CECAN Webinar:

New Economic Models of the Energy Transition:

Using complexity and systems approaches in energy policy appraisal

Tuesday 26th September 2023, 13:00 – 14:00 BST

Presenters: Dr. Pete Barbrook-Johnson (University of Oxford), Simon Sharpe (UNFCCC Climate Champions and WRI), Dr. Femke Nijsse (University of Exeter), and Dr. Fernanda Senra de Moura (University of Oxford)

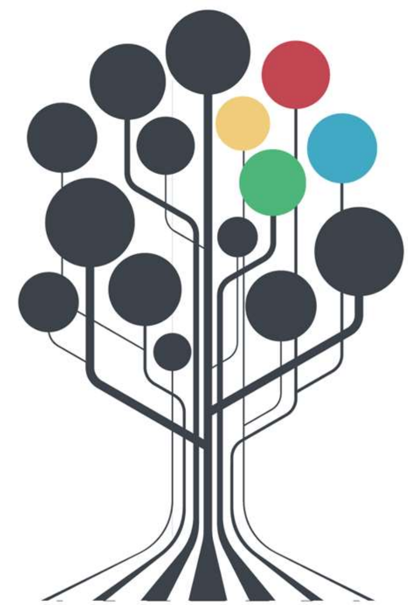
Welcome to our **CECAN Webinar.**

All participants are muted. Only the Presenters & CECAN Host can speak. The webinar will start at **13:00 BST.**

The Presenters will speak for around 45 minutes and will answer questions at the end.

Please submit your questions at any point during the webinar via the Q&A box in the Zoom webinar control panel.

Today's webinar will be recorded and made available on the CECAN website.



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ECONOMICS OF ENERGY INNOVATION AND SYSTEM TRANSITION

New economic models of the energy transition: complexity and systems approaches in policy appraisal

CECAN Webinar
26 September 2023

@EeistP

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Overview

1. Introduction to EEIST
2. Modelling labour impacts of the transition
3. Is a solar future inevitable?
4. Risk-opportunity analysis
5. Complexity and systems approaches across the policy cycle
6. Q&A – use the Q&A zoom function

Dr. Pete Barbrook-Johnson, University of Oxford

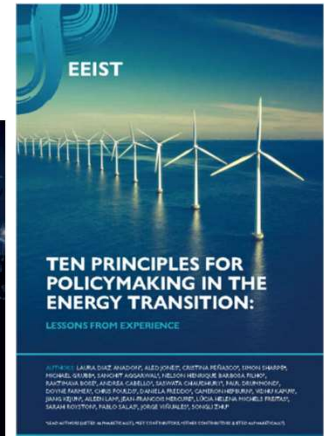
Dr. Fernanda Senra de Moura, University of Oxford

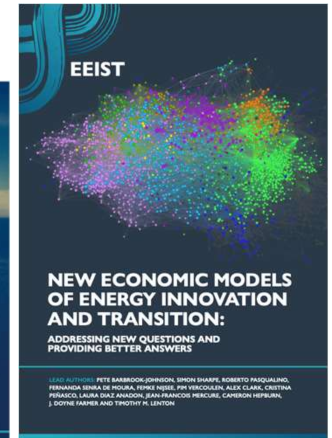
Simon Sharpe, UNFCCC Climate Champions and WRI

Dr. Femke Nijsse, University of Exeter

What is the EEIST project?

- Economics of energy innovation and system transition
- Developing and applying new economic modelling for the energy transition
- New cohort of models for decision making – ex ante appraisal
- Deep engagement and partners in China, India, Brazil, EU, and UK





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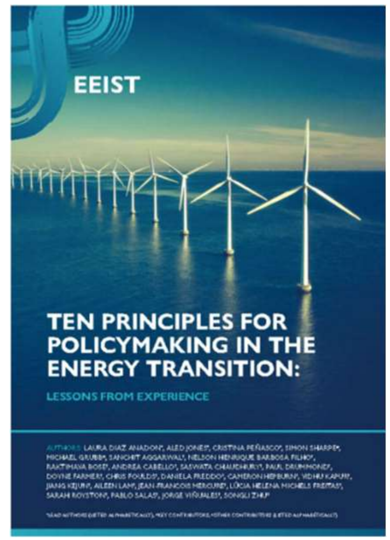
Reports…

The empirics…

Policies critical to the most outstanding successes so far in low carbon transitions in China, India, Brazil, the UK and EU were generally implemented **‘despite, not because of, the predominant economic analysis and advice.’**



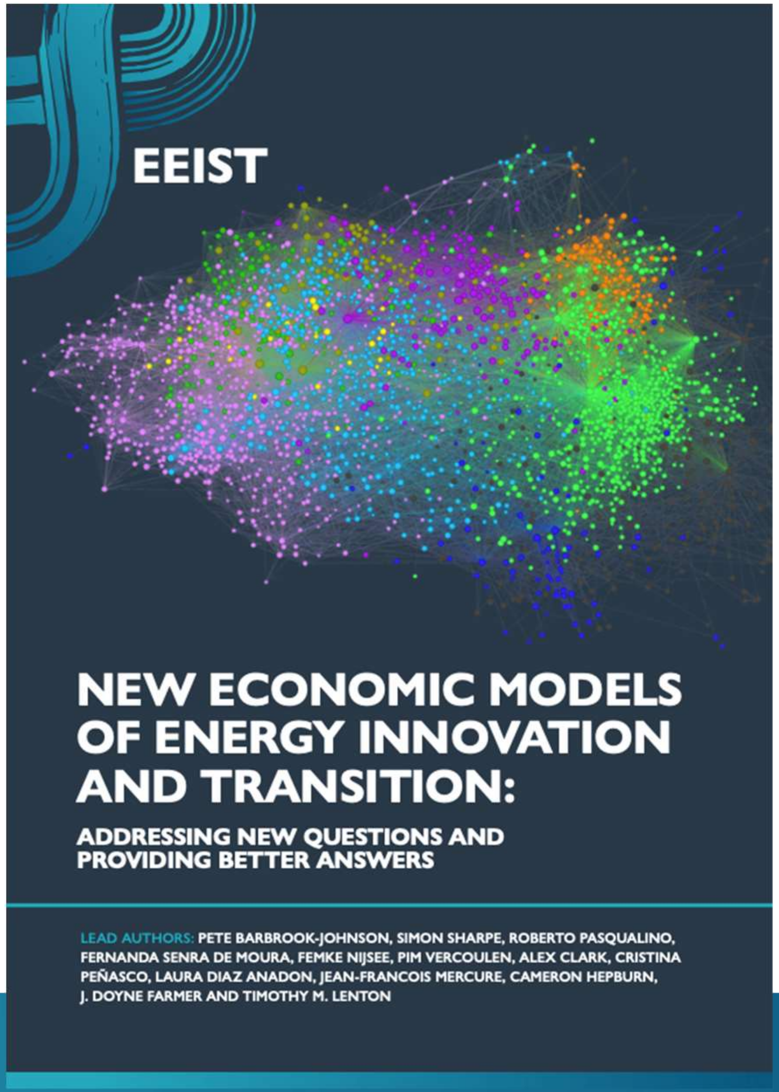
The theory…

In the context of dynamic processes and structural change, **new general principles for policymaking are needed,** built on a wealth of **experience and analysis gathered over the last three decades.**

	Traditional principle	Principle for the transition
1	*Policy should be 'technology neutral'*	**Technology choices need to be made**
2	*Government interventions raise costs*	**Invest and regulate to bring down costs**
3	*Markets on their own optimally manage risks*	**Actively manage risks to crowd-in investment**
4	*Simply price carbon at a level that internalises the damages of climate change*	**Target tipping points**
5	*Consider policies individually based upon distinct 'market failures'*	**Combine policies for better outcomes**
6	*Policy should be optimal*	**Policy should be adaptive**
7	*Act as long as total benefits outweigh the costs*	**Put distributional issues at the centre**
8	*Link carbon markets to minimise current costs*	**Coordinate internationally to grow clean technology markets**
9	*Assess aggregate costs and benefits*	**Assess opportunities and risks**
10	*Policy models and assessment are neutral*	**Know your biases**

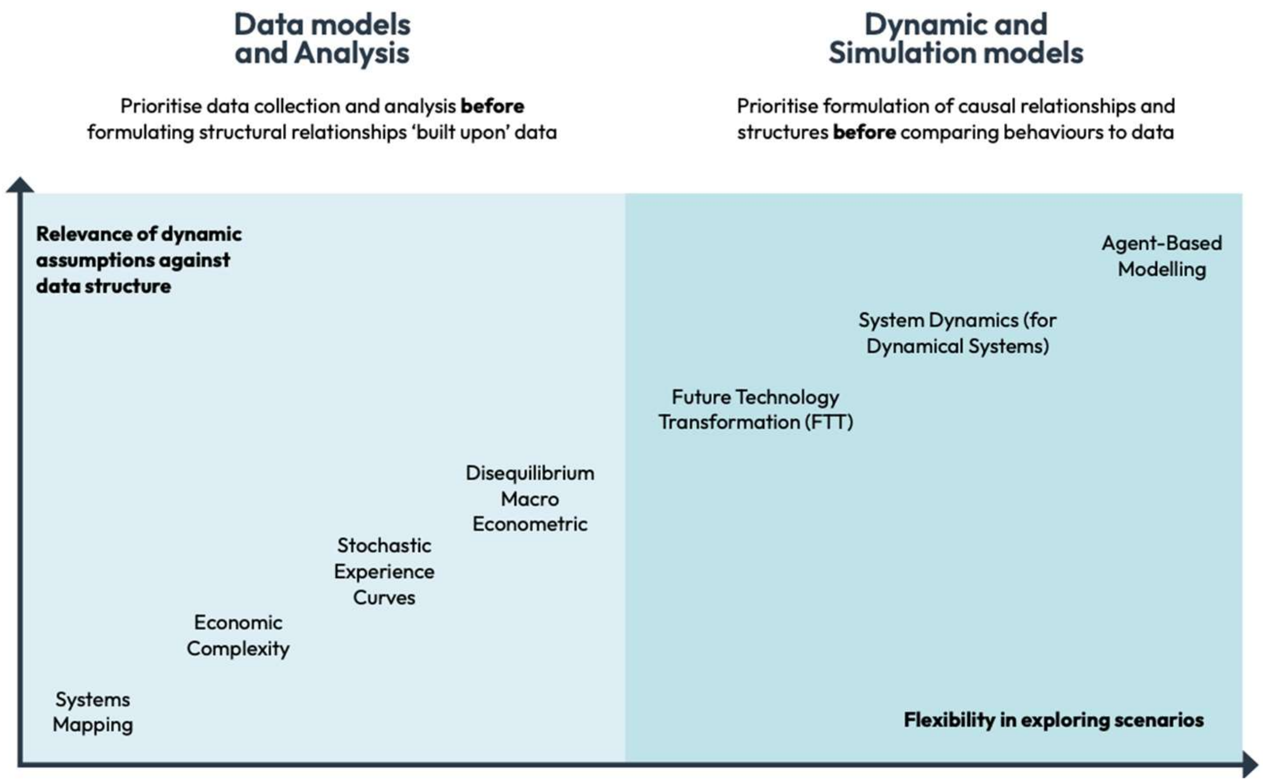
Modelling report

- Delivering on the promise of new economic modelling
- A library of 15 policy-led case studies
- Live questions, many co-produced
  - Global transition
  - Power and industry
  - Transport
  - Agriculture
  - Impacts of transition
  - National decarb plans
  - Finance
- Guidance on how to compare, choose, and use new models



