Exploring the impact of shared mobility services on CO_2 emissions

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BETTER POLICIES FOR BETTER LIVES

Introduction

- Shared mobility: technology-enabled matching of users who share ownership and/or use of vehicles.
- Ride-sharing: shared use **at the same time** (Santos, 2018; Fulton, 2018)
  - Evidence indicates significant reductions possible (up to 54%)
  - Extent of impact is unclear: can reduce vehicle kilometres (+) but may attract public transit and soft mobility users (-)

Research question

- **What role could shared mobility play in reducing CO_2 emissions from urban passenger transport?**
- Impact will depend on:
  - Adoption level
  - Original travel mode of new shared mobility users
  - City-specific characteristics (to the extent that they influence the above and net CO_2 emissions)
- Two scenarios to 2050:
  - Reference scenario: no shared mobility
  - Counterfactual scenario: shared mobility

Modelling emissions

The basic equation: $\mathbf{E_t} = \mathbf{T_t} \left\{ \sum_{r=0}^{R=47} \left(\pi_r \mathrm{D}_r \sum_i \left(P_{rit} \frac{\mathrm{e}_{it}}{L_{it}} \right) \right) \right\}$

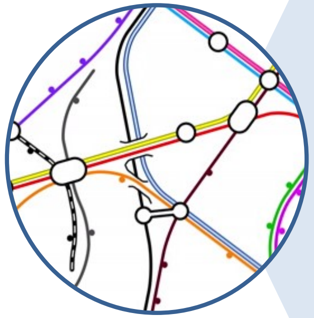
- Emissions in each scenario depend on overall travel demand in pkm and the average emissions per pkm
- Travel demand projections from ITF
- Average emissions per pkm:
  - Type of trip (6 distance categories × 2 departure times × 2 departure locations × 2 SM types (taxi, shuttle))
  - Frequency of trip
  - Distance traveled per trip
  - Emissions intensity of a given mode (walk-bike, car, public transit, shared mobility)
  - Probability of choosing a mode

Modelling mode choice

Mode choice: $$P_{rit}\left(\mathbf{x}_r; \widehat{\boldsymbol{\beta}}_j, \boldsymbol{\Omega}_{it}\right) = \frac{exp\left(\boldsymbol{\Omega}_{iE} + \mathbf{x}_{ri}\widehat{\boldsymbol{\beta}}_i\right)}{\sum_j \left(exp\left(\boldsymbol{\Omega}_{jE} + \mathbf{x}_{rj}\widehat{\boldsymbol{\beta}}_j\right)\right)} \neq P_{i0}^{DATA}$$

- Trip attributes: travel time, cost, comfort vary by mode and city
- Preference parameters: econometrically estimated (Auckland, Helsinki & Dublin)
- Fixed effects (FE): vary across modes, cities and years
  - Calibrated to fit the observed mode splits in each city in 2015

Data sources



ITF urban model:

- For 1692 cities, the model generates information from synthetic trips according to their origin, distance and time of the day
- The ITF also provided data on the probability of each type of trip in each city
- This analysis is based on a subsample of 247 cities in 29 OECD countries

IEA data: carbon intensity of electricity generation

- Data on energy balances and projections from the Energy Outlook 2018

ITF data on travel demand, vehicle occupancy rates and emission factors of the different transport modes, stated preferences for shared mobility

Data sources

Choose the option below that best suits your **preferred mode of travel**. Compare current transport options and shared mobility options.

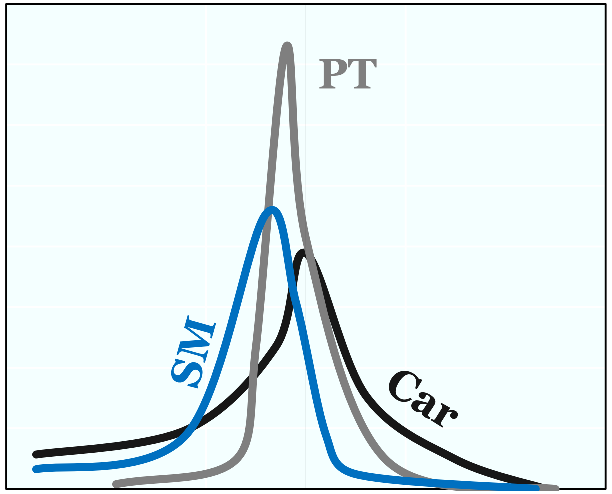
Public Transport	Shared Mobility
On board time: 40mins Fare: NZ$2.5 Walking time: 20 mins Waiting time: 20 mins Number of transfers: 1 Mode: Bus	On board time: 15 mins Fare: NZ$8 Walking time: 10 mins Lost time: 15 mins Passengers on board: 4
Private Car	**Other (non-motorised)**
Travel time: 30 mins Fuel / energy cost: NZ$2 Parking cost: No cost Congestion level: Less than 20% of time stopped Congestion charge / tolls: NZ$5	Travel time: 45 mins Availability of sidewalk: Good Crossing in traffic: Pedestrian crossing Mode: Walk

- Survey data from Auckland, Dublin and Helsinki
- Sample size: 280 individuals who completed 4 choice experiments

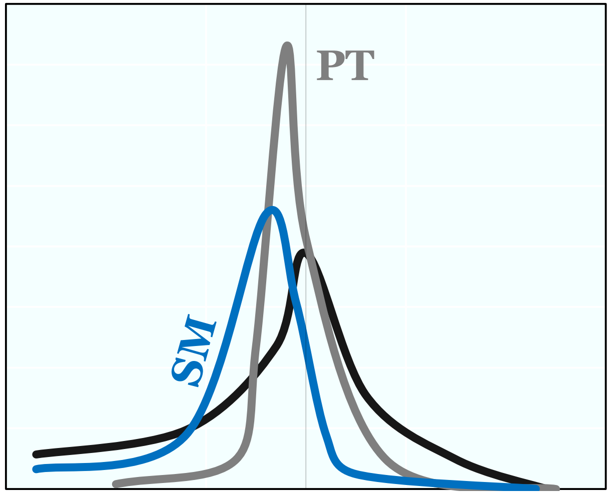
Scenarios

Reference

Relative frequency (%)

