On The Right Track?
Designing Optimal Public Transit Contracts

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How should governments design contracts when outsourcing public transit?

Context: Public transit mitigates externalities, but low quality discourages ridership

- 51% of Americans report inadequate bus, subway, or commuter train service (AHS, 2023)

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Trend: Cities are increasingly contracting out public transit to private firms

- Ex: Singapore, Paris, Hong Kong, Sao Paulo, London, Santiago
- Why? → To discipline operators and benchmark performance and costs

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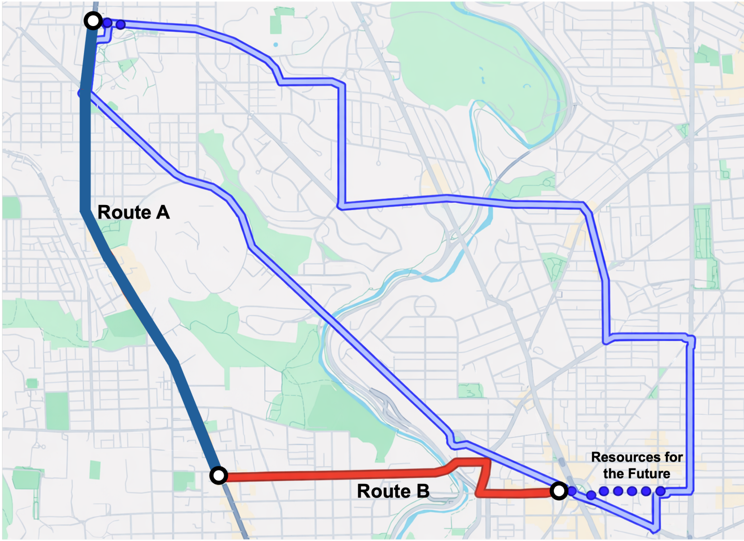
- Ex: Singapore, Paris, Hong Kong, Sao Paulo, London, Santiago
- Why? → To discipline operators and benchmark performance and costs

Challenge: How to design these contracts?

- Quality targets: Too lax → poor service. Too strict → high costs
- Route bundles: Too few → weak competition. Too many → weak coordination

Washington D.C. Example



This Paper

Policy variation

- Large contract reform affecting 40% of transit routes in Santiago, Chile in 2022
  - Stricter quality targets and smaller route bundles (more operators)

Research question

- How should quality targets and route bundles be designed in public transportation contracts to maximize welfare?

Empirical approach: Transportation Engineering + Economics

1. Event study: Estimate how operators respond to quality target and route bundle changes
2. Model: Simulate counterfactual contract designs to identify optimal contract parameters

Roadmap

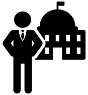
Background and Data

Descriptive Evidence

Model and Counterfactual Analysis

Setting and Institutional Details

Transit Agency

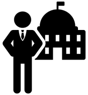


For travelers: Sets public transit fares

For operators:
- Sets quality targets for service attributes
- Creates route bundles for auction

Setting and Institutional Details

Transit Agency



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Bundle 1

Bundle 2

Bundle 3

Bundle 4

Setting and Institutional Details

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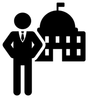

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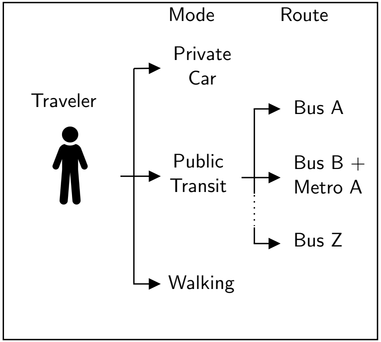
Travelers



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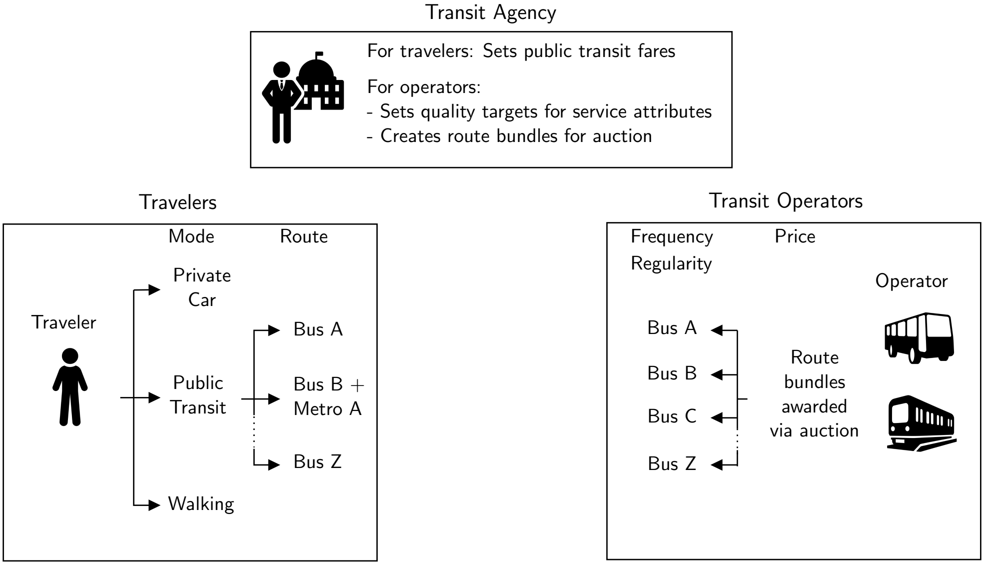