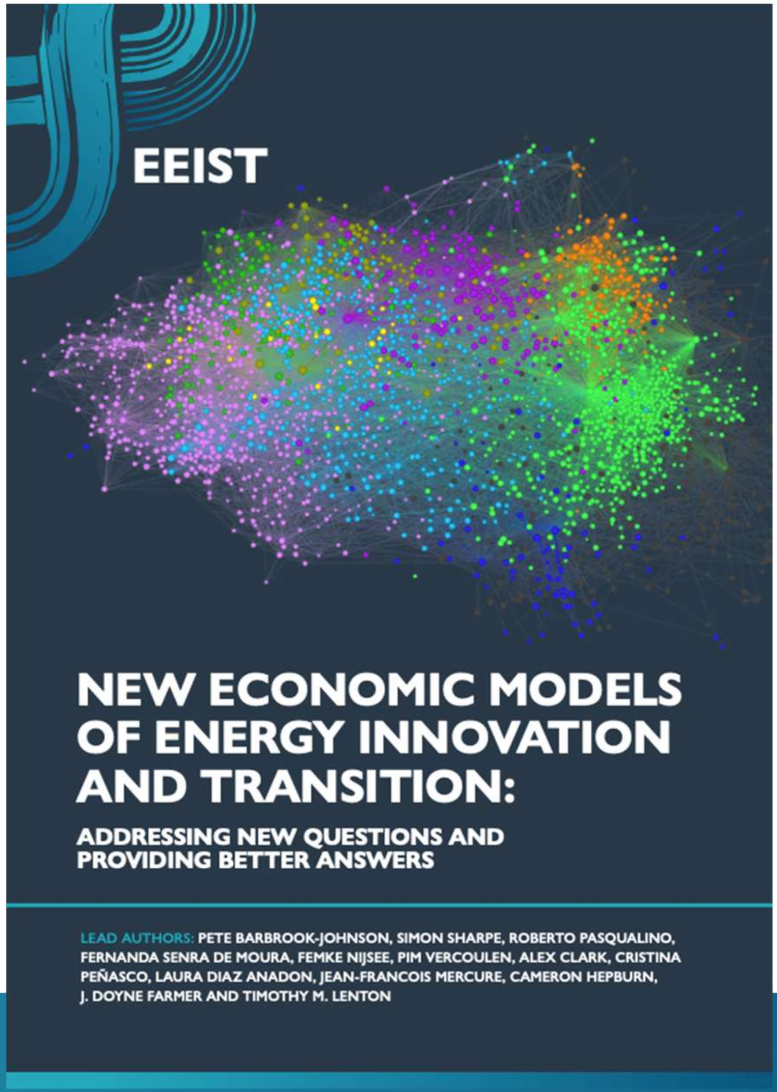
Why 'new' models?

- Energy transition is not marginal -> marginal methods not fit-for-purpose
- Methods becoming mature
  - New focus on policy application
  - New focus on use of data to underpin design and validation
- Complement to existing models where they fall short



What next?

- **Coming months:** more deployment and training programme
- **Now:**
  - Lets look at some examples…



Modelling labour impacts of the transition

Dr. Fernanda Senra de Moura
Research Associate, University of Oxford

ECONOMICS OF ENERGY INNOVATION AND SYSTEM TRANSITION

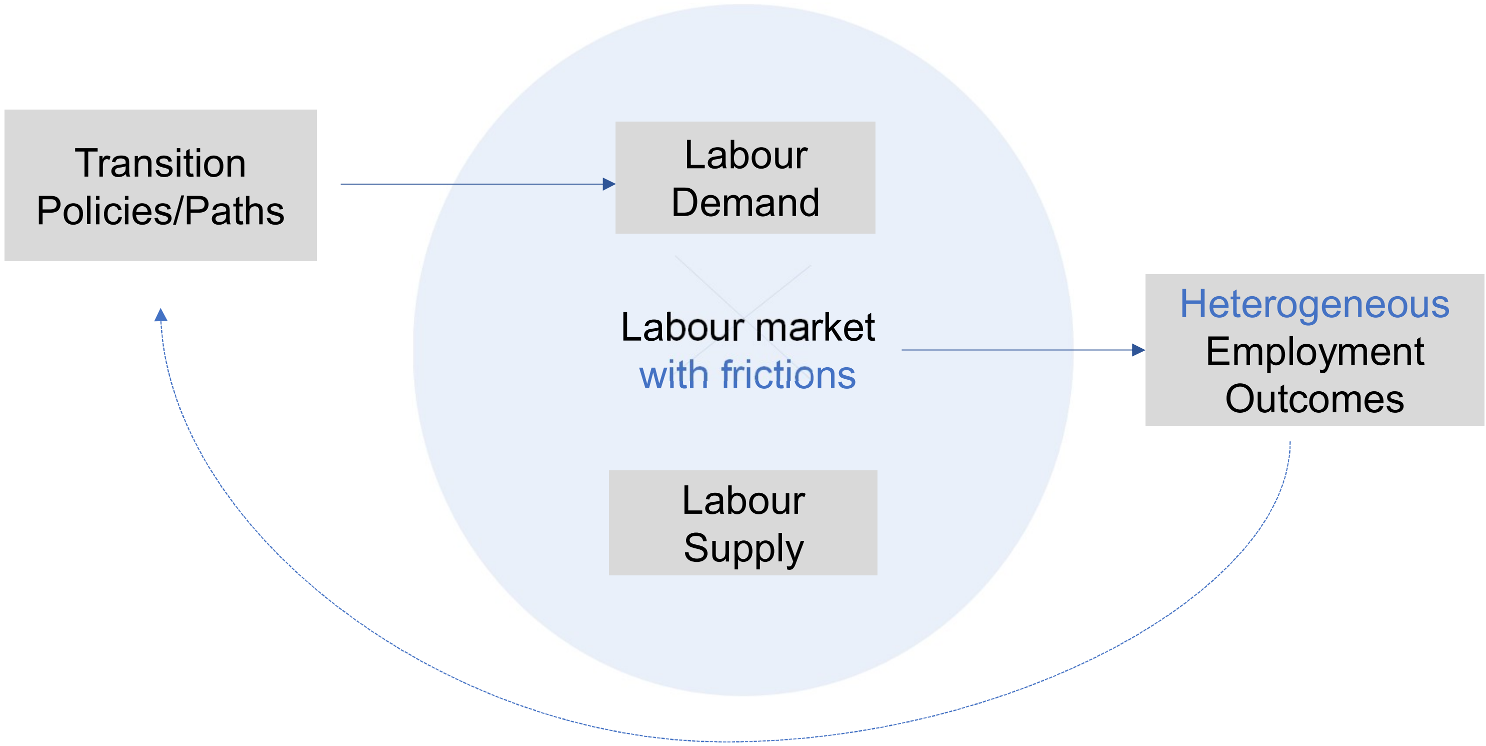
Modelling labour market transitions: the case of productivity shifts in Brazil

Anna Berryman, Joris Bücker, Fernanda Senra de Moura, Pete Barbrook-Johnson, Doyne Farmer (Oxford UK)
Penny Mealy (World Bank/University of Oxford)
Marek Hanusch (World Bank)
Maria del Rio-Chanona (Complexity Science Hub, Vienna)

Overview

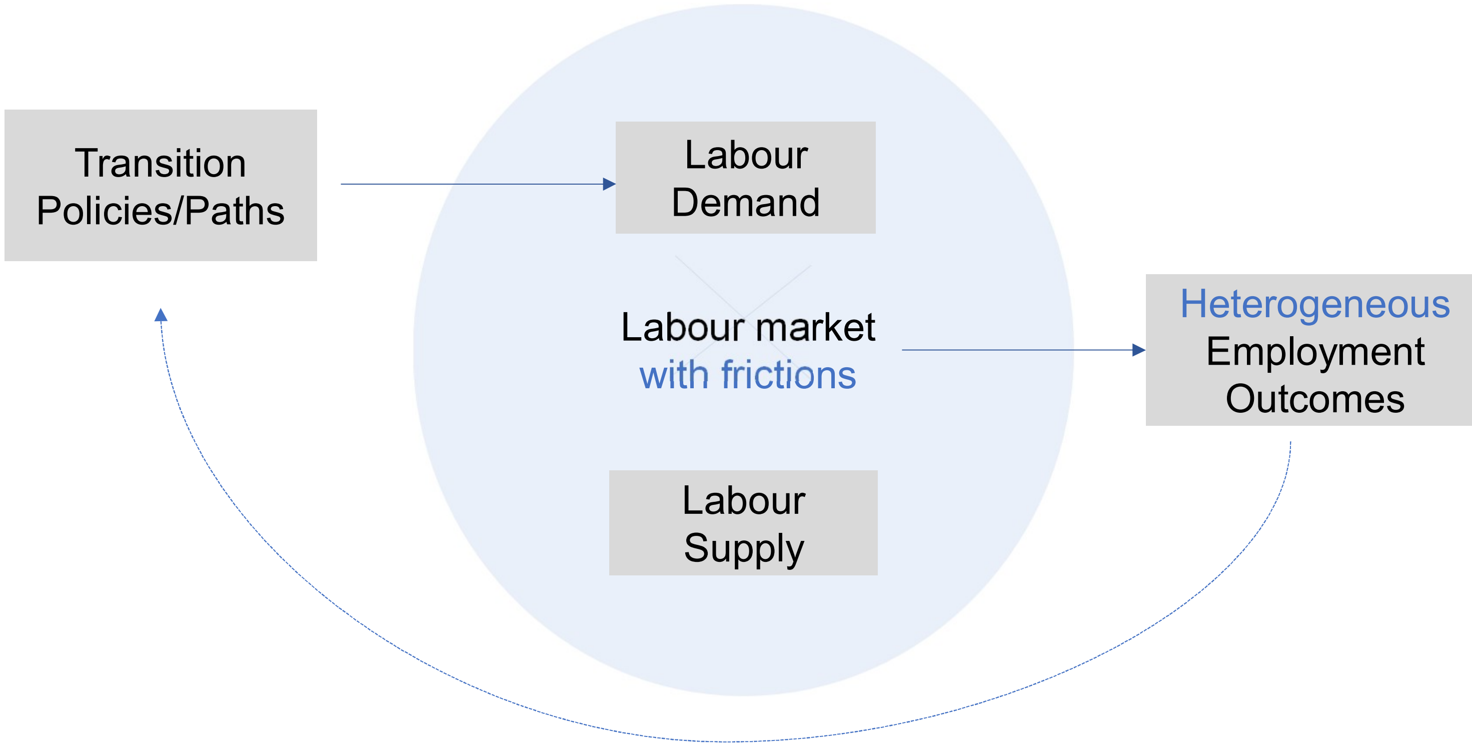
Policy question: How would occupation-level unemployment be affected by growth paths with different drivers and emissions outcomes in Brazil?