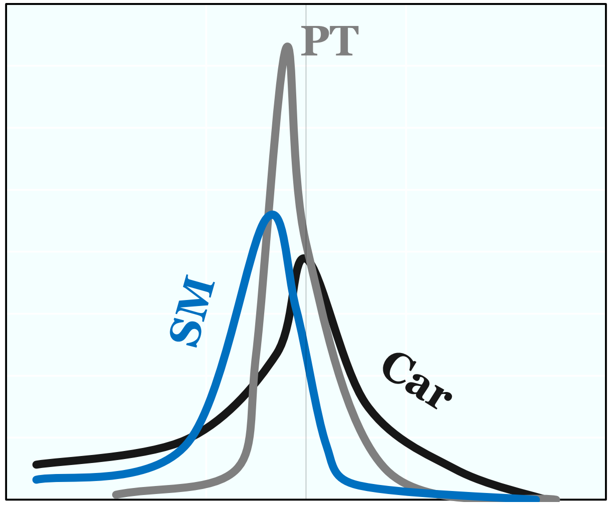


All fixed effects remain fixed

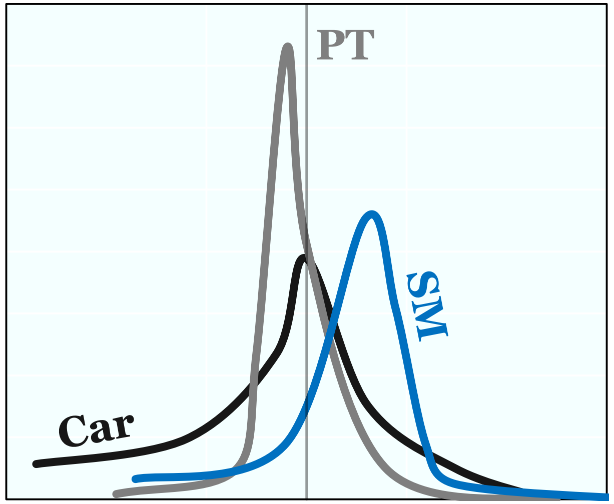


Counterfactual

Relative frequency (%)

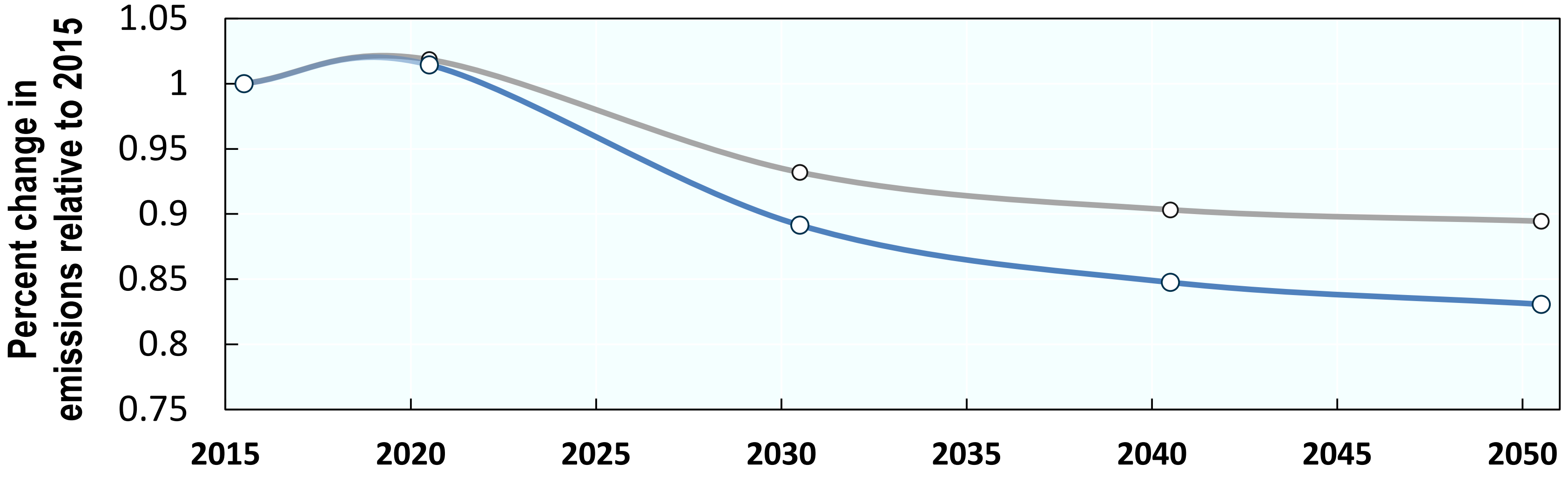


All SM fixed effects increase by one standard deviation.



