INCORPORATING EQUITY IN THE ACTIVE NETWORK DEVELOPMENTS

Mehrdad Memarpour, PhD student, UNSW Australia

Supervisors: Dr Taha Rashidi, Prof. Travis Waller, and Dr Milad Haghani

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Problem Statement

- Active Transport Challenges
- Literature and Industry Highlights
- Strategic Plans

Equitable Active Network Design

- Key Measures for Active Network
- Safety Risk Quantification
- Mathematical Model

Equitable Active Network Finance

- Finance Equity Issues
- Rent Payment
- Tax Incentive

Dilemma of active transport network design

equity in space allocation between and within network user groups

Challenges

Land use

- Continued densification in urban areas
- Urban sprawl

Transportation

- Car dependency and congestion
- Higher safety risks for active mode users
- Limited financial resources

Equity

- Safety, Accessibility, etc.
- Infrastructure for active mode users

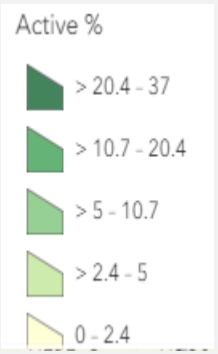
EQUITY CONSIDERATIONS IN ACTIVE NETWORK DESIGN

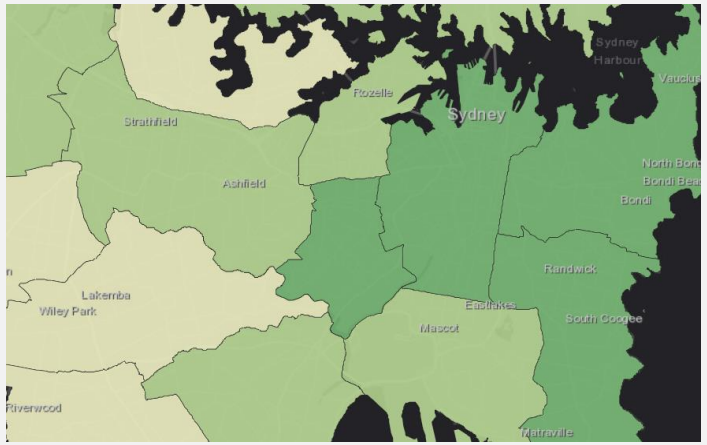
Literature

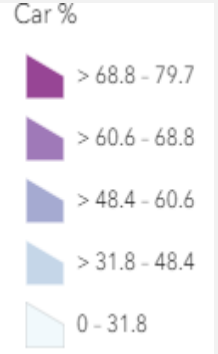
- Methods to identify inequity in active transport provision
- Methods to evaluate the economic benefits of active transport
- Recently a stronger focus on equity/fairness in Motorised network design
- Less attention on equity-based Active network design

- **Industry**
  - Formulating active network development plans
  - Active network design with equity implications
    - Street space allocation
    - Safety for the active modes
  - Neighbourhood deals for financing active network
  - How do we distribute the impact of these initiatives equitably?

EQUITABLE ACTIVE NETWORK DESIGN







Focus areas				
Enable 15-minute neighbourhoods	Deliver connected and continuous cycling networks	Provide safer and better precincts and main streets	Promote walking and riding and encourage behaviour change	Support our partners and accelerate change
Ambitions				
Create walkable and connected 15-minute neighbourhoods across all six cities and in regional centres across NSW to **increase the percentage of short trips made on foot.**	**Deliver more than 1,000 kilometres of new cycleways and supporting infrastructure** for continuous and connected cycling networks across key cities in NSW to **increase the number of trips made by bike.**	Help **halve fatalities and reduce serious injuries by 30 per cent for pedestrians and bike riders** through safer speeds and networks while increasing people walking and riding[1].	**Double the number of children walking or riding to school** in all six cities and major centres across NSW, through behaviour change interventions.	**Accelerate delivery of active transport projects** by cutting red tape, providing resources and measuring success.