Overview


Transition Policies/Paths
Labour Demand
Labour market with frictions
Labour Supply
Heterogeneous Employment Outcomes

Overview

We construct a data-driven occupational mobility network* for Brazil
and use this to structure an agent-based model of the labour market**

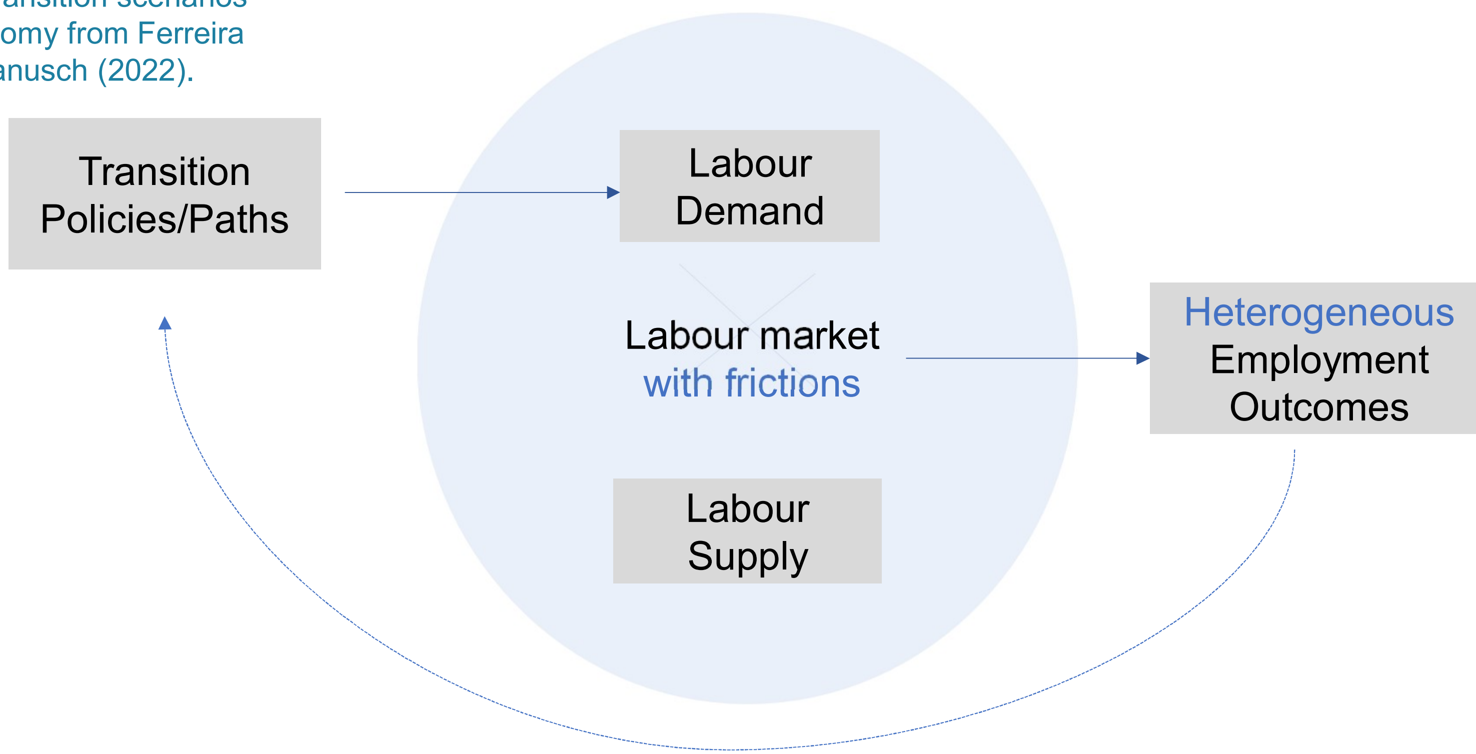


*Mealy, P. et al. (2018).
**del Rio-Chanona, M.R. et al. (2021).

Overview

We construct a data-driven occupational mobility network* for Brazil and use this to structure an agent-based model of the labour market**

We consider 2 transition scenarios for Brazil's economy from Ferreira Filho and Hanusch (2022).

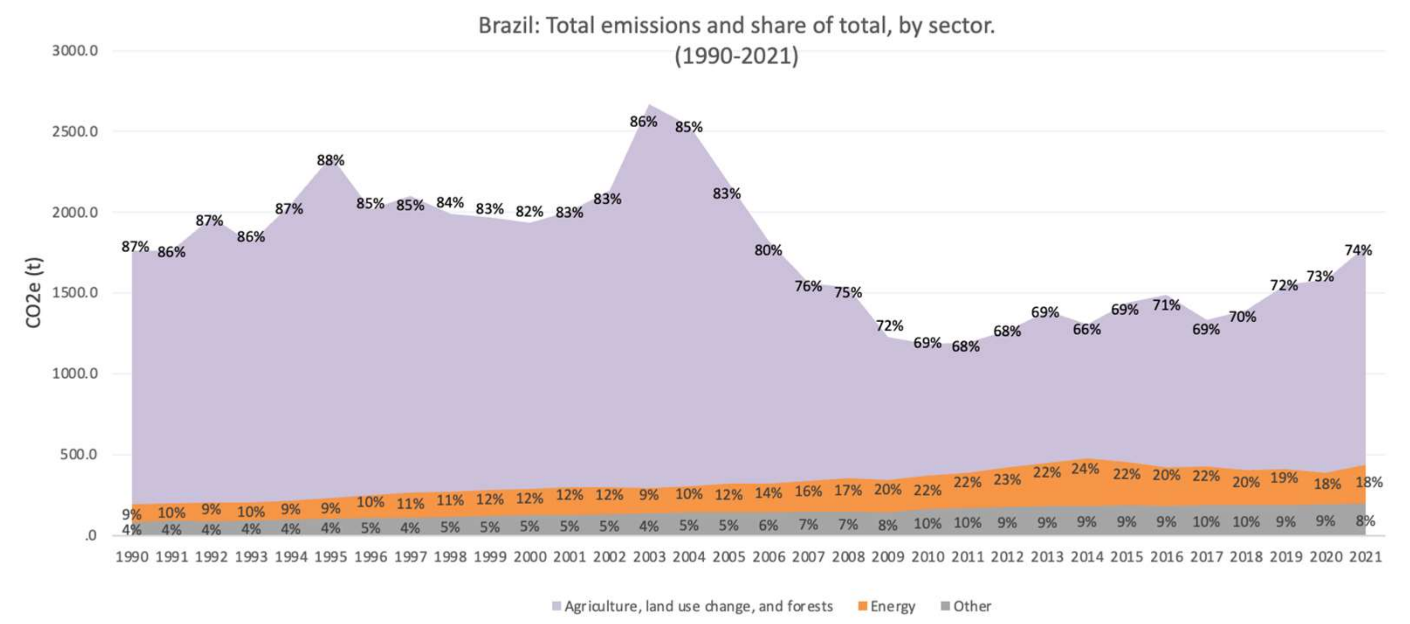


*Mealy, P. et al. (2018).

**del Rio-Chanona, M.R. et al. (2021).

Brazil’s emissions profile and transition scenarios

Brazil is one of the major greenhouse gas emitters in the world, with most emissions coming from Agriculture and Land Use Change



Notes: Other := Waste and industrial processes.
Source: SEEG (Brazil's Greenhouse Gas Emissions Estimation System). GWP-AR5.

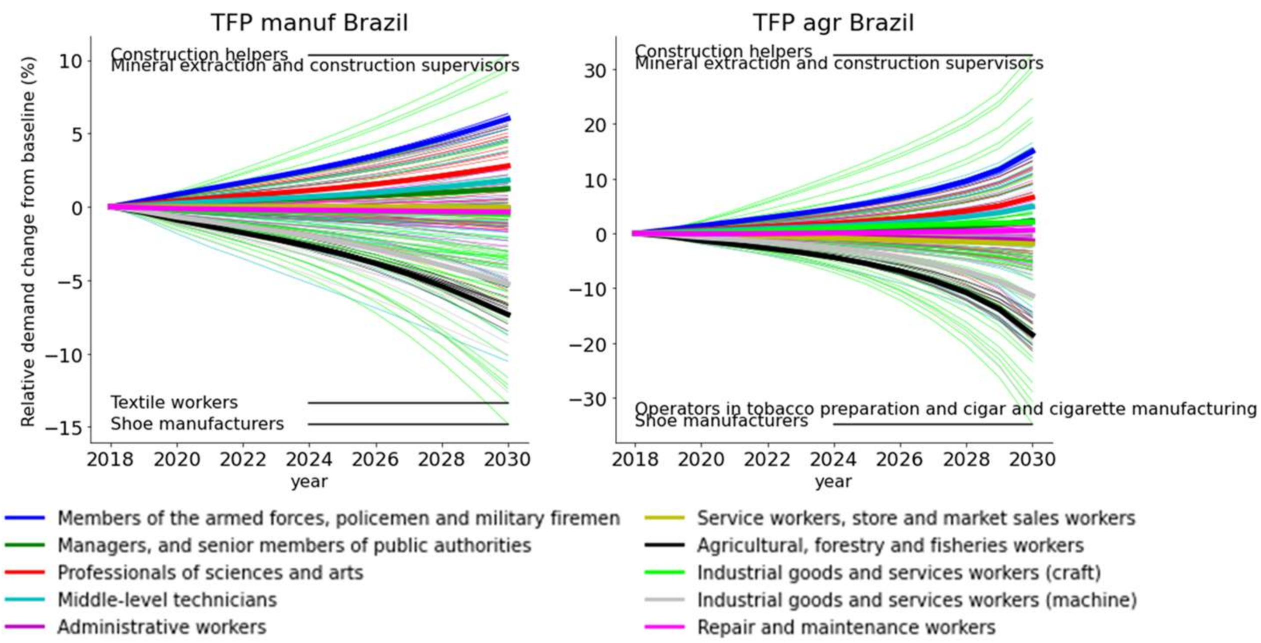
Productivity scenarios and projected emissions
from Ferreira Filho and Hanusch (2022)

Compared to a baseline scenario in which total factor productivity (TFP) does not change:

