - ANA: National Income, Expenditure and Product - September 2017

Division	Current Published GVA Levels	Published GVA Levels from September 2017
Div C Manufacturing	Food, beverage and tobacco Textile, clothing and other manufacturing Wood and paper products Printing and recorded media Petroleum, coal, chemical and rubber products Non-metallic mineral products; Metal products Machinery and equipment	Food, beverage and tobacco manufacturing Petroleum, coal and chemical manufacturing Metal products manufacturing Machinery and equipment manufacturing Other manufacturing
Div E Construction	Construction.	Building construction Heavy and civil engineering Construction services
Div J IMT	Information, media and telecommunications.	Telecommunication services Other information and media
Div K Finance	Finance.	Finance Other financial and insurance services
Div L Rental, hiring and real estate	Rental, hiring and real estate.	Rental and hiring services (except real estate) Property operators and real estate services
Div M PST	Professional, scientific and technical services.	Professional scientific and technical services Computer system design & related services

NOTE: The proposed changes to 5206.0 for 2017 will not affect I-O tables *but*…
future changes will require updates to the SU and I-O industry classifications

Future Changes to the National Accounts Industry Classification

Wholesale Trade (from 1 to 5 IOIGs)

Subdivision	Proposed Benchmarks	% Share of Division
33	**Basic material wholesaling**	38.3
34	**Machinery and equipment wholesaling**	27.7
35	**Motor vehicle and motor vehicle parts wholesaling**	8.4
36	**Grocery, liquor and tobacco product wholesaling**	11.9
	Other Goods and Commission-Based Wholesaling	13.7
37	*Other Goods Wholesaling*	13.7
38	*Commission-Based Wholesaling*	0.01
	Total	100.0

Retail Trade (from 1 to 3 IOIGs)

Subdivision	Proposed Benchmarks	% Share of Division
	Motor vehicle, motor vehicle parts and fuel retailing	6.5
39	*Motor vehicle and motor vehicle parts retailing*	3.9
40	*Fuel retailing*	2.6
41	**Food retailing**	34.3
	Other store-based and non-store retailing	59.2
42	*Other store-based retailing*	59.0
43	*Non-store retailing and retail commission-based buying and/or selling*	0.2
	Total	100.0

Future Changes to the I-O Industry Classification

PST (from 2 to 6 IOIGs)

SD 69

GROUP	Proposed Benchmarks	% Share of Division
691	Scientific research	4.8
692	Architectural, engineering and technical services	26.6
693	Legal and accounting	20.0
694, 696	Management services	22.1
695, 697 & 699	Market and statistical research and other PST services	4.3
SD 70	Computer systems design and related services	22.2
	Total	**100.0**

Health and Social Assistance (from 2 to 4 IOIGs)

Subdivision	Proposed Benchmark	% Share of Division
84	Hospitals	28.0
85	Medical and other health care services	35.0
86	Residential care services	26.0
87	Social Assistance services	11.0
	Total	**100.0**

Constrained Optimisation

SYSTEMS AND PROCESSES

The way forward

Advantages of constrained optimisation:

- SUTs and IOTs are balanced faster
- Same quality – maybe even higher quality

Future directions

- More timely release of IOTs
- IOTs compiled under different classifications – CPC & ISIC
- Publish SUTs
- Review revisions policy

THANK YOU

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Optimisation for ABS National Accounts Balancing

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ABS context

- Measurement errors lead to discrepancies in National Accounts data.
- ABS adjusts these to “balance” the data.
- Subject-matter experts perform manual adjustment for large discrepancies.
- Automated balancing for the remaining discrepancies.
  - Need to balance in multiple dimensions.

ABS context (2)

- Current auto-balancing tool is old and inflexible.
- Lots of manual work required to get to a point where the auto-balancer produces adequate results.
- Opportunity to use modern off-the-shelf tools to build a new & improved balancing system.

WLS balancing

- Basic idea: search for balanced table that minimises weighted sum of squared adjustments.

$$\underline{\tilde{x}} \in F: min\left(\sum w_i(\tilde{x}_i - \hat{x}_i)^2\right)$$

- Originally proposed by Stone *et al.* in 1940s.

WLS balancing (2)

- WLS balancing for large systems was computationally expensive.
- RAS/IPF became popular as a faster alternative for accounts balancing.
- Hardware & software have since improved by many orders of magnitude.
- WLS methods can now balance large accounts tables e.g. Supply-Use in seconds to minutes.

WLS balancing (3)

- Off-the-shelf optimisation products also offer other advantages:
  - User-friendliness
  - Integration support
  - Etc.
- Netherlands CBS moved to optimisation balancing ~ 8 years ago.
- Several other agencies are investigating this option.

WLS balancing (4)

- Specifying a balancing problem involves several components:
  - Constraints: what combinations of values are *possible*?
  - Objective function: what combinations are *plausible*?
- Many decisions to be made here, e.g.:
  - Form of OF
  - Weights for OF

Preservation approaches

- Approaches in the literature are often based on a “preservation” approach:
  - Choose certain characteristics of the unbalanced data.
  - Typically: levels or time-series movements.
  - Define an objective function that penalises changes to these characteristics.
- May combine two or more of these Ofs together for a multi-purpose OF.

MLE approach

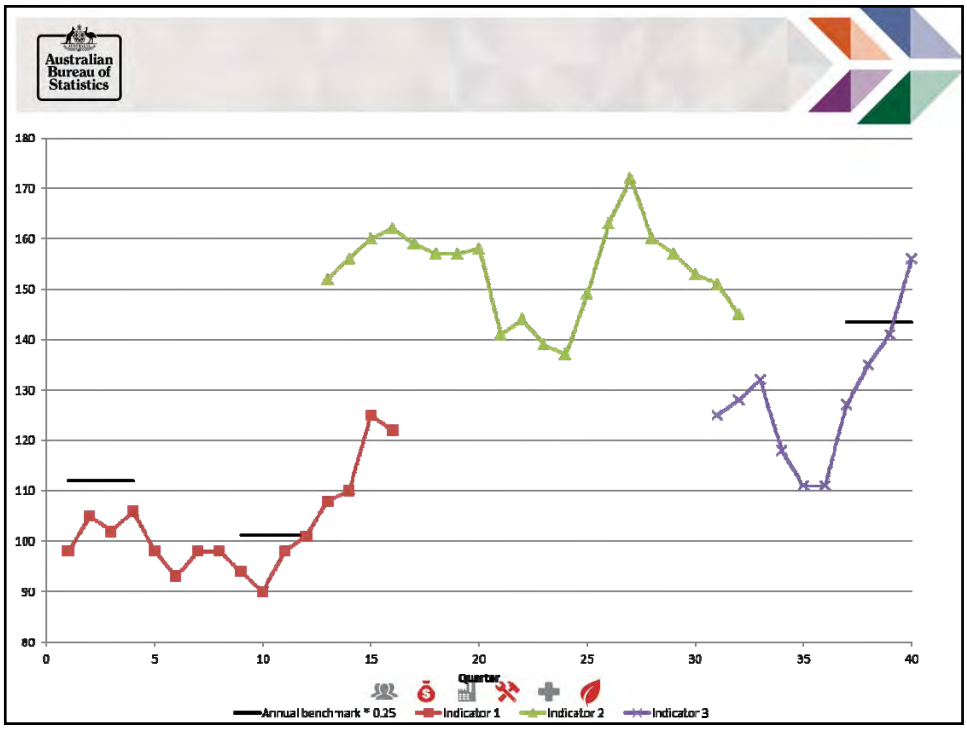
- Assume that observed (unbalanced) data are equal to true values modified by some error function: $\underline{\hat{x}} = \underline{x} + \underline{\varepsilon}$
- Specify a mathematical model for the error function.
- Find the maximum-likelihood estimate for the error values and hence a balanced estimate for the true values.

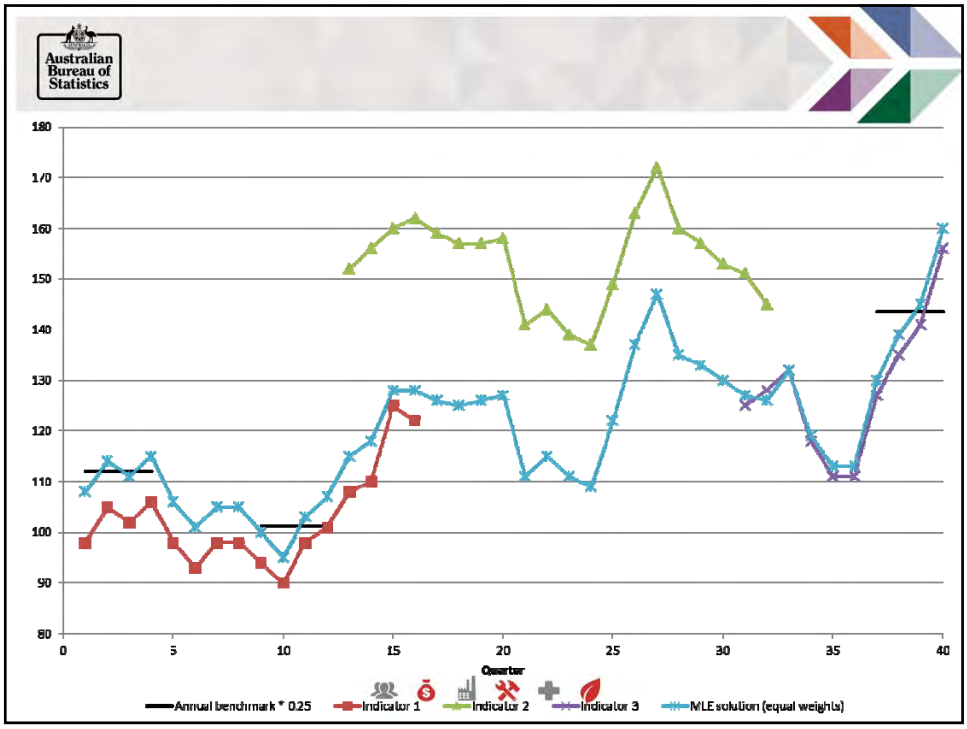
MLE approach (2)

- For simple cases, MLE method is equivalent to "preservation" methods.
  - Independent Gaussian error model ⇔WLS level-preservation objective function.
  - Random-walk error model ⇔ Denton AFD movement-preservation objective function.
- For complex cases e.g. two components to error, these methods are *not* equivalent.
  - "preservation" ⇔ inappropriate independence assumptions?

MLE approach (3)

- MLE approach makes balancing assumptions more explicit, helping to identify when they may fail.
- MLE can be useful for stitching together a coherent set of estimates from multiple/incomplete sources.
- Example: three indicator series, three benchmarked years, no one input covers all quarters…





MLE approach (4)

- MLE approach is fairly straightforward to implement with modern optimisation software.
  - Example shown takes ~ 30 lines of AMPL code.
- Scales well: can add multiple sources etc.

Current work

- Prototyping automated balancing for Supply-Use.
- Using AMPL optimisation language coupled to Gurobi solver.
- First draft largely complete.
  - Fine-tuning and various minor issues to address.

Current work (2)

- Implementation includes many useful capabilities:
  - Simultaneous balancing in current and previous year's prices.
  - "Soft constraints": e.g. ratio x/y should be similar from year to year.
  - Controlled rounding.

Future work

- Validation/refinement of Supply-Use balancing
- Integration with new ABS IT systems
- Expand to other applications e.g. Input-Output balancing
- Potential for more frequent I-O releases?
  - Time series support?
- Non-accounts optimisation applications

Questions?

IDEEA Group
Institute for Development of Environmental-Economic Accounting

www.ideeagroup.com

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Institute for Development of Environmental-Economic Accounting

Using the SEEA Ecosystem Accounting approach to extend economic modelling

Carl Obst, Director, IDEEA Group &
Honorary Fellow, University of Melbourne

VU CGE Workshop 7 August 2017

CONTEXT

Motivation for integrating environmental information

- Declining natural capital and planetary boundaries
- Changing societal expectations on use of the environment
- General lack of recognition of environmental impacts and dependencies in economic and financial discussion

Long history of environment in input-output & CGE analysis

- Accounting for externalities - Ayres & Kneese, Leontief, …
- Integrating ecological systems - Isard, Daly, Hannon

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CHALLENGE

Standard input-output table follows the same scope of production as for measurement of GDP

- Same economic units (classified by industry/activity)
- Same production boundary and set of products
- Exclusion of natural processes

Implications

- Exclude ecosystem services
- Limit value of natural resources to extraction value

Standard EE-IOT do not change these boundaries

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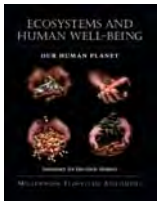
A SHORT HISTORY



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THE FOUR TYPES OF EEA

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CORE ACCOUNTING MODEL

- Single model applied to different landscapes and ecosystem types
- Assess impact of human activity on asset extent and condition
- Asset condition influences the production of ecosystem services
- Ecosystem services provide economic and social-wellbeing benefits

STANDARD SUPPLY AND USE TABLE

	Wheat farmer	Other industries	Household final consumption	Total
Supply table				
Wheat	800			800
Wheat products		2000		2000
Fertilizer		200		200
Other intermediate inputs		150		150
Total output (1)	800	2350		3150
Use table				
Wheat		800		800
Wheat products			2000	2000
Fertilizer	200			200
Other intermediate inputs	150			150
Total input (2)	350	800	2000	3150
Gross value added (3=1-2)	**450**	1550	na	2000

SUT WITH ECOSYSTEM SERVICES (IOTES)

	Wheat farmer	Other industries	Ecosystem asset: Wheat farmland	Household final consumption	Total
Supply table					
Wheat	800				800
Wheat products		2000			2000
Fertilizer		200			200
Other intermediate inputs		150			150
Ecosystem services			**200**		200
Total output (1)	800	2350	200		3350
Use table					
Wheat		800			800
Wheat products				2000	2000
Fertilizer	200				200
Other intermediate inputs	150				150
Ecosystem services	**200**				200
Total input (2)	550	800	0	2000	3350
Gross value added (3=1-2)	**250**	1550	**200**	na	2000

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SUT WITH ECOSYSTEM SERVICES TO SOCIETY

	Wheat farmer	Other industries	Ecosystem asset: Wheat farmland	Household final consumption	Total
Supply table					
Wheat	800				800
Wheat products		2000			2000
Fertilizer		200			200
Other intermediate inputs		150			150
Ecosystem services #1			**200**		200
Ecosystem services #2			**100**		100
Total output (1)	800	2350	300		3450
Use table					
Wheat		800			800
Wheat products				2000	2000
Fertilizer	200				200
Other intermediate inputs	150				150
Ecosystem services #1	**200**				200
Ecosystem services #2				**100**	100
Total input (2)	550	800	0	2100	3450
Gross value added (3=1-2)	**250**	1550	**300**	na	**2100**

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MEASUREMENT CHALLENGES

a. Measurement of ecosystem service flows

b. Pricing of ecosystem services

c. Incorporating private and public ecosystem services

d. Accounting for multiple services and multiple beneficiaries

e. Accounting for ecosystem degradation

f. Clarifying requirements of I-O and CGE modelling

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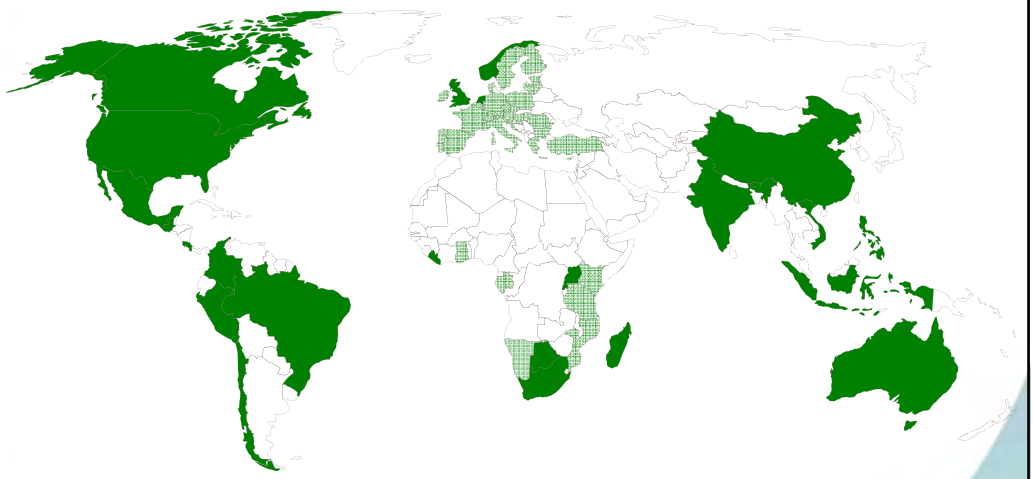
ECOSYSTEM ACCOUNTING IN PRACTICE



World map by www.freeworldmaps.net

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Accounting for ecosystem outcomes

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Modelling the GST in the Victoria University Regional Model (VURM).

21st July 2017

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Introduction

- We specify an equation system describing the legislated details of the GST (tax rates, exemptions, refund factors, registration rates, low-value imports, taxation of on-shore non-resident purchases).
- The GST equation system is: (a) used to better specify the distribution of GST payments in a multi-regional CGE database; (b) embedded in a multi-regional CGE model (VU Regional Model, VURM).
- We use GEMPACK to simulate in VURM the national and regional effects of raising the standard GST rate from 10% to 11%.
- VURM is a multi-regional model. For expository purposes, we focus on results for NSW vs Australia

Introduction (cont.)

- The GST is a value added tax (VAT) levied on the "value added" at each stage of production.
- VAT is implemented in more than 140 countries, contributing over 20% of total tax revenue on average.
- In Australia, it is the 3rd-largest tax source, accounting for 16% of all tax revenue, and 23% of state revenue in 2013-14.
- Widely considered an efficient tool for revenue collection:
  - More broad-based than many other taxes
  - Produces a trail of invoices aids wider tax compliance and enforcement
  - Eliminates the cascading problem of other sales taxes

Introduction (cont.)

- Main features of an ideal GST or VAT system:
  - Only one rate, imposed on final consumption.
  - GST paid on inputs to current production and investment fully reclaimed.
  - Exports are zero rated.
  - All consumption items are covered (i.e. no exemptions).
- Reality always more complicated. The Australian GST system has:
  - Two rates: 0 and 10 per cent.
    - *0% rate: exports; basic food items; education; medical services, aids & appliances; drugs; residential care; private health insurance; water; religious services; charities; sewerage & drainage services…*
    - *10% rate: all other goods and services.*
  - Exempt commodities (hence input-taxed production).
    - *Financial services, life insurance, dwellings, fund-raising events by charities, supply of precious metals.*
  - Non-registration (leading to further input-taxation).
  - Exempt imports. Imports valued below $A1000.

Introduction (cont.)

- Problems with the Australian GST system have been raised by many authors. E.g. Henry Review (2010) noted a number of issues with the current system:
  - GST-free status of many goods and services is costly to the budget, adds complexity to the system, and probably does not benefit intended target populations.
  - Input-taxation of financial services is inefficient and harms the international competitiveness of the Australian financial sector.
  - Compliance costs could be high, particularly for small business, due to the differential tax treatment of different goods and services.
  - Issues of GST collection and redistribution between Commonwealth government and the states.

Introduction (cont.)

- Australia's GST system – possible changes:
  - Broadening the tax base by removing some goods and services from the GST-free list;
  - Removing input-taxed sales
  - Changing (increasing?) the GST rate
  - Reducing compliance costs on some transactions, e.g. by treating business-to-business transactions as if they were GST-free
  - Reforming the GST revenue sharing system between the Commonwealth and state governments

Introduction (cont.)

- Motivation for detailed modelling of the GST:
  - It is important to correctly model the details of the tax if we are to properly model the economic impacts of changes to the tax.
  - This requires a modelling framework that takes into account the full details of the GST system as they relate to: multiple tax rates, multiple exemptions, differential registration rates and refund rates, low value imports, taxation of onshore purchases by non-residents, multi-production firms, etc.
  - This allows allow the model to take into account the interplay between legislated rates, exemptions and refunds, and allows effective GST rates to be influenced by endogenous changes in economic structure.
  - It also facilitates the correct representation of GST payments in the CGE model database.

Introduction (cont.)

- Current GST data in the ABS Australian input output tables: with a detailed theory of the GST, we can identify problems with the allocation of GST in the ABS IO tables:
  1. Outside of finance, insurance and dwellings, no GST is recorded on intermediate inputs to production. This cannot be correct in the presence of unregistered producers or underground production.
  2. Many GST rates exceed the legal rate of 10%. E.g.
     - 22.5% on Motor vehicle used in Finance.
     - Rates on private investment: up to 15%. And this is on inputs for investments in all industries.
  3. No GST is recorded for some commodities on which GST should be collected (e.g. grain, cattle, aquaculture, gas supply, purchases by non-residents of some foods, repair and other services).
  4. Consideration appears not to have been given to the consequences of business non-registration and the underground economy.

The VURM GST equation system

- Generalises to the regional dimension the detailed VAT equation systems described in Giesecke and Tran (2010, 2012).
- The economy:
  - M commodities, from S sources, used by U agents in R regions
  - U agents: N industries, K investors, F final demanders in R regions
  - Multi-production: M commodities produced by N industries in R
- Features of the Australian GST system:
  - Two GST rates,
  - Differentiated GST legal exemptions for commodities
  - Differentiated degree of GST registration (GST thresholds, underground activities)
  - Low Value Threshold imports
  - Unclaimed GST on non-residents' purchases
  - No GST on purchases by government final consumption and investment

GST equation system - overview

GST Revenue (c,s,u,r) = Expected GST liabilities (c,s,u,r) x Compliance rate (c,s,u,r)

Expected GST liabilities (c,s,u,r) = Effective GST base (c,s,u,r) x Legislated GST rate (c,s,u,r)

Effective GST base (c,s,u,r) = Transaction base (c,s,u,r)
– legislated or de-facto exemptions
– sales on which GST is refunded

Transaction base (c,s,u,r) = GST-exclusive value of commodity flows to users
(i.e. = BAS(c,s,u,r) + MAR(c,s,u,r) + non-GST VTAX(c,s,u,r))

De-facto exemption = effective GST exemption arising from non-registration, underground economy, or exempt low-value imports.

GST equation system – domestic users

Effective GST rate

$$GST_{c,s,u,r} = ER_{c,s,u} \times TRBASE_{c,s,u,r}$$

GST revenue — Value of transaction base

Transaction-specific GST collections

Legal GST rate — Refund share

$$ER_{c,s,u,r} = LR_{c,s,u} \times [1\text{-}EEX_{c,s,u,r}] \times [1\text{-}REF_{u,r}] \times CR_{c,s,u,r}$$

Effective GST rate — GST exempt sales share — Compliance rate

Effective rate of GST depends on legal rate, effective exemptions, refund factors, & compliance rate

78 Commodities — 78 + 78 + 1x8 + 1x9 domestic users

$$(c \in COM; s \in SRC, u \in DOMUSER; r \in REG)$$

9 Sources — 8 Regions

GST equation system – examples

Effective GST rate — Legal GST rate — GST exempt sales share — Refund share — Compliance rate

$$ER_{c,s,u,r} = LR_{c,s,u} \times [1\text{-}EEX_{c,s,u,r}] \times [1\text{-}REF_{u,r}] \times CR_{c,s,u,r}$$

(Ex. 1) Standard GST rate. No legal exemption. Use of NSW "TCF" by households in NSW.