Transport for NSW Active Transport Strategy

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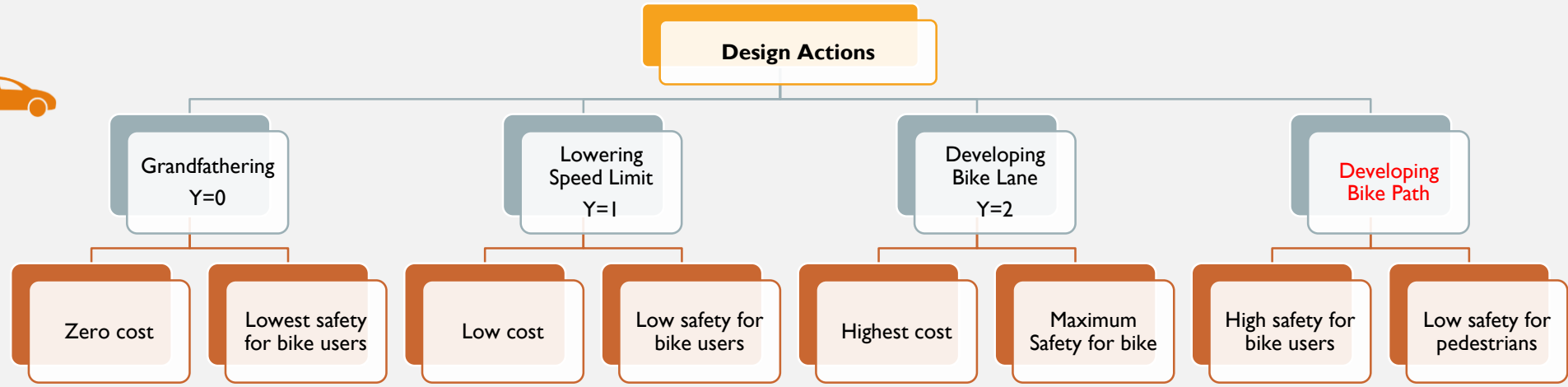
KEY MEASURES IN AN ACTIVE NETWORK DESIGN

- Grossman, A., Rodgers, M., Xu, Y., Guensler, R., & Watkins, K. (2019). If Safety Matters, Let's Measure It: Nationwide Survey Results for Bicycle and Pedestrian Treatment Prioritization. *Journal of Transportation Engineering, Part A: Systems*, 145, 04018081.

MEASURING SAFETY OF AN ACTIVE NETWORK

- Lian, Y., Zhou, E., Lee, J., & Abdel-Aty, M. (2022). Existence of the safety-in-numbers effect in the aspect of injury severity: A macroscopic analysis for bicyclists and pedestrians. *Journal of safety research*, *83*, 302-309.

Number of bicycle crashes= $exp^{\beta_0} \times (Veh)^{\beta_1} \times (Bic)^{\beta_2}$



EQUITABLE ACTIVE NETWORK DESIGN

$$\text{Min } Z$$

$$= \left[\sum_{a\in A} x_a^c t_a{}^c(\omega, x_a^b, y) + \sum_{a\in A} x_a^b t_a{}^b(x_a^b, x_a^c, y)\right] \times (1 - p^{rs}) \quad (1)$$

$$+ \left[\sum_{a\in A} x_a^c t_a(x_a^c, y) + \sum_{a\in A} x_a^b t_a{}^b(x_a^b, y)\right] \times p^{rs}$$

Possibility of unfair spatial distribution

More cost (more budget is required)

$$\rightarrow \sum_{rs\in RS} exp^{\beta_0} \times (q_c^{rs}\, l^{rs})^{\beta_1} \times (q_b^{rs} l^{rs})^{\beta_2} \times \left(1 - \frac{y^{rs}}{2}\right) \leq C \quad (2)$$

$$\rightarrow exp^{\beta_0} \times (q_c^{rs}\, l^{rs})^{\beta_1} \times (q_b^{rs} l^{rs})^{\beta_2} \times \left(1 - \frac{y^{rs}}{2}\right) \leq C^{rs}$$

What is the cost of more equity in safety risk?

