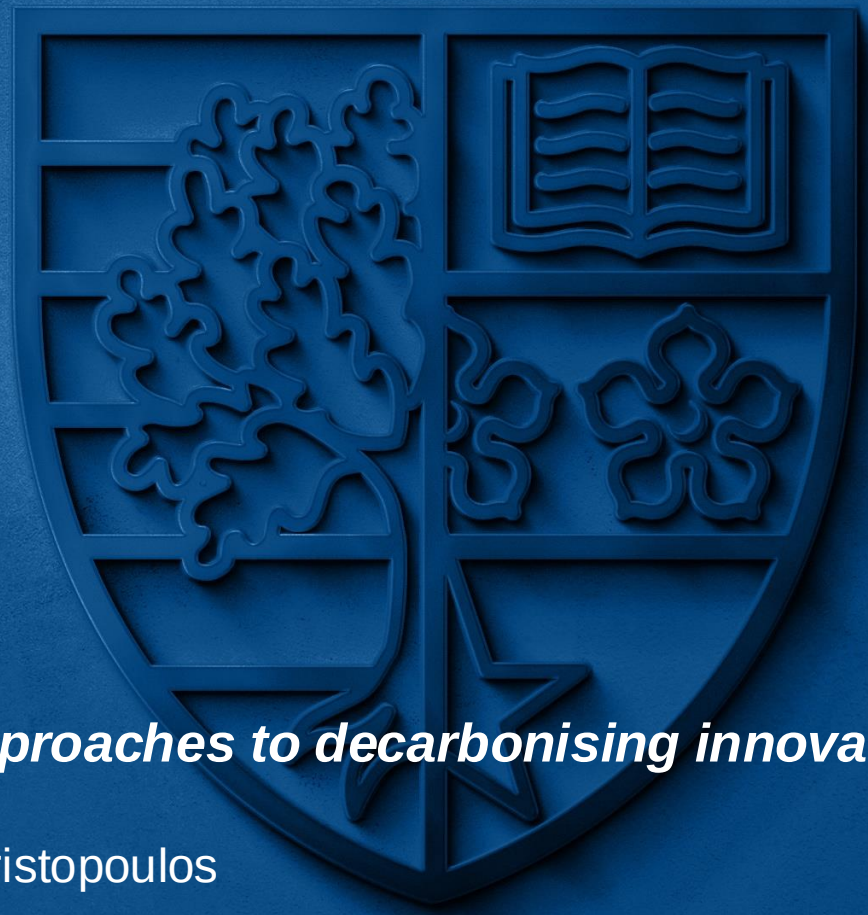
HERIOT WATT UNIVERSITY
UK | DUBAI | MALAYSIA



Emissions Targets and Innovative Behaviour

How emissions targets shape organisational approaches to decarbonising innovation

Ms. Olive Bradshaw, Dr. David Dekker, Prof. Dimitris Christopoulos

ECO-AI Workshop 24th March 2025

WP4: Sectoral Targets for CO2 & Innovation Advantage

Introduction

Net-Zero Commitment

- The UK has committed to net-zero GHG emissions by 2050, with interim targets of 68% reduction by 2030 and 78% by 2035.

Shortfall

- Significant shortfall in credible plans for achieving targets, especially in energy-intensive industries - technological innovation is key to closing the gap.

Our approach

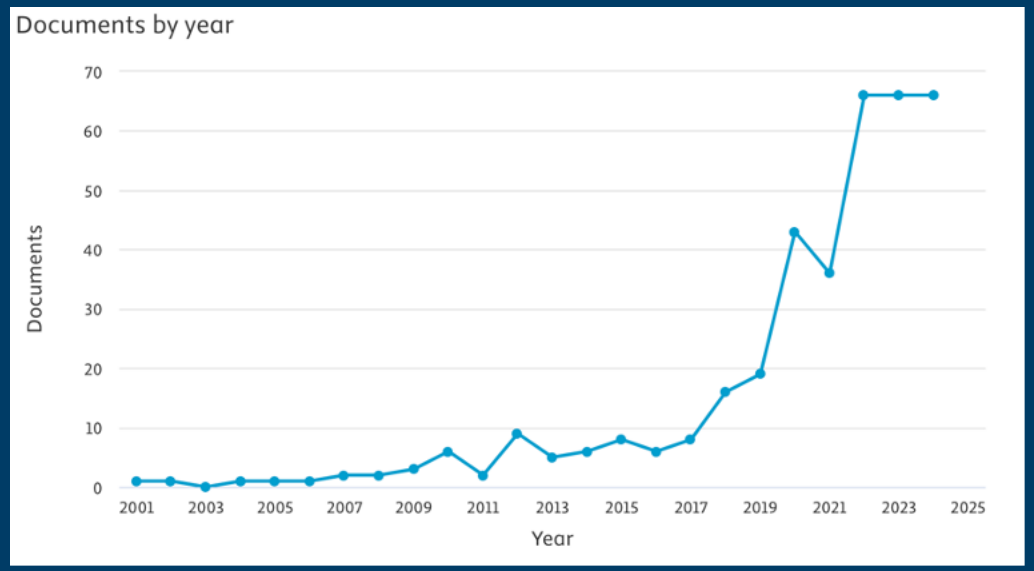
- Use patent data to explore the impact of emissions targets on innovation behaviour, with a focus on risk propensity.
- Integrating **behavioural insights** and exploring the **policy implications.**