TFP scenario		Cumulative impacts (from 2018 to 2030)
• TFP in Agriculture increases 0.5% per year, nationwide	→	1.8% higher GDP 0.3 million hectares less deforestation 18,221 kT **more CO_2 emissions**
• TFP in Manufacturing increases 0.5% per year, nationwide	→	3.9% higher GDP 0.8 million hectares less deforestation over 67,833 kT **lower CO_2 emissions**

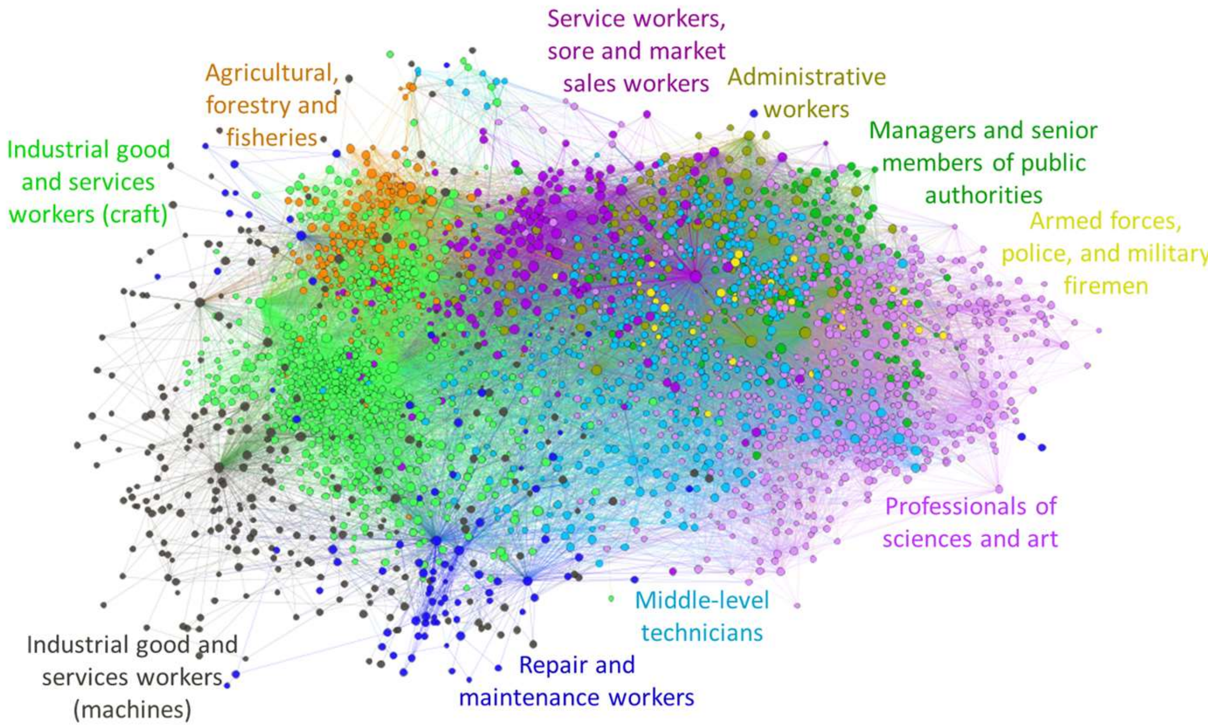
This paper: modelling the labour market

Productivity scenarios - projected labour demand



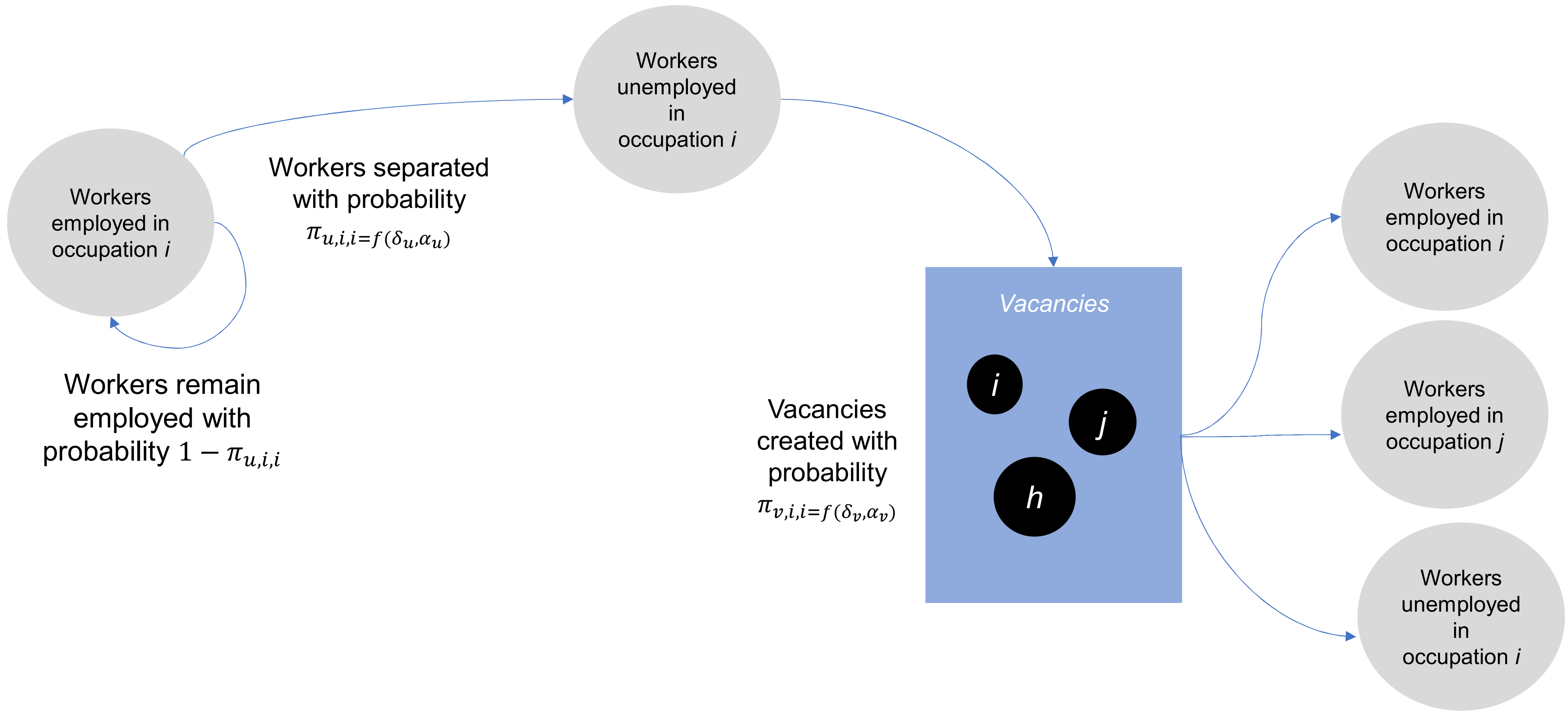
- Their TERM-BR CGE model outputs product level labour demand
- We translate these into occupation-level labour demand

Occupational Mobility Network (A_{ij})

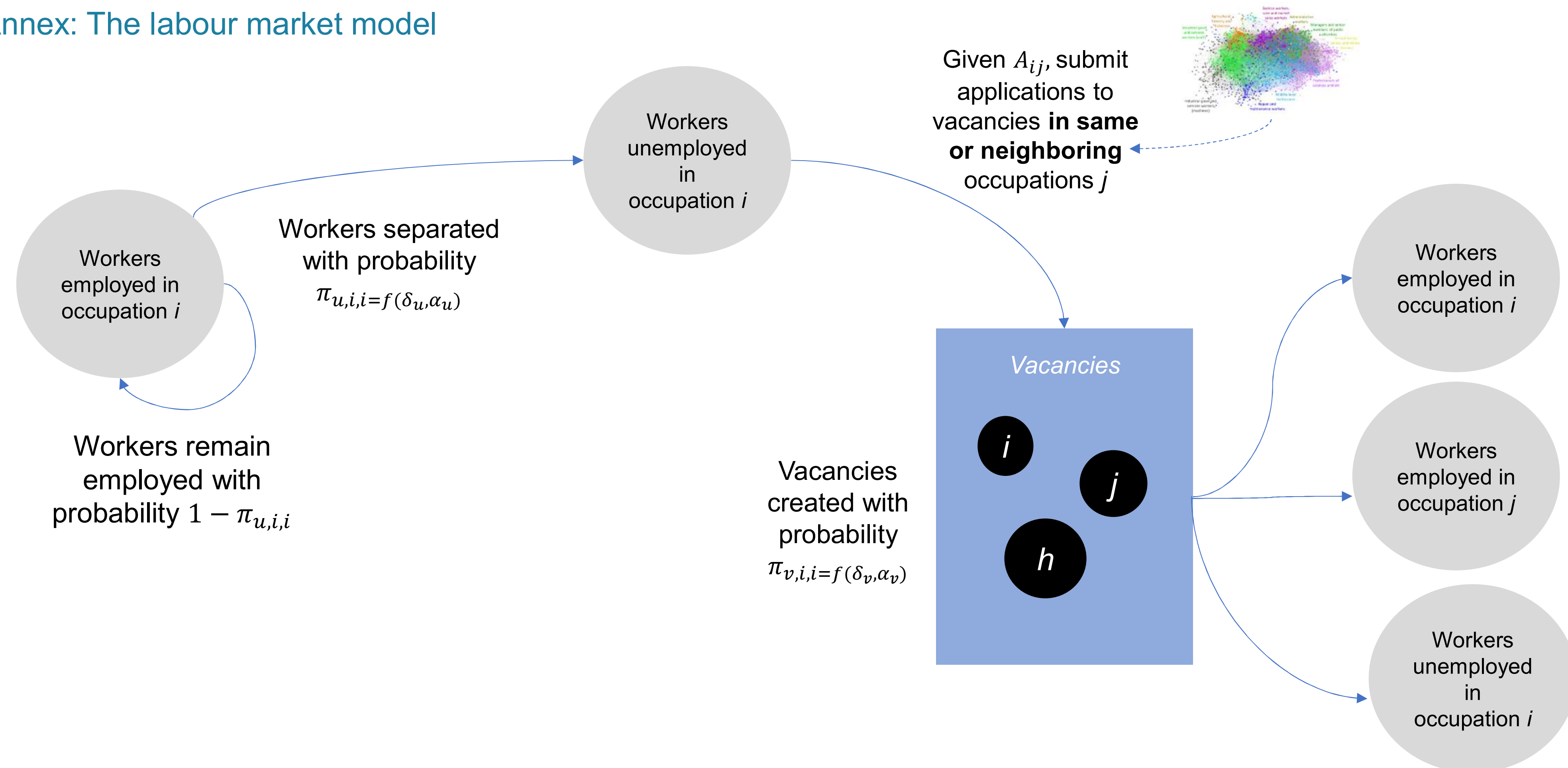


- Empirical network from RAIS dataset
- 2,591 occupations (nodes)
- Represents worker transitions (edges) made between 2011 to 2019

Annex: The labour market model



Annex: The labour market model



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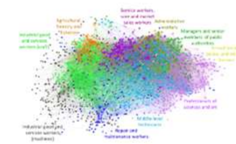


Given A_{ij}, submit applications to vacancies **in same or neighboring** occupations *j*

Workers employed in occupation *i*

Workers separated with probability $\pi_{u,i,i=f(\delta_u,\alpha_u)}$

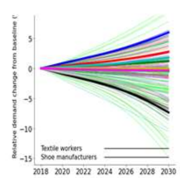
Workers unemployed in occupation *i*

Workers remain employed with probability $1 - \pi_{u,i,i}$

Shifts in labour demand:

$\boldsymbol{\delta}$ refers to spontaneous components

$\boldsymbol{\alpha}$ refers to state-dependent components: depend on (i) **gap between target and realized labour demand** and on (ii) firm's speed of adjustment (by firing and creating new vacancies).