0.0973 = 0.10 x [1 – 0.027] x [1 - 0] x 1

(Ex. 2) GST exempt sales. Use of NSW "banking" by households in NSW.

0 = 0.10 x [1 – 1] x [1 - 0] x 1

(Ex. 3) GST-free goods. Use of NSW "dairy products" by households in NSW.

0.0256 = 0.026 x [1 – 0.015] x [1 - 0] x 1

(Ex. 4) Current production. Use of NSW "wood products" by NSW "Residential construction"

0.0035 = 0.10 x [1 – 0.018] x [1 - 0.965] x 1.006

(Ex. 5) GST exempt prod'n. NSW "residential construction" input to NSW "dwelling" investment

0.0971 = 0.10 x [1 – 0.035] x [1 - 0] x 1.006

GST equation system – legal rate example

IOPC 1267 commodities	IO115	Share in IO115	LR
Processed liquid milk (incl whole milk and skim)	DairyProds	0.136	0
Cream (incl thickened), not concentrated or sweetened	DairyProds	0.015	0
Ice cream and frozen confections	DairyProds	0.169	0.1
Flavoured whole milk drinks	DairyProds	0.092	0.1
Sour cream, yoghurt and other cultured milk products	DairyProds	0.116	0
Buttermilk (excl cultured)	DairyProds	0.022	0
Powdered skim milk	DairyProds	0.008	0
Fats and oils derived from milk (incl butter oil); casein	DairyProds	0.002	0
Butter	DairyProds	0.085	0
Cheese and curd	DairyProds	0.281	0
Milk based food preparations (excluding malt extracts) a	DairyProds	0.039	0
Milk and cream, concentrated or sweetened; lactose an	DairyProds	0.035	0
Dairy products - commission production (1131-1133)	DairyProds	0	0
Dairy products LR		**1**	**0.026**

GST equation system – domestic users

Transaction base = basic value + non-GST indirect taxes + margins

Value of transaction base | Indirect taxes (excluding GST)

$$TRBASE_{c,s,u,r} = VBAS_{c,s,u,r} + VTAX_{c,s,u,r} + \sum_{m \in MAR} VMAR_{c,s,u,r,m}$$

Transaction at basic prices | Margins (e.g. transport)

GST exempt sales share | De-facto exemption share

$$EEX_{c,s,u,r} = LEX_{c,s,u,r} + (1 - LEX_{c,s,u,r}) \times DEX_{c,s,u,r}$$

Effective exemptions depend on legal exemptions and de-facto exemptions

Legal exemption share

78 Commodities | 78 + 78 + 1x8 + 1x9 domestic users

$$(c \in COM; s \in SRC, u \in DOMUSER; r \in REG)$$

9 Sources | 8 Regions

GST equation system – domestic users

Share of commodity *c* from domestic source *s* produced by industry *i*

$$DEX_{c,s,u,r} = 1 - \sum_{i \in IND} SJ_{c,s,i} \times REGIST_{i,s}$$

De-facto exemption share (domestic goods)

Share of output of industry *i* in domestic region s produced by firms registered for GST

De-facto exemption rate depends on GST registration rate (domestic goods)

Undeclared imports

$$DEX_{c,foreign,u,r} = ILM_{c,u,r}$$

De-facto exemption share (imported goods)

De-facto exemption rate depends on low value import threshold (imported goods)

$$(c \in COM; s \in REG, u \in DOMUSER; r \in REG)$$

GST equation system – domestic users

Share of output of industry *i* in domestic region *s* produced by firms registered for GST

Non-registration arising from informal activity

$$REGIST_{i,s} = (1\text{-}NRL_{i,s})(1\text{-}NRI_{i,s})$$

Legal non-registration rate

Registration rate

Proportion of GST paid on purchases by industry *i* in region *s* that are refundable

Share of industry *i,s'* output represented by commodity *c*

$$REF_{i,s} = REGIST_{i,s} \sum_{c \in COM} \sum_{u \in USER} \sum_{r \in REG} SO_{c,i,s} SS_{c,s,u,r} \left[1 - LEX_{c,s,u,r}\right]$$

Registration rate

Share of sales to user *u* in region *r* in total sales of commodity *c* produced in region *s*.

Refund rate

$$(i \in IND; s \in REG)$$

GST equation system – domestic users

Share of GST paid on inputs to investment in industry *k,r* that is refundable

Share of GST paid on inputs to production in industry *i,r* that is refundable

$$\mathrm{REF}_{k,r} = \sum_{i \in IND} \delta_{k,i} \mathrm{REF}_{i,r}$$

Kronecker delta

Investor refund rate

$$(k \in INV; r \in REG)$$

Share of GST paid on household purchases that is refundable

$$\mathrm{REF}_{households,r} = 0$$

Household refund rate

Share of GST paid on government purchases that is refundable

$$\mathrm{REF}_{State\ gov,r} = \mathrm{REF}_{Fed\ gov,r} = 1$$

Government refund rate

$$(r \in REG)$$

GST equation system – foreign users

Share of total sales of (c.s) represented by on-shore sales to non-residents

Proportion of GST collected on non-resident sales refunded under TRS

Legal rate of GST (households)

GST collected on exports

$$\mathrm{GST}_{c,s,export} = \mathrm{CR}_{c,s,export} \left\{ \begin{array}{l} \mathrm{LR}_{c,s,household} \cdot \mathrm{SHNRES}_{c,s} \cdot (1\text{-}\mathrm{TRS}_{c,s}) \\ \mathrm{TRBASE}_{c,s,export} \cdot (1\text{-}\mathrm{EEX}_{c,s,household}) \\ + \\ \mathrm{LR}_{c,s,export} \cdot (1 - \mathrm{SHNRES}_{c,s}) \cdot \\ \mathrm{TRBASE}_{c,s,export} \cdot (1\text{-}\mathrm{EEX}_{c,s,export}) \end{array} \right\}$$

Compliance rate

Typically 0

$$(c \in COM)(s \in REG)$$

Simulation design

We raise the standard rate of GST from 10% to 11% under an environment in which:

(1) Regional real wages are sticky in the short-run, but flexible in the long-run, with region-specific unemployment rates returning to baseline in the long-run.

(2) Regional migration rates are sticky in the short-run, but adjust gradually in order to ensure that per capita regional real consumption relativities return to baseline levels.

(3) Government borrowing requirements (federal and state) are exogenously held at baseline values via endogenous adjustment of national and regional lump sum household transfers.

(5) Federal government GST collections are allocated to state governments on the basis of existing GST allocation shares.

(6) The current account balance is exogenously held at its baseline value via movements in the economy-wide average propensity to consume.

(7) Subject to (6) above, region-specific household consumption spending is determined as a fixed proportion of region-specific household disposable income.

(8) Real public consumption spending by federal and state governments is exogenously held at its baseline value.

A useful "back-of-the-envelope" model

Adapted from Dixon and Rimmer (1999)

(1) $P_C = P_D^{\alpha_D^C} \cdot P_M^{\alpha_M^C} \cdot T_C$ — Cobb-Douglas unit cost function for consumption

(2) $P_I = P_D^{\alpha_D^I} \cdot P_M^{\alpha_M^I} \cdot T_I$ — Cobb-Douglas unit cost function for investment

(3) $MP_L(K/L) = T_D \cdot (W/P_D)$ — Optimising use of labour under CRS production technology

(4) $MP_K(K/L) = T_D \cdot (Q/P_D)$ — Optimising use of capital under CRS production technology

(5) $W_R = W/P_C$ — Real wage

(6) $\rho = Q/P_I$ — Gross rate of return on capital

Consumption taxes; Input taxes; Real wage

(7) $MP_L(K/L) = T_D \cdot T_C \cdot W_R \cdot (P_M/P_D)^{\alpha_M^C}$

Marginal product functions, depending on K / L only

P_M/P_D is a function of the terms of trade

(8) $MP_K(K/L) = \rho \cdot T_D \cdot T_I \cdot (P_M/P_D)^{\alpha_M^I}$

Rate of return; Investment taxes

A useful "back-of-the-envelope" model

In terms of the BOTE model, when we raise the GST, we are raising T_C, T_D and T_I

T_C: For the household user, values for EEX tend to be very low, and REF is 0. Hence, tendency for movements in LR to translate to equivalent movements in ER. This is a rise in T_C.

T_D, T_I: Under a theoretically pure GST system, $REF_{u,r}$ is 1 for all producers and investors. In practice, GST refunds are reduced by: (a) production of GST exempt commodities; (b) non-registration for GST. GST exempt status of banking, finance, insurance, & dwellings results in input-taxation of production and capital for these sectors. Low levels of non-registration create low levels of input taxation for all other sectors. A rise in the GST rate causes T_D and T_I to rise.

$$ER_{c,s,u,r} = LR_{c,s,u} \times [1\text{-}EEX_{c,s,u,r}] \times [1\text{-}REF_{u,r}] \times CR_{c,s,u,r}$$

$$REF_{i,s} = REGIST_{i,s} \sum_{c \in COM} \sum_{u \in USER} \sum_{r \in REG} SO_{c,i,s} \, SS_{c,s,u,r} \left[1 - LEX_{c,s,u,r}\right]$$

$$REGIST_{i,s} = (1\text{-}NRL_{i,s})(1\text{-}NRI_{i,s})$$

A useful "back-of-the-envelope" model

Short-run expectations from the BOTE model

$$(7) \quad MP_L(K/L) = T_D \cdot T_C \cdot W_R \cdot (P_M / P_D)^{\alpha_M^C}$$

$$(8) \quad MP_K(K/L) = \rho \cdot T_D \cdot T_I \cdot (P_M / P_D)^{\alpha_M^I}$$

In the short-run, we expect:
- **Employment to fall.**
- **GDP to fall.**
- **Investment to fall.**

Red denotes an exogenous variable

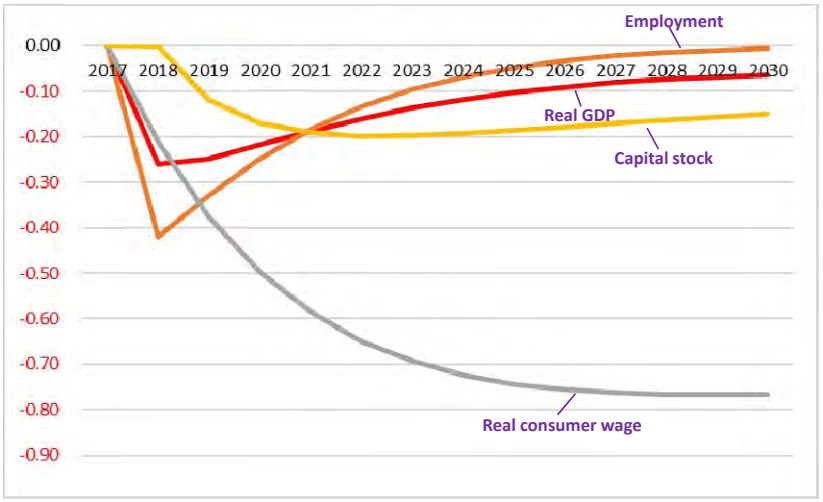
Long-run expectations from the BOTE model

$$(7) \quad MP_L(K/L) = T_D \cdot T_C \cdot W_R \cdot (P_M / P_D)^{\alpha_M^C}$$

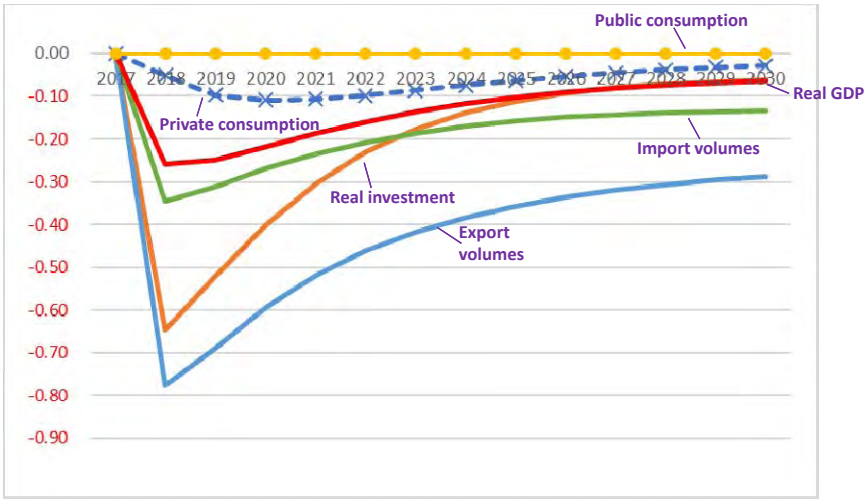
$$(8) \quad MP_K(K/L) = \rho \cdot T_D \cdot T_I \cdot (P_M / P_D)^{\alpha_M^I}$$

In the long-run, we expect:
- **Capital to fall.**
- **GDP to fall.**
- **Real wage to fall.**

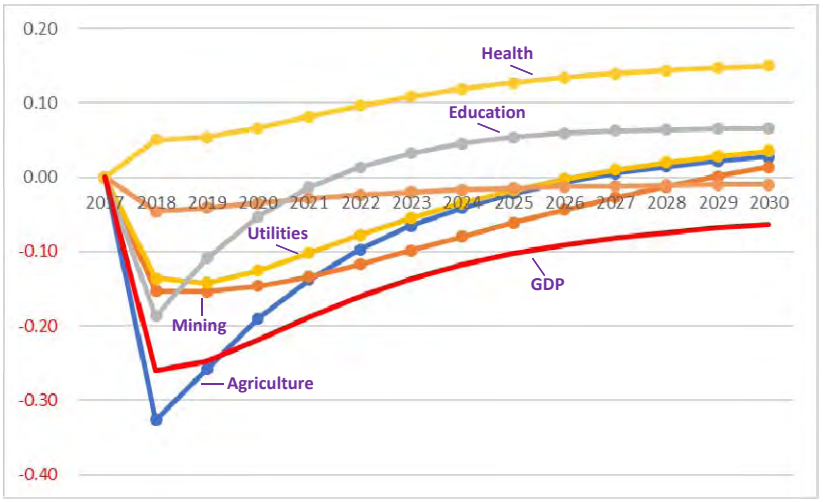
National employment, capital, GDP & wage



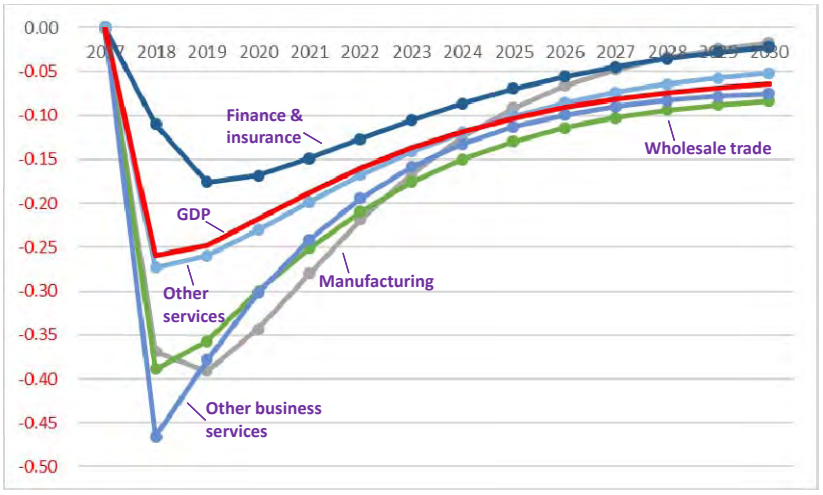
GDP and its expenditure components



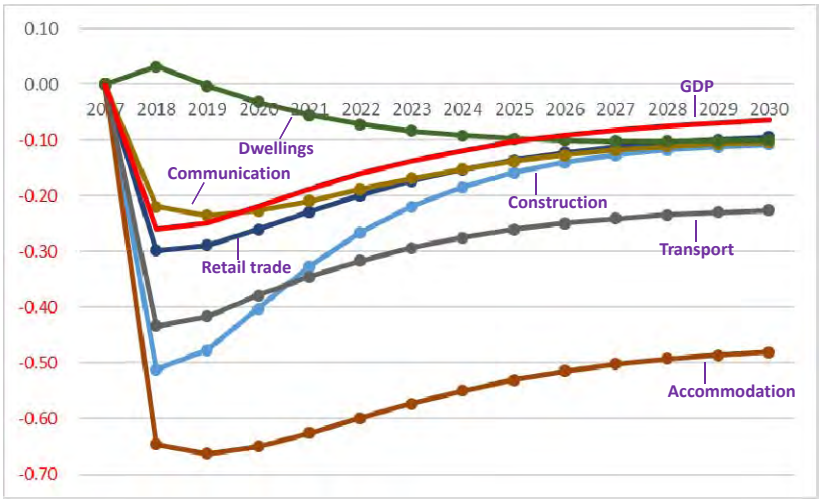
National sectors – top ranked



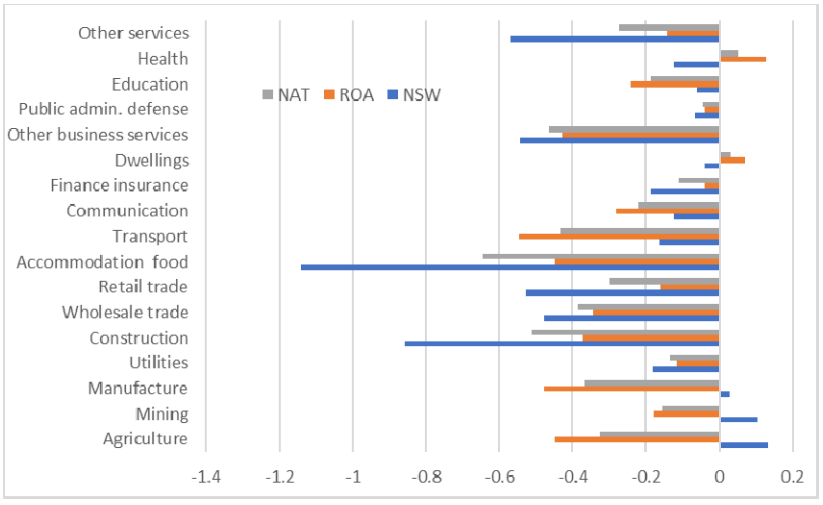
National sectors – middle ranked



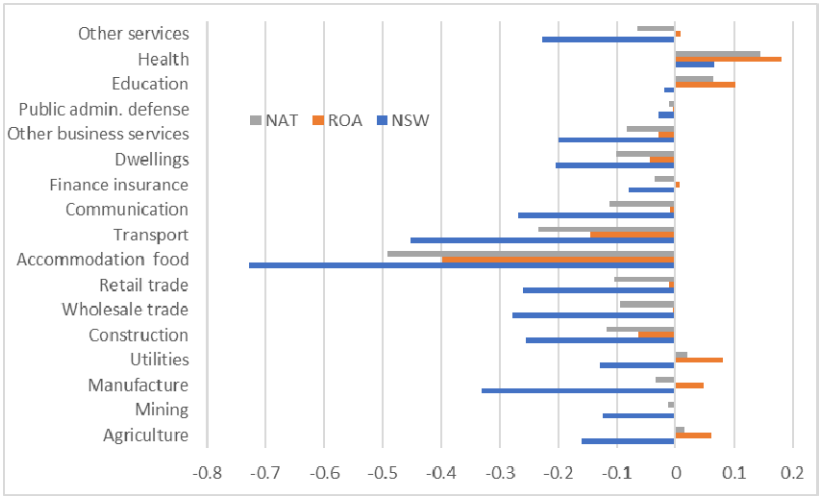
National sectors – bottom ranked



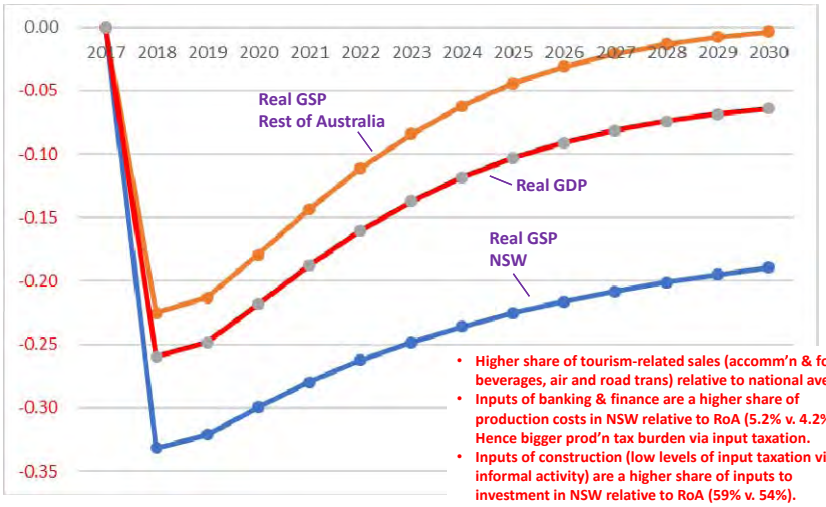
National and regional industry output: 2018



National and regional industry output: 2028



State and national GDP outcomes



- Higher share of tourism-related sales (accomm'n & food, beverages, air and road trans) relative to national average.
- Inputs of banking & finance are a higher share of production costs in NSW relative to RoA (5.2% v. 4.2%). Hence bigger prod'n tax burden via input taxation.
- Inputs of construction (low levels of input taxation via informal activity) are a higher share of inputs to investment in NSW relative to RoA (59% v. 54%).
- 33.4% of GST revenue is collected from NSW. Per-capita allocation would be 32%. Actual allocation is 31.2%

Concluding remarks

Explicit framework for modelling GST allows better modelling of:

(i) How changes in GST rates affect different sectors, commodities and users: important for sectoral and state and national macro impact analysis.
(ii) The sectoral distribution of indirect tax wedges between value in use and value in supply: important for welfare analysis.

In forecasting and policy analysis, allows changes in economic structure to endogenously affect GST collections and deadweight losses (e.g. role of multi-production in refund rate).

Opens a wide range of policy-relevant GST simulations: exemptions, registration rates, legal rates, compliance rates, low value import threshold, TRS: all explicit exogenous variables.

Comparing the impact of bank regulation in Australia and the U.S.

National CGE Workshop (Victoria University), August 2017

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Todays outline

What is bank capital regulation? Description, previous studies and cross-country impacts using financial CGE models.

Financial CGE models. Their structure, key agents and linkages with traditional real-side CGE models.

Structural differences between the US and Australia. How do the US and Australian financial economies differ?

Real-side versus financial differences and their relative impacts: Comparing USAGE2F and VU-Nat outputs using decomposition diagrams.

Concluding remarks.

What is bank capital regulation?

Our focus today: the impact of higher common equity tier-1 capital adequacy ratios (*CAR*) using financial CGE models.

$$CAR = \frac{\text{CET1 equity}}{\text{Risk weighted assets}} = \frac{\sum_d Al_{(Banks,Equity,d)}}{\sum_s \sum_f RW_{(s,f,Banks)} \cdot Al_{(s,f,Banks)}}$$

- **Basel III Capital Requirements (2010):**
  - Bank for International Settlements recommended minimum common equity tier-1 (CET1) CAR was adopted by 27 Basel Committee members and 95 of 117 non-Committee members.
  - **Different countries measure this ratio in very different ways.**
- **Giesecke *et al.* (2017):** Studied the impact of a 100bp rise in the CAR for Australian banks using the VU-Nat financial CGE model for Australia.