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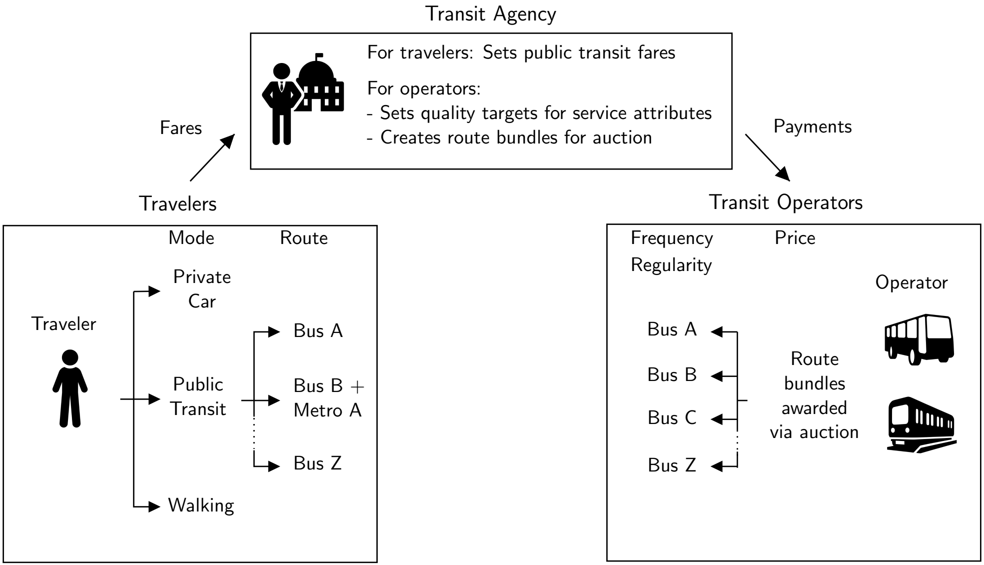

Data Sources

1. Quality targets and route bundles → Policy variation
   - Transit contracts data: Before and after the contract reform.

2. Frequency and headway regularity choices → Transit Operators
   - GPS (30 sec) for all buses (2022–2023): $\sim$ 15M a day.

3. Transportation mode and public transit route choices → Travelers
   - Household travel survey (2012–2013): Representative sample of $\sim$ 50,000 trips.
   - Smartcard data (2012–2023): All transit trips ($\sim$ 30M a week) and itinerary.

4. Traffic flows and travel time → Traffic congestion
   - Traffic readers and Google Maps API (2022): 70 locations in 15-min intervals.

Roadmap

Background and Data

Descriptive Evidence

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Descriptive Evidence: Do stricter Quality Targets bite?

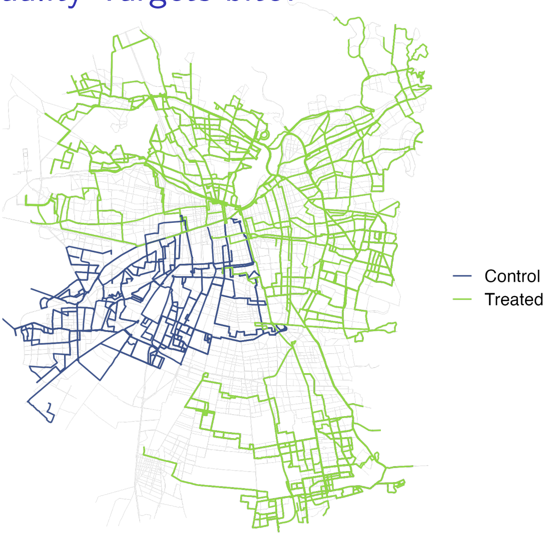
Treated group
112 routes

$+$

Control group*
31 routes

$=$

Difference-in-differences sample
Aug 2022 – Aug 2023



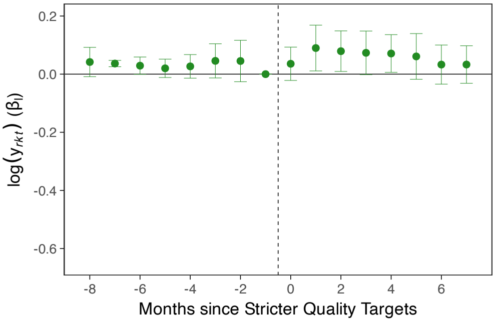
*Spillovers: Only 0.8% of O–D pairs have choice sets that include both a treated and a control route.