Vacancies created with probability $\pi_{v,i,i=f(\delta_v,\alpha_v)}$

Vacancies

i

j

h

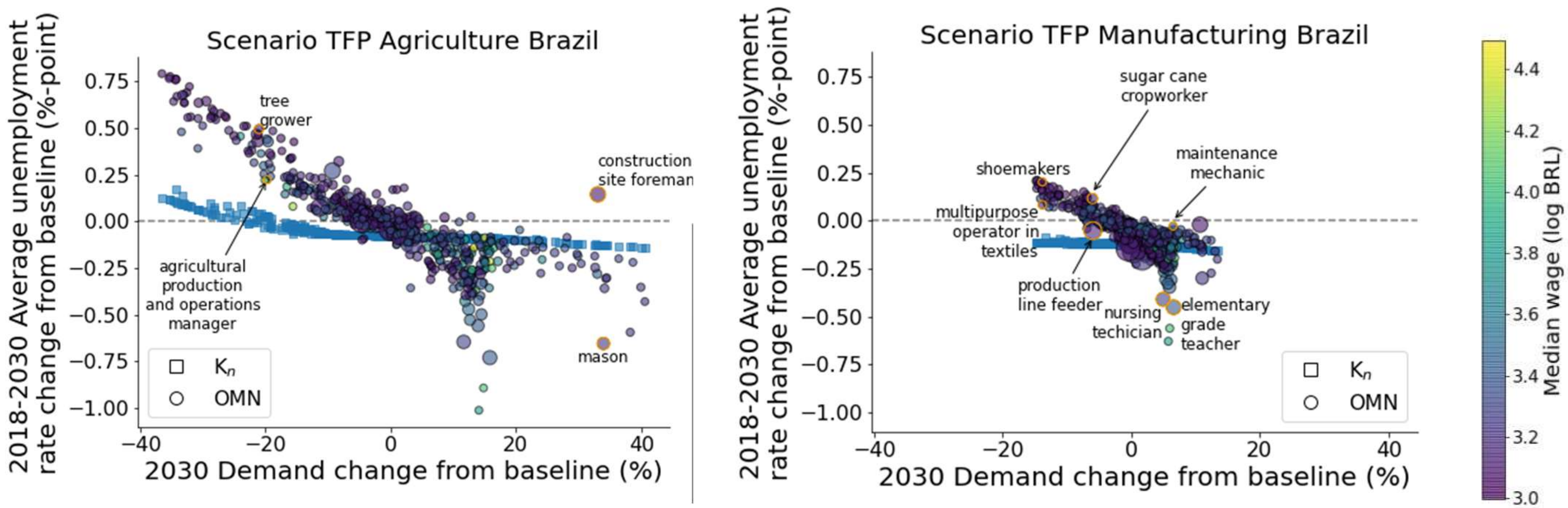
Workers employed in occupation *i*

Workers employed in occupation *j*

Workers unemployed in occupation *i*

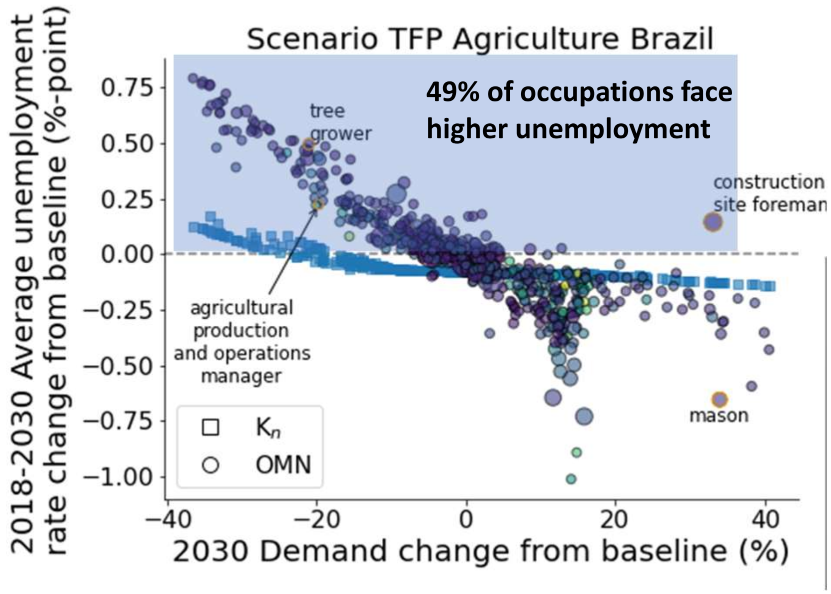
Labour market outcomes

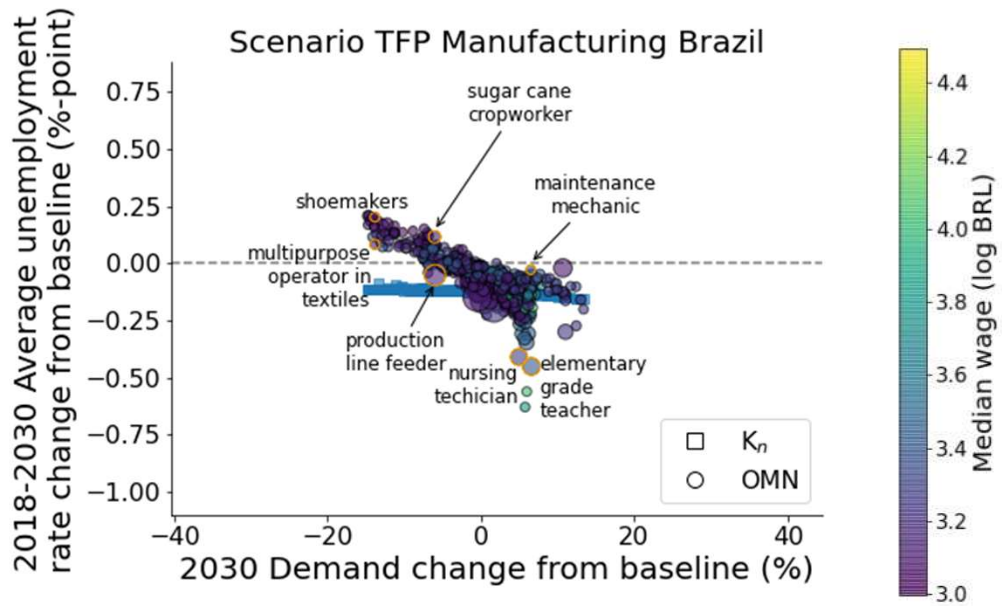
Results



Scenario TFP Agriculture Brazil
2018-2030 Average unemployment rate change from baseline (%-point)
2030 Demand change from baseline (%)
tree grower
construction site foreman
agricultural production and operations manager
mason
K_n
OMN
Scenario TFP Manufacturing Brazil
sugar cane cropworker
shoemakers
maintenance mechanic
multipurpose operator in textiles
production line feeder
nursing techician
elementary grade teacher
Median wage (log BRL)

Results


Scenario TFP Agriculture Brazil
49% of occupations face higher unemployment
tree grower
construction site foreman
agricultural production and operations manager
mason
K_n
OMN
2018-2030 Average unemployment rate change from baseline (%-point)
2030 Demand change from baseline (%)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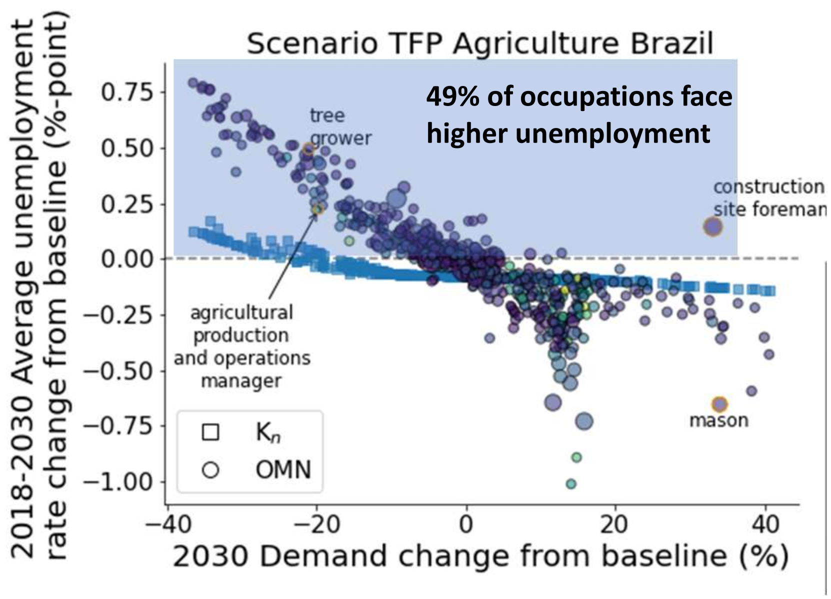