P.3

How do banks accommodate higher CET1 capital requirements?

LIABILITY-SIDE BALANCE SHEET ADJUSTMENT
For a given risk-weighted asset base, banks can issue more common equity

$$\Delta CAR_{\text{Base-Policy}} = \Delta\left(\frac{\sum_d Al_{(Banks,Equity,d)}}{\sum_s \sum_f RW_{(s,f,Banks)} \cdot Al_{(s,f,Banks)}}\right)$$

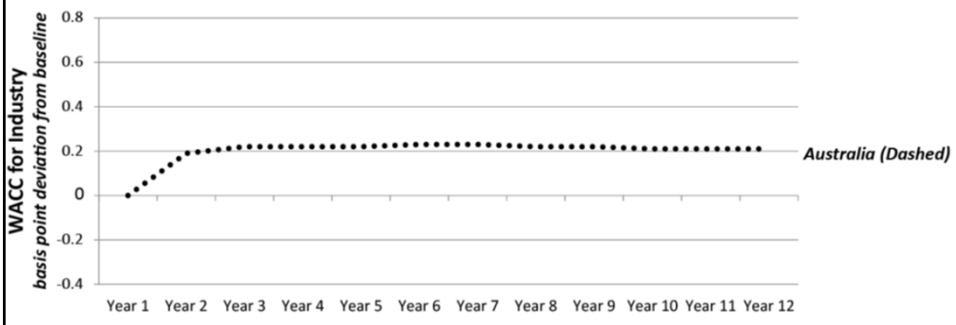
ASSET-SIDE BALANCE SHEET ADJUSTMENT
For a given level of common equity, the mix of risky financial assets banks own can be tilted towards lower risk-weight assets

ASSET- and LIABILITY-SIDE ADJUSTMENT
For a given level of common equity, banks can contract

P.4

The impact of more stringent bank regulation in Australia Industry WACC by Giesecke *et al.* (2017)

$$\Delta CAR_{\text{Base-Policy}} = \Delta\left(\frac{\sum_d Al_{(Banks,Equity,d)}}{\sum_s \sum_f RW_{(s,f,Banks)} \cdot Al_{(s,f,Banks)}}\right) = +100\text{bp}$$



P.5

Same shock, same ruler, different outcome US and Australian results

P.6

What is a financial CGE model?

What is a financial CGE model?

Consists of two integrated parts:

1. A traditional real-side CGE model.
    - Many industries producing many commodities, multiple final demanders.

2. A financial module, spanning multiple financial agents.

The financial agents use multiple financial instruments in their dual roles as:

- Liability agents:
    - Capital structure is set to facilitate purchases of physical capital/financial assets;
- Asset agents:
    - **Pension funds:** obliged to purchase financial assets on behalf of members in line with member contributions;
    - **Commercial banks:** act as financial intermediaries by issuing loan finance subject to regulator-imposed capital requirements.

Financial agents & instruments

Agents (s,d):

1. **Government**
2. **Households**
3. **Industries**
4. **Foreigners**
5. Commercial banks
6. Central bank
7. Non-bank financial intermediaries
8. Pension funds
9. Life insurance funds
10. **Reproducible housing**
11. Non-reproducible housing

Housing sector split in two –
- Reproducible housing: outer suburbs & units
- Non-reproducible housing: established inner city

Financial instruments (f)

1. Bonds
2. Cash
3. Deposits and loans
4. Equity
5. Gold & special drawing rights

We require behavioural assumptions relating to (s,d) over (f)

A (s,f,d)

Value of financial instrument (f), issued as a liability by agent (s), and held as an asset by agent (d)

Also: R (s,f,d) F (s,f,d)

P.9

Linking the financial and real economies

Various linkages exist between the financial module and the real-side CGE model:
- CAD financing requirement;
- PSBR financing requirement;
- Household savings;
- Financing of gross fixed capital formation by industry and housing sectors.

Multiple optimising agents with many financial sector / real economy links establishes a series of policy transmission channels:
- *Interest rate channel*: Interest-sensitive real expenditure can be affected by a rise in the cost of bank finance;
- *Exchange rate channel*: Offshore funding propensities can induce exchange rate movement;
- *Asset price channel*: ROE is a residual after the cost of debt, and banks are competitors for equity finance;
- *Bank lending channel*: Banks are more important for some sectors (e.g. housing construction) in some countries than in others.

P.10

The impact of a mandated rise in the capital adequacy ratio in Australia and the US

Simulation design

Shock: A 100 bps rise in the *CAR* of the commercial banking sector [Giesecke *et al.* (2017)].

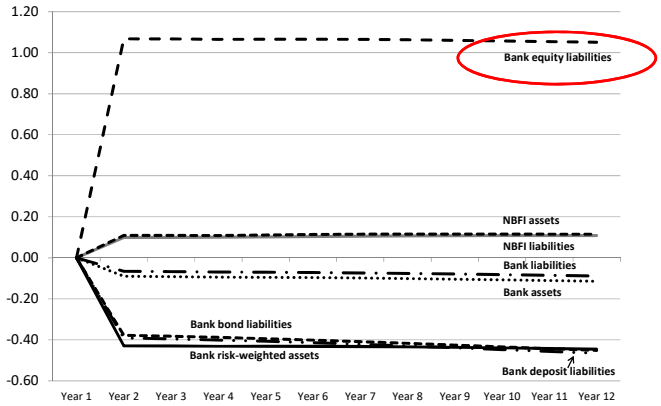
Closure assumptions:

- **Nominal wages:** are sticky in the short-run, but sufficiently flexible over the medium term to ensure the unemployment rate is returned to its natural rate.
- **Real public consumption:** Fixed at baseline. The PSBR/GDP ratio follows its baseline path via adjustment of a direct tax.
- **Policy interest rate:** Adjusts in response to: (i) movements in the CPI away from target; and, (ii) movements in the employment rate (an output gap measure) away from target.
- Bank operate under a fixed mark-up rule.

All simulations are conducted using GEMPACK.

How do banks accommodate the CAR rise?
Increase in CET1

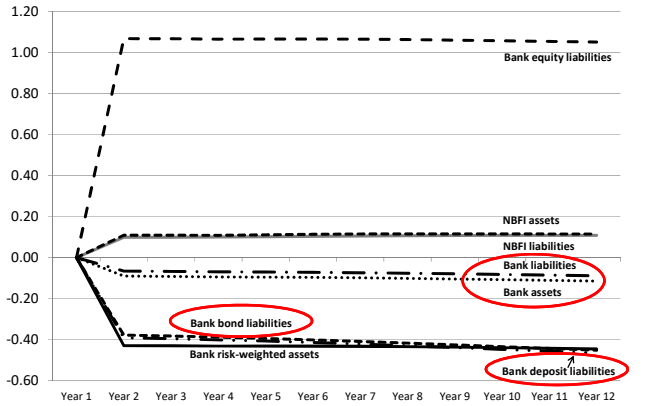
$$\Delta CAR_{\text{Base-Policy}} = \Delta\left(\frac{\sum_d Al_{(Banks,Equity,d)}}{\sum_s \sum_f RW_{(s,f,Banks)} \cdot Al_{(s,f,Banks)}}\right) = +100\text{bp}$$



P.13

How do banks accommodate the CAR rise?
Contraction

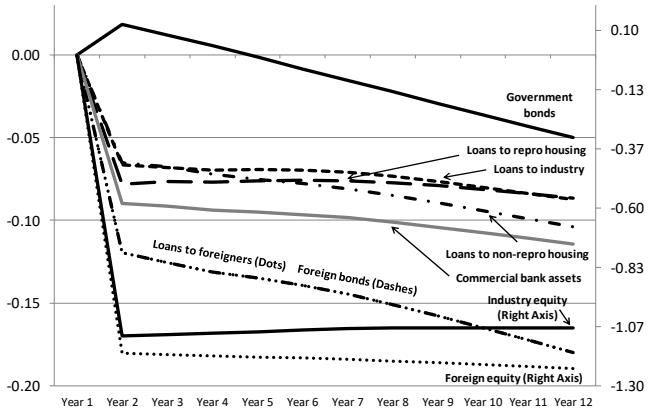
$$\Delta CAR_{\text{Base-Policy}} = \Delta\left(\frac{\sum_d Al_{(Banks,Equity,d)}}{\sum_s \sum_f RW_{(s,f,Banks)} \cdot Al_{(s,f,Banks)}}\right) = +100\text{bp}$$



P.14

How do banks accommodate the CAR rise?
The mix of risk-weighted assets adjusts

$$\Delta CAR_{\text{Base-Policy}} = \Delta\left(\frac{\sum_d Al_{(Banks,Equity,d)}}{\sum_s \sum_f RW_{(s,f,Banks)} \cdot Al_{(s,f,Banks)}}\right) = +100\text{bp}$$

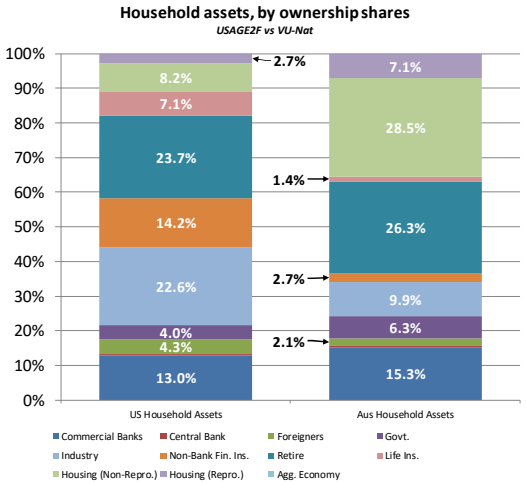


P.15

Decomposing differences between the US and Australian model results
Why financial structure matters

P.16

Question One
Where are households investing?



Similar propensities to invest with commercial banks:

- Make up a similar proportion of US (12.3%) and Australian (13.3%) households total financial assets.

Industry liabilities:

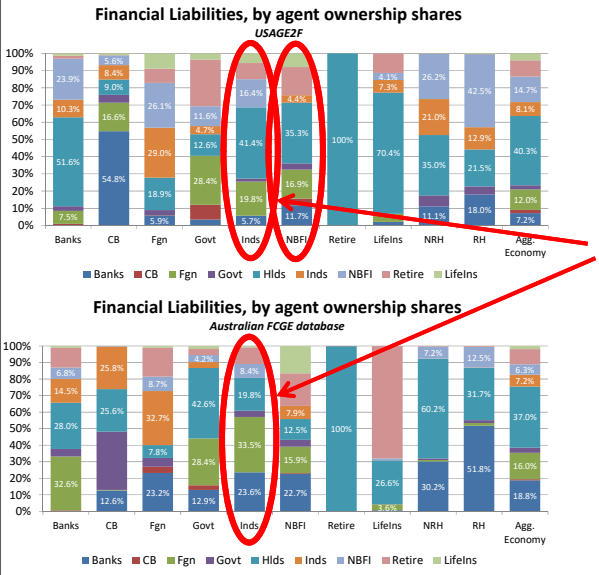
- US households directly allocate much more (22.6% of aggregate financial assets) to Industry than Australian households (9.9%).

NBFI liabilities:

- US Households allocate 14.2% of financial assets to NBFI liabilities, versus 2.7% for Australian households.

P.17

Question Two
Where does Industry source its financing from?



Australian industry is more reliant on Bank financing.

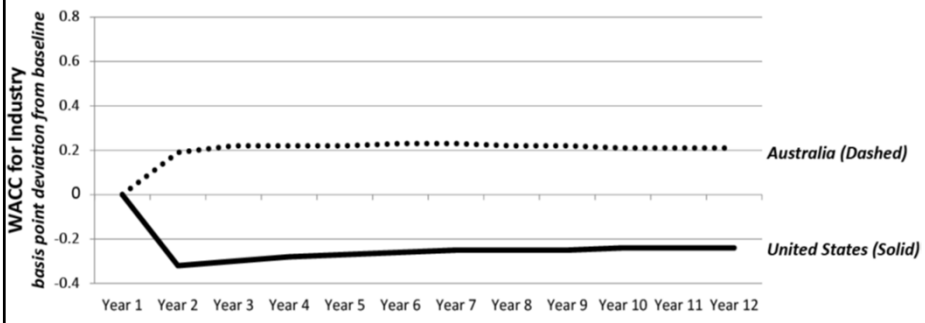
- 5.7% of US Industry liabilities are US Bank assets (USAGE2F);
- 23.6% of Industry liabilities are Australian Bank assets (VU-Nat);

US Industry is more reliant on US Household and NBFI financing.

- For example, households provide 41.4% of total financing to Industry in the US, versus 19.8% in Australia.

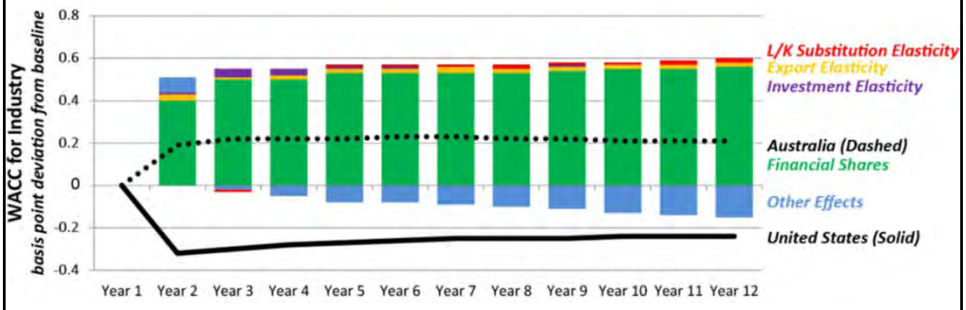
P.18

Same shock, same ruler, different outcome
US and Australian results



P.19

Industry WACC
Decomposition of the variation between USAGE2F and VU-Nat model
Basis point deviation from baseline

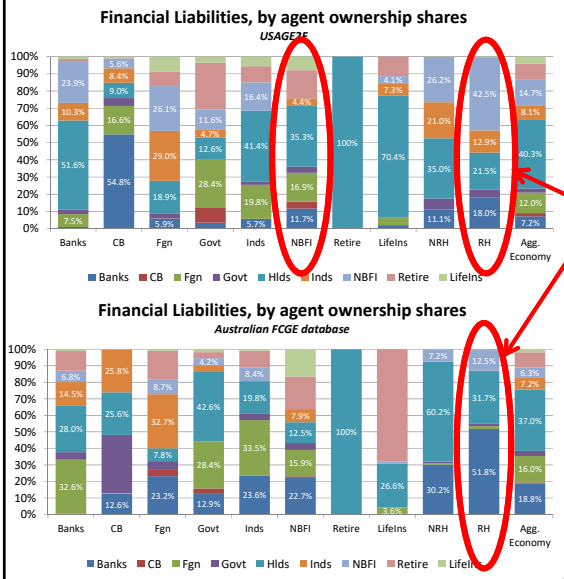


Financial structure differences are the key.

- **Australian Industry:** Source (23.6%, 19.8%, 8.4%) of liabilities from (bank, household, NBFI);
- **US Industry:** Source (5.7%, 41.4%, 16.4%) of liabilities from (bank, household, NBFI);

P.20

Question Three
Where does reproducible housing source its financing from?



Australian housing is more reliant on Bank financing.

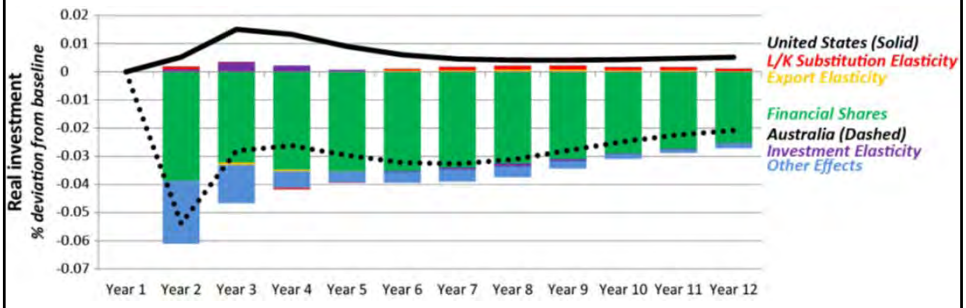
- 51.8% of RH liabilities are Australian Bank assets (VU-Nat);
- 18.0% of US RH liabilities are US Bank assets (USAGE2F).

US housing is more reliant on NBFI financing.

- 12.5% of RH liabilities are Australian NBFI assets (VU-Nat);
- 42.5% of US RH liabilities are US NBFI assets (USAGE2F).

P.21

Real Investment
Decomposition of the variation between USAGE2F and VU-Nat model
Percentage deviation from baseline

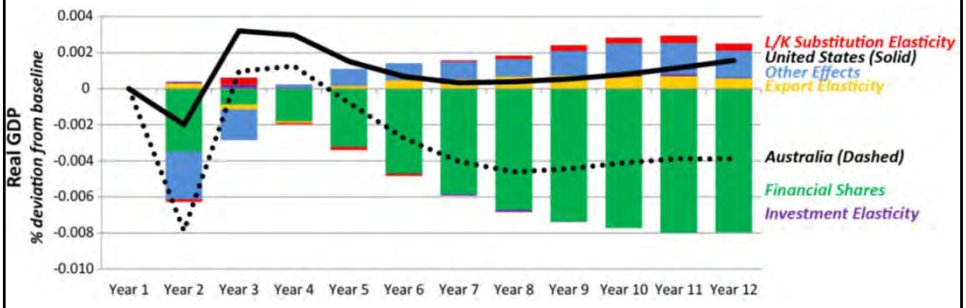


Financial structure differences dominate the policy responses of US and Australian industry and housing WACC's.

- **US Banks:** Invest 13.8% of total financial assets at the Federal Reserve;
- **Australian Banks:** Invest 0.3% of total financial assets at the RBA.

P.22

Real GDP
Decomposition of the variation between USAGE2F and VU-Nat model
Percentage deviation from baseline



SHORT RUN: Capital is fixed. Differences that arise due to the employment response (real-side other effects) are of similar order to differences due to financial structure.

LONG RUN: Employment returns to baseline. Capital response (driven by differences in real investment) causes the majority of the difference in the real GDP response.

P.23

Findings and Future Work

- The macro impacts of an increase in the capital adequacy ratio of Australian and US commercial banks are small.
- Some implications are similar between the two countries.
  - For example, banks accommodate the rise by equity raisings, contraction and rebalancing away from more risky assets.
- Inhomogeneous economy-wide impacts are largely driven by **financial structure**.
  - Sign of responses may change across jurisdictions, when the regulatory frameworks are identical;
  - **Why do capital regulations differ across jurisdictions?** Perhaps regulators take account of financial structure differences.
- Extensions: USAGE2F as a standalone FCGE model.
  - **Regulatory perimeter leakage: A case for further disaggregation?**
    - Government-sponsored enterprises (GSE's), e.g., Fannie Mae;
    - Dodd-Frank Act and SI-NBFI's, e.g., GE Capital.
  - **US-specific risk weights.**

P.24

GLOBAL CLIMATE CHANGE MITIGATION: STRATEGIC INTERACTIONS OR UNILATERAL GAINS?

SIGIT PERDANA
University of Western Australia

- Presented in **2017 National CGE Workshop**, Melbourne, August 7th 2017.
- This presentation is based on joint paper with **Prof Rod Tyers of** University of Western Australia and Research School of Economics, The Australian National University.

I. OVERVIEW/ BACKGROUND

Global warming gridlock under Kyoto :

- **Scale Mitigation Cost;**
- **Voluntary Base Commitment;**
- **Free Riding;**
- **Carbon Leakage;**

3

I. OVERVIEW/ BACKGROUND

Uniform Carbon Taxation Regime (Cooper, 2007 ; Nordhaus, 2013) as Alternate to Kyoto.

Claims:

1. easier to formulate;
2. enforcing broad participation;
3. same benefit as quantity based;
4. reduce leakage;
5. dynamically efficient.

Critics:

1. big but shallow;
2. coordination game.

4

I. OVERVIEW/ BACKGROUND

This research offers evaluations of mitigation using uniform carbon tax of 20 USD:

1. **Mitigation cost using Adapted GTAP Dynamic Model**;
2. **Benefit from Mitigation (Reduced Temperature Rise) using Meta Analysis of Prior Studies;**
3. **Strategic Interactions (Game Theory Analysis);**
4. **Policy Consideration (Side Payment Analysis)**.