Descriptive Evidence: Do stricter Quality Targets bite?

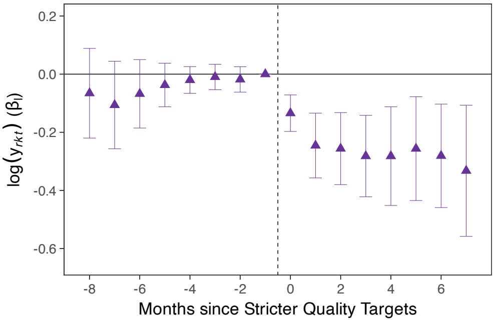
I compare treated and control routes over time:

- If similar trends before the reform $\rightarrow$ Groups are comparable ✓

Effect on Frequency



Effect on Headway Regularity

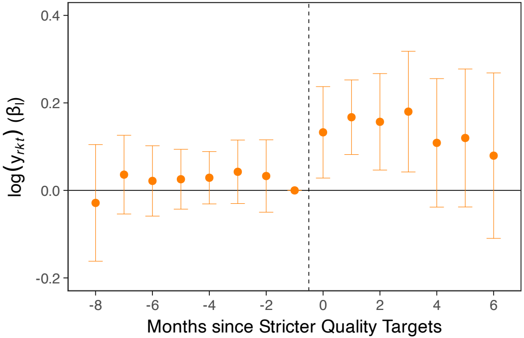


Descriptive Evidence: Do Travelers respond to better Service Quality?

I compare treated and control routes over time:

- If similar trends before the reform → Groups are comparable ✓

Effect on Ridership



Descriptive Evidence: Takeaways

Stricter quality targets improve reliability and travelers respond

- Headway regularity improves by 16% and ridership increases by 11%
- Suggests penalties may be lower than effort costs of improving regularity

I develop and estimate a model to:

- Map changes in contract design into firms' costs of providing service attributes
- Capture traveler substitution patterns within transit and across modes
- Quantify welfare implications of alternative contract designs and optimal policy