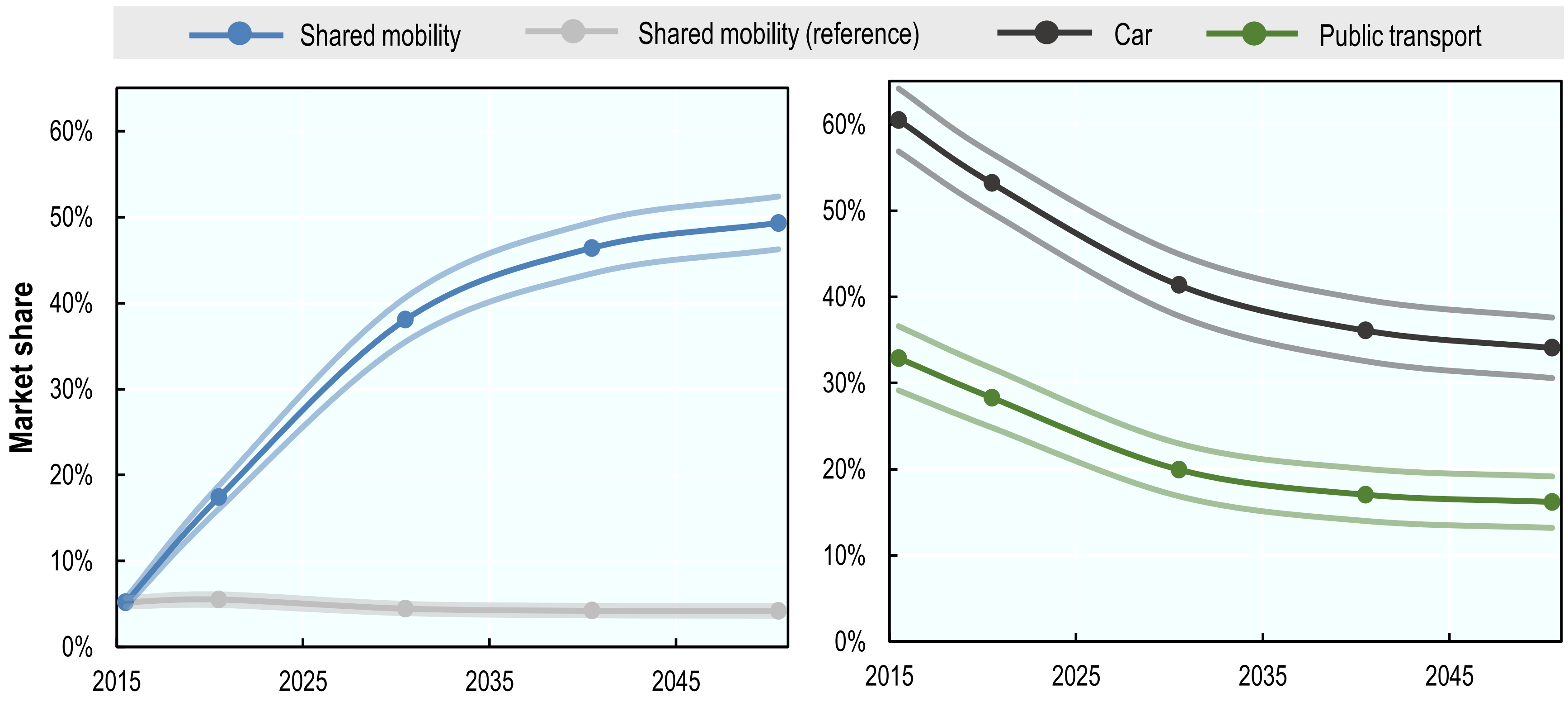
2015 **Transition** **2050**

The key finding:



Reference scenario without shared mobility:	-10.6 %
Counterfactual scenario with shared mobility:	-16.9 %
Net impact of shared mobility:	-6.3 %

Mode shares



Shared mobility
Shared mobility (reference)
Car
Public transport
Market share
60%
50%
40%
30%
20%
10%
0%
2015
2025
2035
2045

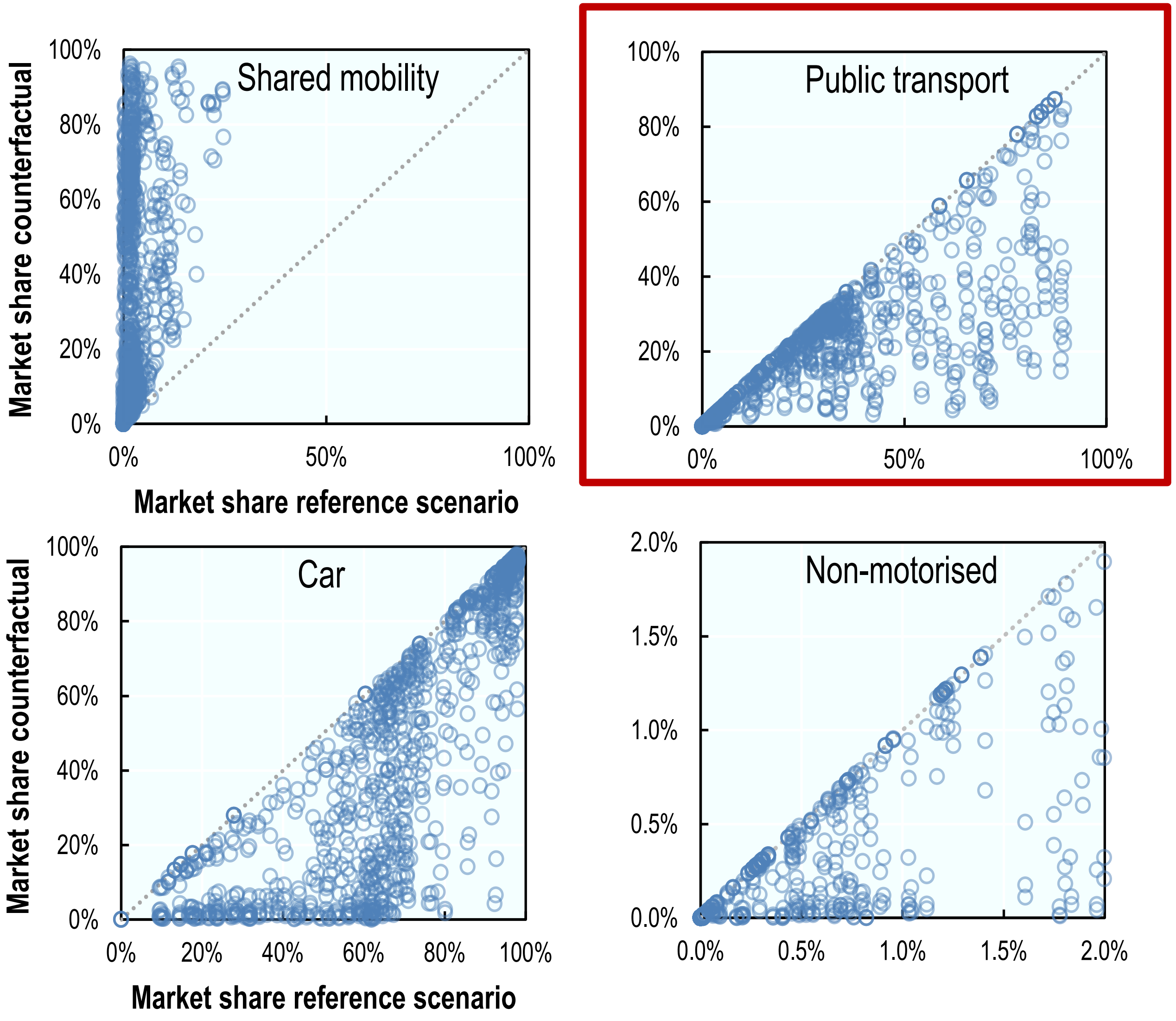
Mode shares


Shared mobility
Public transport
Car
Non-motorised
Market share counterfactual
Market share reference scenario
100%
80%
60%
40%
20%
0%
50%
2.0%
1.5%
1.0%
0.5%
0.0%