Sectoral Climate Targets and Innovation

- Limited sector-specific, quantitative emissions targets at the national level (in the UK and elsewhere).

- Recent attention on ‘Science Based Targets’ initiative demonstrates demand for research-backed policy advice on climate targets.

("science-based targets" OR "science based targets") OR ("evidence-based" AND "targets" AND "climate")



Organisational Response to Targets

- unclear feedback loop between targets and outcomes
- ambitious self-set targets show higher rates of completion
- firms with less ambitious targets tend to make greater progress
- ambitious targets risk political posturing and greenwashing

Exploitation vs. Exploration

Explorative Innovation:

Novel technologies, processes, or products.

Risk-taking, experimentation, adaptability.

Exploitative Innovation:

Refines and improves existing processes or products.

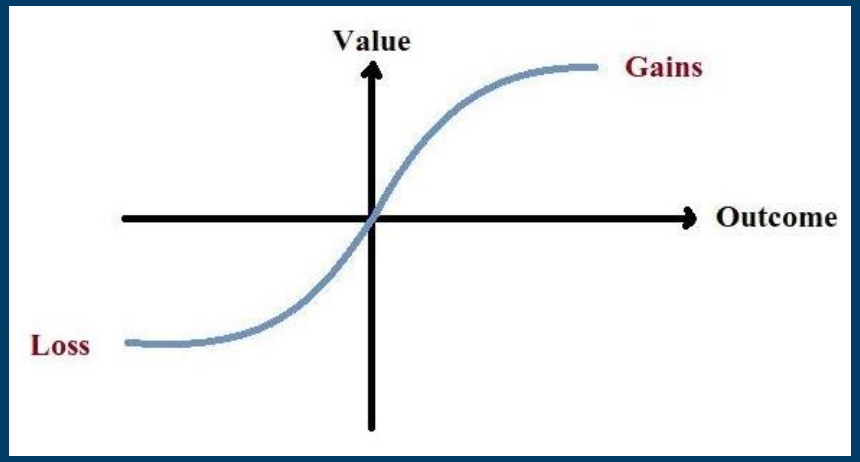
Risk-averse, efficiency, optimisation.

Why exploitation/exploration?

- **Contrasting risk propensity** between organisations adopting explorative and exploitative strategies.
- Lends itself methodologically to **analysing patent data**, by looking at in-domain and out-of-domain citations.
- Balance is key to **organisational competitiveness** and **adaptability**.

Prospect Theory and Variable Risk

(Kahneman & Tversky, 1979; March & Shapira, 1992; Sobrepere & Greve, 2025; Greve 2003).



Targets can reframe risks and influence approaches to innovation, in part by influencing firm's propensity to risk.

Dealing with risks

People evaluate potential outcomes relative to a reference point rather than in absolute terms.

Decision-makers are typically more risk-averse when facing potential gains and risk-seeking when trying to avoid losses.

Targets can reframe risks

Emission targets create reference points that frame risk perceptions: when targets are perceived as *distant or unachievable*, firms become more risk-tolerant, favouring explorative innovations to close performance gaps. When targets are close, firms become risk-averse and will favour exploitative innovation to consolidate current performance.