Scenario TFP Agriculture Brazil
49% of occupations face higher unemployment
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2018-2030 Average unemployment rate change from baseline (%-point)
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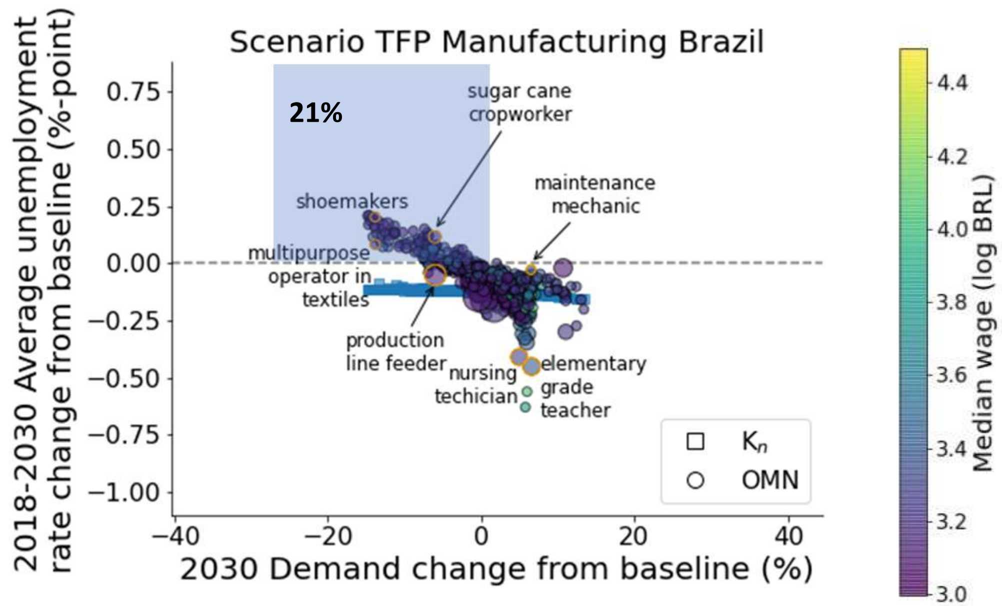
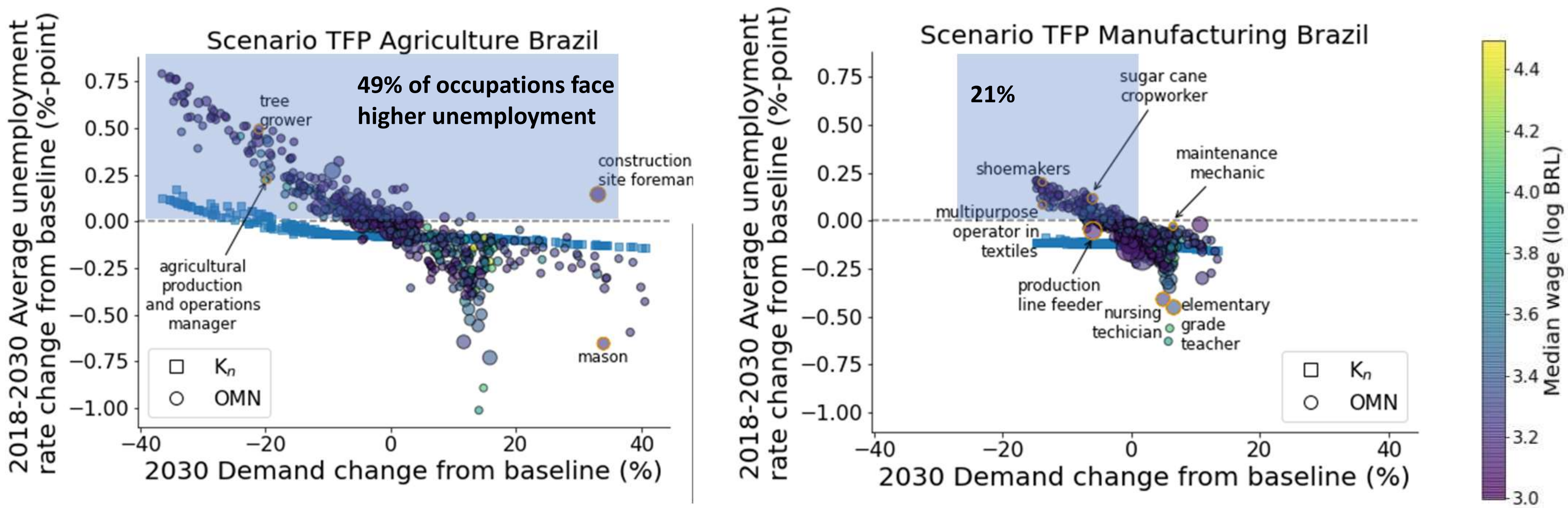


Scenario TFP Manufacturing Brazil
21%
sugar cane cropworker
shoemakers
maintenance mechanic
multipurpose operator in textiles
production line feeder
nursing techician
elementary grade teacher
K_n
OMN
2018-2030 Average unemployment rate change from baseline (%-point)
2030 Demand change from baseline (%)
Median wage (log BRL)

Results



So, more attention towards higher productivity in manufacturing is better aligned with the country's NDC targets and results in fewer labour market frictions.

Thank you!

fernanda.senrademoura@ouce.ox.ac.uk

Annex: occupation-level unemployment rates during the transition (2018-2030 avg. change)

- Manufacturing (lower emissions) → 21% of occupations face higher unemployment due to limited mobility compared to the baseline

- Agriculture (higher emissions) → 49% of occupations face higher unemployment due to limited mobility compared to the baseline

So, more attention towards higher productivity in manufacturing is better aligned with the country's NDC targets and results in fewer labour market frictions.

Is a solar future inevitable?

Dr. Femke Nijsse
Lecturer, University of Exeter

EEIST

Is a solar future inevitable?

Femke Nijsse,

In collabarotion with Jean-Francois Mercure, Nadia Ameli, Francesca Larosa, Sumit Kothari, Jamie Rickman, Pim Vercoulen, Hector Pollitt

September 2023

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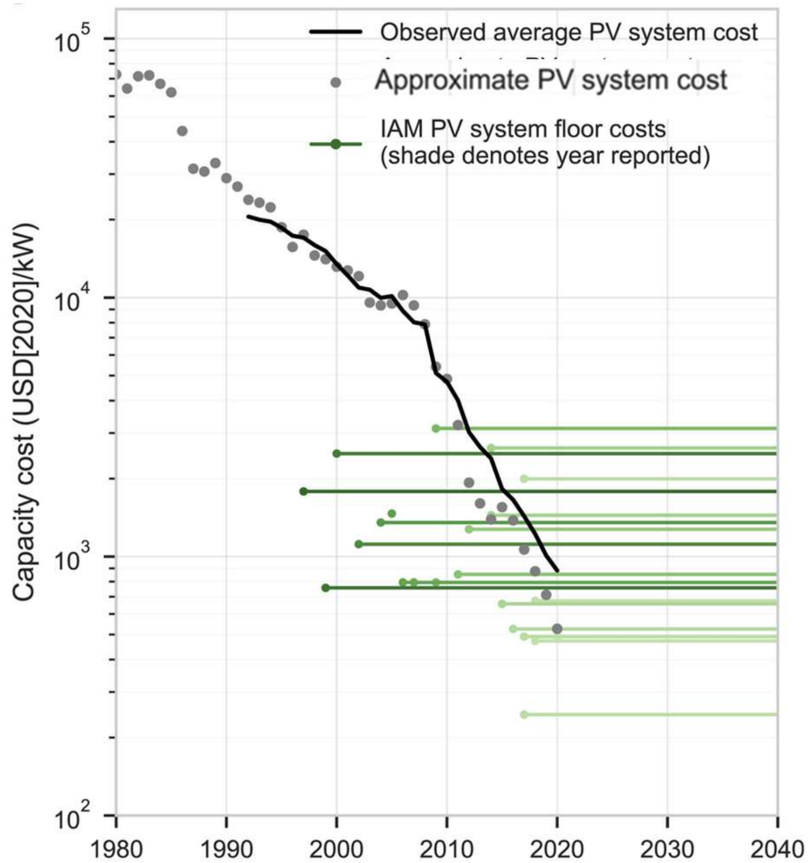
Models often get it wrong

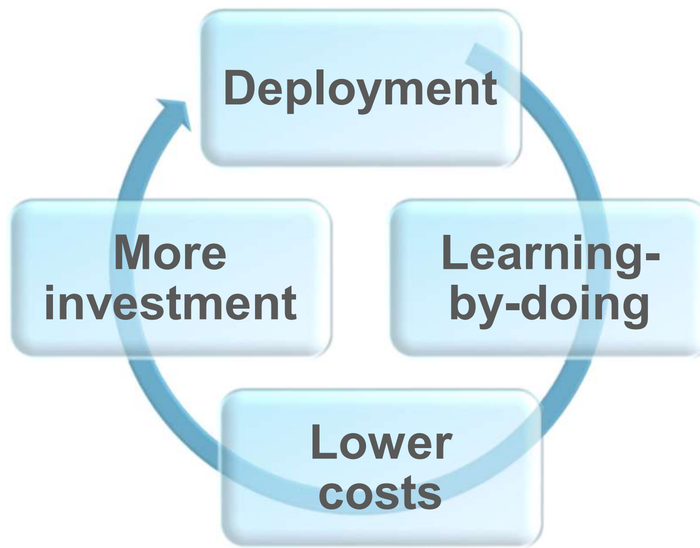


Way et al., Joule, 2022

Future Technologies Transformations (FTT)

Dynamics	**Investor choices** based on perceived costs **Industry strength**: large industries add more capacity per year **Inertia:** lifetime of technologies considered