Mode shares

- Shared mobility is taken up in the counterfactual scenario

Mode shares



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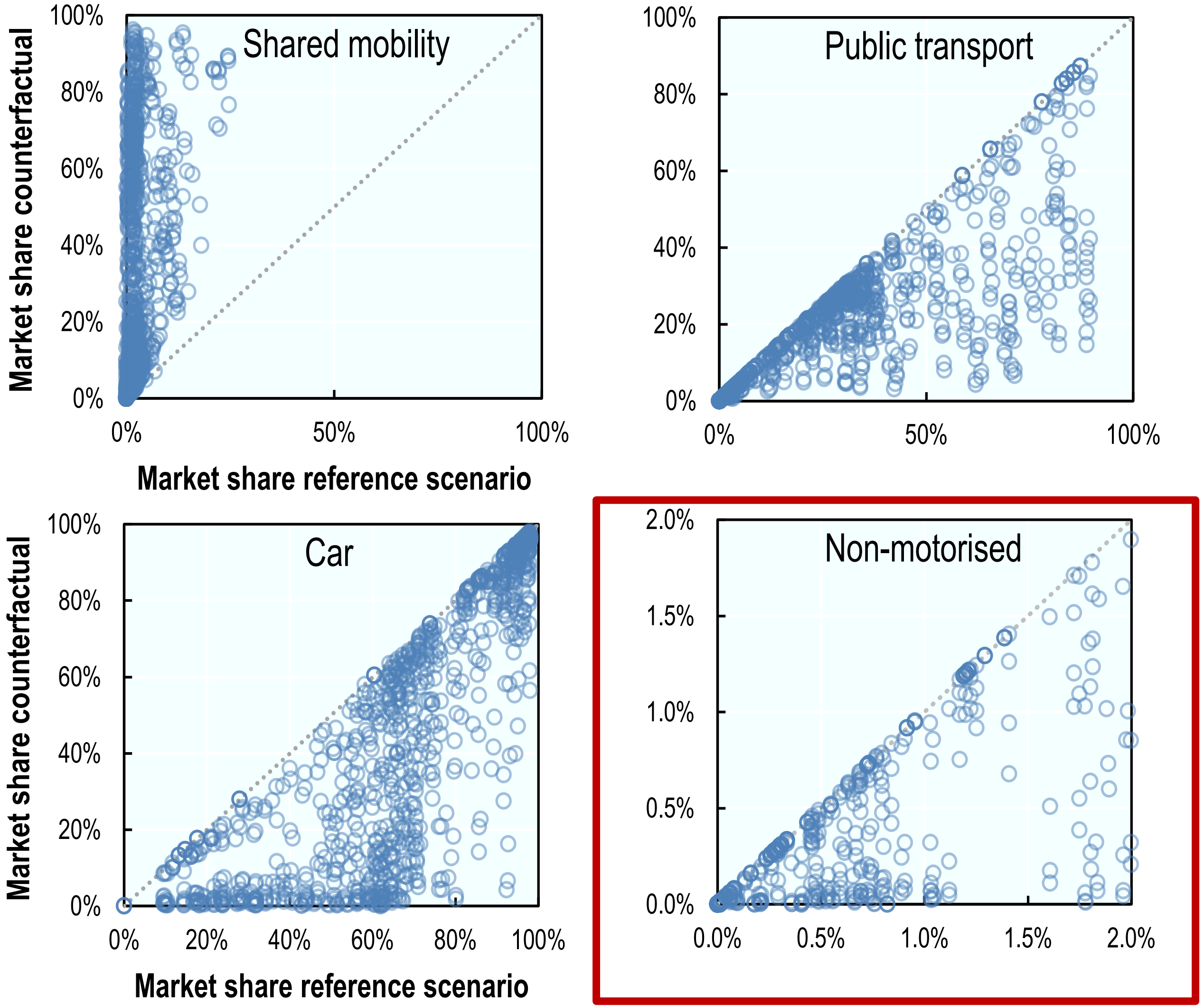
- SM displaces some PT ridership, but ridership remains stable in many cities

Mode shares



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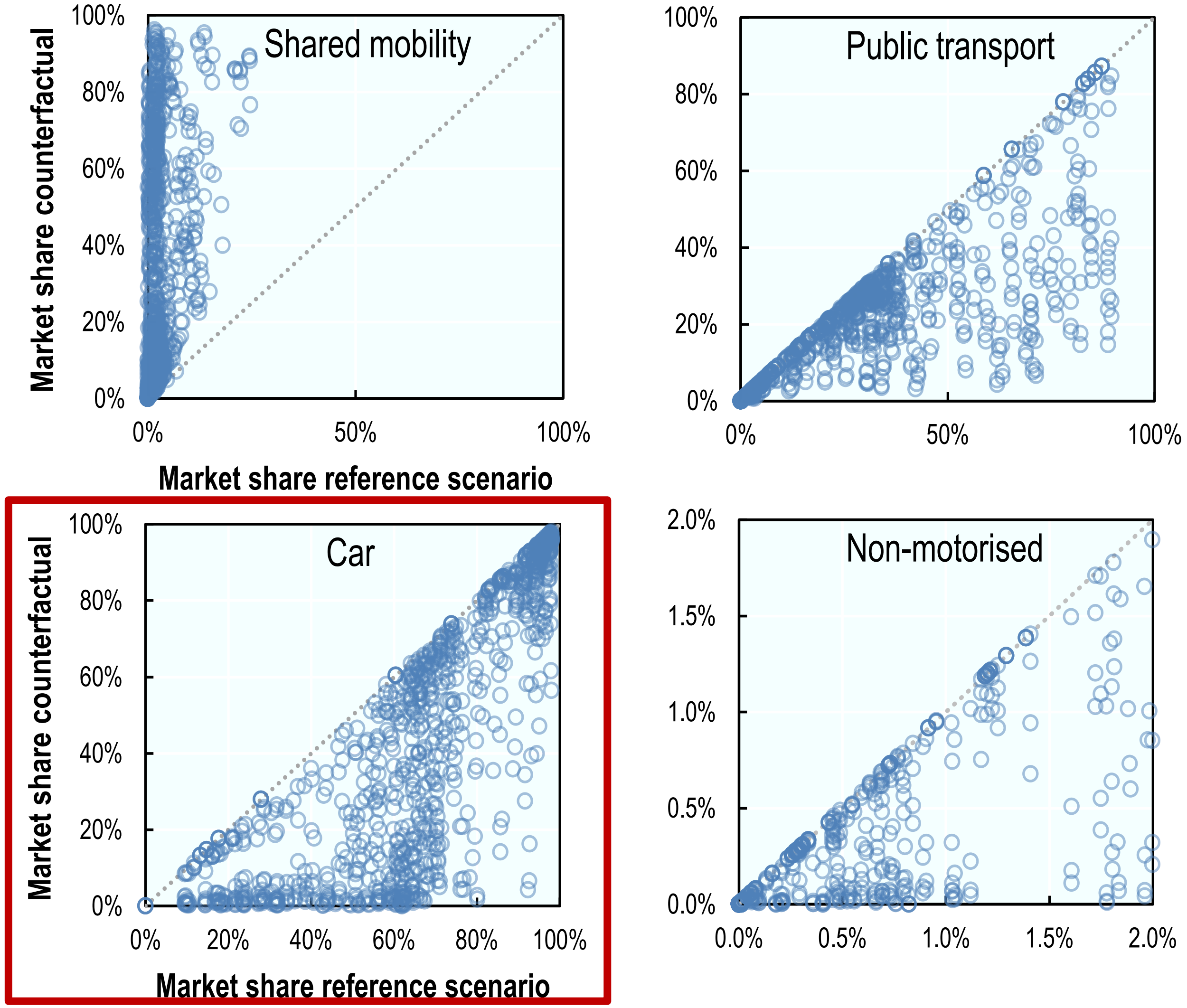
- SM displaces some PT ridership, but ridership remains stable in many cities
- SM displaces some walk/bike travel