$$\rightarrow \sum_{rs\in RS} l^{rs}\, y^{rs} \geq L \quad (3)$$

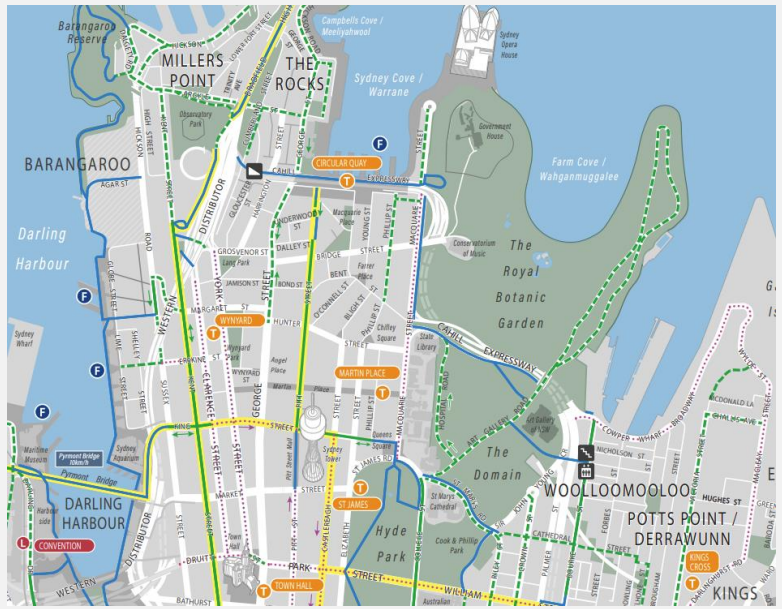
$$\sum_{rs\in RS} l^{rs}\, Cost\, y^{rs} \leq B \quad (5)$$

$$y^{rs} - 1 \leq p^{rs}, \qquad \forall rs \in RS \quad (6)$$

$$p^{rs} \leq y^{rs}, \qquad \forall rs \in RS \quad (7)$$

$$y^{rs} \in \{0,1,2\},\ p^{rs} \in \{0,1\}, \qquad \forall rs \in RS$$

EQUITABLE FINANCE OF ACTIVE NETWORKS



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EQUITABLE FINANCE OF PUBLIC TRANSPORT

Barbara T.H. Yen, Corinne Mulley, Min Zhang, (2020): Equity in financing public transport infrastructure: Evaluating funding options, *Transport Policy*,68-77.

- Investigated equity implications of value capture method to finance PT (case study: Gold Coast Light Rail Transit (GCLRT) stage one in Gold Coast)
- Imposing a levy based on the increase value of the property located in the proximity of the new infrastructure may not be equitable for some lower-income households

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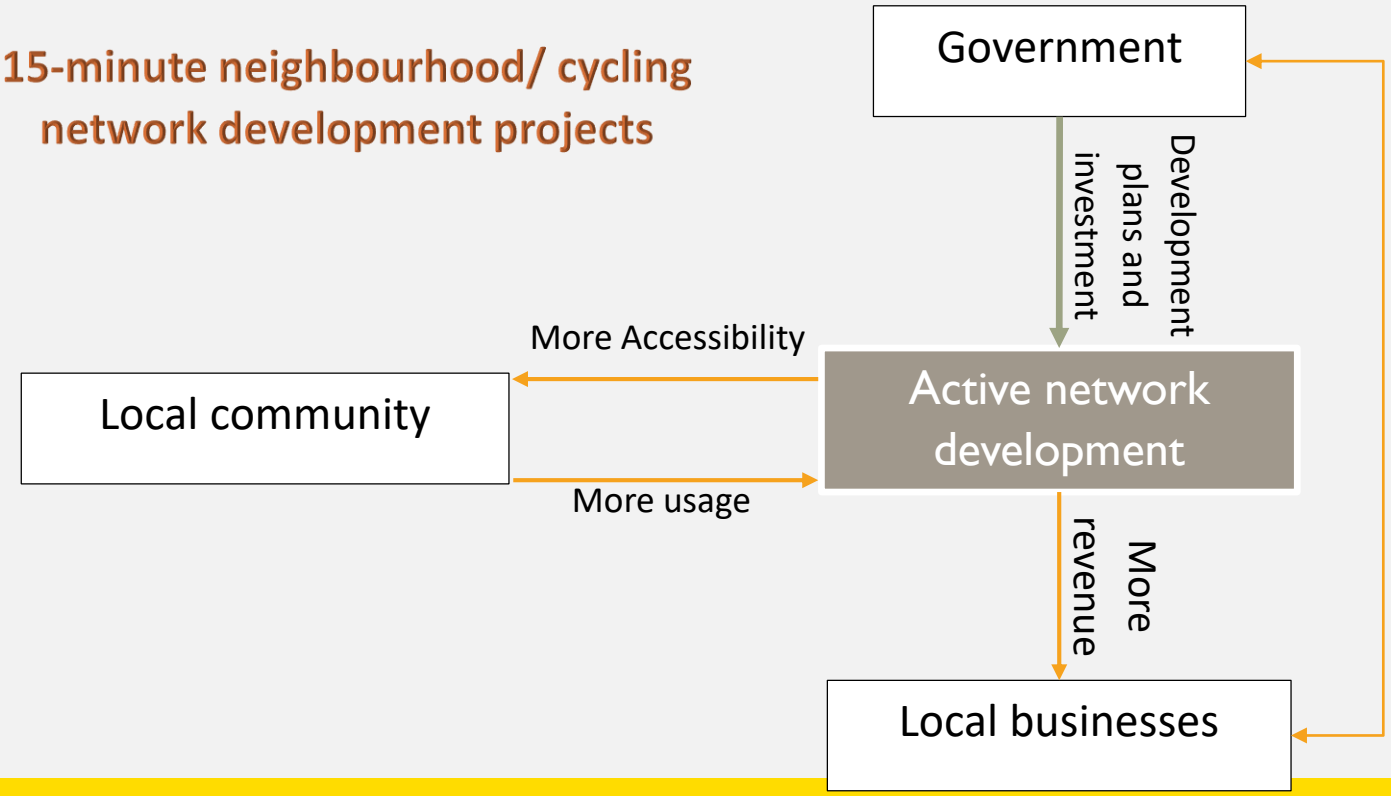
EQUITY IN FINANCING ACTIVE NETWORKS THROUGH NEIGHBOURHOOD DEALS