Hypothesis

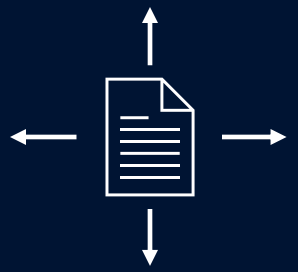
H1: *The emission reduction performance of sectors relative to their emissions targets shapes how industry players approach risk.*

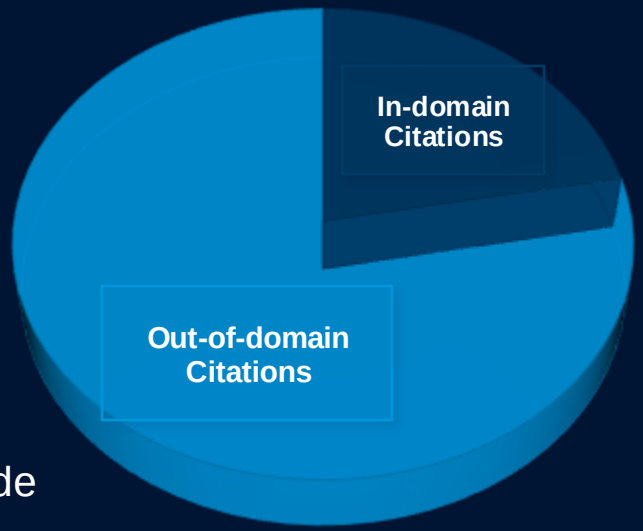
In sectors closer to meeting their emissions targets, firms are more likely to engage in exploitative innovation, whereas those further from their targets tend to pursue more explorative innovation.

Methodology

In-domain vs. out-of-domain citation ratio

Exploitative Innovation: Patents citing prior work within the same domain → builds on existing knowledge, lower risk.