Mode shares



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- SM displaces a large portion of demand for private car travel, but not for highly car-dependent cities

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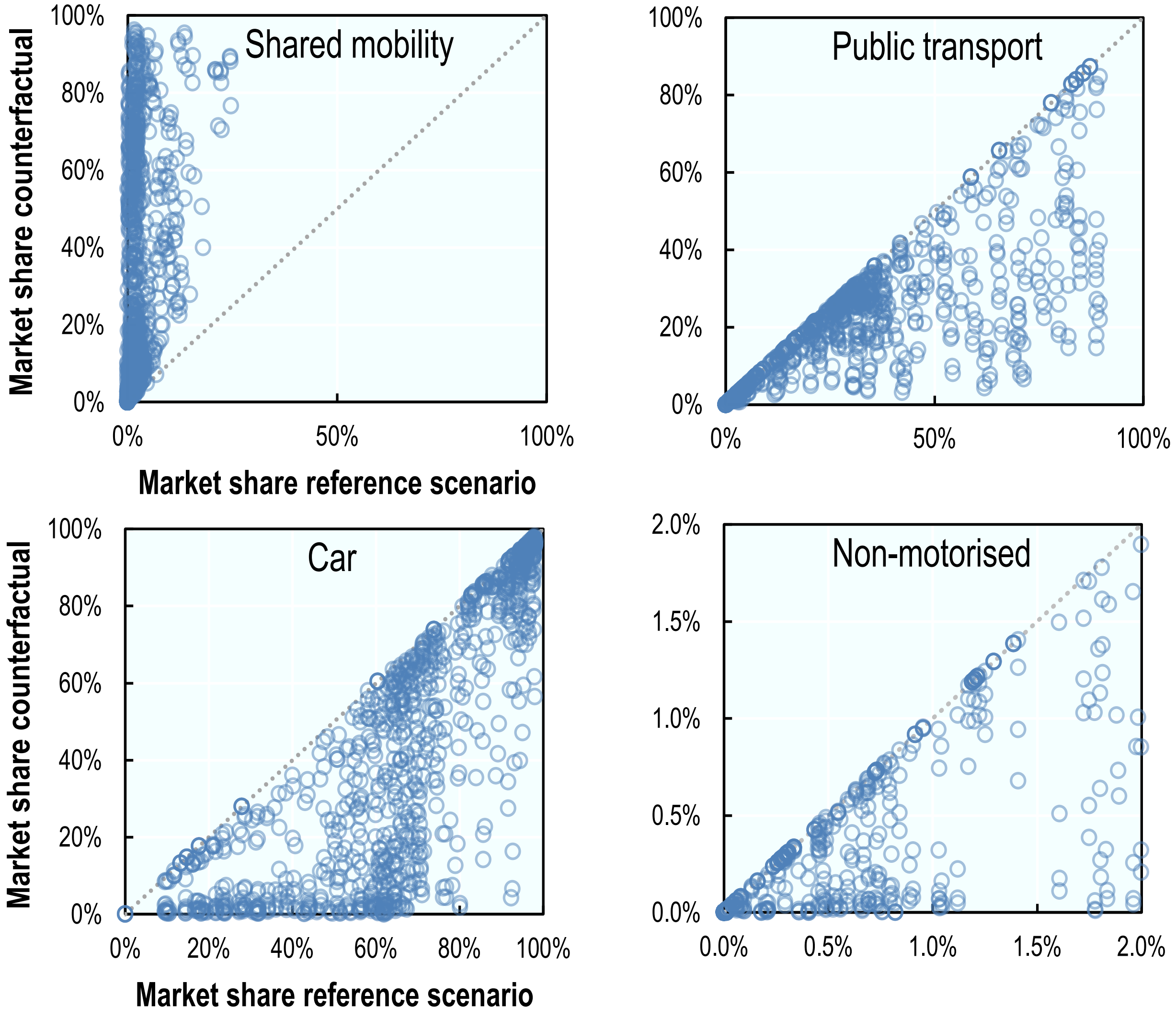