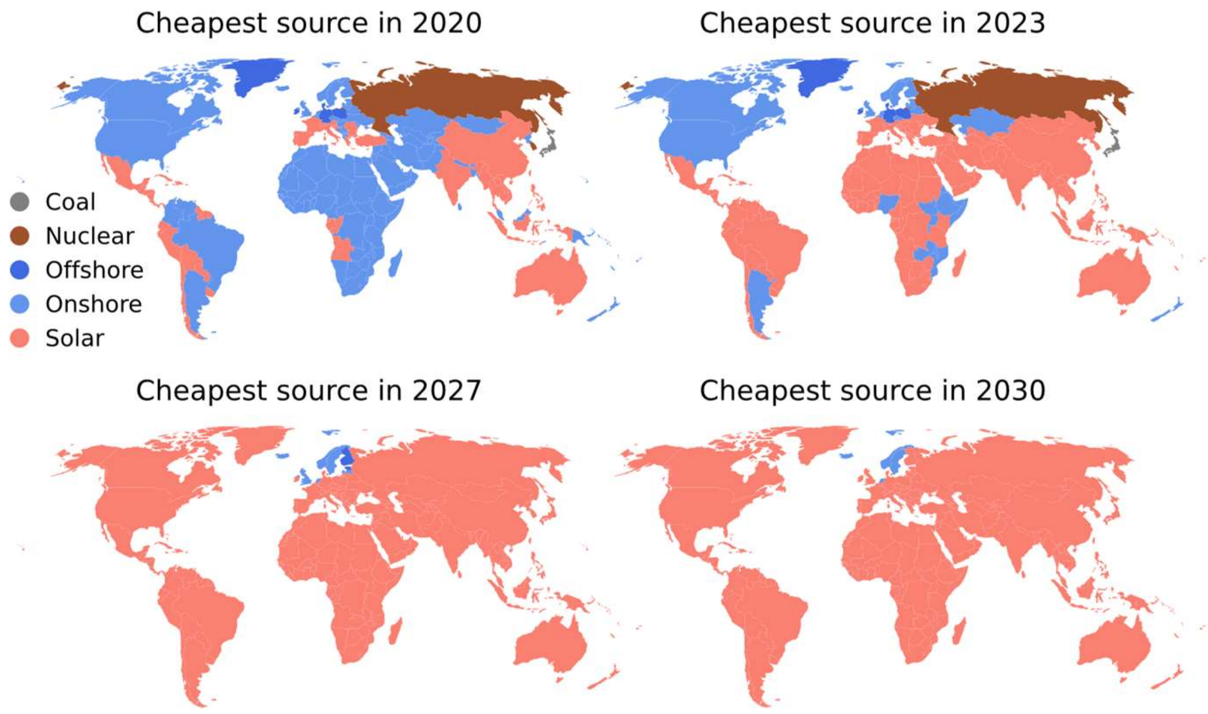
Core feedback



ECONOMICS OF ENERGY INNOVATION
AND SYSTEM TRANSITION

Cheapest form of energy

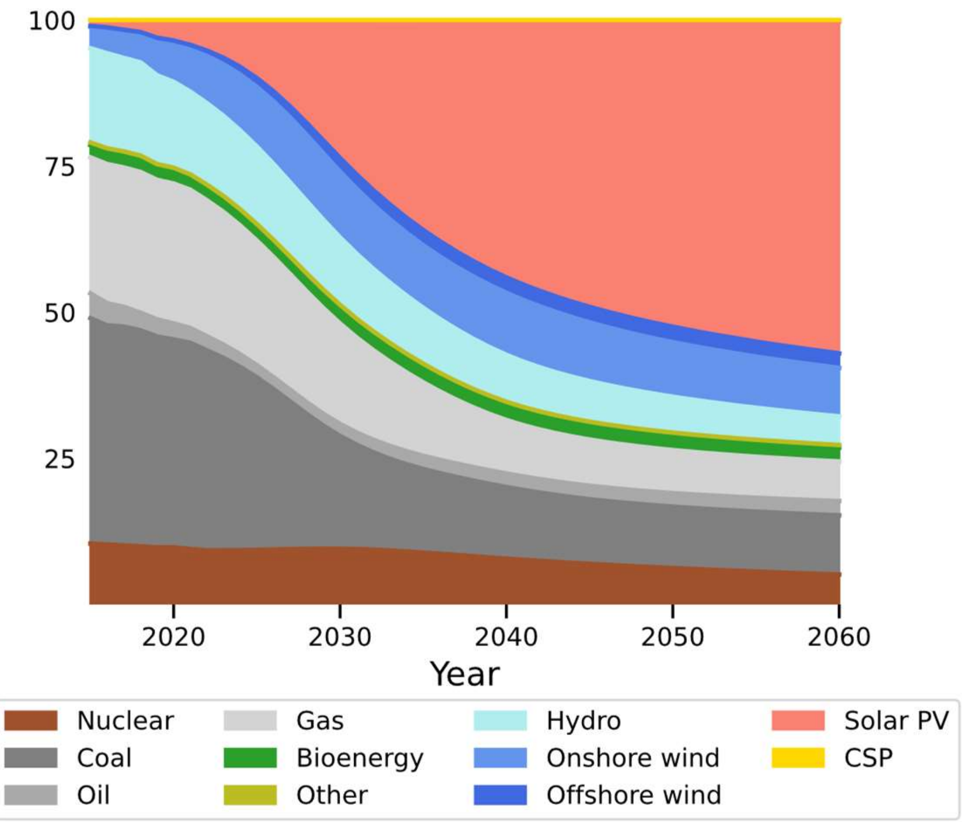
LCOE + system storage costs



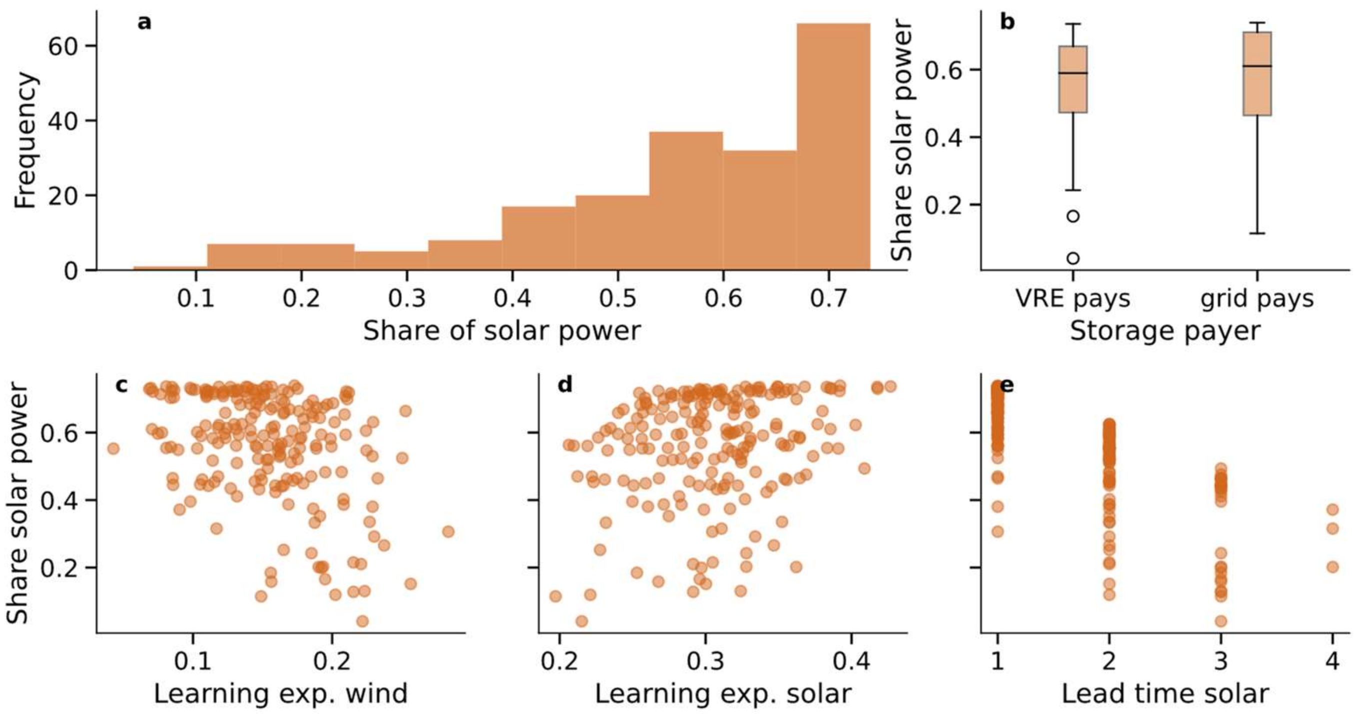
Baseline

The baseline is more and more dominated by renewables

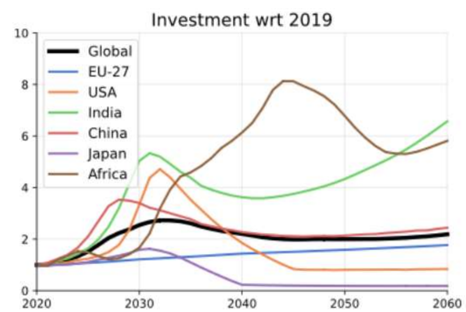
Global shares of renewables in power production



What if?
Shares of solar power



Potential barriers



Finance

Finance may not be available in Global South

Supply chain:

Mining and recycling may not scale up fast enough

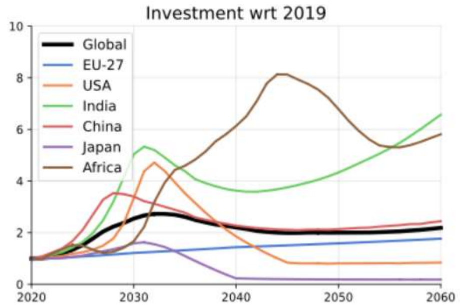
Grid resilience

More weather-related disturbances

Resistance from incumbents

Risk of additional support if job losses large

Policies: beyond a carbon tax



Finance

Offer guarantees to lenders

Supply chain

Efficiency

Grid resilience

Invest in wind

Invest in the "small" renewables

Resistance from incumbents

Just transition policies

Conclusions

A tipping point has been reached

Innovation and deployment policies have driven the costs of solar down.

Barriers to clean power

Finance
Supply chain
Grid resilience
Incumbent industries

Policies beyond a carbon tax

Deploying storage
Guarantees for finance
Deploying wind
Energy efficiency

Risk-opportunity analysis

Simon Sharpe
Director of Economics, UNFCCC Climate Champions
Senior Fellow, WRI

Risk-opportunity analysis

- Generalised / expanded form of CBA
- Helpful where we require or expect transformational change
- Aimed at assessing dynamic economic transformation, not marginal impacts
- Supports a holistic systems thinking approach

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Risk-opportunity analysis for transformative policy design and appraisal

Jean-Francois Mercure [a,b,c,*], Simon Sharpe [d], Jorge E. Vinuales [b], Matthew Ives [e,f], Michael Grubb [g], Aileen Lam [h,b], Paul Drummond [g], Hector Pollitt [b,c], Florian Knobloch [b], Femke J.M.M. Nijsse [a]

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[b] Cambridge Centre for Energy, Environment and Natural Resources Governance, University of Cambridge, UK
[c] Cambridge Econometrics, Cambridge, UK
[d] Institute for Innovation and Public Purpose, UCL, UK
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[f] Smith School of Enterprise and the Environment, University of Oxford, Oxford UK
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ARTICLE INFO

Keywords:
Policy appraisal
Climate policy
Science-policy interface
Complexity science
Evolutionary economics
Public policy-making

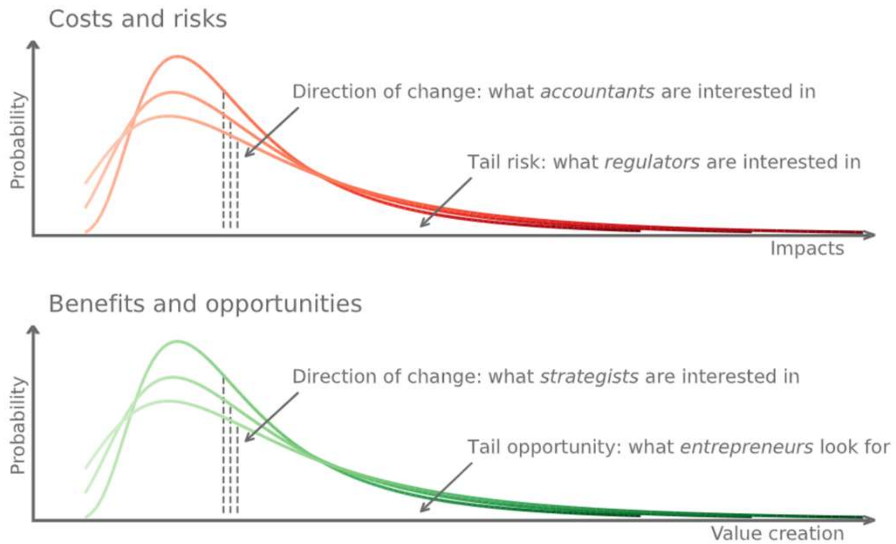
ABSTRACT

The climate crisis demands a strong response from policy-makers worldwide. The current global climate policy agenda requires technological change, innovation, labour markets and the financial system to be led towards an orderly and rapid low-carbon transition. Yet progress has been slow and incremental. Inadequacies of policy appraisal frameworks used worldwide may be significant contributors to the problem, as they frequently fail to adequately account for the dynamics of societal and technological change. Risks are underestimated, and the economic opportunities from innovation are generally not assessed in practice. Here, we identify root causes of those inadequacies and identify them to structural features of standard analysis frameworks. We use a review of theoretical principles of complexity science and the science of dynamical systems and formulate a generalisation of existing frameworks for policy analysis and the appraisal of outcomes of proposed policy strategies, to help better identify and frame situations of transformational change. We use the term "risk-opportunity analysis" to capture the generalised approach, in which conventional economic cost-benefit analysis is a special case. New guiding principles for policy-making during dynamic and transformational change are offered.