5

II. ESTIMATING FUTURE ECONOMIC COST OF MITIGATION

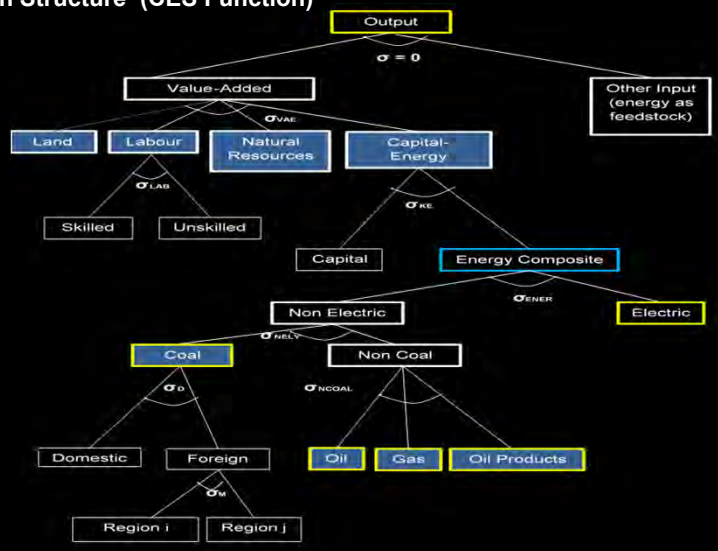
Modelling Approach

1. GDYN-Energy Model ;
2. Combined GTAP-E Model & GTAP Dynamic Model;
3. Neoclassical structure :
   a. perfect competition,
   b. Armington product differentiation;
   c. non-homothetic consumer demand;
   d. international trade ;
   e. endogenous international financial flows;
4. Minimize portfolio complexity with **global trust.**

6

II. ESTIMATING FUTURE ECONOMIC COST OF MITIGATION

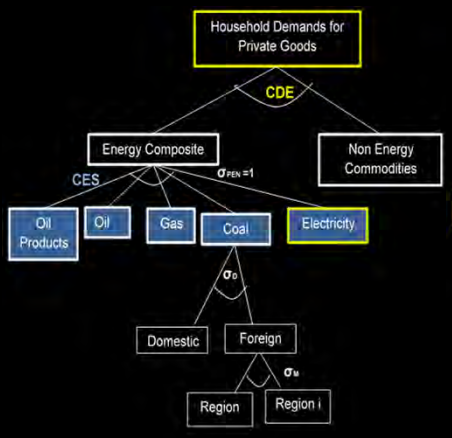
Production Structure (CES Function)



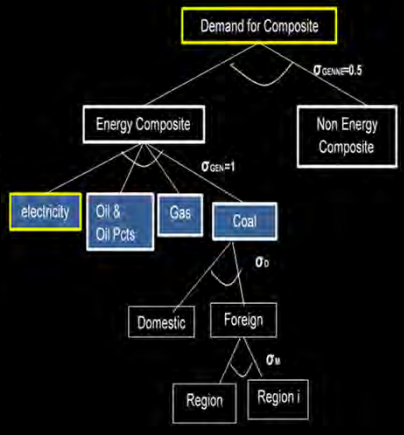
7

II. ESTIMATING FUTURE ECONOMIC COST OF MITIGATION

Household Consumption (CDE Function)



Government Consumption (CES Function)



8

II. ESTIMATING FUTURE ECONOMIC COST OF MITIGATION

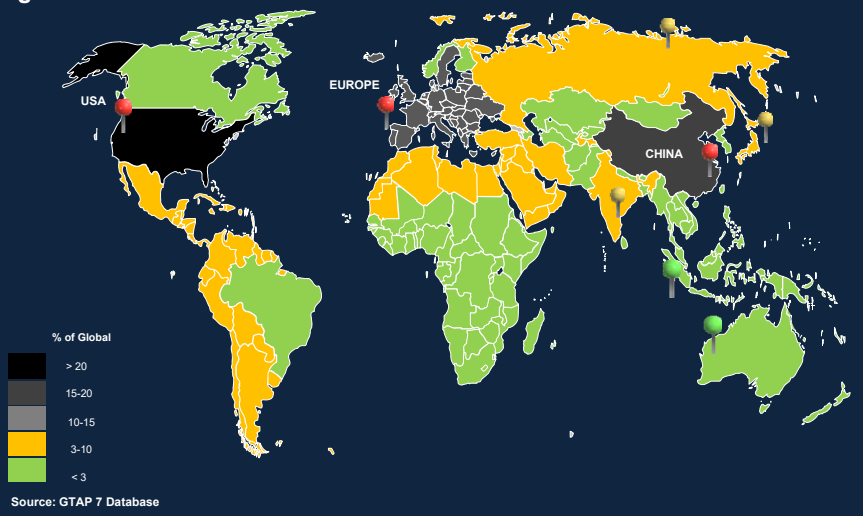
Database and Baseline Construction

1. Dataset of **GTAP 7 (2004)**: **113 regions** and **57 sectors;**
2. Condensed to **21 regions** and **12 sectors;**
3. Calibrated regional investment **risk premium**;
4. **Exogenous population and labour supply** projections (CEPII 2010);
5. **Carbon emission coefficients** from Lee (2008);

9

II. ESTIMATING FUTURE ECONOMIC COST OF MITIGATION

Regional Carbon Emission 2004

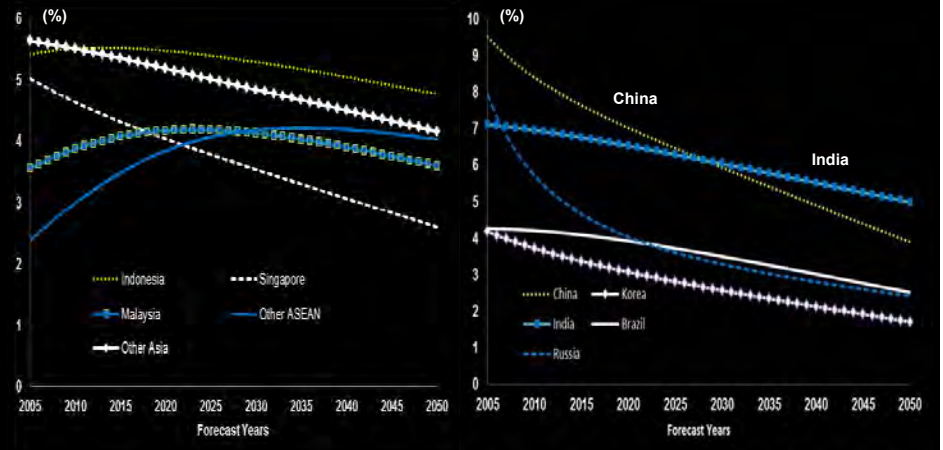


Source: GTAP 7 Database

10

II. ESTIMATING FUTURE ECONOMIC COST OF MITIGATION

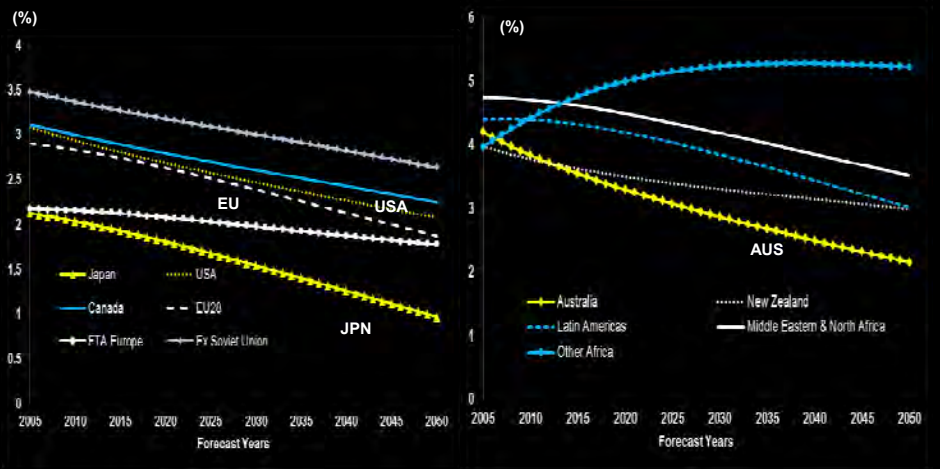
Baseline Projection of Regional GDP Growth Rates



11

II. ESTIMATING FUTURE ECONOMIC COST OF MITIGATION

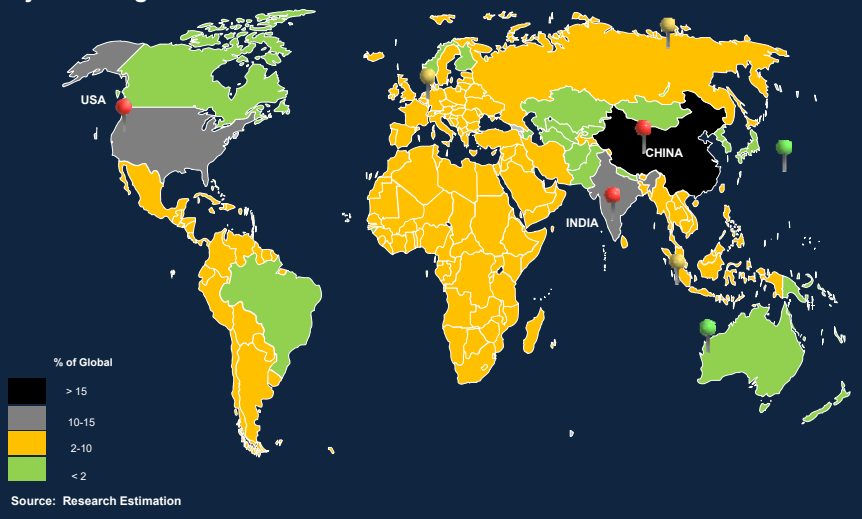
Baseline Projection of Regional GDP Growth Rates



12

II. ESTIMATING FUTURE ECONOMIC COST OF MITIGATION

Projected Regional Carbon Emission 2050

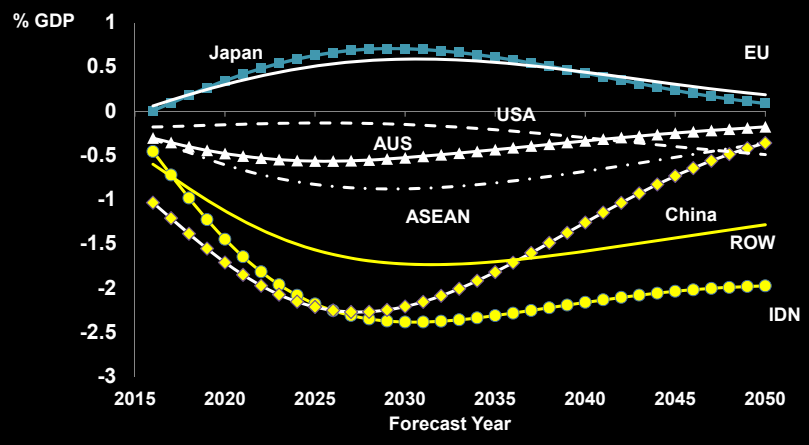


Source: Research Estimation

13

II. ESTIMATING FUTURE ECONOMIC COST OF MITIGATION

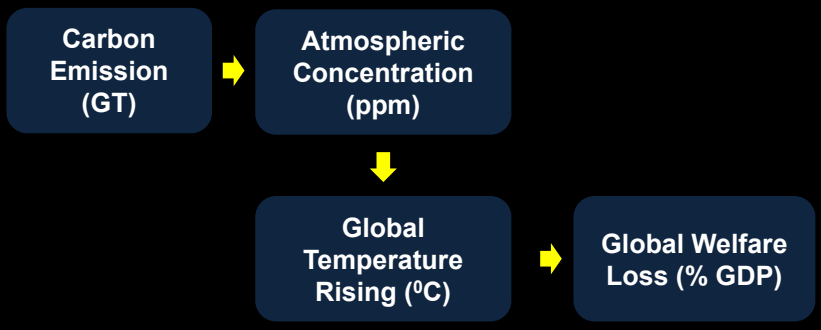
Projected Real GDP Growth Deviation 20 USD Uniform Tax



14

III. CALCULATING BENEFIT OF MITIGATION

Shared benefit from lower global carbon load (as % of GDP)



15

III. CALCULATING BENEFIT OF MITIGATION

- Mitigation scenarios give projected total carbon emissions in 2050
- Baseline (No country) : 100.2 GT; All countries 64 GT;
- Match total emissions with IPCC Global Temperature Scenario

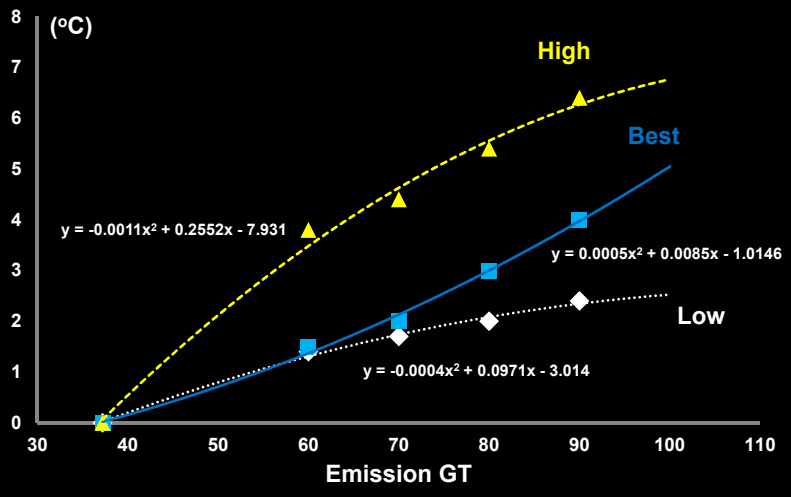
Emission (GT) in 2050/ Lower Border	IPCC (GHG scenario)	Atmospheric Concentration (PPM)	Best Temperature Estimate (^{0}C)	Likely Uncertainty Range (^{0}C)
90	A1F1	660-790	4	2.4-6.4
80	A2	570-660	3	2.0-5.4
70	A1B	485-570	2.8	1.7-4.4
60	A1T	440-485	2.4	1.4-3.8

- Note: The IPCC scenarios use year 2005 as baseline, then projected until year 2100. Comparative table above show its projection in 2050
- Atmospheric Concentration of GHG in 2005 is 379 ppm

16

III. CALCULATING BENEFIT OF MITIGATION

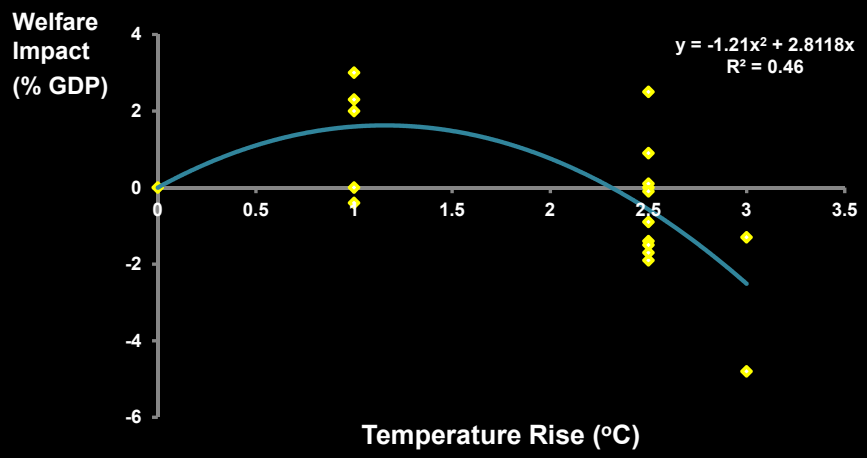
Emission and Global Temperature Change from year 2015



17

III. CALCULATING BENEFIT OF MITIGATION

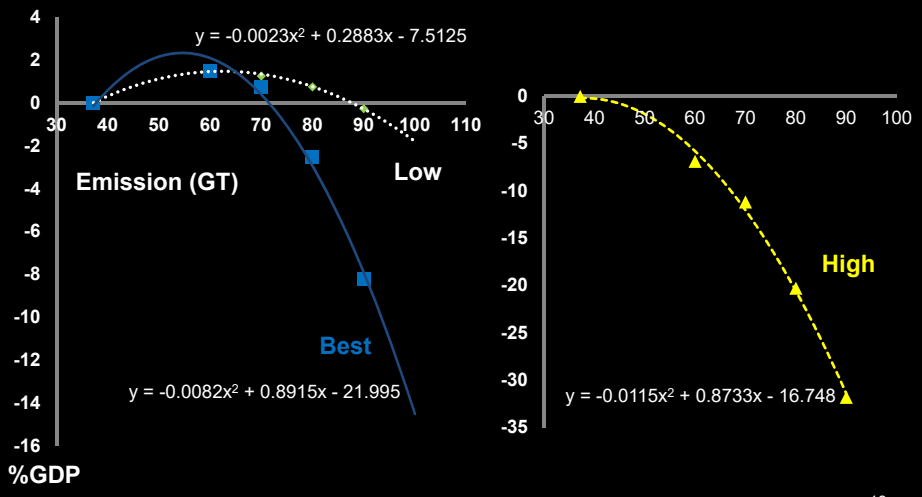
17 Studies of Temperature Rising & Global GDP Loss



18

III. CALCULATING BENEFIT OF MITIGATION

Emission and Global Welfare Reduction



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IV. STRATEGIC GAME ANALYSIS: STATIC GAMES

a. **Normal form games:** move simultaneously;

b. Construct payoff : **netting cost from shared benefit in present value term (unilateral and collective effect calculated as 2004**) for each temperature scenario;

c. Using **10 year Treasury Bond** yield rate of 0.0235;

d. 3 Players (China, US, EU);

e. 5 Players (China, US, EU, Indonesia, Australia).

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IV. STRATEGIC GAME ANALYSIS: STATIC GAMES 3 PLAYERS

LOW Scenario (in Trillion USD)

EU Participate

USA \ China	Participate	Defect
Participate	2.03 -2.17 4.08	1.45 2.23 2.65
Defect	4.82 -2.59 2.97	3.89 1.66 1.22

EU Defect

USA \ China	Participate	Defect
Participate	1.79 -2.45 6.93	1.03 1.86 5.31
Defect	4.48 -2.91 5.72	3.40 1.26 3.77

DSNE: All Defect
(No Prisoners Dilemma)

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IV. STRATEGIC GAME ANALYSIS: STATIC GAMES 3 PLAYERS

BEST Scenario (in Trillion USD)

EU Participate

USA \ China	Participate	Defect
Participate	-1.99 -4.20 -0.07	-6.54 -1.83 -5.64
Defect	-0.73 -5.43 -2.76	-6.45 -3.56 -9.55

EU Defect

USA \ China	Participate	Defect
Participate	-2.98 -4.89 2.00	-8.13 -2.79 -4.22
Defect	-2.02 -6.24 -1.01	-8.32 -4.64 -8.44

Nash Equilibrium: USA Participate;
Others: Defect

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IV. STRATEGIC GAME ANALYSIS: STATIC GAMES 3 PLAYERS

HIGH Scenario (in Trillion USD)

EU Participate

USA \ China	Participate	Defect
Participate	-37.43 / -20.78 / -37.74	-53.40 / -23.44 / -55.57
Defect	-41.53 / -24.35 / -46.20	-59.10 / -27.70 / -65.72

EU Defect

USA \ China	Participate	Defect
Participate	-41.18 / -22.67 / -38.63	-57.96 / -25.70 / -57.36
Defect	-45.67 / -26.40 / -47.52	-64.03 / -30.11 / -67.91

DSNE: ALL Participate

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IV. STRATEGIC GAME ANALYSIS: STATIC GAMES 5 PLAYERS

LOW SCENARIO (TRILLION USD)

	COUNTRY	PARTICIPATE	DEFECT
1	US	1.03	3.40
2	China	-2.91	1.26
3	EU	1.22	3.77
4	Indonesia	-0.19	0.12
5	Australia	-0.05	0.21

DSNE: ALL DEFECT

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IV. STRATEGIC GAME ANALYSIS: STATIC GAMES 5 PLAYERS

BEST SCENARIO (TRILLION USD)

	COUNTRY	PARTICIPATE	DEFECT
1	US	-8.13	-8.32
2	China	-6.24	-4.64
3	EU	-9.55	-8.44
4	Indonesia	-0.76	-0.48
5	Australia	-0.80	-0.56

Nash Equilibrium:
USA Participate.
Others : Defect (Free Riding)

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IV. STRATEGIC GAME ANALYSIS: STATIC GAMES 5 PLAYERS

HIGH SCENARIO (TRILLION USD)

	COUNTRY	PARTICIPATE	DEFECT
1	US	-57.96	-64.03
2	China	-26.40	-30.11
3	EU	-65.72	-67.91
4	Indonesia	-3.25	-3.02
5	Australia	-4.36	-4.17

DSNE: Indonesia & Australia
Free Riding

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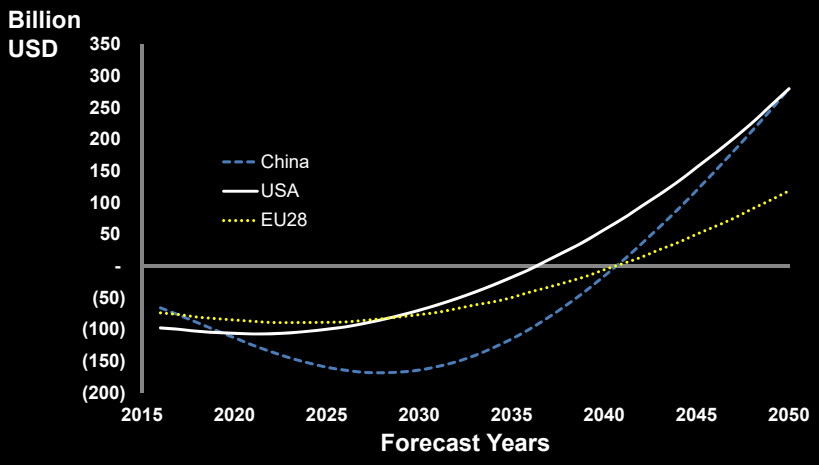
V. STRATEGIC GAME ANALYSIS: SIDE PAYMENT

Unilaterally Benefit by Carbon Tax Compare to Non Abatement Case



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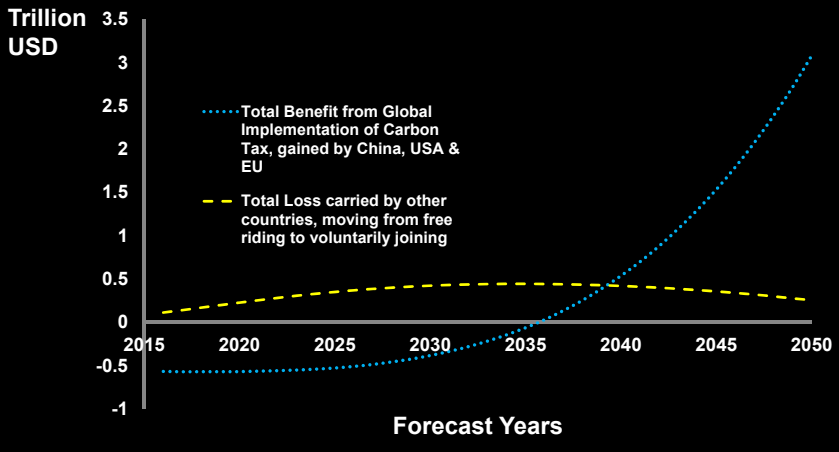
V. STRATEGIC GAME ANALYSIS: SIDE PAYMENT

Affordability of Side Payment



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VI. CONCLUSION

1. USA is a net gainer. IPCC Best temperature scenario yields unilateral implementation of US.
2. The comparative net benefits is small to EU and China;
3. All Other Countries Best Strategy : Free Ride;
4. To commit is politically difficult :
   a. Gain to large countries do not increase enough by wider participation
   b. Side payments are still not affordable at least until two decades.

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"THANK YOU"

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APPENDIX I

Cumulative Discounted Dollar Value of Net Welfare Benefit/ Loss of Uniform Tax (US$ Trillions)

Regions (A)	Unilateral Implementation (B)	"BIG Three" Implementation (C)	Universal Implementation (D)	Extra Benefit By Universal Implementation (D-C)
China	-1.60	0.44	3.34	2.90
USA	0.18	6.33	9.22	2.89
EU	-1.10	8.38	12.65	4.27
Total "Big Three"	-2.52	15.15	25.21	10.06

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APPENDIX I (Cont.)