From the perspective of car owners, it might **not be fair** or **equitable** to use their tolls or fuel taxes to develop active networks, which could even reduce their shares of the road network resource.

This issue can be mitigated through **leveraging** the **financial resources of the beneficiary businesses** in the neighbourhood deals.

EQUITY IN FINANCE OF ACTIVE NETWORKS

15-minute neighbourhood/ cycling network development projects



- Co-investment models
  - Rent payment
  - Tax incentives

EQUITY IN FINANCING ACTIVE NETWORKS- RENT PAYMENT

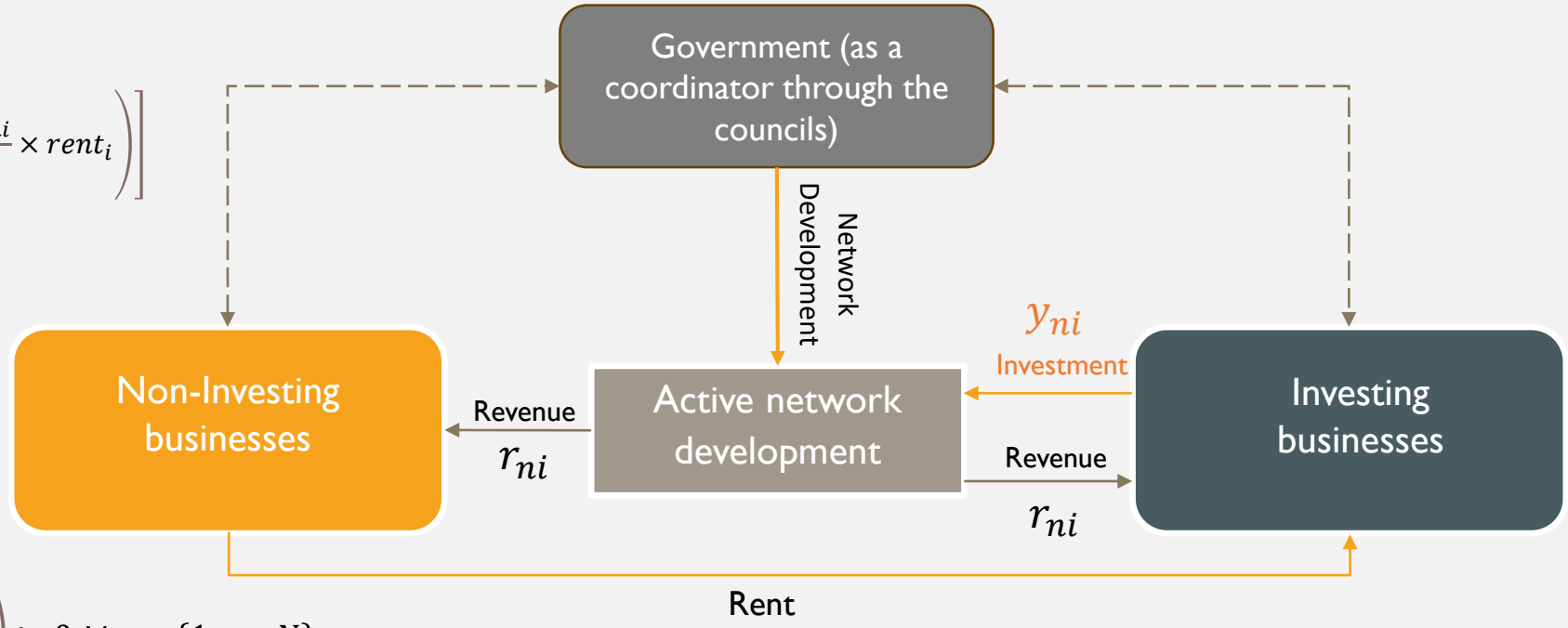
$$\max(\pi(y)) = \sum_{n=1}^{N}\left[\sum_{i=1}^{I}\left(r_{ni} - y_{ni} + \frac{y_{ni}}{C_i}\times rent_i - \sum_{m=1,m\neq n}^{N}\frac{y_{mi}}{C_i}\times rent_i\right)\right]$$