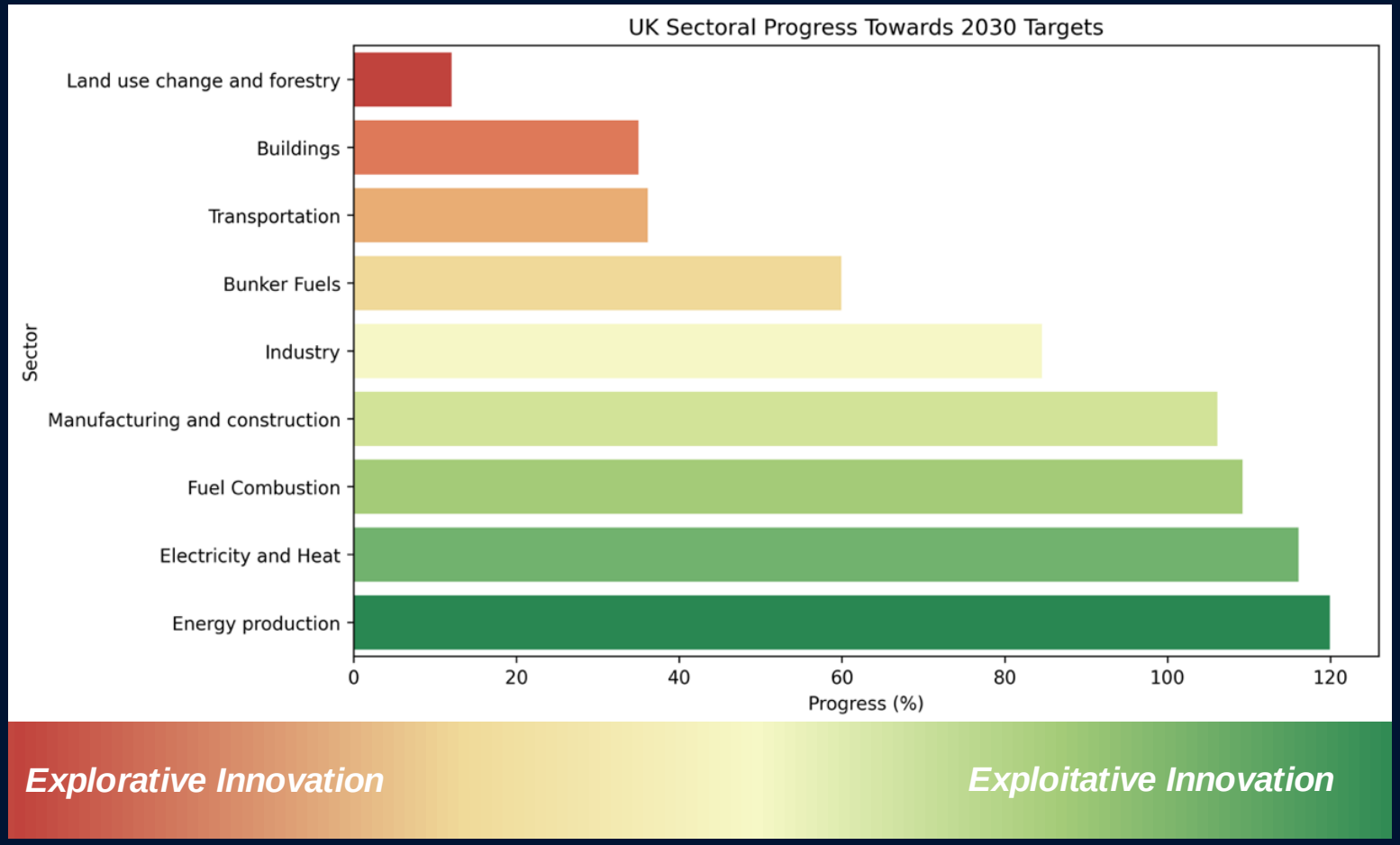


Explorative Innovation: Patents citing works outside their domain → integrates distant knowledge, higher risk.

Methodology

Progress and reference points

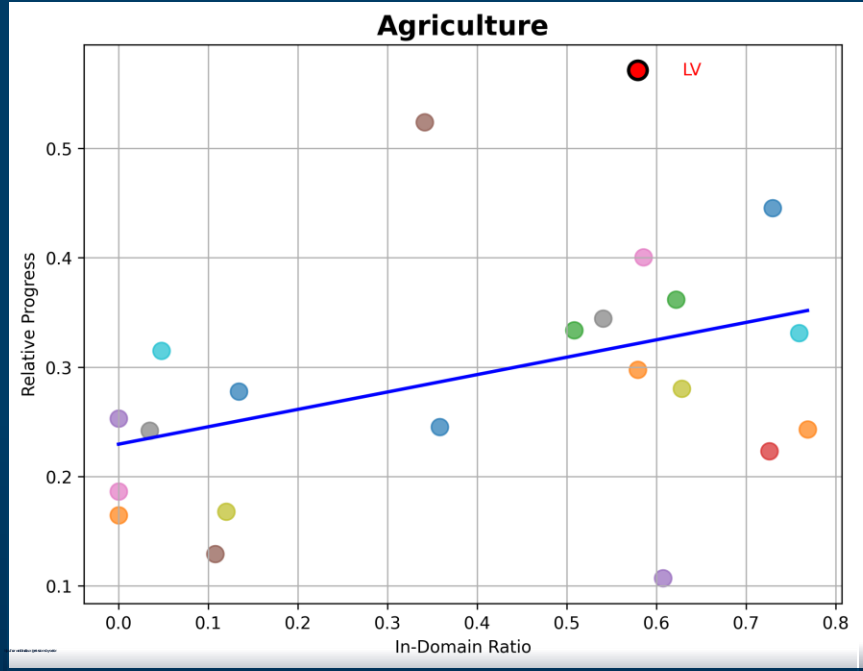
- Relative progress calculated as sectoral emissions reduction vs. expected linear progression toward 2030 goal.
- Global Carbon Project
- Comparisons made between EU and G7 countries.