Mercure, Jean-Francois, et al. "Risk-opportunity analysis for transformative policy design and appraisal." *Global Environmental Change* 70 (2021): 102359. https://www.sciencedirect.com/science/article/pii/S0959378021001382

Risk-opportunity analysis

- CBA assumes
  - intervention does not change the system
  - heterogeneity of stakeholders and outcomes are low
  - certainty, and quantified uncertainty
- Do these hold for climate?
  - 'Heavy-tail' uncertainty
  - Fundamental uncertainty
  - Systemic risk
  - Long-term, the economy is dynamic
  - Different values and beliefs



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Risk-opportunity analysis

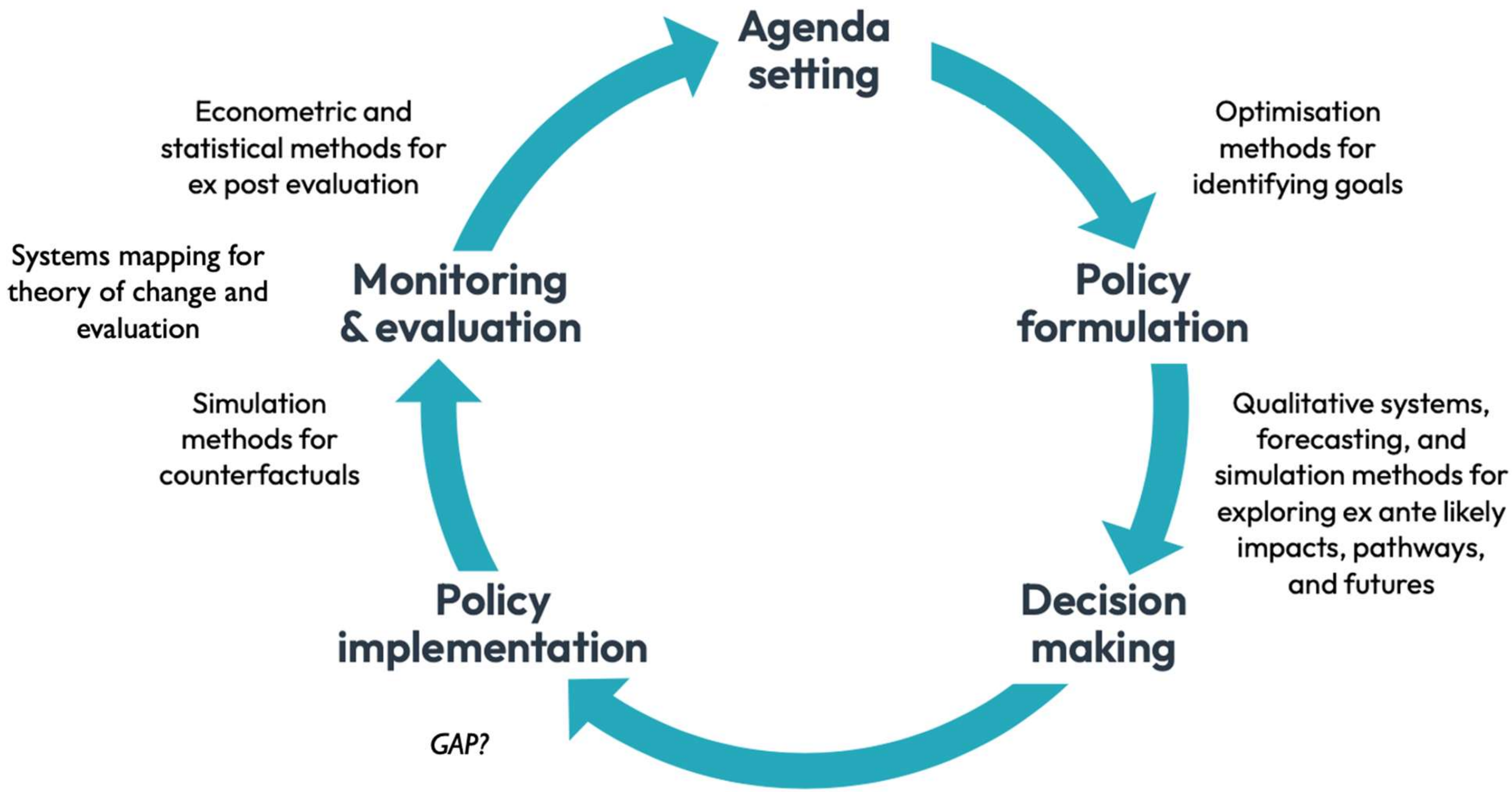
- Steps in ROA
  - Map the system – identify boundaries, feedbacks
  - Estimate median outcomes (not mean), establish ranges – simulation modelling
  - Risk assessment – explore extreme outcomes, unintended consequences
  - Opportunity assessment – explore potential for creating new options, best case, cascades
  - Report all these to decision-makers
- Issues
  - Technically more demanding?
  - Not a simple yes/no / single figure answer
  - Difficult to communicate with limited space

Figure 11: Steps of the risk–opportunity analysis framework

Grubb et al. 2021. https://eeist.co.uk/eeist-reports/

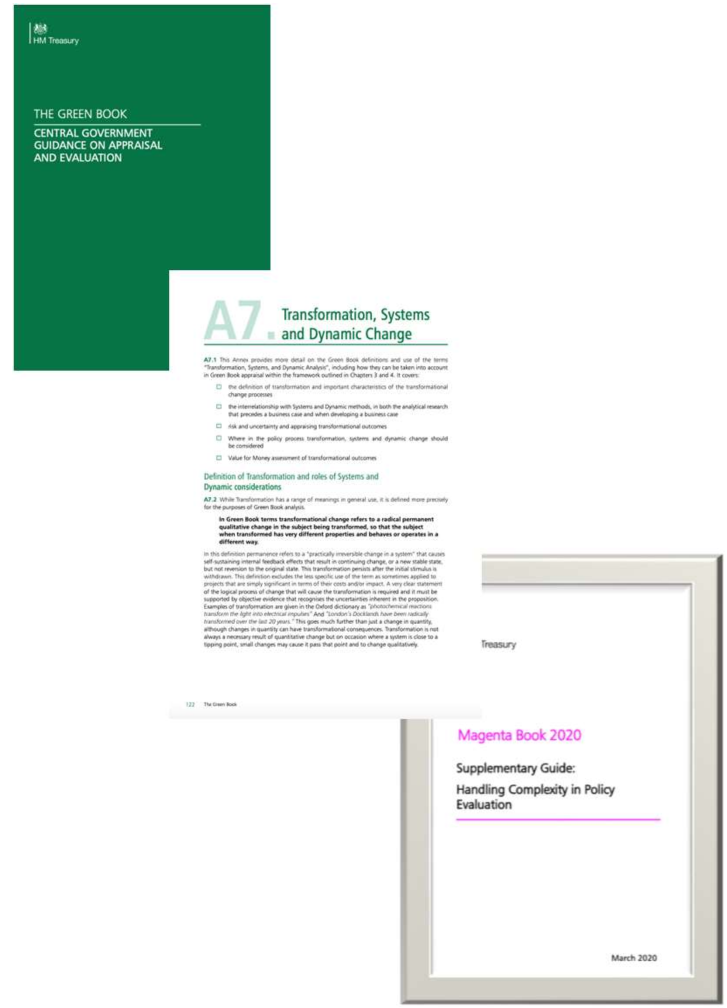
Complexity and systems approaches across the policy cycle

Dr. Pete Barbrook-Johnson
Lecturer, University of Oxford


Agenda setting
Optimisation methods for identifying goals
Policy formulation
Qualitative systems, forecasting, and simulation methods for exploring ex ante likely impacts, pathways, and futures
Decision making
Policy implementation
GAP?
Simulation methods for counterfactuals
Monitoring & evaluation
Systems mapping for theory of change and evaluation
Econometric and statistical methods for ex post evaluation

Connecting the policy cycle

- Use the same model at appraisal and evaluation
  - Trust qual and systems mapping methods at ex ante
  - Trust simulation models at ex post
  - Bare minimum – have a updateable systems Theory of Change map throughout
- Develop the capacity to use both across professions
- How can ROA follow a policy around the cycle?
- Feeding learning into agenda setting
  - Combined ex ante and ex post analysis to feed into agenda setting



How to start using these approaches

- Hopefully, it is clear there are great opportunities to use these tools
  - Directly inform policy to bring about transition
  - Sector-focussed, empirically grounded, intuitive, dynamic
- But, there are conceptual, practical, and institutional constraints to consider

How to start using these approaches

Conceptual challenges	Practical challenges	Institutional challenges
• Is it new vs old economic modelling? No! Horses for courses • New economic models are not tested?	• Data • Different types of outputs	• Risk aversion • Structures around existing models

How to start using these approaches

- How to proceed?
  - Start small and ramp up
  - Systems mapping as an entry point
  - Become an advocate
  - Build capacity and expertise
  - Develop bespoke guidance
  - Consider some EEIST training https://eeist.co.uk/training/

Training

The EEIST team is offering bespoke, hands-on training sessions in new modelling approaches. These sessions will enable partners to develop new analysis capabilities, either through own models or through licensing existing models. The target audience for these sessions is experienced modellers in the EEIST project's partner countries (UK, China, India, Brazil) who are seeking to explore new methods.

The topics covered include:

- Risk and Opportunity thinking
- E3ME-FTT
- Labour market agent-based modelling
- Systems mapping
- Green complexity analysis
- Energy technology cost forecasting

If this training is relevant to you or your organisation, please get in touch with us who will be pleased to discuss your needs.

ECONOMICS OF ENERGY INNOVATION AND SYSTEM TRANSITION

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Q&A

Read more

https://eeist.co.uk/eeist-reports/

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