$$S.t.$$

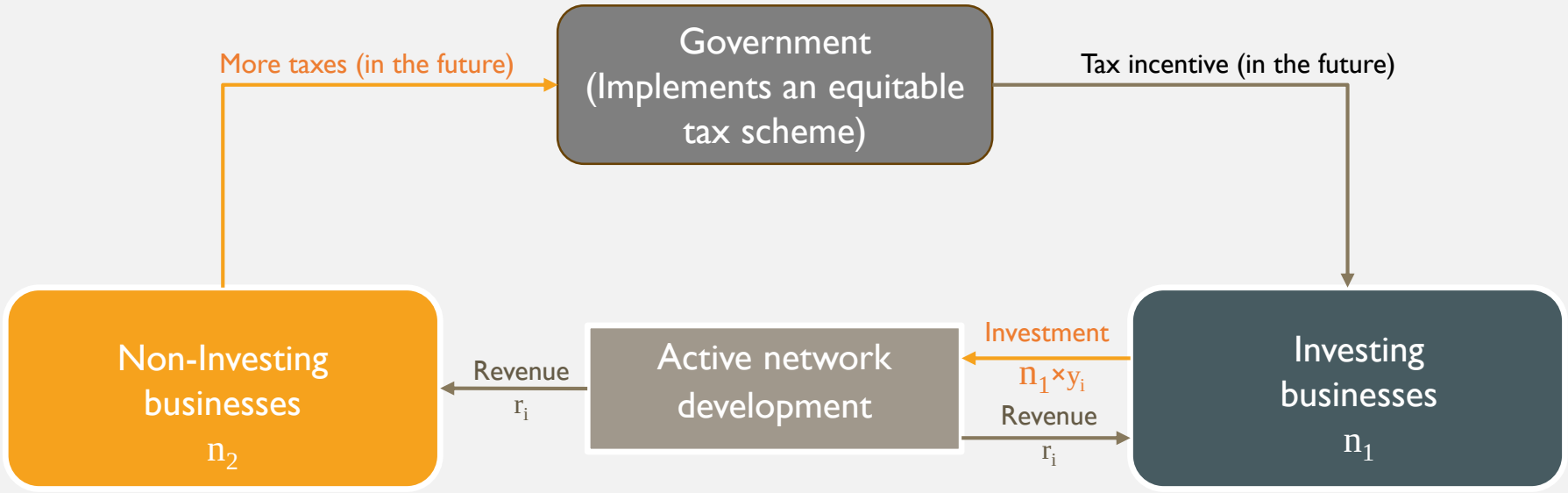
$$\sum_{i=1}^{I} y_{ni} \leq B_n, \forall\, n \in \{1, \dots, N\}$$

$$\sum_{n=1}^{N} y_{ni} \geq C_i, \forall\, i \in \{1, \dots, I\}$$

$$\sum_{i=1}^{I}\left(r_{ni} - y_{ni} + \frac{y_{ni}}{C_i}\times rent_i - \sum_{m=1,m\neq n}^{N}\frac{y_{mi}}{C_i}\times rent_i\right) \geq 0, \forall\, n \in \{1, \dots, N\}$$