Regions (A)	"BIG Three" Implementation/ Benefit As Free Rider (B)	Joining "Big Three" (C)	Losing Benefit from Altering Mitigation Strategy (C-B)
Indonesia	0.50	0.20	0.30
Other ASEAN Countries	0.74	0.38	0.36
Australia	0.69	0.43	0.26
Japan	3.50	2.92	0.58
India	1.91	0.47	1.44
Russia	0.70	-1.74	2.44
Middle East & North Africa	1.56	-0.70	2.26
New Zealand & Oceania	0.13	0.09	0.04
Brazil	0.89	0.66	0.23
Korea	0.90	0.48	0.42
Canada	0.92	0.56	0.36
Latin America	2.33	0.71	1.62
Other Asia	1.06	0.63	0.43
FTA Europe	0.53	0.45	0.08
EX Soviet Union	0.53	-0.28	0.81
Africa	1.01	0.45	0.56
Total	17.91	5.71	12.20

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APPENDIX: Disc Rates!
PAY-OFFS 3 Player

R=5%

LOW Scenario (in Trillion USD)

EU Participate, China

USA \ China	Participate	Defect
Participate	0.81 / 1.75	0.74 / 1.31
Defect	2.23 / 1.35	2.02 / 0.77

EU Defect, China

USA \ China	Participate	Defect
Participate	0.75 / 3.16	0.61 / 2.63
Defect	2.13 / 2.72	1.85 / 2.05

BEST Scenario (in Trillion USD)

EU Participate, China

USA \ China	Participate	Defect
Participate	-0.45 / 0.46	-1.73 / -1.25
Defect	0.56 / -0.36	-1.23 / -2.60

EU Defect, China

USA \ China	Participate	Defect
Participate	-0.70 / 1.67	-2.25 / -0.32
Defect	0.17 / 0.70	-1.88 / -1.82

HIGH Scenario (in Trillion USD)

EU Participate, China

USA \ China	Participate	Defect
Participate	-13.91 / -13.91	-20.06 / -20.87
Defect	-15.23 / -17.25	-22.08 / -24.95

EU Defect, China

USA \ China	Participate	Defect
Participate	-15.36 / -13.99	-21.87 / -21.34
Defect	-16.86 / -17.52	-24.05 / -25.60

US Defect in Best Scenario

APPENDIX: Disc Rates!
PAY-OFFS 3 Player

R= 7.2%

LOW Scenario (in Trillion USD)

EU Participate, China

USA \ China	Participate	Defect
Participate	0.36 / 0.88	0.42 / 0.74
Defect	1.22 / 0.71	1.20 / 0.49

EU Defect, China

USA \ China	Participate	Defect
Participate	0.36 / 1.71	0.37 / 1.52
Defect	1.19 / 1.52	1.13 / 1.25

BEST Scenario (in Trillion USD)

EU Participate, China

USA \ China	Participate	Defect
Participate	-0.13 / 0.37	-0.49 / -0.20
Defect	0.62 / 0.10	-0.01 / -0.75

EU Defect, China

USA \ China	Participate	Defect
Participate	-0.19 / 1.16	-0.68 / 0.44
Defect	0.49 / 0.81	-0.27 / -0.19

HIGH Scenario (in Trillion USD)

EU Participate, China

USA \ China	Participate	Defect
Participate	-6.39 / -6.32	-9.29 / -9.65
Defect	-6.87 / -7.94	-10.15 / -11.66

EU Defect, China

USA \ China	Participate	Defect
Participate	-7.07 / -6.22	-10.16 / -9.76
Defect	-7.65 / -7.94	-11.11 / -11.87

US Defect in Best Scenario

APPENDIX: Disc Rates!
PAY-OFFS 5 Player

R=5% LOW SCENARIO (TRILLION USD)

NO	COUNTRY	PARTICIPATION	
		PARTICIPATE	DEFECT
1	US	0.61	1.85
2	China	-1.41	0.68
3	EU	0.77	2.05
4	Indonesia	-0.07	0.07
5	Australia	-0.01	0.12

BEST SCENARIO (TRILLION USD)

NO	COUNTRY	PARTICIPATION	
		PARTICIPATE	DEFECT
1	US	-2.25	-1.88
2	China	-2.44	-1.24
3	EU	-2.60	-1.82
4	Indonesia	-0.26	-0.13
5	Australia	-0.25	-0.13

HIGH SCENARIO (TRILLION USD)

NO	COUNTRY	PARTICIPATION	
		PARTICIPATE	DEFECT
1	US	-21.87	-24.05
2	China	-10.17	-11.15
3	EU	-24.95	-25.60
4	Indonesia	-1.23	-1.12
5	Australia	-1.66	-1.56

Best scenario: All Defect: No Unilteral Gain fror USA

R=7.2% LOW SCENARIO (TRILLION USD)

NO	COUNTRY	PARTICIPATION	
		PARTICIPATE	DEFECT
1	US	0.37	1.13
2	China	-0.82	0.41
3	EU	0.49	1.25
4	Indonesia	-0.04	0.04
5	Australia	0.00	0.07

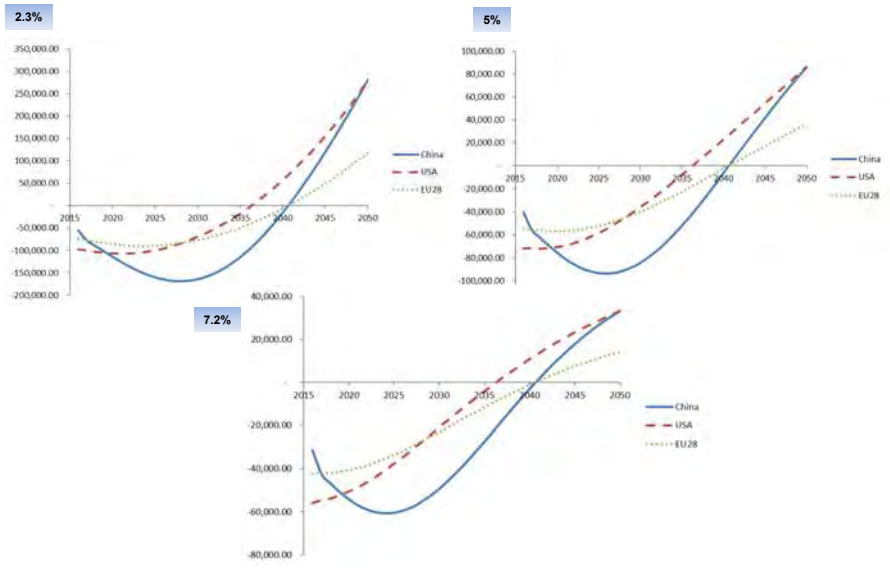
BEST SCENARIO (TRILLION USD)

NO	COUNTRY	PARTICIPATION	
		PARTICIPATE	DEFECT
1	US	-0.68	-0.27
2	China	-1.20	-0.34
3	EU	-0.75	-0.19
4	Indonesia	-0.11	-0.04
5	Australia	-0.09	-0.02

HIGH SCENARIO (TRILLION USD)

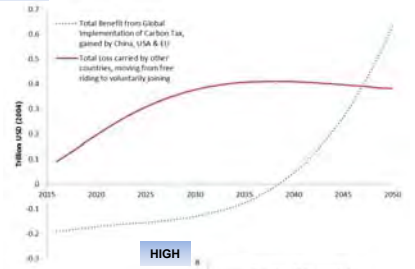
NO	COUNTRY	PARTICIPATION	
		PARTICIPATE	DEFECT
1	US	-10.16	-11.11
2	China	-4.84	-5.08
3	EU	-11.66	-11.87
4	Indonesia	-0.57	-0.51
5	Australia	-0.78	-0.72

APPENDIX: Unilaterally Benefit
TOP 3 From Non Abatement Case



APPENDIX: Disc 2.3% Affordability of Side Payment

LOW



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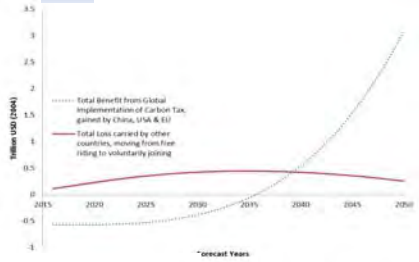

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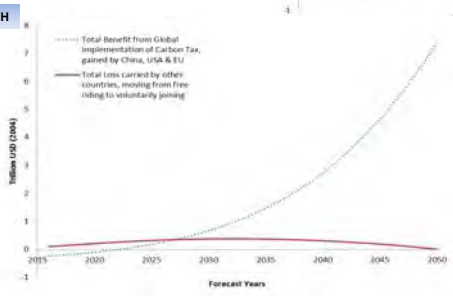
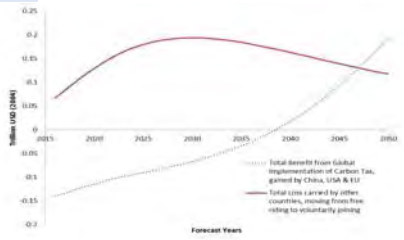
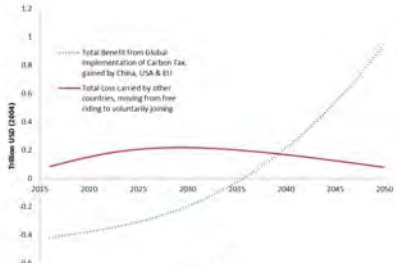


APPENDIX: Disc 5% Affordability of Side Payment

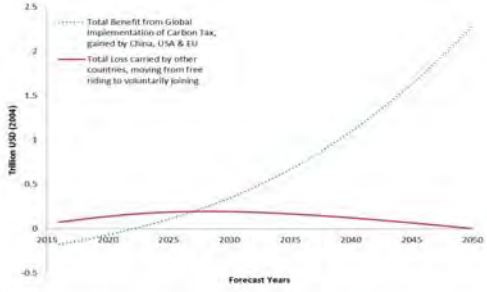
LOW



BEST

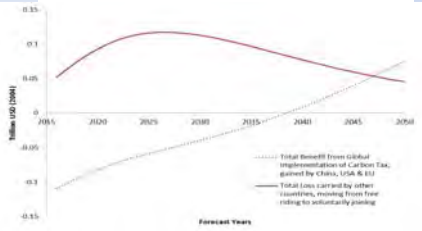


HIGH

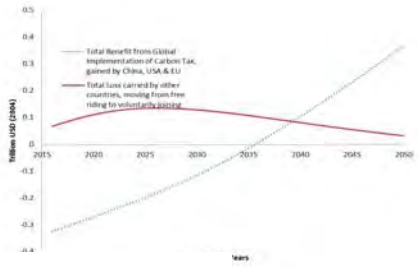


APPENDIX: Disc 7.2%
Affordability of Side Payment

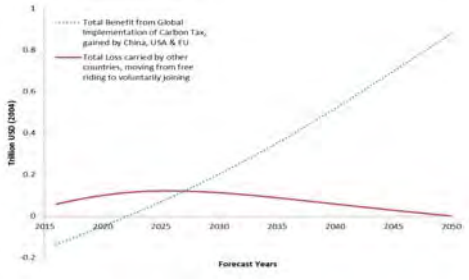
LOW



BEST



HIGH



Minimising aggregation bias in regional models

Cedric Hodges, Gabby McGrath and Hom Pant
Deloitte Access Economics

1

Outline

- Literature
- Key question – what is the best trade-off between computational efficiency and bias?
- Our approach to answering this question
- Results
- Conclusion
- Q&A

2

Literature

Standardi, Cai and Yeh (2016)

Find a significant difference in both the estimated carbon price and the economic costs of de-carbonisation in Italy between models with and without regional and technological detail.

Britz, Drudd and Mennsbrugghe (2015)

Find that even if full regional and sectoral disaggregation are the best way to avoid aggregation bias, there exists some degree of aggregation which can deliver very similar impacts.

Ko and Britz (2013)

Looking at the trade generation effects of an FTA between EU and South Korea, find that variation of tariffs and export shares within the block causes regional aggregation to have an effect on the trade generation impacts.

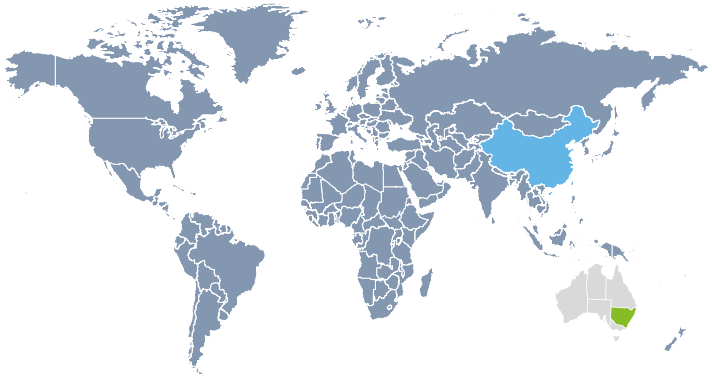
Brockmeier and Bektasoglu (2014)

Looking at shocks in the agriculture sector, find that there are substantial differences in the results due to the level of sectoral disaggregation.

3

Key Question

Suppose that a mining boom in New South Wales is propelled by a demand surge from China. We want to project the economic impacts on NSW and Australia of the mining boom. What regional aggregation of the global database would provide the best trade off between computational efficiency and minimisation of regional aggregation bias?



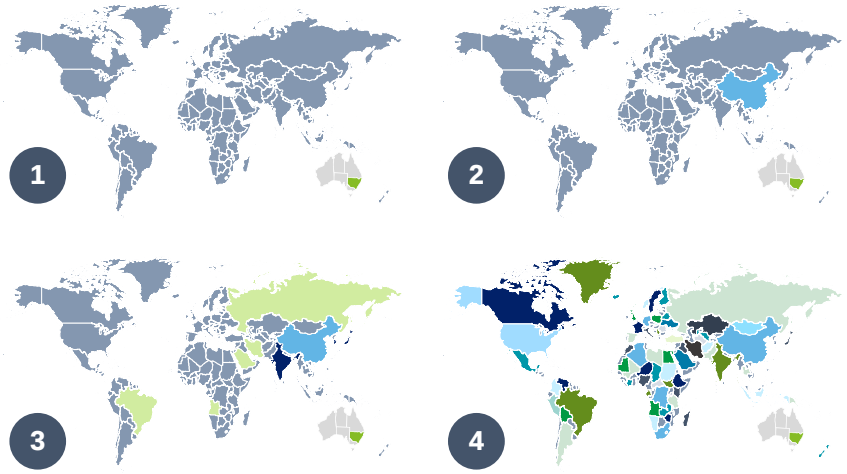
4

Method

Shock: $1 billion export demand shock to NSW, driven by demand from China

Scenarios:

1) Australia, Rest of World
2) Australia, China, Rest of World
3) Australia, China, major importers of NSW minerals, other major exporters of minerals to China, Rest of World
4) Full disaggregation

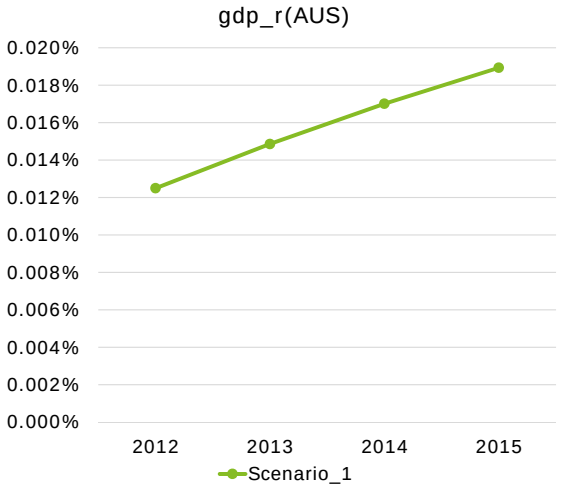


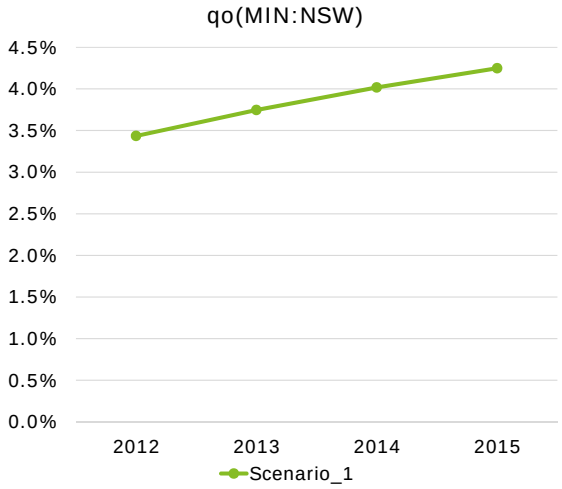
5

Results

Scenarios

1) Australia, Rest of World
2) Australia, China, Rest of World
3) Australia, China, IMP, EXP, RoW
4) Full disaggregation





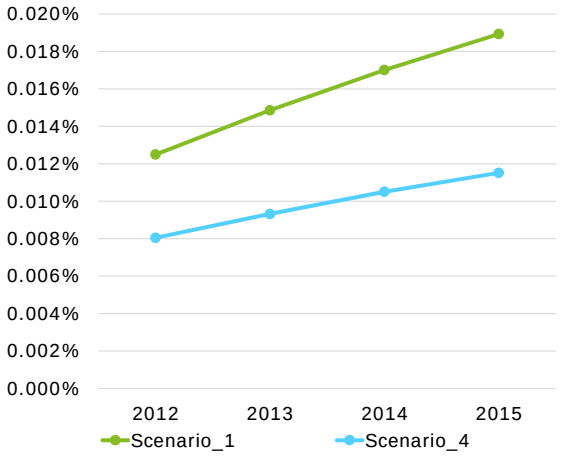
6

Results

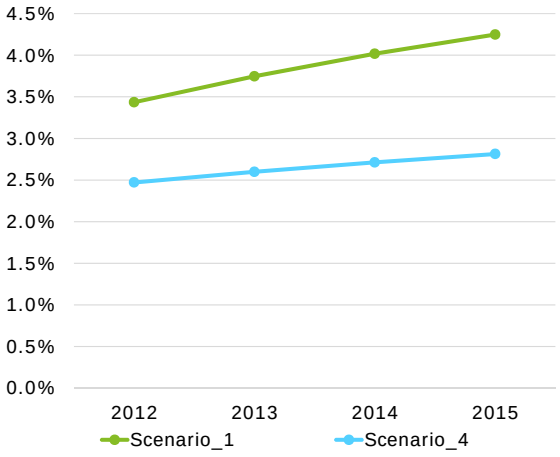
Scenarios

1) Australia, Rest of World
2) Australia, China, Rest of World
3) Australia, China, IMP, EXP, RoW
4) Full disaggregation

gdp_r(AUS)



qo(MIN:NSW)



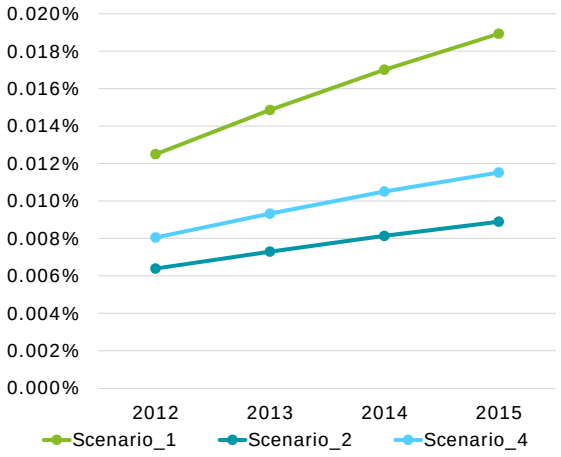
7

Results

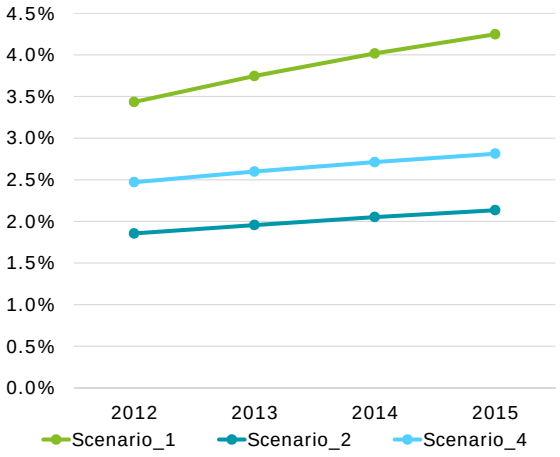
Scenarios

1) Australia, Rest of World
2) Australia, China, Rest of World
3) Australia, China, IMP, EXP, RoW
4) Full disaggregation

gdp_r(AUS)



qo(MIN:NSW)

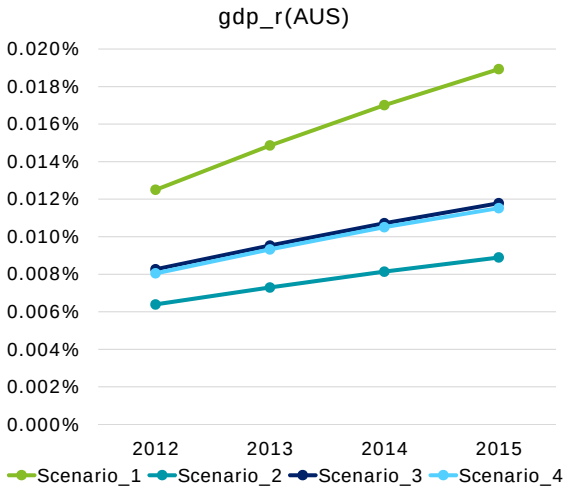


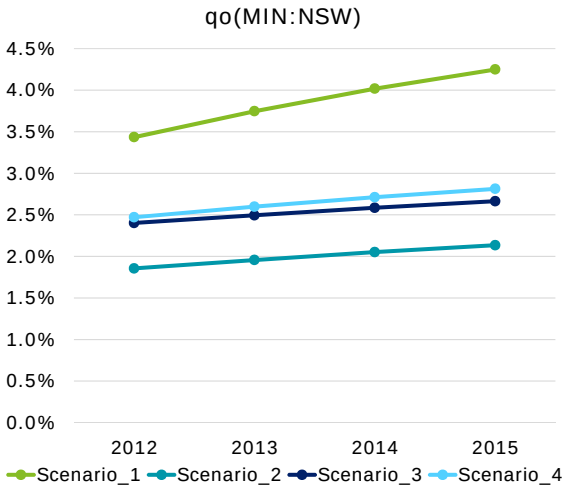
8

Results

Scenarios

1) Australia, Rest of World
2) Australia, China, Rest of World
3) Australia, China, IMP, EXP, RoW
4) Full disaggregation



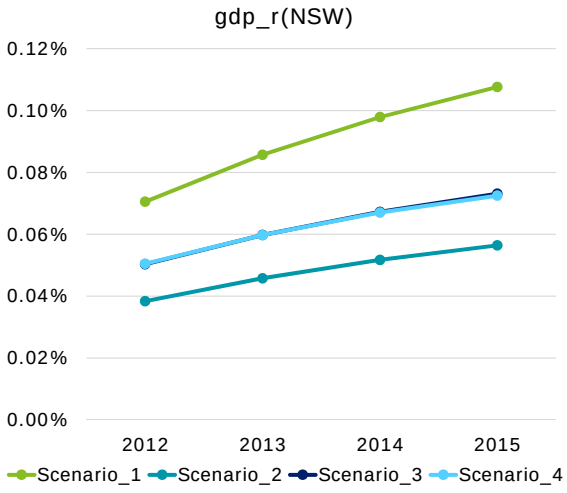


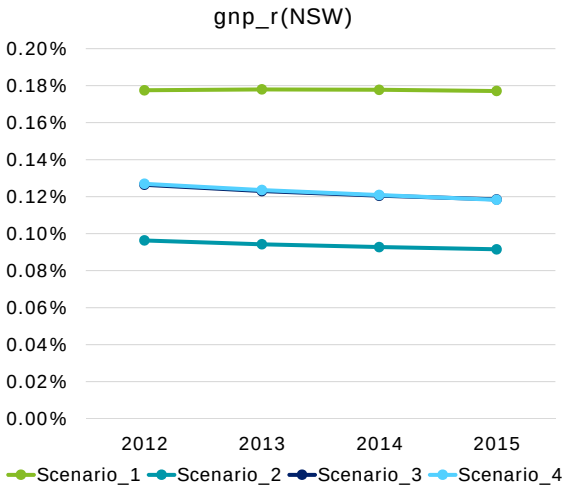
9

Results

Scenarios

1) Australia, Rest of World
2) Australia, China, Rest of World
3) Australia, China, IMP, EXP, RoW
4) Full disaggregation



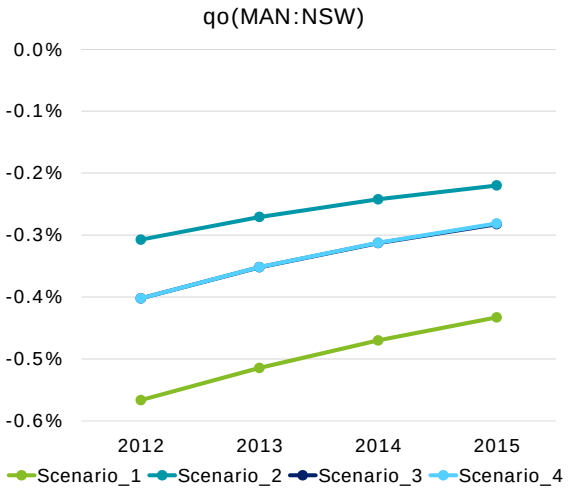


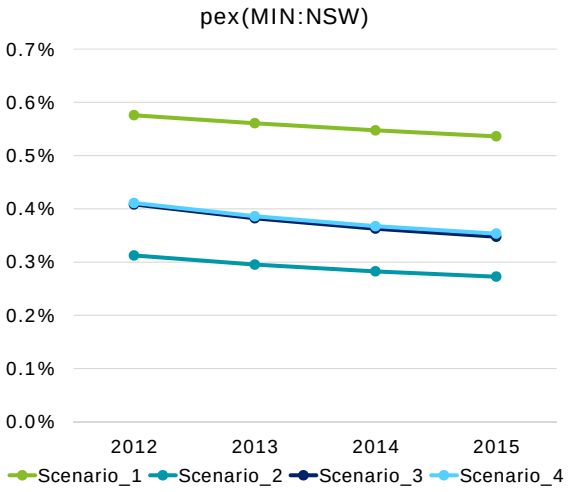
10

Results

Scenarios

1) Australia, Rest of World
2) Australia, China, Rest of World
3) Australia, China, IMP, EXP, RoW
4) Full disaggregation





11

Conclusions

1. Having a single Rest of World region produces biased results
2. But we can achieve relatively unbiased results with a fast computation time by selecting the right regions
3. This can likely be broadened to sectoral aggregation

12

Q&A

Thoughts, comments, feedback?