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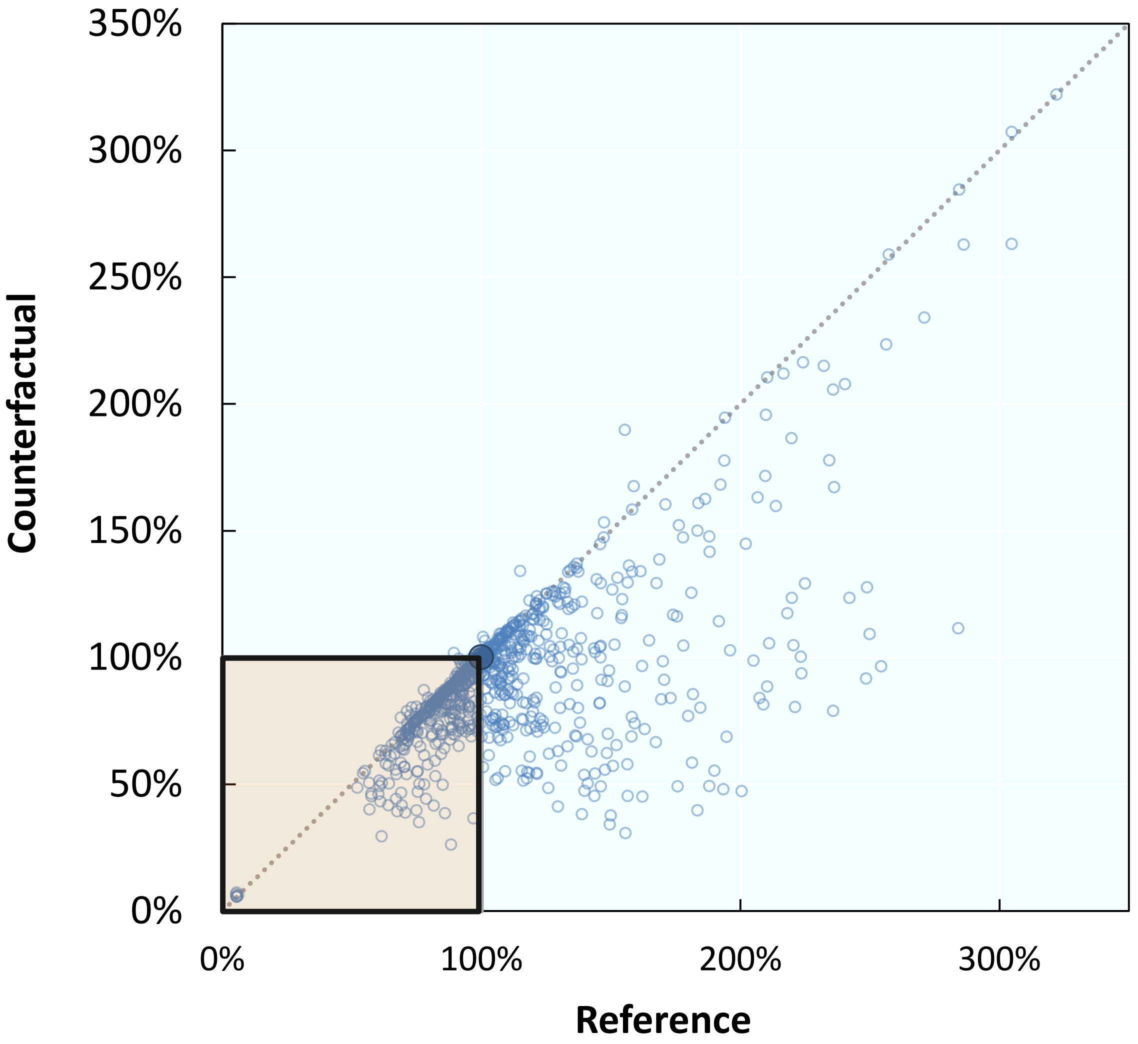
Total CO2 in 2050 relative to 2015



- Emissions decrease in both scenarios

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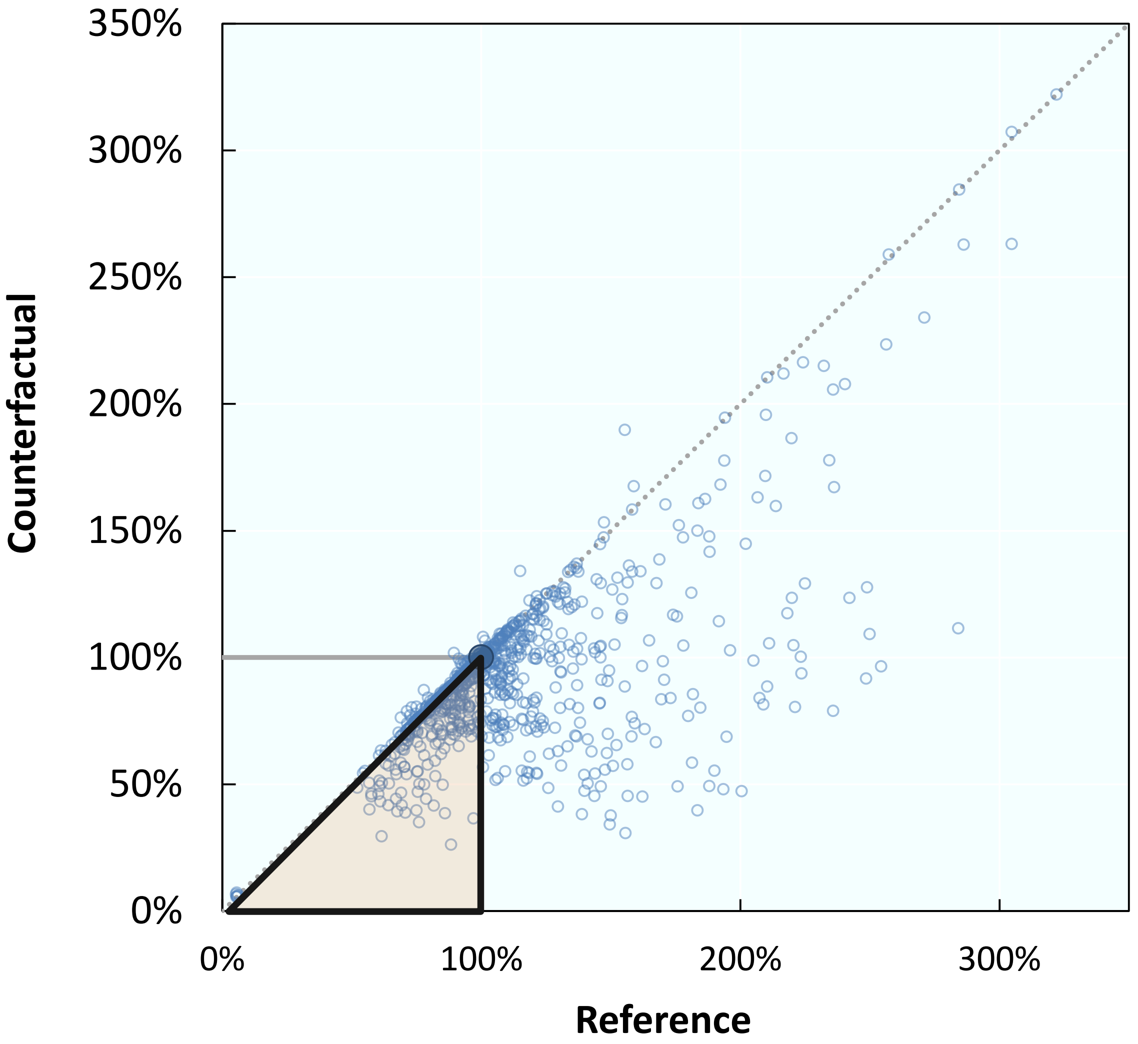