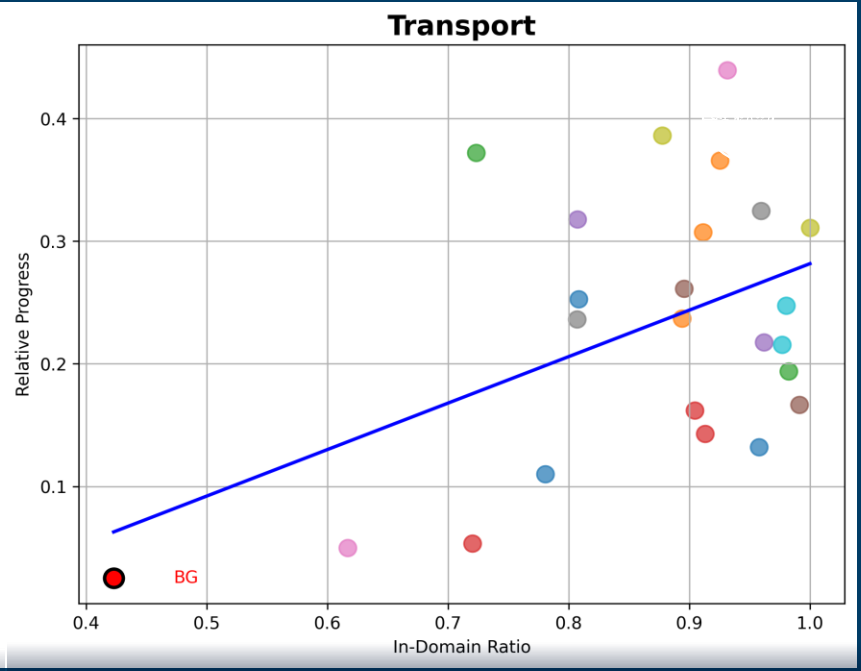
Preliminary Results

- *In-domain ratio against relative progress*
- *EU and G7 countries*
- *2016-2021 patent data*
- *Performance normalised*

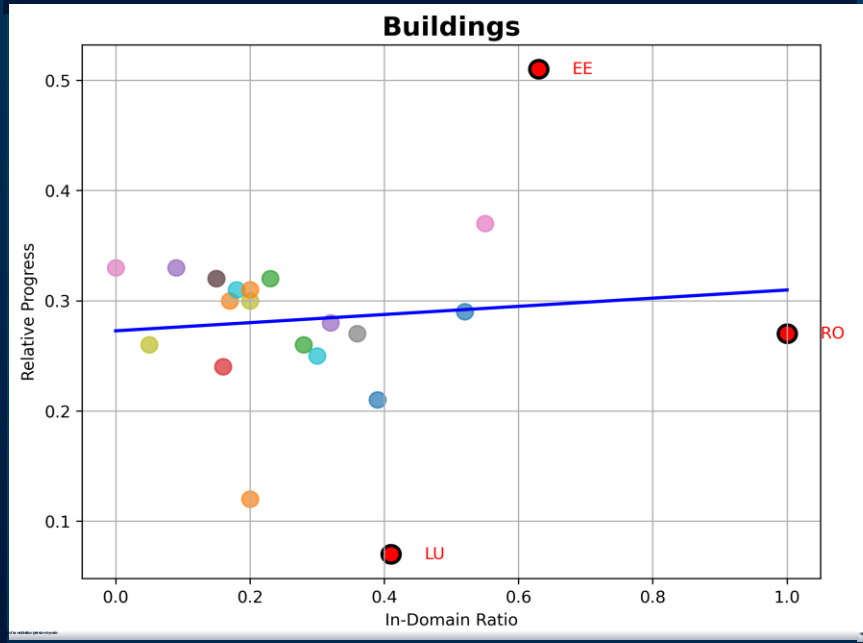
- **High in-domain ratio — exploitative**
- **Low in-domain ratio — explorative**



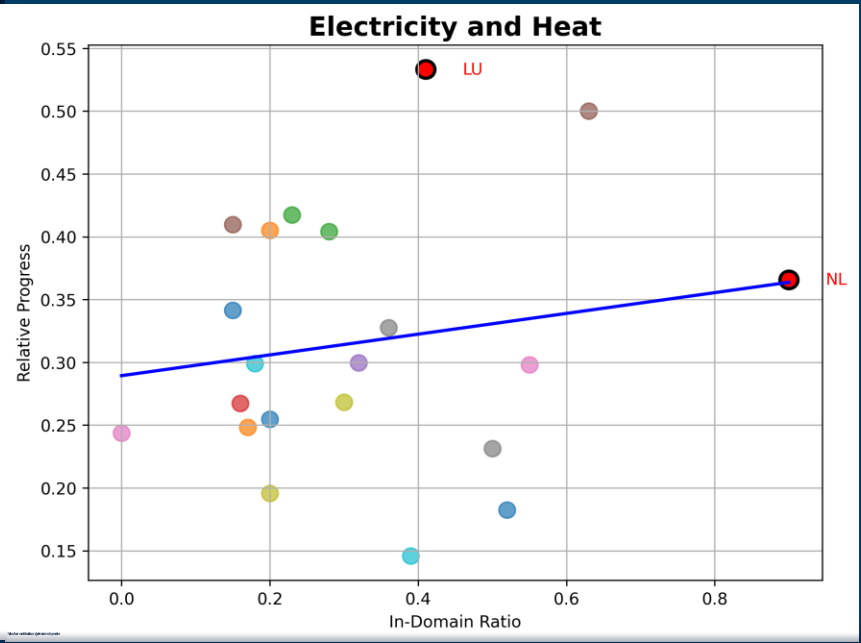
Pearson Correlation Coefficient: 0.385 P-value: 0.077



Pearson Correlation Coefficient: 0.466 P-value: 0.022



Pearson Correlation Coefficient: 0.098 P-value: 0.664



Pearson Correlation Coefficient: 0.168 P-value: 0.467

Application to Policy

How will firms react to decarbonisation targets and regulation?