13

Achieving longer-run equilibrium in the dynamic GTAP model

Session 2, 2017 National CGE Workshop, Victoria University
7 August 2017

Paul Gretton
Crawford School, ANU
(Draft: Not for quotation or circulation)

Some background

- Desire to extend capabilities from comparative static GTAP to dynamic framework to…
  - Trace out the time scale of effects of a policy change
  - Examine the impact of population, workforce participation and productivity assumptions on global growth and convergence of economies
- GDyn appeared the reasonable starting point
  - Built out of GTAP – with long tradition of applications
  - Documented – Ianchovichina and Walmsley (2012); Gdyn tablo file
  - Accessible public domain general purpose technology

Introduction of dynamics through Gdyn architecture

- Partial adjustment rule for accumulation of capital, rates of return
- Full accounting of capital-finance through Regional household wealth, Firm capital accumulation, and Global trust
- Neo-classical stability conditions for longer-run equilibrium (I&W, pp 68,9)

$$RORGEXP(r) = RORGTARG(r) = RORGROSS)(r), \forall r \quad (2.104)$$

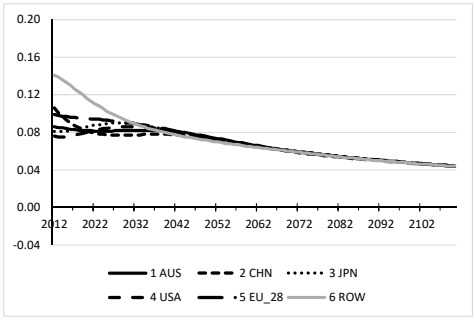
$$\dot{RORGEXP}(r) = \dot{RORGTARG}(r) = \dot{RORGROSS}(r) = 0, \forall r \quad (2.105)$$

$$KHAT(r) = 0, DKHAT(r) = 0, \forall r \quad (2.106)$$

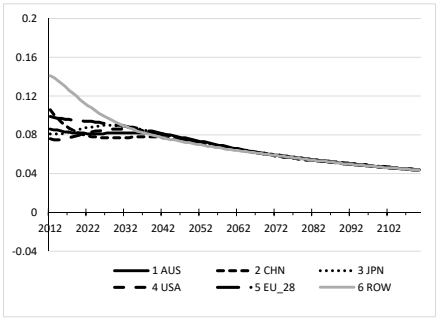
Test simulation: TIME shocked; Std parameters; Simulation period 100 years

Snag – Stability conditions not satisfied: Evidenced by projections & failure of coefficient (ge 0) tests

Projected actual rates of return (RORGROSS) trends down
(note tendency to depn rate of 0.04)



Price-neutral rate of growth in the capital stock KHAT also trends down
(note tendency to depn rate of 0.04)



Model fails when: RORGROSS = Depn rate; Coefficient on Firm income paid to global trust negative

Stability conditions not met **partly** because no ROR variable exogenous

- Actual gross rate of return – RORGROSS (rorga percentage change)
  - rorga endogenous; RORGROSS calculated from data
- Expected rate of return – RORGEXP (rorge)
  - Modelling based on: RORGEXP = RORGROSS * [K(1)/K(0)] ^ -rorgflex

  (if planned capital (K(1) is above base capital, the expected rate of return is lower relative to base rate of return by parameter rorgflex = 10)
  - rorge endogenous; RORGEXP updated by rorge
- Target rate of return – RORGTARG (rorgt)
  - rorgt endogenous in basic model; RORGTARG updated by rorgt
- RORGTARG arguably determined outside model – should be exogenous

Modify investment rule to include an exogenous treatment of RORGTARG

- Equation INVESTMENT # *rule for investment* # (all,r,REG)
  - erg_rorg(r) = LAMBRORG(r) * [rorgt(r) - rorge(r) +

Original

Addition

100.0 * LAMBRORGE(r)*ERRRORGT(r)*time]

where, ERRRORGT(r) is **loge(RORGTARG(r)/RORGEXP(r))**

LAMBRORGE = 0.2 in standard parameter set

- By making rorgt(r) exogenous – RORGTARG also exogenous
- Meets all market clearing and neo-classical stability conditions

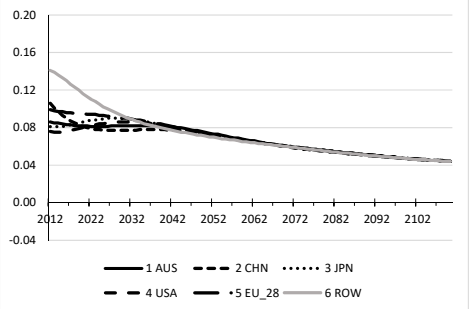
Making the target rate of return (rorgt| RORGTARG) exogenous

- Add a new equation defining the percentage change in the target rate of return by region - rorgt(r) - as the sum of:
  - A regional shifter for rorgt for each region – new variable srorc(r)
  - A shifter for world average rorgt – new variable srorc_r
- Closing the model
  - srorc(r) is naturally exogenous
  - **Swap** sqkworld = srorc_r,

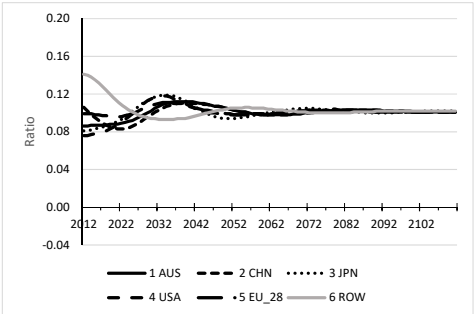
  where sqkworld is a region-generic shock to capital stock
- Swap reconciles Net investment with Change in capital services (a divisia index approach)
  - Recognises all investment over period is not available as input from beginning

Model stability achieved – Projected actual rates of return (RORGROSS)

Original specification
(from above)

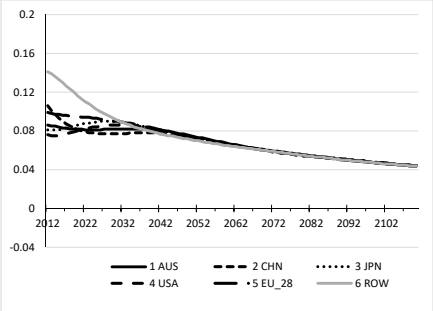


Revised specification
(RORGROSS (and RORGEXP) converges to RORGTARG)

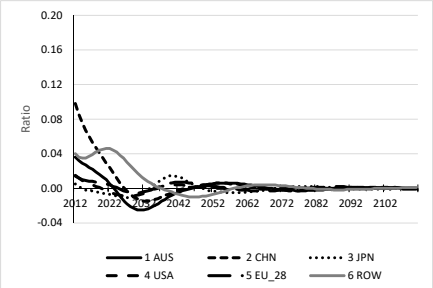


Model stability – Projected growth in capital stock (KHAT) converges to zero

Original specification

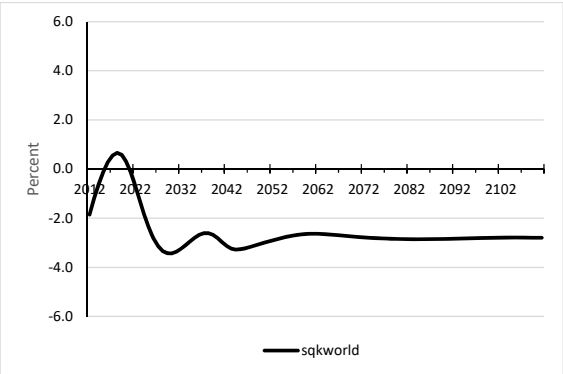


Revised specification




```
Coefficient (all,r,REG)
    KHAT(r) # price-neutral rate of growth in the (net) capital stock #;
```

What do projections of sqkworld look like?



sqkworld NE 0 implies commissioning of K not strictly proportional to net K formation (implying divisia index approach needed)
<0 in steady state implies all new installed capacity during period is not available as production input (capital capacity) at the beginning of the period

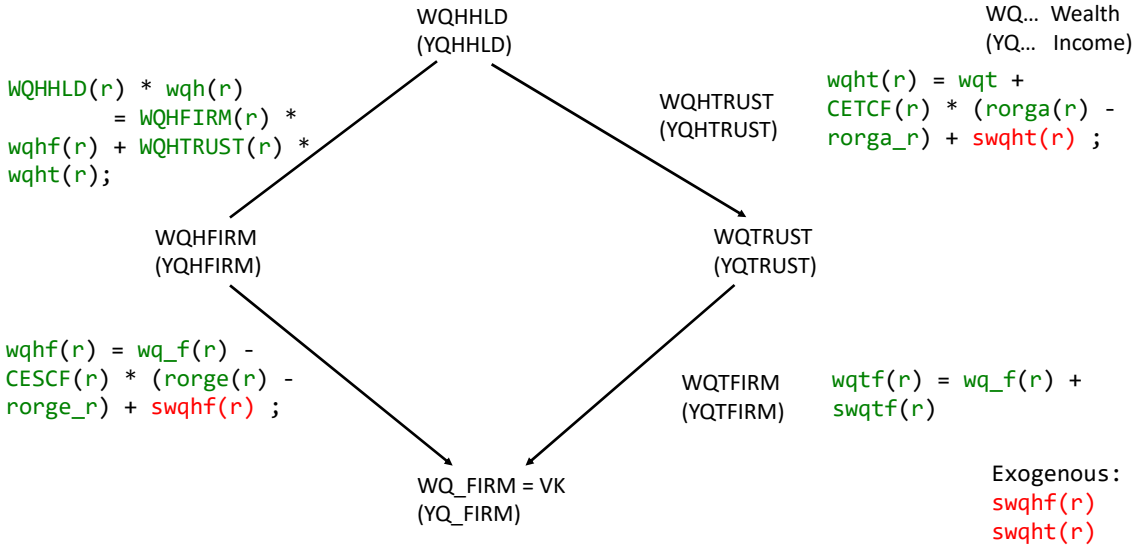
- sqkworld – *arbitrary region-generic shock to capital stock (capital services) in percentage change*

To address a second source of instability also needed to revise Gdyn capital-finance treatment

Original approach – utilizes funding rigidity parameters	**Alternative approach – utilizes standard CET|CES theory**
RIGWQH(r) # rigidity of allocation of wealth by regional household #	CETCF(r) # region-specific elasticity of transformation domestic/foreign holdings #;
RIGWQ_F(r) # rigidity of source of funding of enterprises #;	CESCF(r) *# region-specific elasticity of substitution domestic/foreign capital finance #*;

- Under original approach projected firm income remitted to global trust turns negative with standard parameters
  - Difficult to stabilize with ad hoc parameter changes
- Model stable with the CET|CES alternative

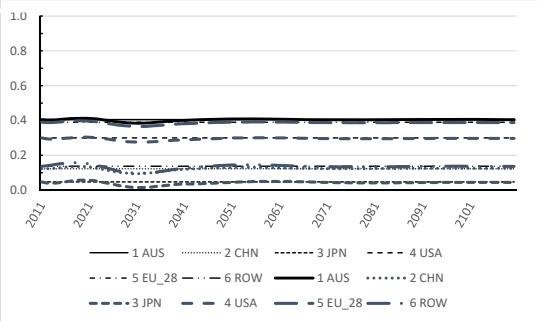
The revised approach to capital-finance



A glimpse at some capital-finance projections

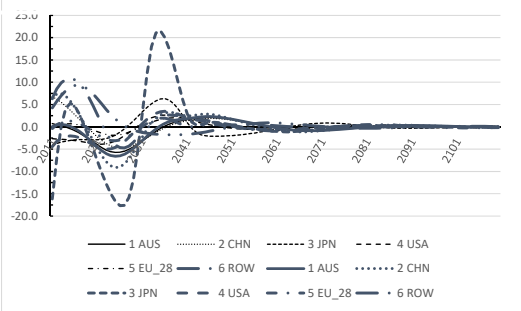
WQ_FTRUSTSHR – Global trust share in local firms

C-D and CES = 0.10



wqtf(b) Percentage change in Equity held by the global trust in local firms

C-D and CES = 0.10



Light lines are C-D case
Heavy lines are CES|CET cases

What achieved and some other issues

- Longer-run neo-classical equilibrium conditions satisfied
- Modified Gdyn model more suitable for building neo-classical growth reference case from projections of population, workforce participation and productivity
- Some further issues to consider:
  - Primary factor substitution elasticities (ESUBVA) – standard GTAP (~1.2) ; Adopt 0.5?
  - Elasticity of transformation of primary factors between industries (ETREA) – standard GTAP 1 for land, 2 for labour and capital – Should be higher?
  - More detailed modelling of labour market - an occupational labour substitution nest?
- Treatment of reinvested earnings; Treatment of mineral deposits
- And what about
  - A C-S closure with Gdyn code – a worthwhile experiment?
  - Historical validation with GDyn – would this be possible, or just a dream?

BAEconomics

The effects of Trade Openness on Food Prices and Welfare: A Monte Carlo Approach

Raymond Mi

National CGE Workshop
Victoria University, 7 August 2017

Outline

BAEconomics

1. Motivations: trade openness, welfare, agricultural productivity, climate condition, uncertainty
2. Methodology:
   - Monte Carlo simulations (18,000 comparative static runs)
   - 3 scenarios (different degrees of trade openness)
   - 3 global climate conditions ('good', 'neutral', 'bad')
3. Results
4. Conclusions & Further works

Motivation of the study

BAEconomics

- The effect of trade openness on food prices and welfare has not been fully understood.
- The effect of climate events on agricultural productivity is uncertain (mean and variance). Not every region will experience the same effect in a year.
- The release of the GTAP 9 database gives rise to new investigation; a new set of global data.
- To quantify the effects, we need a credible economic model to separate the effect of trade openness from other trade-related factors, such as technology transfer, policies encouraging foreign direct investment and any trade driven by political decisions.
- GTAP best suit this purpose: 1. A rigourous model; 2.Supported by a reliable database; 3. Transparent; 4. Widely used by academic community

The climate effect on agricultural productivity

BAEconomics

- All climate variables (e.g. temperature, rainfall, humidity) influence agricultural productivity.
- Most studies focus on negative climate events (e.g. a storm, a drought, a catastrophic climate change event) .

Possible effects:

A Monte Carlo approach to CGE modelling

BAEconomics

- A deterministic approach gives limited insight. (e.g. 10% decrease in agricultural productivity across the globe)
- It capture a wide range of possibilities: favourable climate, neutral climate, unfavourable climate and different combinations
- It captures the variations across regions (e.g. Favourable climate condition in Indonesia but Unfavourable climate condition in Australia)
- Policy development must consider all possibilities; a good policy can become a bad policy when circumstance change
- It tells an indicator of certainty (e.g. How certain a policy would raise the welfare of residents?)
- It expands the capability of CGE models
- Cost to run a Monte Carlo sim has come down significantly; 18,000 runs on a i7 laptop takes around 7 hours using GEMAPCK (default solver)

Monte Carlo approach: considering all possibilities

BAEconomics

- Each population represent a group of climate events.

Population	Effect on agricultural productivity	Mean	Standard Deviation
1		-10	10
2		0	10
3		10	10

- 32,000 random samples are drawn from each normally distributed population, distributing to 16 aggregated regions (2,000 vectors).

Productivity shocks from population 1

BAEconomics

afesec	1 S1	2 S2	3 S3	4 S4	5 S5	6 S6	7 S7	8 S8	9 S9	10 S10	11 S11	12 S12	13 S13	14 S14	15 S15	16 S16	17 S17
1 Australia	-16.9	-14.0	-7.3	-10.5	-2.6	-27.9	-8.6	-0.5	12.2	-16.7	-24.0	-2.4	-10.9	6.7	-12.8	-9.5	-5.4
2 China	-21.0	-13.7	1.4	-12.3	-28.2	3.7	5.4	16.9	-5.5	-4.5	-7.3	-20.1	-0.0	-10.1	-2.1	-18.7	-19.6
3 Japan	-18.9	6.5	-17.8	-5.0	-15.2	-19.0	-2.9	-12.2	-16.8	-9.8	-26.4	-18.9	-19.2	-16.8	-17.2	-4.7	-5.6
4 Korea	-4.7	2.0	2.6	-16.6	-2.1	-12.4	-2.6	10.8	-24.8	-13.7	-17.1	-5.1	-13.1	-1.2	-16.7	-7.3	-5.3
5 Taiwan	-13.5	3.2	-23.6	-5.8	-26.9	-9.6	-11.2	1.6	12.2	-0.6	-13.7	-14.5	-13.1	-11.5	-6.0	-13.7	-12.6
6 Indonesia	-18.2	-14.7	-17.4	-6.7	-27.0	4.9	-7.2	-6.1	16.3	-10.4	-6.8	-1.5	-0.8	-13.6	-13.6	-7.7	-15.7
7 Malaysia	1.0	-10.7	-9.7	-12.5	-10.1	-10.3	3.4	-20.4	-15.8	7.3	-11.6	-20.3	-11.2	-9.9	-22.1	-7.0	-3.8
8 RestofASEAN	-7.5	-22.3	-23.8	-15.2	-0.5	-2.8	-6.8	-8.6	0.6	-1.2	-15.1	-19.2	-16.1	-6.3	-14.3	-21.7	-11.6
9 India	-1.5	-14.5	-13.6	-3.6	-4.2	-17.5	-5.0	-6.5	-5.4	-18.7	10.0	6.7	-9.7	-5.6	2.4	-17.1	0.4
10 Canada	-4.6	-3.9	-20.6	-18.4	-7.5	-13.3	-11.1	-17.2	-6.5	-0.8	-24.8	-10.2	-13.3	-18.1	-18.8	4.2	-2.2
11 USA	-17.9	-11.2	-9.4	8.3	-9.8	0.9	-8.7	-2.5	-5.8	-13.8	-3.7	-14.0	-11.4	-18.0	-19.2	-9.7	-14.9
12 Brazil	-31.1	-11.5	-24.0	-19.1	-3.4	-5.5	6.3	-19.9	-23.6	4.0	-21.6	1.5	-5.0	-7.9	7.1	-8.3	4.3
13 LatinAm	-16.3	-4.8	-8.6	-3.9	-29.1	2.2	-24.6	-7.7	7.6	4.0	-41.7	-8.7	0.7	-27.1	-7.2	-13.3	-18.4
14 Russia	2.6	-10.4	-8.6	-12.0	-6.6	-5.2	-19.6	-4.5	-3.9	-23.0	-29.8	-7.9	-5.2	-32.9	-6.1	-10.7	-6.6
15 EU28	2.7	-5.8	-19.1	-12.6	8.3	5.3	7.5	-13.3	-9.6	-3.7	-21.0	-20.6	-2.0	-32.6	-13.2	11.8	-9.4
16 ROW	-26.2	-3.9	3.7	-16.2	-38.8	-7.3	-26.8	-7.1	-11.7	-5.9	-16.8	-22.3	10.7	-4.2	-27.3	-15.6	-11.1
Total	-192.0	-129.7	-195.7	-162.1	-203.8	-113.8	-112.3	-97.1	-80.5	-107.7	-271.6	-177.5	-119.6	-209.2	-187.0	-149.0	-137.5

Statistics of the 3 sets of samples

BAEconomics

	Set 1 (Pop. Mean = -10)			Set 2 (Pop. Mean = 0)			Set 3 (Pop.Mean = 10)		
Regions	Shock>0	Mean	S.D	Shock>0	Mean	S.D	Shock>0	Mean	S.D.
1 Australia	16%	-9.83	9.95	51%	-0.18	9.94	85%	10.17	9.94
2 China	17%	-9.66	10.30	49%	-0.39	9.95	83%	9.89	10.18
3 Japan	17%	-9.66	10.20	50%	-0.16	10.20	83%	9.66	10.30
4 Korea	16%	-10.07	10.22	49%	-0.19	9.92	84%	9.96	9.98
5 Taiwan	16%	-10.18	9.88	51%	0.20	10.00	85%	10.28	9.90
6 Indonesia	15%	-10.32	10.02	50%	0.16	9.92	85%	10.11	9.99
7 Malaysia	15%	-9.99	9.79	49%	-0.12	10.26	84%	10.35	10.25
8 Rest of ASEAN	15%	-10.11	9.71	48%	-0.13	10.04	83%	9.79	10.28
9 India	17%	-9.72	9.89	50%	0.02	10.12	85%	9.84	9.89
10 Canada	16%	-9.72	9.71	50%	-0.07	9.90	85%	10.07	10.05
11 USA	15%	-10.02	9.78	49%	-0.27	10.02	85%	10.31	10.22
12 Brazil	15%	-10.31	10.32	52%	0.33	9.99	83%	9.63	10.12
13 Latin America	16%	-10.05	9.87	48%	-0.06	10.12	86%	10.22	9.83
14 Russia	16%	-9.83	10.06	50%	0.05	9.96	85%	10.20	9.80
15 EU28	16%	-10.18	10.11	51%	0.30	9.76	84%	10.00	9.81
16 ROW	15%	10.01	9.87	50%	0.03	9.69	84%	9.63	9.89
All samples	16%*	-9.98	9.98	50%*	-0.03	9.99	84%*	10.01	10.03

GTAP industries

BAEconomics

- GTAP 57 industries are aggregated into 10 industries. Productivity shocks applied to the Agriculture and Cattle industries.

Industrial Sectors				
1. Agriculture	2. Cattle	3. Bovine Meat	4. Processed Food	5. Resources & Manufacturing
6. Energy, Gas and Water	7. Construction	8. Land Transport	9. Sea and Air Transport	10.Services

- Changes to the default GTAP closure.

```
Swap pcgdswld = pfctwld;
Swap del_ttaxr = tp;
```

Three stylized scenarios: representing different degrees of trade openness

BAEconomics

- Productivity shocks from 3 sets of populations (favourable, neutral, unfavourable) are applied to each scenario.