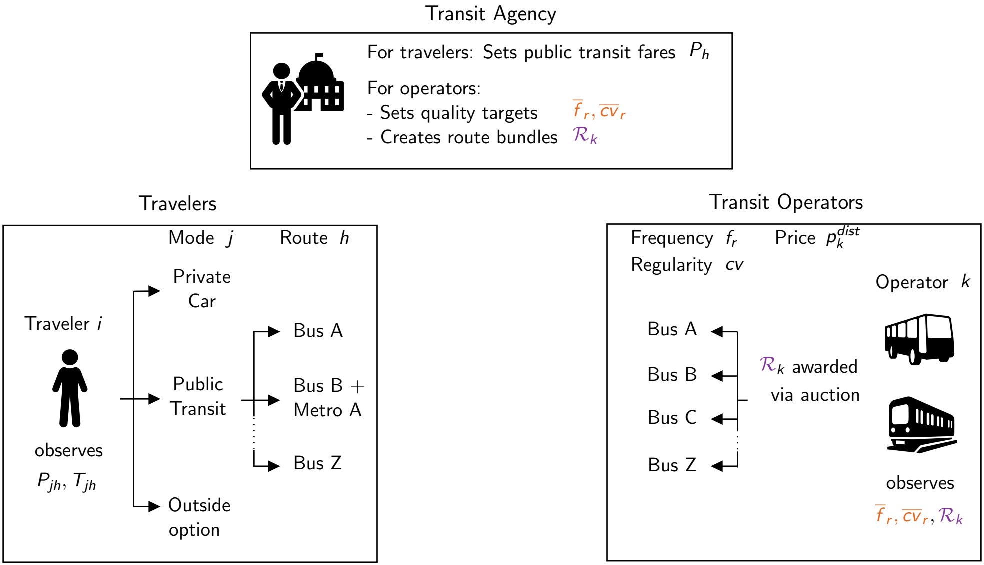
Roadmap

Background and Data

Descriptive Evidence

Model and Counterfactual Analysis

Model Overview



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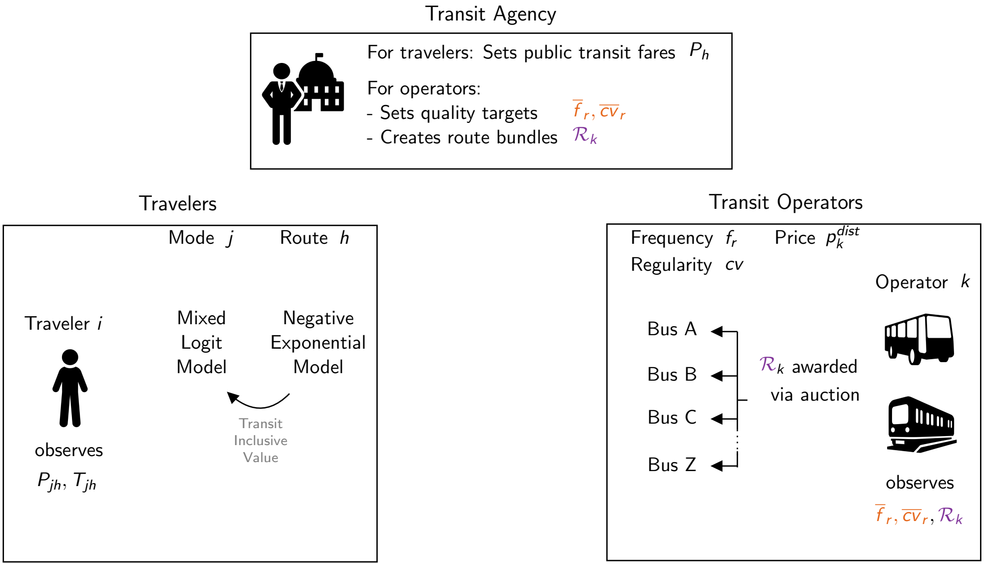

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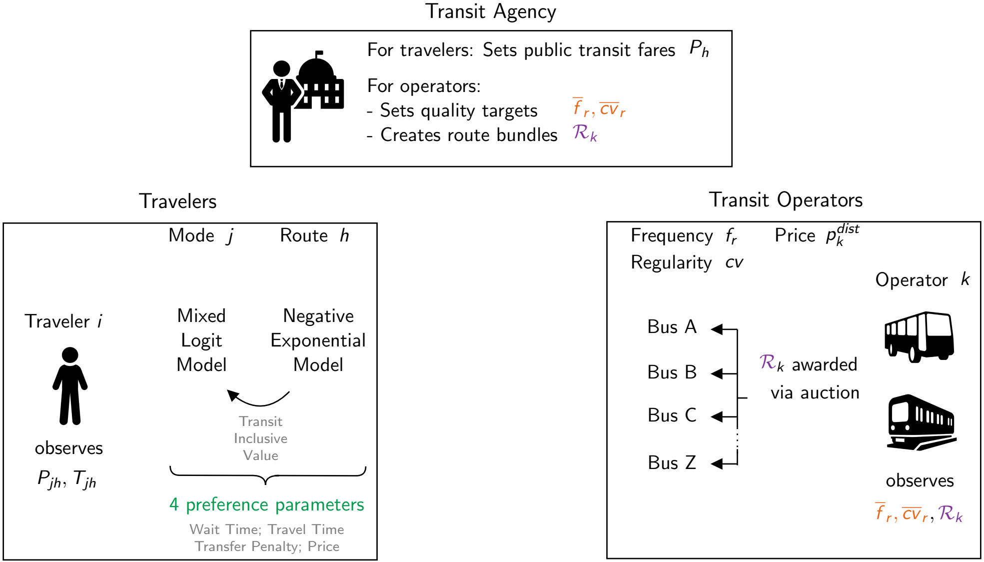

Model Overview

Transit Agency

For travelers: Sets public transit fares P_h

For operators:

- Sets quality targets $\overline{f}_r, \overline{cv}_r$
- Creates route bundles $\mathcal{R}_k$

Travelers

Mode j — Route h

Traveler i

observes P_{jh}, T_{jh}

Mixed Logit Model ← Negative Exponential Model

Transit Inclusive Value

4 preference parameters

Wait Time; Travel Time
Transfer Penalty; Price

Transit Operators

Frequency f_r — Price p_k^{dist}

Regularity cv

Operator k

Profit FOCs → Recover Marginal Cost

observes $\overline{f}_r, \overline{cv}_r, \mathcal{R}_k$

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Traveler i observes P_{jh}, T_{jh}