Application to Policy

Tailored Emissions Targets:

- One-size-fits-all policies are inadequate; strategic balance between exploitative and explorative innovation is needed based on sector-specific challenges.

Target Redistribution:

- Use insights on technological domain characteristics to redistribute emissions targets.
- Encourage breakthrough innovations in key sectors and refining existing technologies elsewhere.

Sector-Specific Support:

- Adjust support mechanisms and regulatory frameworks to steer firms toward the most impactful innovation pathways.

⚠ **Multinational relocation**

⚠ **Industry lobbying**

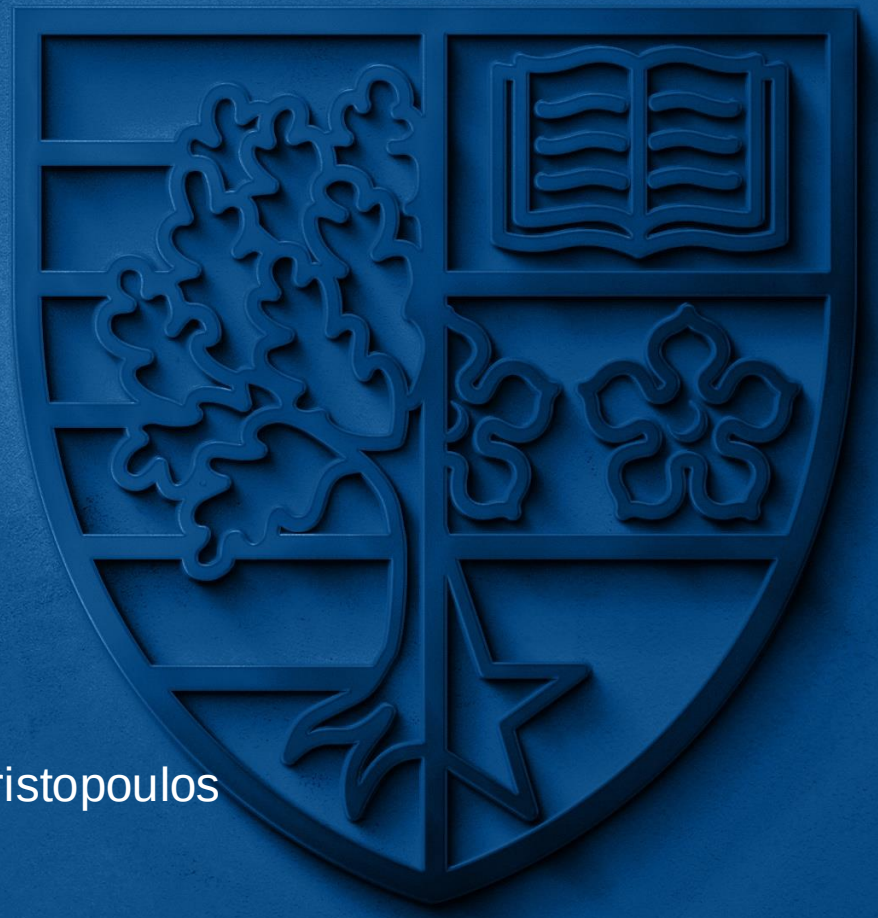
Key takeaways

- Organisational behaviour insights inform innovation models in decarbonisation.
- Promising support for a positive correlation between target progress and exploitative, risk-averse innovation.
- Patent data and citation networks are valuable for analysing trends in decarbonising innovation.
- Strategic target setting is crucial and needs further focus.

Future directions

- **Target stringency, R&D Investment and Sectoral Performance**: Examine how emissions targets shape R&D investment and innovation.
- **Financial and Regulatory Mechanisms**: Assess the role of financial and regulatory factors in global innovation.
- **Integrating ECO-AI for Policy Impact**: Use ECO-AI insights to engage policymakers in strategic target setting.

HERIOT WATT UNIVERSITY
UK | DUBAI | MALAYSIA



Thank you

Ms. Olive Bradshaw, Dr. David Dekker, Prof. Dimitris Christopoulos

ECO-AI Workshop 24th March 2025

WP4: Sectoral Targets for CO2 & Innovation Advantage