	Elasticities of substitution between domestic and imported products (σ_D)	Elasticities of substitution among imports from different sources (σ_M)	Import tariff shocks (t_m)
Reference Case R	Default (2.0-3.9)	Default (4.0-7.7)	No
Scenario A	Increase by 50	Increase by 50	No
Scenario B	Increase by 50	Increase by 50	Yes

- For each scenario, it is run by 6,000 times with different shocks (2,000 productivity shocks from each population).
- Same productivity shocks applied to each scenario.

Questions to be answered

- What are the effects of trade openness on global food prices and national welfare?
- Would trade openness put downward pressure on global food prices?
- Would the effects depend on the sign of productivity shocks (climate events)?
- Would an universal cut in tariff across the globe increase welfare of all countries?

Our Measures

- Food price: the weighted average of all regions (PW)
- Welfare : Utility (U) and Real GDP (QGDP)

Results

Number of shocks (out of 2,000) producing a higher world price, the reference case

BAEconomics

Effects of productivity shocks

	'Bad Time'	'Neutral'	'Good Time'
	Set 1 (Mean = -10)	Set 2 (Mean = 0)	Set 3(Mean = 10)
Agriculture (agri)	1991	1072	14
Cattle (ctl)	1989	1086	19
Bovine meat (cmt)	1997	1070	9
Processed food(food)	1992	1089	15

Number of shocks (out of 2,000) producing an increase in utility, the reference case

BAEconomics

	'Bad Time'		'Neutral'		'Good Time'	
U	Set 1 (Mean = -10)		Set 2 (Mean = 0)		Set 3 (Mean = 10)	
Regions	Mean*	%>0**	Mean*	%>0**	Mean*	%>0**
1 Australia	-0.02	48%	0.00	52%	0.05	61%
2 China	-1.31	14%	-0.10	49%	1.03	87%
3 Japan	-0.25	5%	-0.01	49%	0.20	94%
4 Korea	-0.49	1%	-0.01	49%	0.39	99%
5 Taiwan	-0.45	2%	-0.01	49%	0.36	97%
6 Indonesia	-1.38	14%	-0.04	50%	1.05	86%
7 Malaysia	-0.68	14%	-0.01	51%	0.59	87%
8 Rest of ASEAN	-1.04	16%	-0.04	49%	0.82	84%
9 India	-1.88	17%	-0.09	50%	1.48	85%
10 Canada	-0.06	33%	0.00	51%	0.07	78%
11 USA	-0.05	37%	0.00	50%	0.04	68%
12 Brazil	-0.42	30%	0.01	54%	0.32	72%
13 Latin America	-0.41	24%	-0.02	49%	0.35	80%
14 Russia	-0.49	3%	-0.01	49%	0.40	96%
15 EU28	-0.36	8%	0.00	51%	0.29	92%
16 ROW	-1.03	12%	-0.03	50%	0.82	88%

* Percentage change in U for 2000 samples

Number of shocks (out of 2,000) producing an increase in real GDP, the reference case

BAEconomics

	'Bad Time'		'Neutral'		'Good Time'	
QGDP	Set 1 (Mean = -10)		Set 2 (Mean = 0)		Set 3 (Mean = 10)	
Regions	Mean*	%>0**	Mean*	%>0**	Mean*	%>0**
1 Australia	-0.24	16%	-0.01	51%	0.20	85%
2 China	-0.96	15%	-0.07	49%	0.77	84%
3 Japan	-0.13	10%	-0.01	49%	0.10	88%
4 Korea	-0.20	3%	-0.01	49%	0.16	97%
5 Taiwan	-0.18	14%	0.00	51%	0.15	87%
6 Indonesia	-1.18	15%	-0.02	50%	0.93	85%
7 Malaysia	-0.64	14%	-0.02	50%	0.57	85%
8 Rest of ASEAN	-0.95	14%	-0.03	48%	0.77	84%
9 India	-1.71	15%	-0.07	49%	1.39	86%
10 Canada	-0.17	11%	0.00	49%	0.14	89%
11 USA	-0.13	13%	-0.01	49%	0.11	87%
12 Brazil	-0.65	17%	0.00	52%	0.49	83%
13 Latin America	-0.58	15%	-0.02	48%	0.49	87%
14 Russia	-0.34	7%	-0.01	49%	0.28	92%
15 EU28	-0.29	8%	0.00	51%	0.23	92%
16 ROW	-0.81	14%	-0.02	50%	0.65	85%

* Percentage change in QGDP for 2000 samples

Number of shocks (out of 2,000) producing a larger increase in world price, Scenario A vs Reference Case

BAEconomics

$PW(Ref)_i$ vs $PW(Scenario\ A)_i$

	'Bad Time'	'Neutral'	'Good Time'
	Set 1 (Mean = -10)	Set 2 (Mean = 0)	Set 3(Mean = 10)
Agriculture (agri)	48	197	1710
Cattle (ctl)	32	88	1649
Bovine meat (cmt)	429	93	1050
Processed food(food)	111	27	1678

Compared with the reference case

Number of shocks (out of 2,000) producing an improvement in utility, Scenario A vs Reference Case

BAEconomics

Effect of Increasing Armington elasticities only

U	Set 1 (Mean = -10)	Set 2 (Mean = 0)	Set 3 (Mean = 10)
Regions	% of positive gain	% of positive gain	% of positive gain
1 Australia	65%	49%	37%
2 China	69%	53%	34%
3 Japan	90%	50%	13%
4 Korea	11%	48%	84%
5 Taiwan	22%	54%	85%
6 Indonesia	38%	51%	67%
7 Malaysia	21%	51%	83%
8 Rest of ASEAN	22%	49%	77%
9 India	99%	74%	32%
10 Canada	76%	52%	23%
11 USA	63%	48%	29%
12 Brazil	35%	52%	60%
13 Latin America	40%	51%	63%
14 Russia	26%	48%	71%
15 EU28	78%	48%	28%
16 ROW	81%	53%	24%

* Percentage for 2000 samples, compared with the reference case

Number of shocks (out of 2,000) producing an improvement in real GDP, Scenario A vs Reference Case

BAEconomics

Effect of Increasing Armington elasticities only

QGDP	Set 1 (Mean = -10)	Set 2 (Mean = 0)	Set 3 (Mean = 10)
Regions	% of positive gain	% of positive gain	% of positive gain
1 Australia	25%	49%	81%
2 China	66%	50%	30%
3 Japan	37%	50%	64%
4 Korea	20%	48%	68%
5 Taiwan	56%	54%	56%
6 Indonesia	86%	50%	18%
7 Malaysia	91%	56%	22%
8 Rest of ASEAN	99%	58%	5%
9 India	86%	51%	17%
10 Canada	58%	51%	60%
11 USA	67%	52%	41%
12 Brazil	54%	57%	70%
13 Latin America	94%	51%	14%
14 Russia	31%	48%	63%
15 EU28	44%	48%	57%
16 ROW	76%	50%	29%
Total	98%	61%	12%

* Percentage for 2000 samples, compared with the reference case

Number of shocks (out of 2,000) producing an improvement in utility, Scenario B vs Scenario A

BAEconomics

Effects of tariff cut

U	Set 1 (Mean = -10)	Set 2 (Mean = 0)	Set 3 (Mean = 10)
Regions	% of positive gain	% of positive gain	% of positive gain
1 Australia	60%	75%	90%
2 China	66%	65%	72%
3 Japan	99%	100%	100%
4 Korea	100%	100%	100%
5 Taiwan	100%	100%	100%
6 Indonesia	0%	0%	0%
7 Malaysia	100%	100%	100%
8 Rest of ASEAN	100%	100%	100%
9 India	100%	100%	100%
10 Canada	48%	65%	86%
11 USA	0%	0%	0%
12 Brazil	88%	89%	91%
13 Latin America	4%	17%	39%
14 Russia	81%	90%	96%
15 EU28	0%	0%	0%
16 ROW	100%	100%	100%

Number of shocks (out of 2,000) producing an improvement in real GDP, Scenario B vs Scenario A

BAEconomics

Effects of tariff cut

qgdp	Set1 (Mean = -10)	Set 2 (Mean = 0)	Set 3 (Mean = 10)
Regions	% of positive gain	% of positive gain	% of positive gain
1 Australia	0%	0%	0%
2 China	96%	97%	98%
3 Japan	100%	100%	100%
4 Korea	100%	100%	100%
5 Taiwan	100%	100%	100%
6 Indonesia	4%	15%	40%
7 Malaysia	100%	100%	100%
8 Rest of ASEAN	100%	100%	100%
9 India	100%	100%	100%
10 Canada	0%	0%	0%
11 USA	0%	0%	0%
12 Brazil	0%	0%	3%
13 Latin America	0%	0%	1%
14 Russia	75%	86%	93%
15 EU28	0%	0%	1%
16 ROW	100%	100%	100%
Total	100%	100%	100%

* Percentage for 2000 samples, compared with the reference case

Conclusions

- Trade Openness (Scenarios A and B) is likely to put downward pressure on world food prices during bad global climate conditions. But it also put upward pressure on world food prices during favourable global climate conditions.
- Trade Openness is likely to reduce volatility of world food prices.
- There is no evidence that a universal cut in tariff (in percentage terms) could provide benefits to every region.
- However, it appears that an universal cut in tariff could increase the aggregate real GDP of the world.
- The results may suggests that there is room to achieve "win-win" solutions through bi-lateral trade negotiations.

Further works

- The assumption of CRTS and the Armington specification may underestimate the benefit of international trade.
- World Bank (2016) suggests that Trans-Pacific Partnership (TPP) would raise GDP for all member countries in the TPP but cut GDP for all non-member countries outside TPP.
- Re-run the exercise with the Melitz (2003) framework
- Dixon et al (2016) suggests that Melitz modelling framework does not provide support for a large gains from free trade. This is in contrast with Zhai (2008).

BAEconomics

Thank you!

Number of shocks (out of 2,000) producing an improvement in utility, Scenario B

BAEconomics

Effects of trade openness plus tariff cut

U	Set 1 (Mean = -10)	Set 2 (Mean = 0)	Set 3 (Mean = 10)
Regions	% of positive gain	% of positive gain	% of positive gain
1 Australia	64%	53%	48%
2 China	81%	67%	53%
3 Japan	98%	89%	55%
4 Korea	100%	100%	100%
5 Taiwan	79%	95%	100%
6 Indonesia	12%	21%	35%
7 Malaysia	39%	71%	93%
8 Rest of ASEAN	52%	79%	95%
9 India	100%	100%	100%
10 Canada	73%	54%	32%
11 USA	29%	21%	13%
12 Brazil	44%	60%	67%
13 Latin America	32%	44%	60%
14 Russia	34%	75%	97%
15 EU28	43%	22%	15%
16 ROW	98%	94%	86%

* Percentage for 2000 samples, compared with the reference case

Number of shocks (out of 2,000) producing an improvement in real GDP, Scenario B

BAEconomics

Effects of trade openness plus tariff cut

QGDP	Set 1 (Mean = -10)	Set 2 (Mean = 0)	Set 3 (Mean = 10)
Regions	% of positive gain	% of positive gain	% of positive gain
1 Australia	0%	0%	0%
2 China	84%	71%	49%
3 Japan	58%	78%	95%
4 Korea	100%	100%	100%
5 Taiwan	100%	100%	100%
6 Indonesia	68%	18%	2%
7 Malaysia	100%	100%	86%
8 Rest of ASEAN	100%	100%	100%
9 India	100%	100%	91%
10 Canada	0%	0%	0%
11 USA	0%	0%	0%
12 Brazil	1%	1%	7%
13 Latin America	0%	0%	0%
14 Russia	34%	63%	85%
15 EU28	29%	36%	49%
16 ROW	100%	100%	100%
Total	100%	100%	100%

* Percentage for 2000 samples, compared with the reference case

Six CGE Opportunities
(and Threats)
in Subterranean Freight

National CGE Workshop

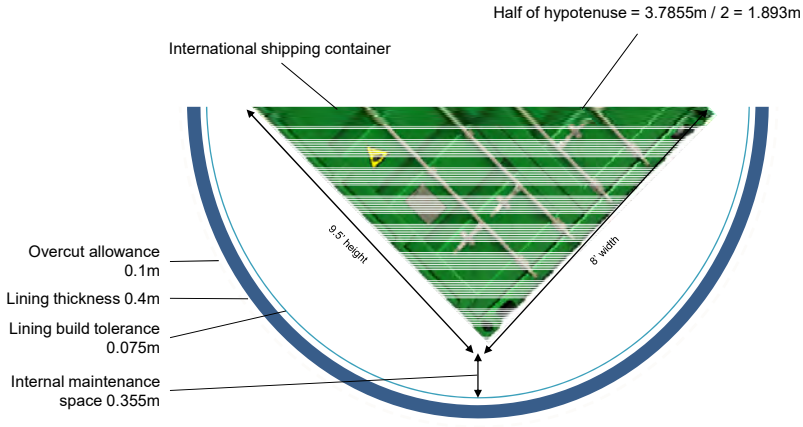
7 August 2017

Philip Norman

Subterranean freight requires a minimum tunnel excavation radius of 2.823m

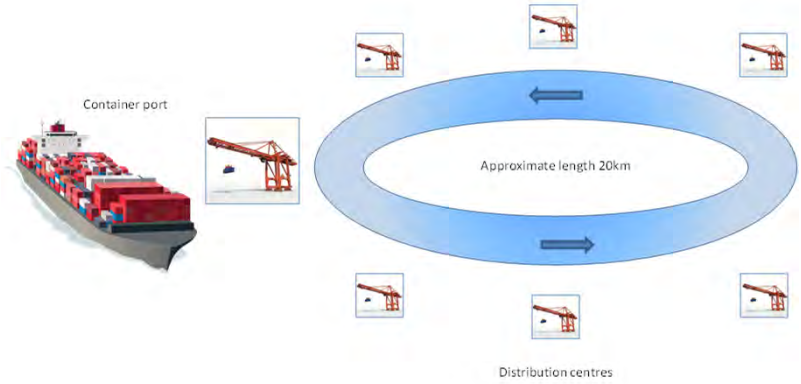
20 km tunnel through basalt

Cost estimate = $(\pi\ r^2\ L) \times \$1{,}500 / m^3 = \$751$m



Land-side Access to Australia's Largest Container Port

Figure 2. Transport from container port to strategic distribution centres



Economic Capital Costs (Melbourne)

	ACE 16	ACE 17	Quality of ACE17
	$m NPV at 4%	$m Raw	
Tunnel	1039	751	Medium - High
Vehicles (800)	178	400	Medium
Hoists	247	247	
ICT	523	100	
Electricity Supply		100	
Ventilation		100	
Project Management		100	
IP		100	
Fire Services		50	
River Crossing	185	0	
Contingency		0	
TOTAL	**2172**	**1948**	

Operating Costs (Melbourne)

- Freight Movement
- Other

Enduring market power

- May need A* journal treatment in CGE
- Demand curves can almost be vertical (Freo)
  - Road train option to Darwin
  - Rail option to Adelaide
- Transport economics faces legal risks in naming firms for producer surplus
- CGE seems at less risk of litigation

Economic Benefits (Melbourne)

	ACE 16	ACE 17	Discussion
Road Vehicles Saved	690	DOWN	
Congestion	675	UP	
Vehicle Operating Costs	540	DOWN	
Social (crash costs)	345	DOWN	UP with $9m
Health	86	UP	life
Producer Surplus	-11	DOWN	STOP
Noise reduction	0	UP UP	
Wider Economic Benefits	0	Not needed?	Now Needed
Real Options	0	UP UP	
Reduced Road Damage			UP
Threat of competition	0	UP	
Emissions		Not Yet Valued	
TOTAL	**2325**	**UP a little**	**UP more**

Most freight is not carried by freight companies

- Economic Papers June 2013
  - *Transport Satellite Accounts are essential to boost Productivity and to improve Public Understanding*
  - *Norman, McGeehan, Mak, Maurer and Murray*
- Does ABS need to make new Input/output tables for our CGE work?

First five CGE opportunities

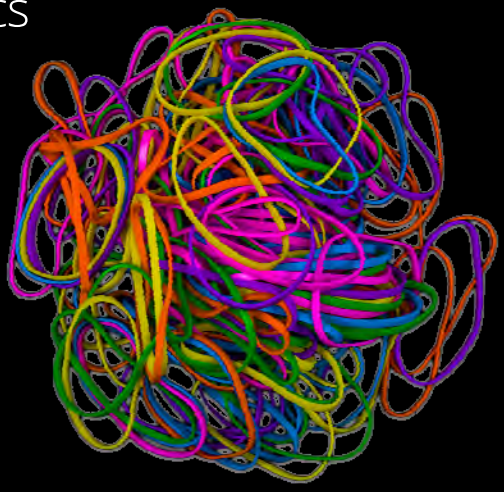
- Land-side access to sea ports
  - Fremantle, WA
  - Kwinana (2030?), WA
  - Melbourne
  - Hastings, VIC
  - Brisbane (ARTC through Dividing Range)

Sixth opportunity

- All 5
- Taking 5 million trucks off port access annually
- A* journal opportunity
  - Linking back to Dr. Duncan Ironmonger AM
    - Travel time saved?
    - TrSA
    - Framework for ex-post audit of project economics

Deloitte.
Access Economics

Firm Closures in Small Regional Economies



Nathan Brierley & Cedric Hodges

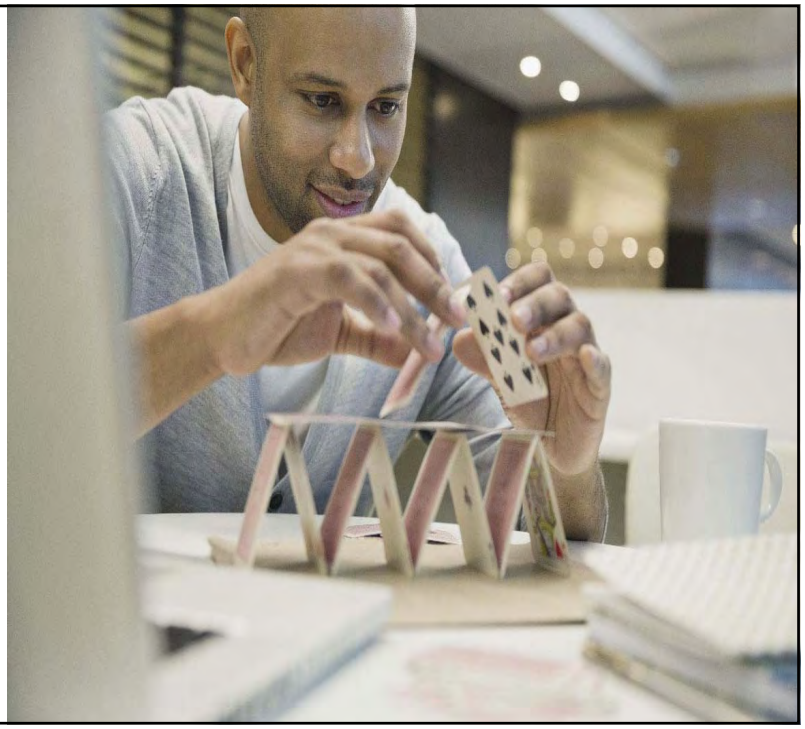
7 August 2017

Outline

- Introduction
- Motivation
- Literature
- Theory
- Method
- Results
- Q&A

Introduction

- What are we doing?

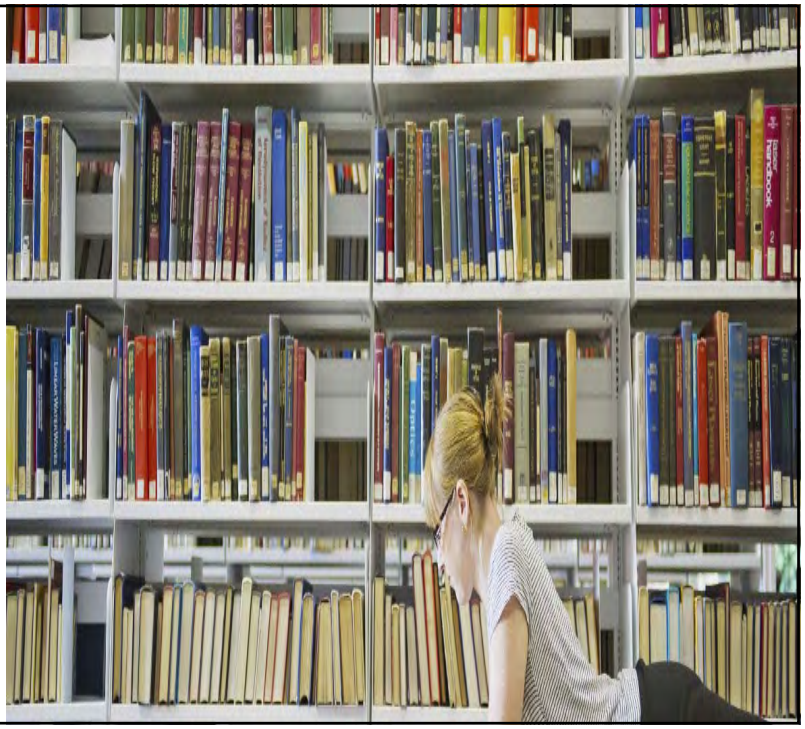


Motivation

- Why are we doing this?

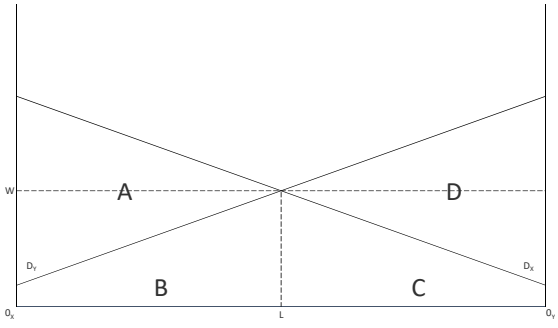
Literature

- Groenewold, Hagger & Madden (1987)
- Dixon & Wittwer (2004)
- Dixon & Rimmer (2004)
- The Allen Consulting Group (2013)
- Productivity Commission (2014)



Theory

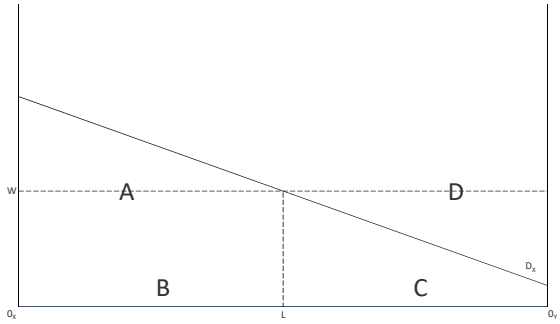
- 2 industries
- 1 factor



- Value added of X = A + B
- Value added of Y = C + D
- GDP = A + B + C + D

Theory

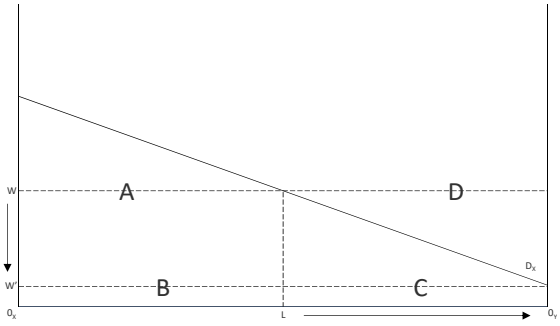
- What if Industry Y shut down?



- Value added of X = A + B
- GDP = A + B

Theory

- What if Industry Y shut down?