Mode j: Mixed Logit Model

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Transit Operators

Frequency f_r
Regularity cv

Price p_k^{dist}

Operator k observes $\overline{f}_r, \overline{cv}_r, \mathcal{R}_k$

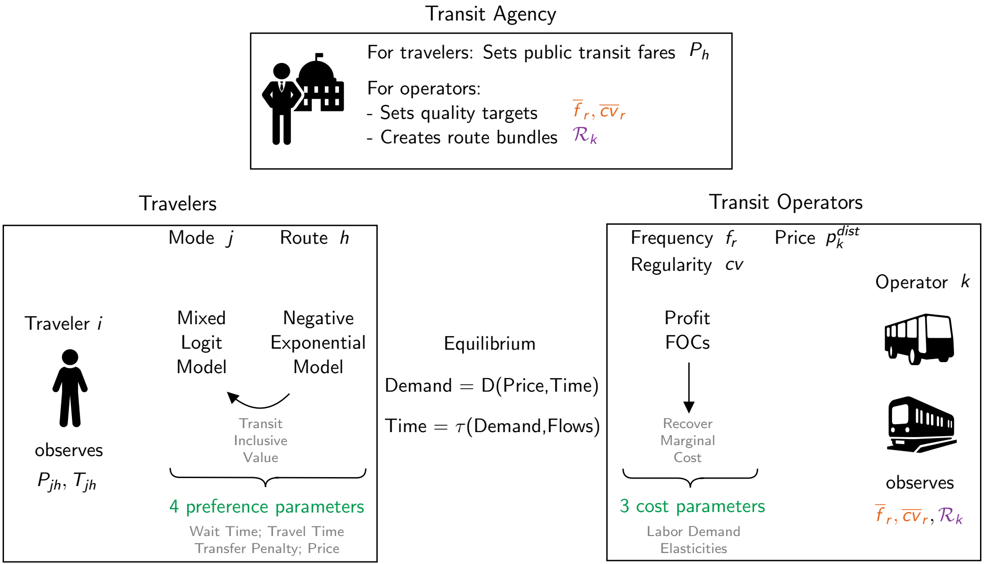
Profit FOCs

Recover Marginal Cost

3 cost parameters

Labor Demand Elasticities

Model Overview



Counterfactual Analysis: Policy Questions

I simulate counterfactual scenarios to answer

1. How efficient are the baseline quality targets and route bundling relative to:
   - Social planner
   - Unregulated monopoly: Pure market power
   - Regulated monopoly: Role of competition

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2. What are the welfare implications of optimal route bundling design?
   - I evaluate mergers of existing bundles $\rightarrow$ Optimal composition: ongoing work

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2. What are the welfare implications of optimal route bundling design?
   - I evaluate mergers of existing bundles $\rightarrow$ Optimal composition: ongoing work

3. What are the welfare implications of optimal quality targets?
   - I focus on the headway regularity target $\rightarrow$ Frequency target assumed optimal

Counterfactual Analysis: Efficiency of Baseline Contract Design

	Baseline (1)
Panel A: Prices	
Bus Price ($)	0.90
Bus → Metro Transfer Price ($)	0.10
Panel B: Service Attributes	
Δ Frequency (%)	0.00%
Δ CV of Headways (%)	0.00%
Avg. Wait (min)	5.30
Avg. Speed (km/h)	19.06
Panel C: Trips	
Transit (M)	0.15
Private Car (M)	0.19
Panel D: Welfare and Fiscal Cost	
Δ Welfare (T)	0.00
Δ Consumer Surplus (T)	0.00
Δ Producer Surplus (T)	0.00
Δ Externalities (T)	0.00
Δ Regulator Net Cost (T)	0.00

Counterfactual Analysis: Efficiency of Baseline Contract Design

	Baseline (1)	Social Planner (2)
Panel A: Prices		
Bus Price ($)	0.90	0.37
Bus $\rightarrow$ Metro Transfer Price ($)	0.10	0.13
Panel B: Service Attributes		
Δ Frequency (%)	0.00%	19.50%
Δ CV of Headways (%)	0.00%	-19.96%
Avg. Wait (min)	5.30	4.15
Avg. Speed (km/h)	19.06	22.20
Panel C: Trips		
Transit (M)	0.15	0.28
Private Car (M)	0.19	0.10
Panel D: Welfare and Fiscal Cost		
Δ Welfare (T)	0.00	544.56
Δ Consumer Surplus (T)	0.00	329.24
Δ Producer Surplus (T)	0.00	-0.24
Δ Externalities (T)	0.00	-215.56
Δ Regulator Net Cost (T)	0.00	-

Counterfactual Analysis: Efficiency of Baseline Contract Design

	Baseline (1)	Social Planner (2)	Monopoly (U) (3)
Panel A: Prices			
Bus Price ($)	0.90	0.37	2.11
Bus $\rightarrow$ Metro Transfer Price ($)	0.10	0.13	0.10
Panel B: Service Attributes			
Δ Frequency (%)	0.00%	19.50%	-29.26%
Δ CV of Headways (%)	0.00%	-19.96%	39.93%
Avg. Wait (min)	5.30	4.15	8.79
Avg. Speed (km/h)	19.06	22.20	16.01
Panel C: Trips			
Transit (M)	0.15	0.28	0.07
Private Car (M)	0.19	0.10	0.24
Panel D: Welfare and Fiscal Cost			
Δ Welfare (T)	0.00	544.56	-943.98
Δ Consumer Surplus (T)	0.00	329.24	-95.76
Δ Producer Surplus (T)	0.00	-0.24	0.18
Δ Externalities (T)	0.00	-215.56	848.40
Δ Regulator Net Cost (T)	0.00	-	-