- Emissions decrease in both scenarios
- Greater reductions with shared mobility

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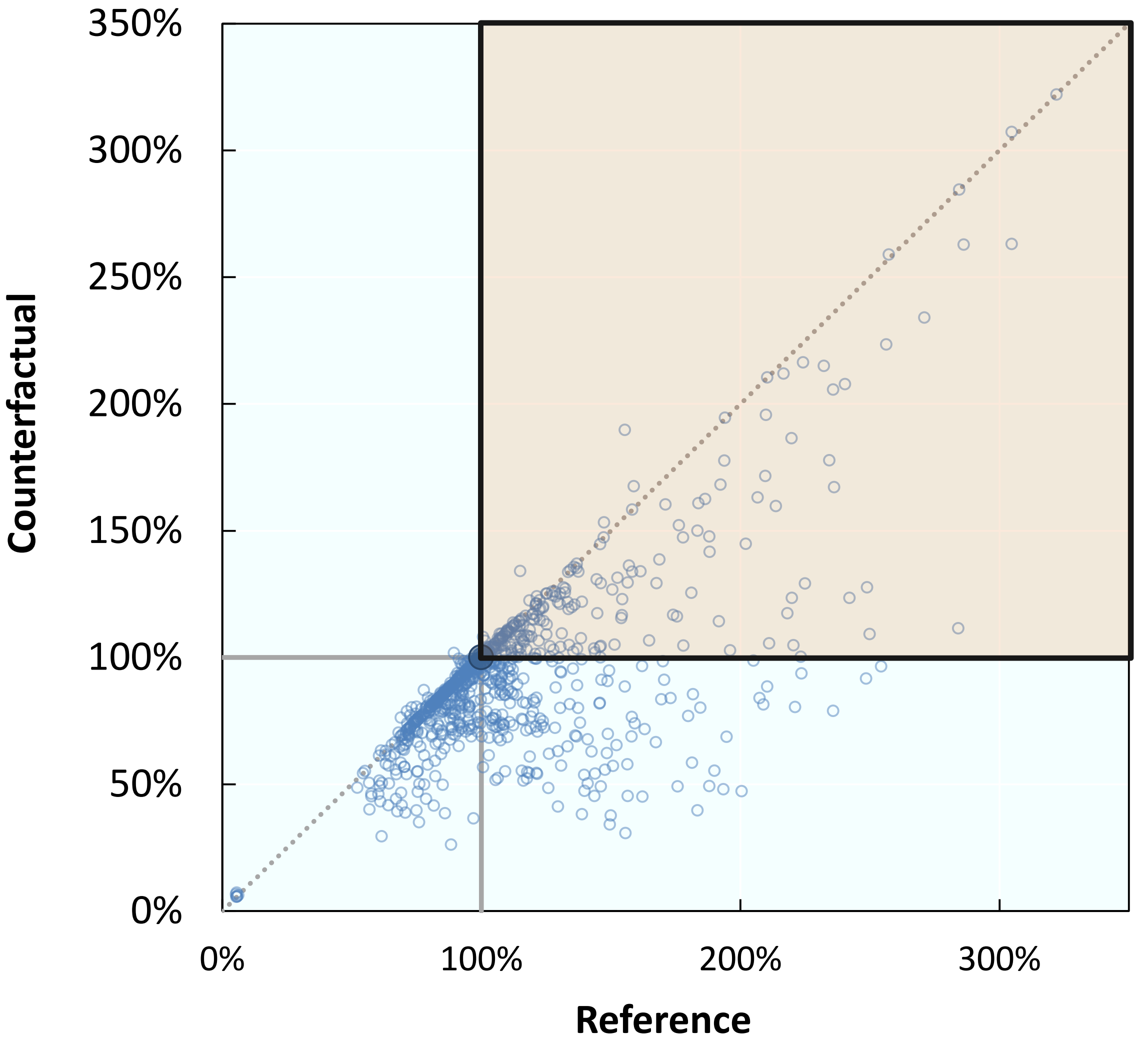