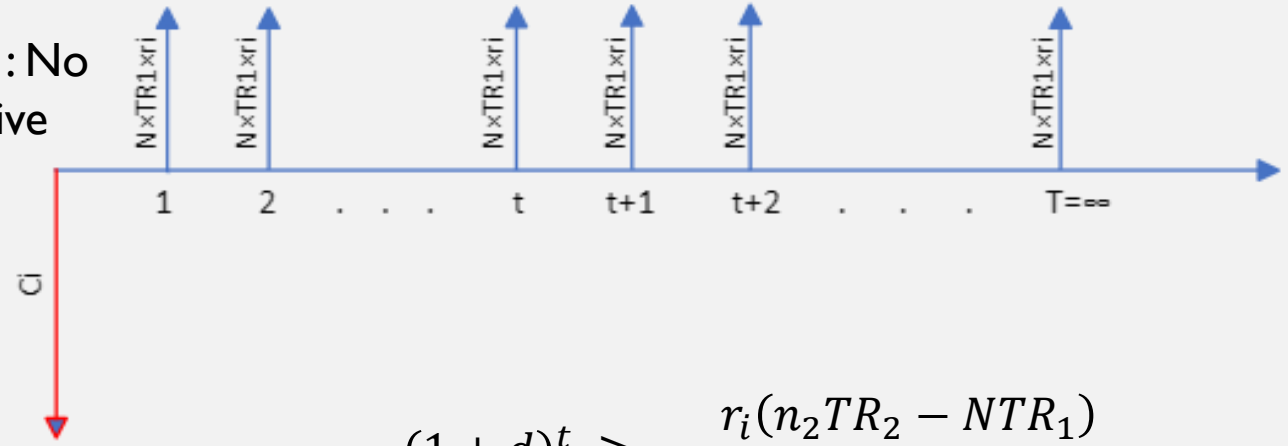


EQUITY IN FINANCING ACTIVE NETWORKS- TAX INCENTIVE



EQUITY IN FINANCE THROUGH TAX INCENTIVE (GOVERNMENT SIDE)

Scenario I: No tax incentive

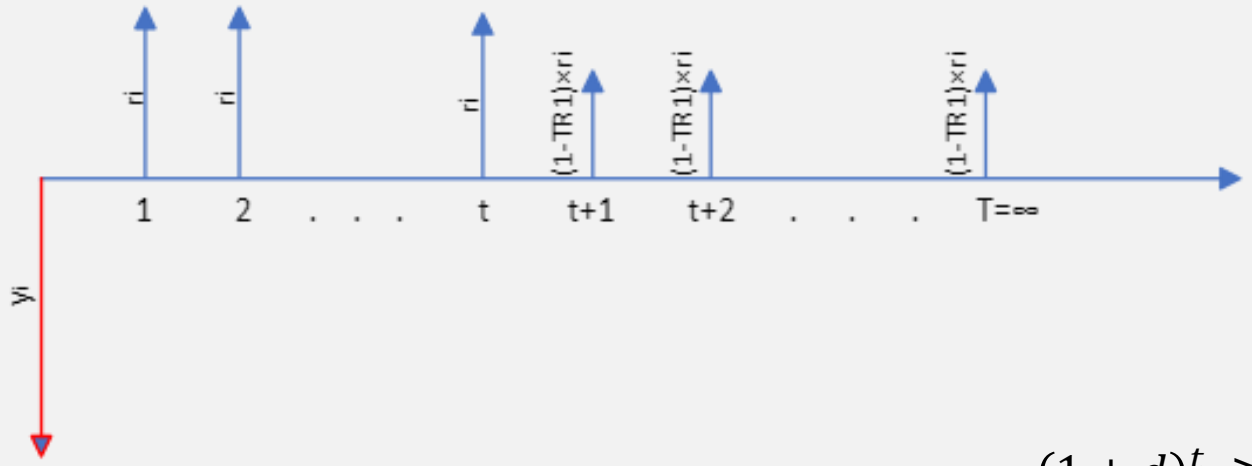


Scenario II: tax incentive scheme

$$(1+d)^t \geq \frac{r_i(n_2TR_2 - NTR_1)}{r_i(n_2TR_2 - NTR_1) - n_1y_i} \quad , TR_2 \geq \frac{N}{n_2}TR_1$$

EQUITY IN FINANCE THROUGH TAX INCENTIVE (BUSINESS SIDE)

Scenario I: Investing



$$(1+d)^t \geq \frac{r_i}{TR_2 r_i - y_i d}$$

Scenario II: Not investing

Final remarks

- This study seeks for two key goals in designing active networks : 1) equity in safety and 2) equity in finance of the network.
- This study aims to quantify the equity in the safety risks for active network users while optimizing other network performance measures.
- A Genetic algorithm is developed to solve the bi-level programming model to reach the most equitable design.
- It also addresses how to finance the active network projects in more equitable manner.