Challenges and Opportunities for the Transport System

A summary of recent research

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Introduction

• Transport sector:
  ▪ a main component of economic development

• Critical long-term challenge worldwide:
  ▪ 20% of global energy
  ▪ One-quarter of the overall energy-related CO₂
  ▪ Road transport: three quarters of total transport emissions

• NZ’s unique emissions profile:
  ▪ NZ’s gross GHGs were 80.9 Mt CO₂-e in 2017 = 2.2% increase from 2016 emissions, mainly caused by an increase of emissions from road transport
  ▪ Two largest emitters in 2017: Agriculture (48.1%) & Energy (40.7%)
  ▪ Road Transportation - 44% of total emissions from energy sector

Fig. 1 NZ’s gross and net emissions from 1990 to 2017, 23%+ (MfE, 2019) Fig. 2 International comparisons for per capita emissions in 2016 (MfE, 2019)
1. Transport Mode Choice Modelling and Social Networks Effect

• Transport mode choice decision-making is dependent on social network effects.

• People’s transport mode choice decisions DO influence each other, positively.
  ▪ As the % of commuters taking public transport to work increases, we expect to see a spillover effect that changes some non-public transport users travel behaviour

• The social network effects = the 2nd largest impact (approx. 20%) on commuter’s transport mode choice (in Auckland, after household vehicles, approx. 30%).
  ▪ Shifting road user’s travel behaviour - a more economical way?

• For urban/transportation planners:
  ▪ Improving infrastructure
  ▪ Strengthening the city’s ‘greener’ transport mode culture


2. Traffic Congestion Issues

- Congestion
  - Most prominent negative externality with economic cost: NZD$0.9 billion to NZD$1.3 billion ≈ 1% and 1.4% of Auckland’s GDP (NZIER, 2017)

- The Congestion Question in Auckland
  - Auckland Council’s pilot study: how to reduce congestion on Auckland roads?
  - No further progress as to date

- A complementary method for achieving the “ideal” economically efficient vehicular diverging
  - The combination of charging toll fee on the highway and applying an average pricing structure for public transportation

- We conduct a laboratory experiment to simulate transportation route-choice games.

- We vary the highway entry fee structure (i.e. with toll fee or without toll), the pricing scheme for public transport (i.e. between a constant and an average cost structure), and the road capacity (i.e. before and after an expansion)

- Preliminary results
  - If we increase road capacity then congestion will increase
  - Different policy mixes contribute to lowering congestion to a socially optimal level
  - E.g. A combination of congestion tolls with price differentiation in public transport reduces congestion

3. The Relationship between Transport Emissions, Road Energy Consumption and Economic Growth

• Reducing Methane emissions from agriculture? Nah...
• Reducing Energy demand (CO₂ emissions) from transport? Yes!
• This study:
  ▪ Investigates the impact of energy consumption from road transport and economic growth on CO₂ emissions from transport sectors;

1) Bidirectional causality (transport CO₂ emissions & road energy consumption):
  ▪ The carbon abatement policy initiatives should be directed at energy use from fossil fuels and incentivise the adoption of alternative renewable energy sources.
  ▪ 85%+ of NZ’s electricity: renewable sources, rapid adoption of EVs as replacements for ICE based passenger transport should be an obvious goal.

2) One-way causality (from economic growth to environmental pollutant emissions growth):
  ▪ Transport policies addressing carbon emissions abatement, will not hurt economic growth.
  ▪ Any investment in emission reduction strategies could serve as a practicable policy instrument for NZ govt. to achieve its net-zero emission target by 2050.

4. Economic Analysis on Future Transport Infrastructure for Electric Vehicles

*Development of IPT Roadway Transportation Systems*, Research Project 3714101. 2017 – 2022, MBIE Endeavour Fund 2017 (Associate Investigator)

- Inductive Power Transfer (IPT) Technology = Wireless transfer of Power
- History of IPT technology (Sheng *et al.*, 2019)
  - mid 90’s: Profs John Boys and Andrew Green from the UoA (U.S. Patent 5 293 308A) developed IPT in Daifuku’s monorail systems for vehicle assembly plants and clean factory automation
  - 1998: IPT was first implemented with a vehicle transportation application at Rotorua Thermal Park in NZ
  - 2013: 1st commercialised Dynamic Wireless Charging EV, Online Electric Vehicle (OLEV) was developed by the Korea Advanced Institute of Technology (KAIST) in Gumi, Korea
- 3 Types for Wireless Charging of EVs (Zaheer & Covic, 2016)
  - Static IPT
  - Semi-Dynamic IPT
  - Dynamic IPT
- Economic Viability of IPT (Sheng *et al.*, 2019)
  - DIPT under PPP scheme

*Selected papers funded by the MBIE include:*

Thank you ☺️
Questions?