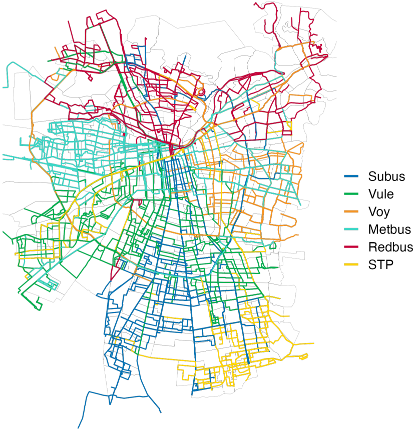
Counterfactual Analysis: Efficiency of Baseline Contract Design

	Baseline (1)	Social Planner (2)	Monopoly (U) (3)	Monopoly (R) (4)
Panel A: Prices				
Bus Price ($)	0.90	0.37	2.11	0.90
Bus $\rightarrow$ Metro Transfer Price ($)	0.10	0.13	0.10	0.10
Panel B: Service Attributes				
Δ Frequency (%)	0.00%	19.50%	-29.26%	-4.88%
Δ CV of Headways (%)	0.00%	-19.96%	39.93%	-8.98%
Avg. Wait (min)	5.30	4.15	8.79	5.41
Avg. Speed (km/h)	19.06	22.20	16.01	19.06
Panel C: Trips				
Transit (M)	0.15	0.28	0.07	0.15
Private Car (M)	0.19	0.10	0.24	0.19
Panel D: Welfare and Fiscal Cost				
Δ Welfare (T)	0.00	544.56	-943.98	-1.25
Δ Consumer Surplus (T)	0.00	329.24	-95.76	-1.21
Δ Producer Surplus (T)	0.00	-0.24	0.18	0.02
Δ Externalities (T)	0.00	-215.56	848.40	0.06
Δ Regulator Net Cost (T)	0.00	-	-	67.73

Counterfactual Analysis: Optimal Route Bundling for Current Regulation

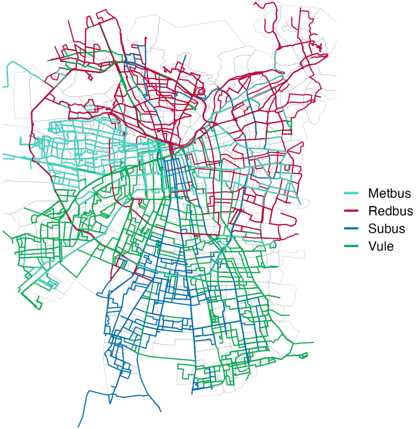
Baseline (6 firms)

Δ Welfare (T) = 0.00



Optimal (4 firms)

Δ Welfare (T) = 91.06

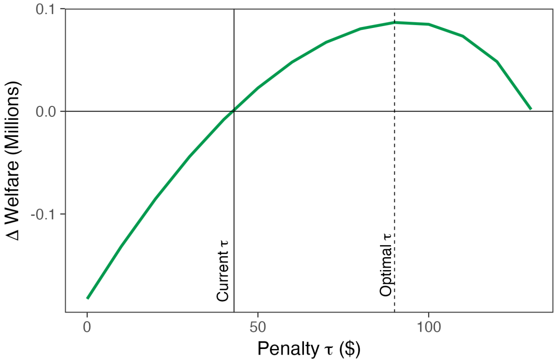


Better coordination + scale economies

Counterfactual Analysis: Optimal Headway Regularity Target

The penalty has the form: $\tau^w \cdot (\bar{CV}_r - CV_{rt})$

- I set the headway regularity target $\bar{CV}_r$ at the Planner's solution under baseline prices.
- I solve for the penalty τ^{w^*} that maximizes social welfare.



Policy Takeaways

1. Contract design is a cost-effective lever to improve transit and support mode shift
   - Quality targets: Reliability $\uparrow$ 16% $\rightarrow$ Ridership $\uparrow$ 11%
2. Wait time is a key traveler welfare margin
   - Wait time is valued at $1.8\times$ in-vehicle travel time $\rightarrow$ central for policy evaluation
3. Network coordination remains central in multi-operator systems
   - Fragmented contracting ($\uparrow$ competition) can undermine system-wide performance
4. Quality regulation can improve user experience without large budget expansions
   - Most gains came from reallocating firm effort rather than expanding fleets

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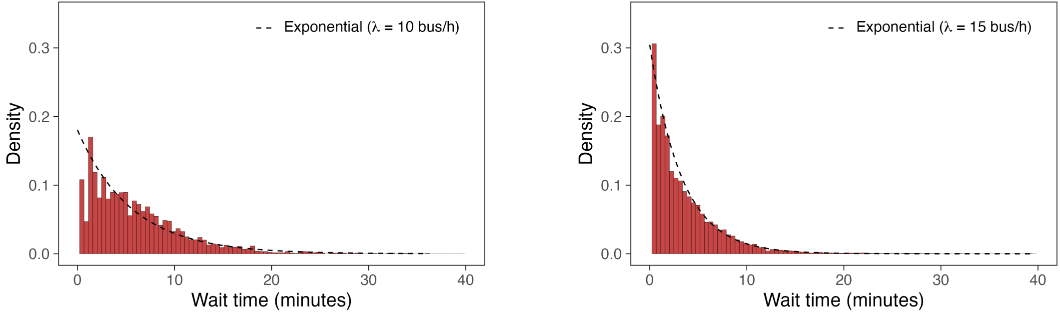
Roadmap