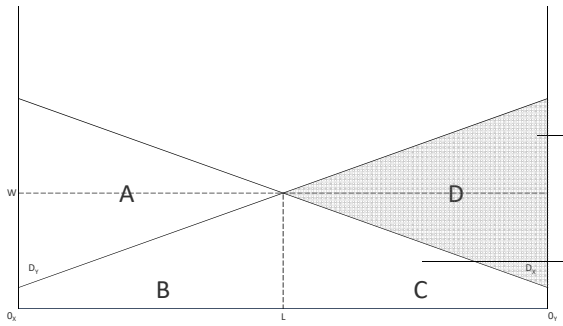


- Value added of X = A + B + C
- GDP = A + B + C

Theory

- What if Industry Y shut down?

- Value added of X = A + B + C
- GDP = A + B + C

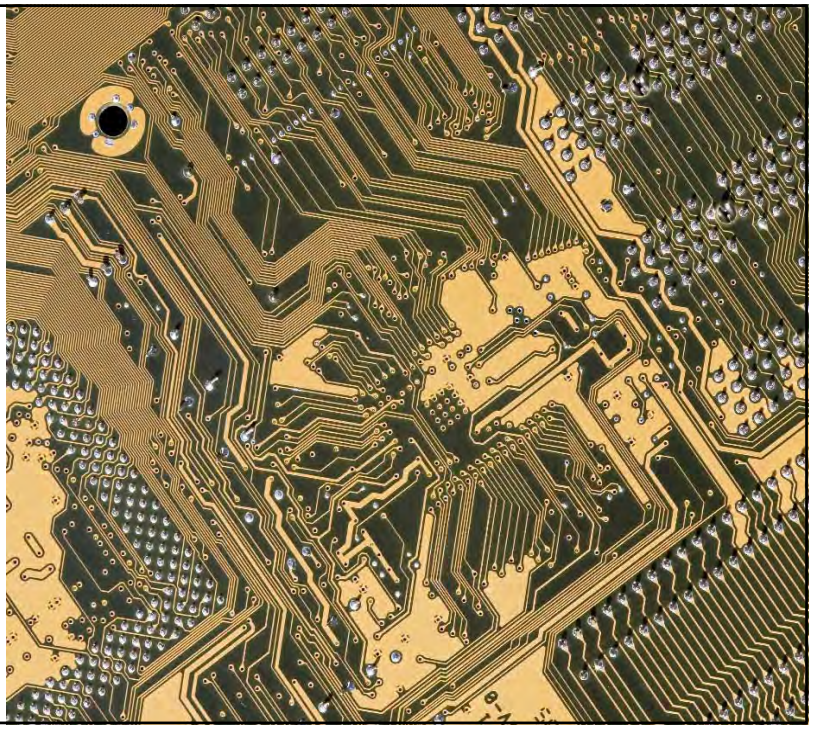


Loss in GDP / Contribution of Industry Y

Social opportunity cost of labour used by Industry Y

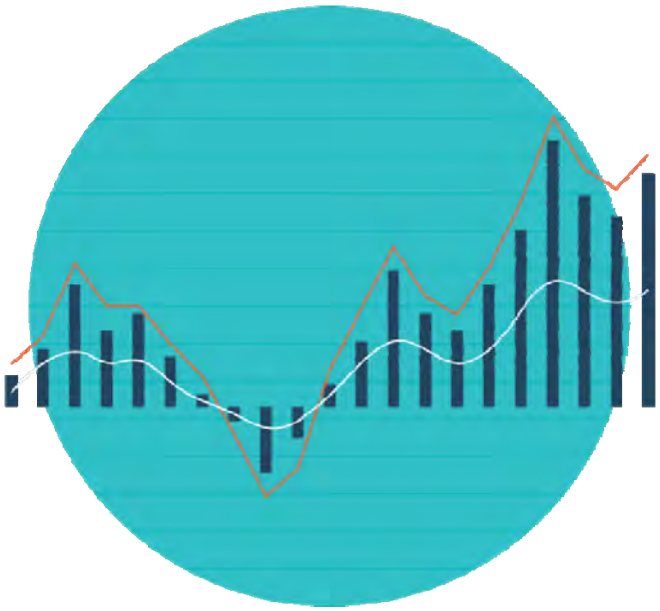
Method

- DAE-RGEM
- Food processing
- New South Wales
- Productivity shift variable over 3 years
- Key ratios
  - Gross Regional Product / Food processing output
  - Employment / Food processing output



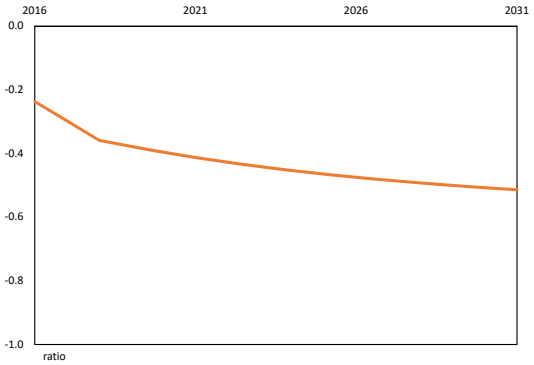
Results

- Central scenario
- Inter-sector factor mobility
- Migration
- Access to markets

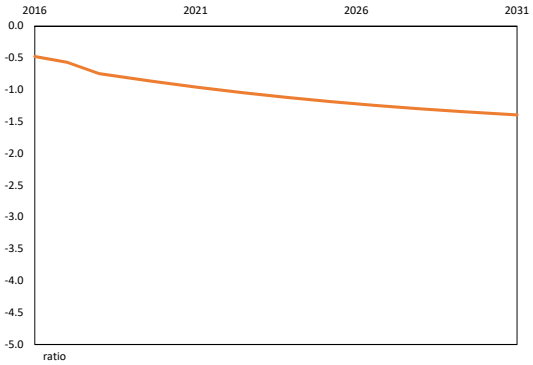


Central scenario

GRP/Output

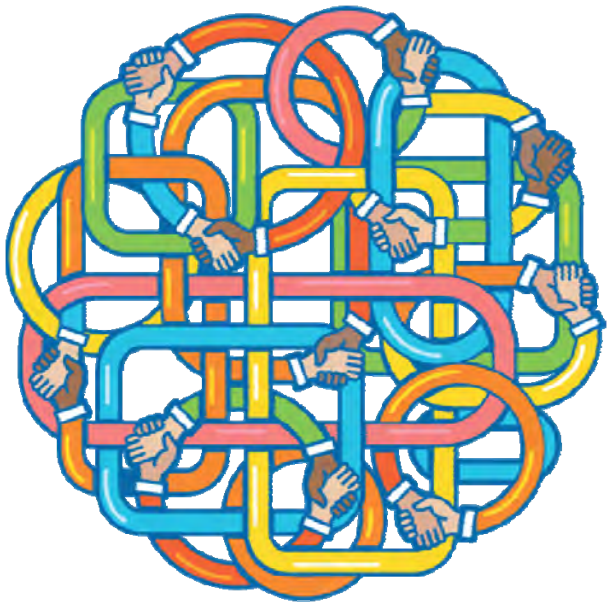


FTE Employment/Output



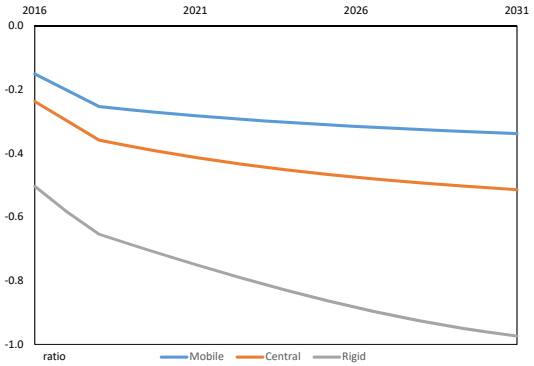
Factor mobility

- How does it work?
- What have we changed?
- How important is it?

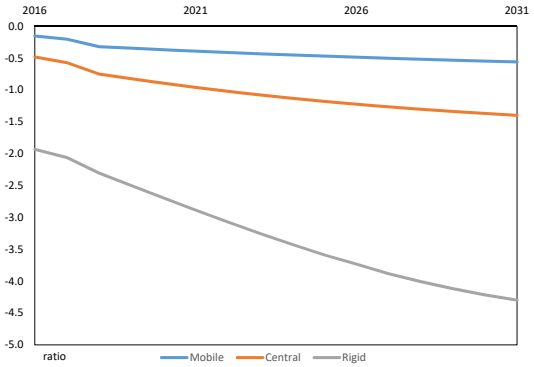


Inter-sector factor mobility

GRP/Output



FTE Employment/Output

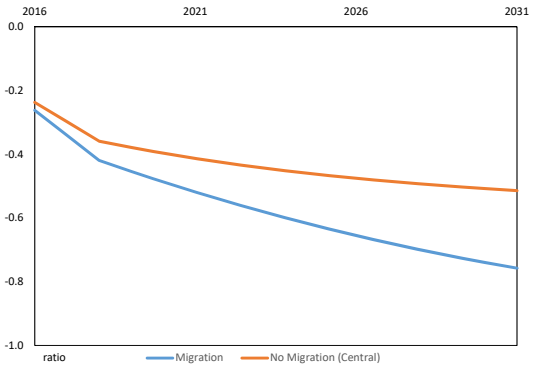


Migration

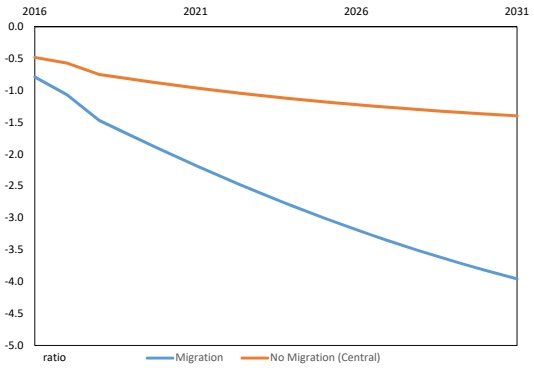
- How does it work?
- What have we changed?
- How important is it?

Migration

GRP/Output

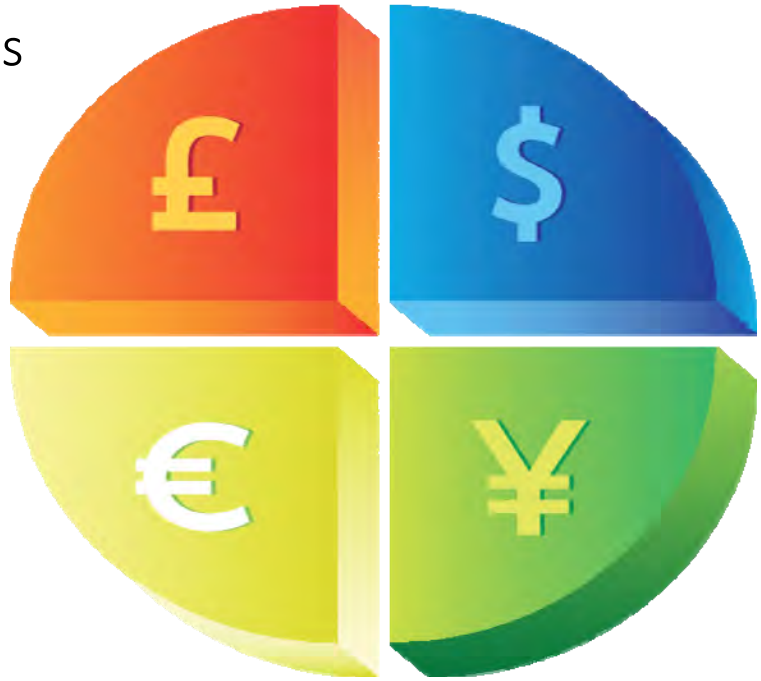


FTE Employment/Output



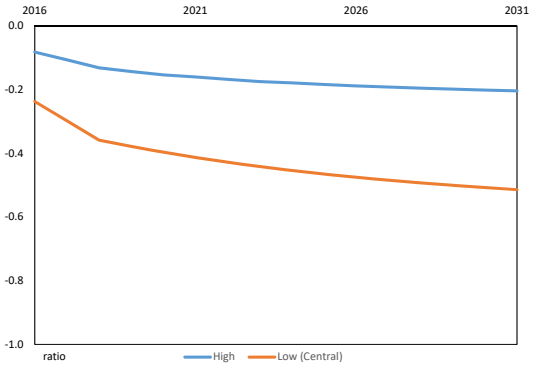
Access to markets

- How does it work?
- What have we changed?
- How important is it?

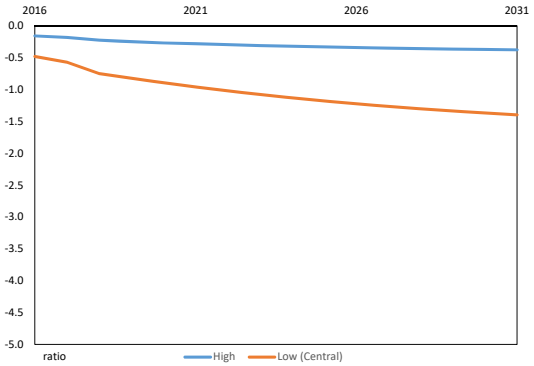


Access to markets

GRP/Output



FTE Employment/Output



Q&A

Housing and transport policies: a spatial general equilibrium analysis for Melbourne

Aug 7, 2017

Dr James Lennox
Email: James.Lennox@vu.edu.au

Centre of Policy Studies

Introduction
VU Cities framework
Illustrative results
Conclusions

Lennox & Adams VU Cities

Motivations

Urban policy imperatives in Australia's largest cities:

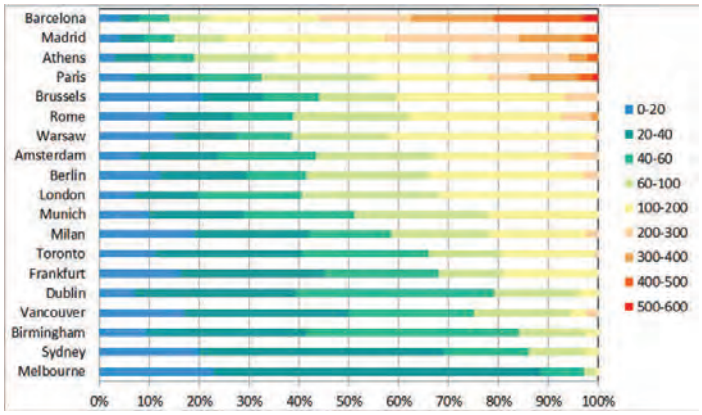
- Increase (dramatically) housing supply in established (inner, middle) suburbs—access to new economy jobs and civic amenities, achieve densities to support public transport, avoid loss of natural and agricultural areas
- Address heavy reliance on private vehicles—alleviate congestion, save road and parking space, reduce CO_2 emissions, air and noise pollution

Policy-makers and planners lack tools to study the economic of policies within cities

Melbourne in perspective

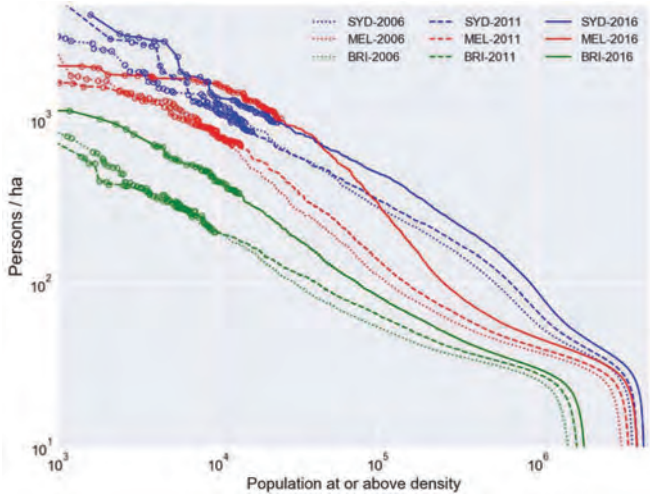
Australian cities are very low density

Share of population at different densities (residents per hectare)



Adapted version of Chris Loader's figure at chartingtransport.com, 2016

Major metropolitan densities in Australia



Spatial Computable General Equilibrium (SCGE)

- What is it?
  - Spatial: agents make explicit locational choices between places (discrete zones)
  - GE: prices adjust to clear demand in all markets
  - Computable: model only solvable using numerical methods
- Discrete locational choices of households
  - Multinomial logit (MNL) model represents individual discrete choices probabilistically
  - High- vs. low-skilled households
  - Households choose place of work, place of residence and industry
  - Given local wages, local living costs, commuting costs, residential amenity
- Comparative static (long run)

VU Cities framework

- Household income
  - Wage: depends on skill, industry, workplace
  - Capital and transfers: depends on household type
- Conditional on skill & discrete choices, households make continuous choices of
  - Floorspace, tradables and non-tradable goods
  - Non-tradables purchases influenced by shopping costs
- Positive effects of agglomeration
  - Local density of firms increases productivity
  - Local density of households increases amenity

Multinomial logit specification

Indirect utility function depends on non-market values B_{ijr}, local prices $\mathcal{Q}_r$, $\mathcal{R}_r$, wages W_{ijs}, commuting costs τ_{rs} and individual idiosyncratic shocks $z_{jrso|i} \sim$ Fréchet

$$u_{jrso|i} = \frac{z_{jrso|i} B_{ijr} W_{ijs}}{e^{\tau_{rs}} \mathcal{Q}_r^{\beta_V} \mathcal{R}_r^{\beta_F}}$$

For each skill level k, integrating over individuals o yields workers in industry j by place of residence r and by place of work s

$$H_{ijr} = \frac{H_i}{\Theta_i} \sum_s (\mathbb{E}u_{ijrs})^{\epsilon_i} \qquad L_{ijs} = \frac{H_i}{\Theta_i} \sum_r (\mathbb{E}u_{ijrs})^{\epsilon_i}$$

$$\Theta_i \equiv \sum_j \sum_r \sum_s (\mathbb{E}u_{ijrs})^{\epsilon_i}$$

Shopping for local goods

From each place of residence r, households shop for locally non-tradable goods in every place of production q. Local shoppables price indices:

$$\mathcal{Q}_r = \left(\sum_q \left(e^{\tau_{rq}} Q_q \right)^{1-\varepsilon_i} \right)^{\frac{1}{1-\varepsilon_i}}$$

VU Cities–Melbourne prototype model

- Greater Melbourne & Geelong—312 spatial zones
- Census of Population and Dwellings: persons by place of residence, work, industry & occupation
- Cadastral and planning layers: amount of land used for residential and commercial structures
- Travel costs for origin–destination pairs reflect driving times
- Regional average wages by industry and occupation

Population growth scenarios

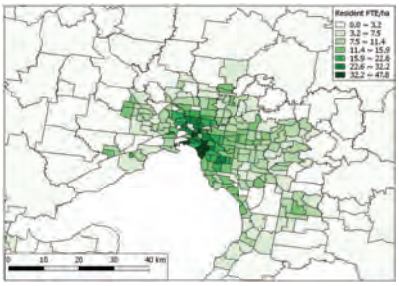
- Three scenarios:
  1. Expansive Growth: additional greenfield development
  2. Densification: reduce regulatory constraints to permit higher densities in established 'middle' suburbs and prohibit greenfield development
  3. Travel Tax: increase costs of commuting and shopping travel by 20%, still permitting greenfield development
- All assume 22% increase in total population (10 years growth)

Aggregate effects

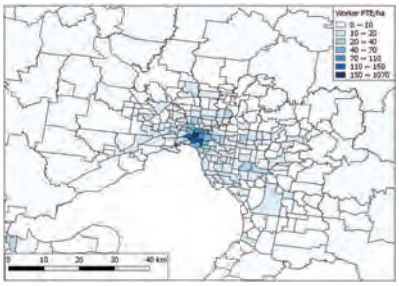
Table: Aggregate quantities and price indices (% change vs. calibration)

	Expansive Growth	Densification	Travel Tax
Residential land per person	−8.75	−18.0	−8.75
Commuting time per worker	0.58	−0.60	−10.7
Output per worker	1.61	1.87	4.83
Average wage	1.73	1.95	4.25
Floorspace per person	−1.81	0.67	−0.71
Residential rental prices	3.60	1.27	5.00

Urban form under Expansive Growth

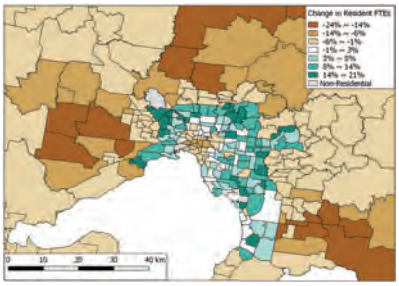


Resident workers

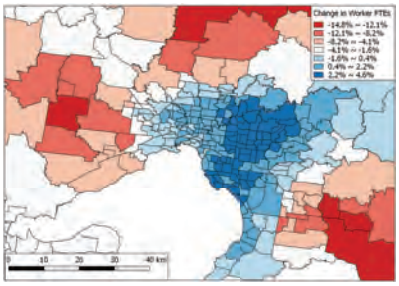


Jobs

Spatial impacts of Densification vs. Expansive Growth

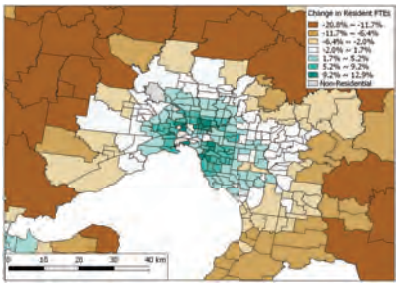


Resident workers

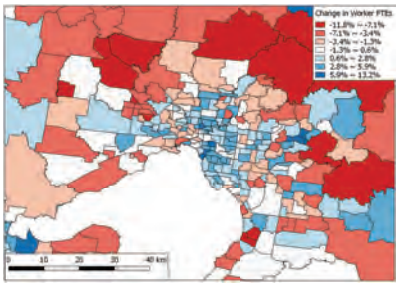


Jobs

Spatial impacts of Travel Tax vs. Expansive Growth

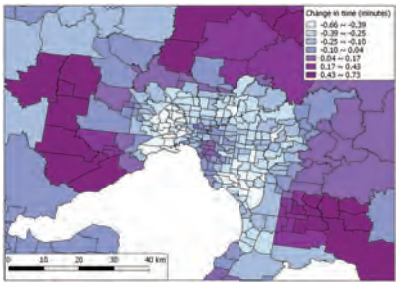


Resident workers

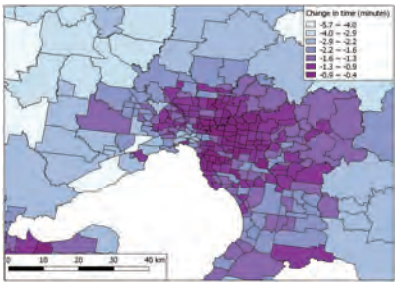


Jobs

Spatial impacts on travel times



Workers' average travel times:
Densification vs. Expansive Growth



Workers' average travel times:
Travel Tax vs. Expansive Growth

Conclusions

- Existence of productivity and amenity spillovers suggests policies to increase urban density
- Negative externalities from passenger transport, while not modelled here, motivate policies to reduce travel and induce mode switching
- Rezoning and transport taxes both increase residential densities
- Travel tax effective in increasing employment densities and reducing travel
- Rezoning for densification increases housing supply and affordability
- These two types of policies are potentially complementary

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