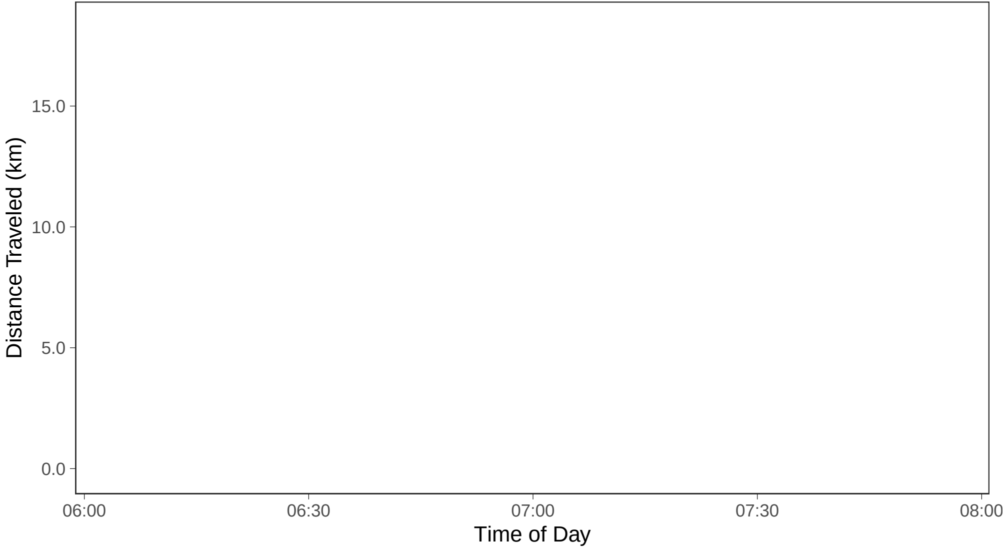
Appendix

Travelers: Wait time distribution

Return



Service Attributes: Frequency and Headway Regularity



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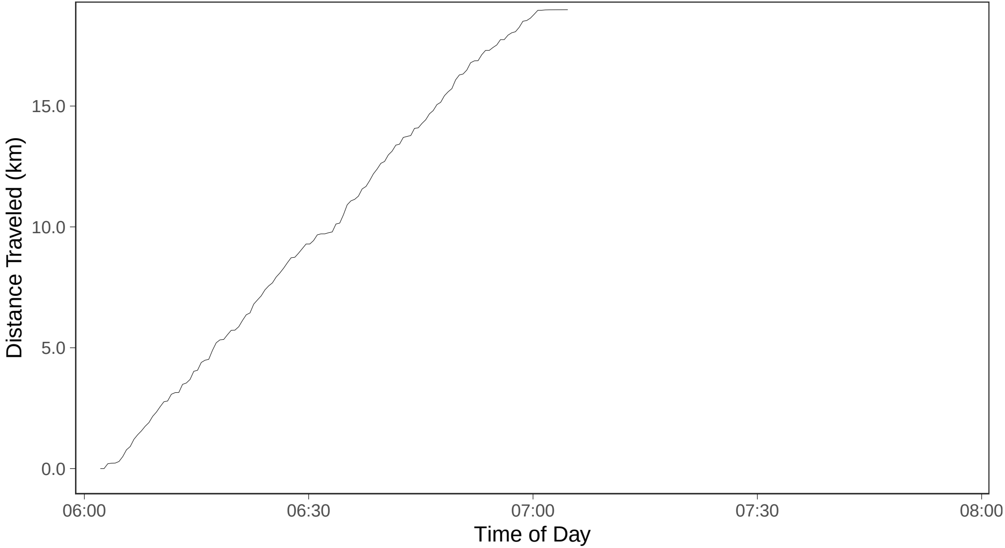

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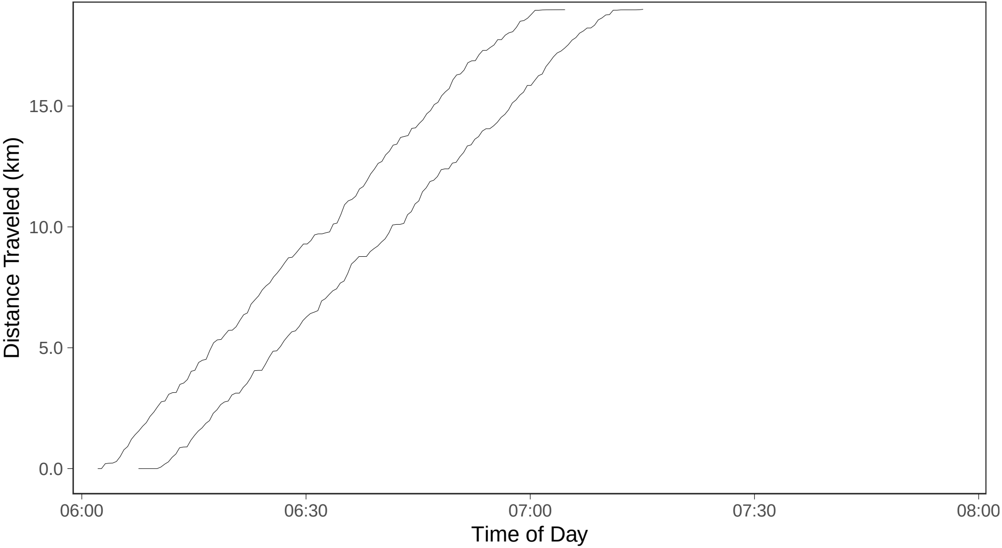

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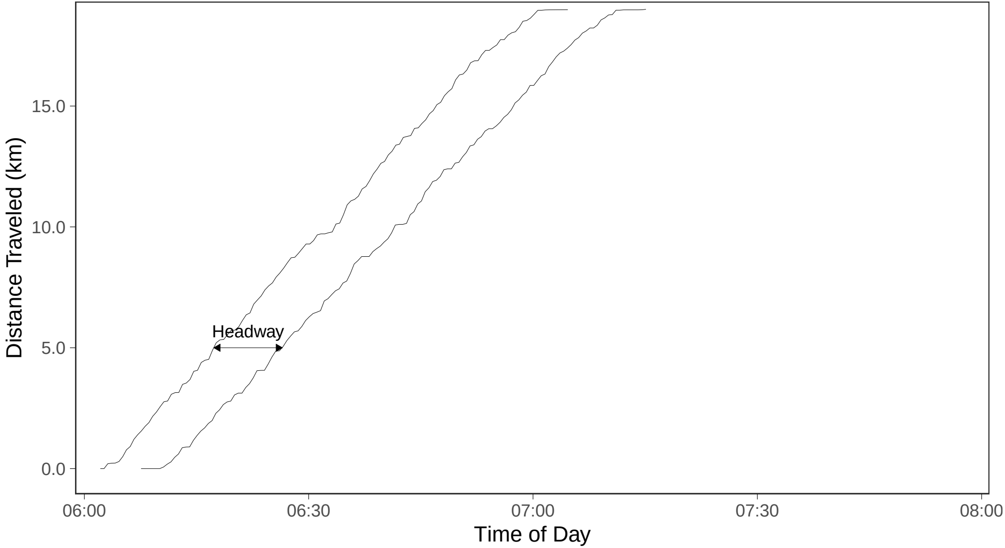

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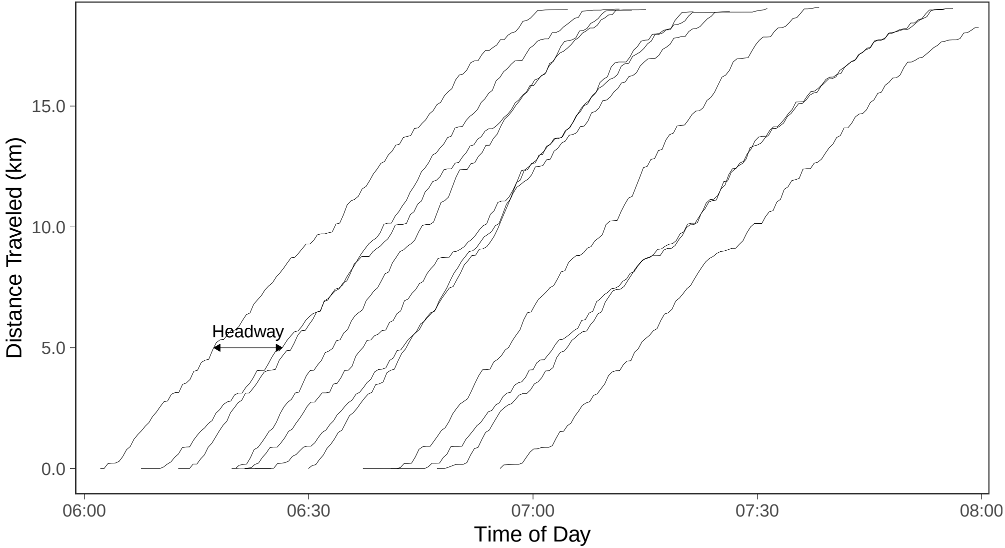

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