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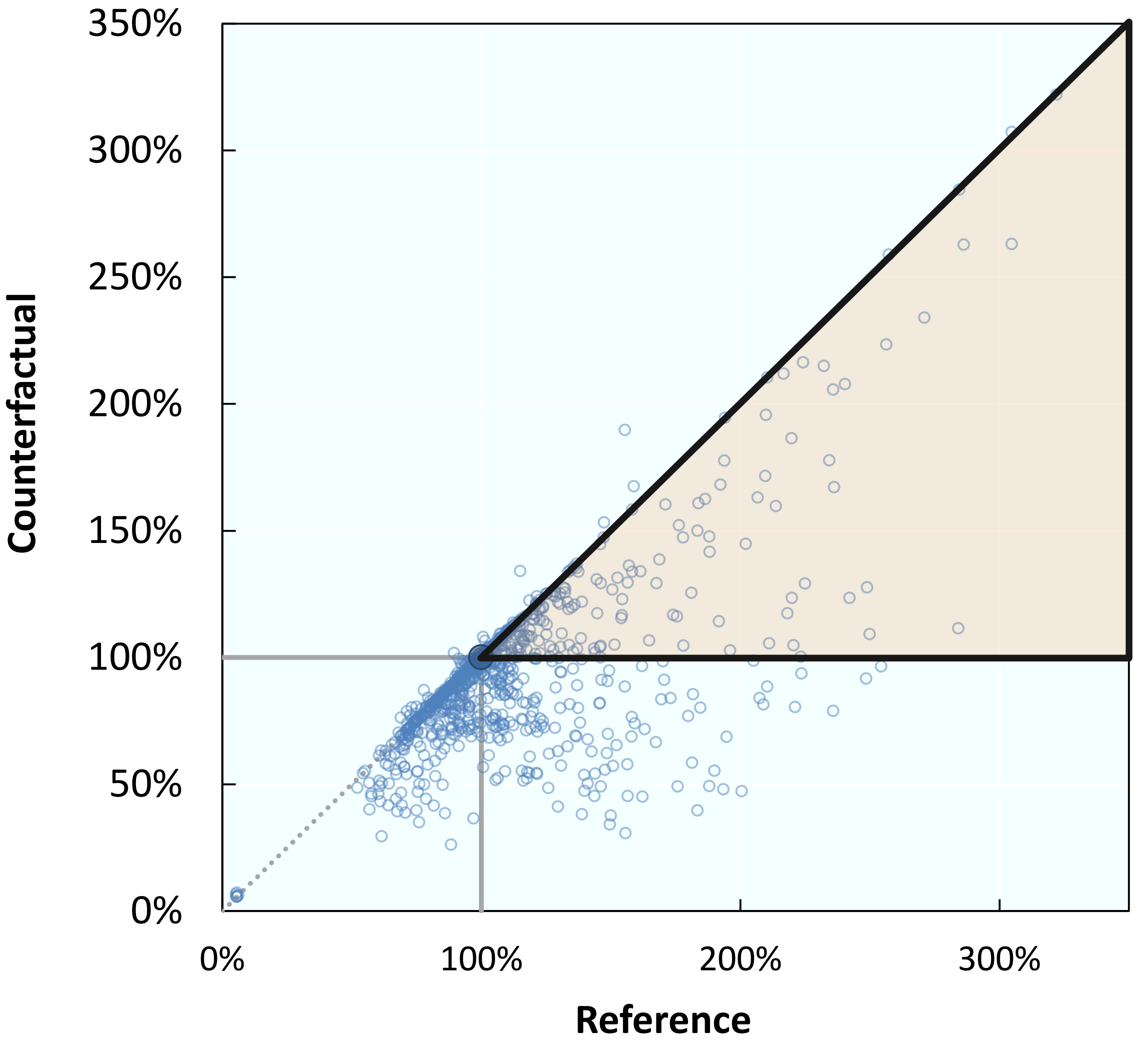
- Greater reductions with shared mobility
- Total CO2 emissions increase in both scenarios

Total CO2 in 2050 relative to 2015



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- Total CO2 emissions increase in both scenarios
- Emissions increase is mitigated with shared mobility

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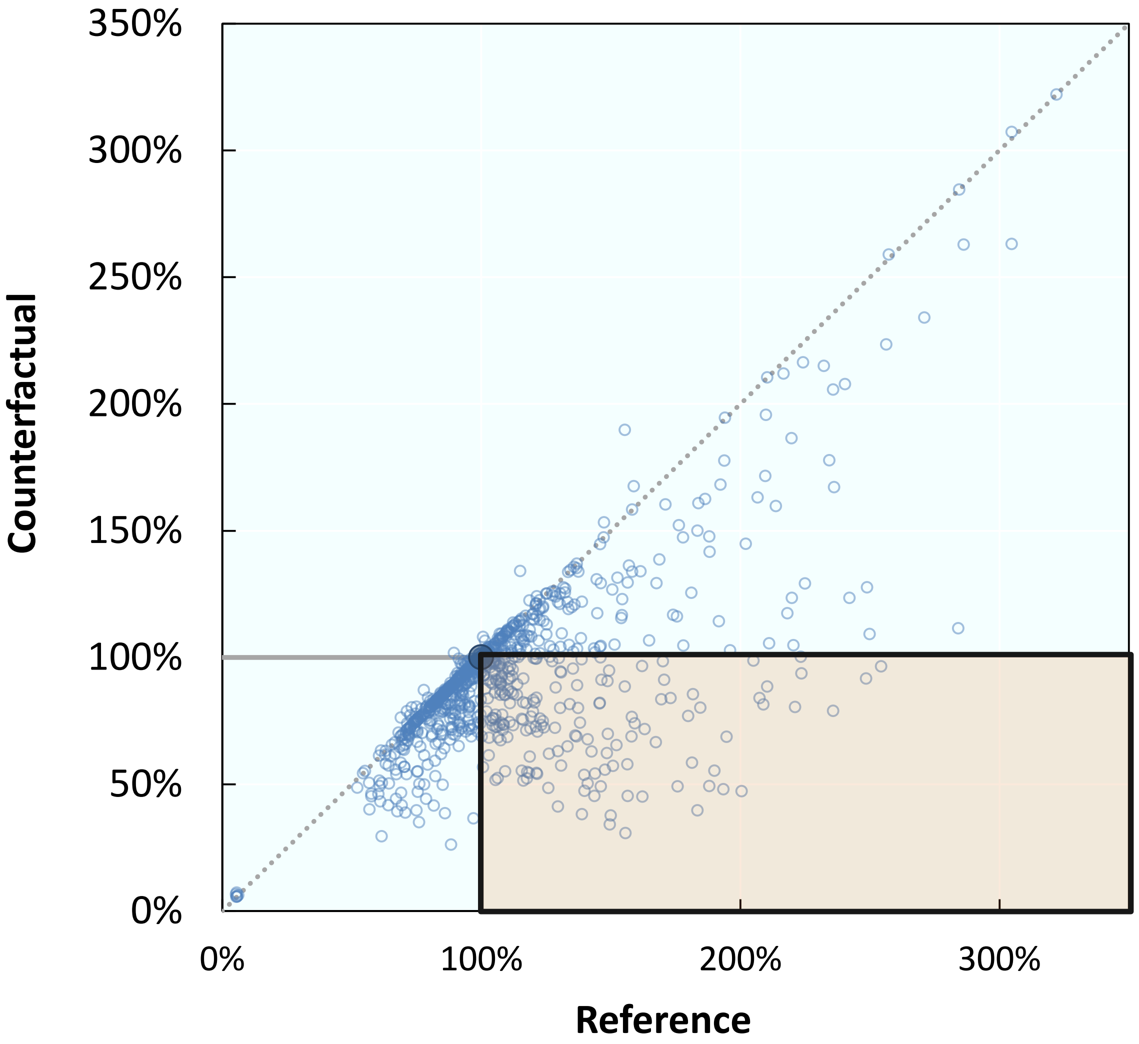

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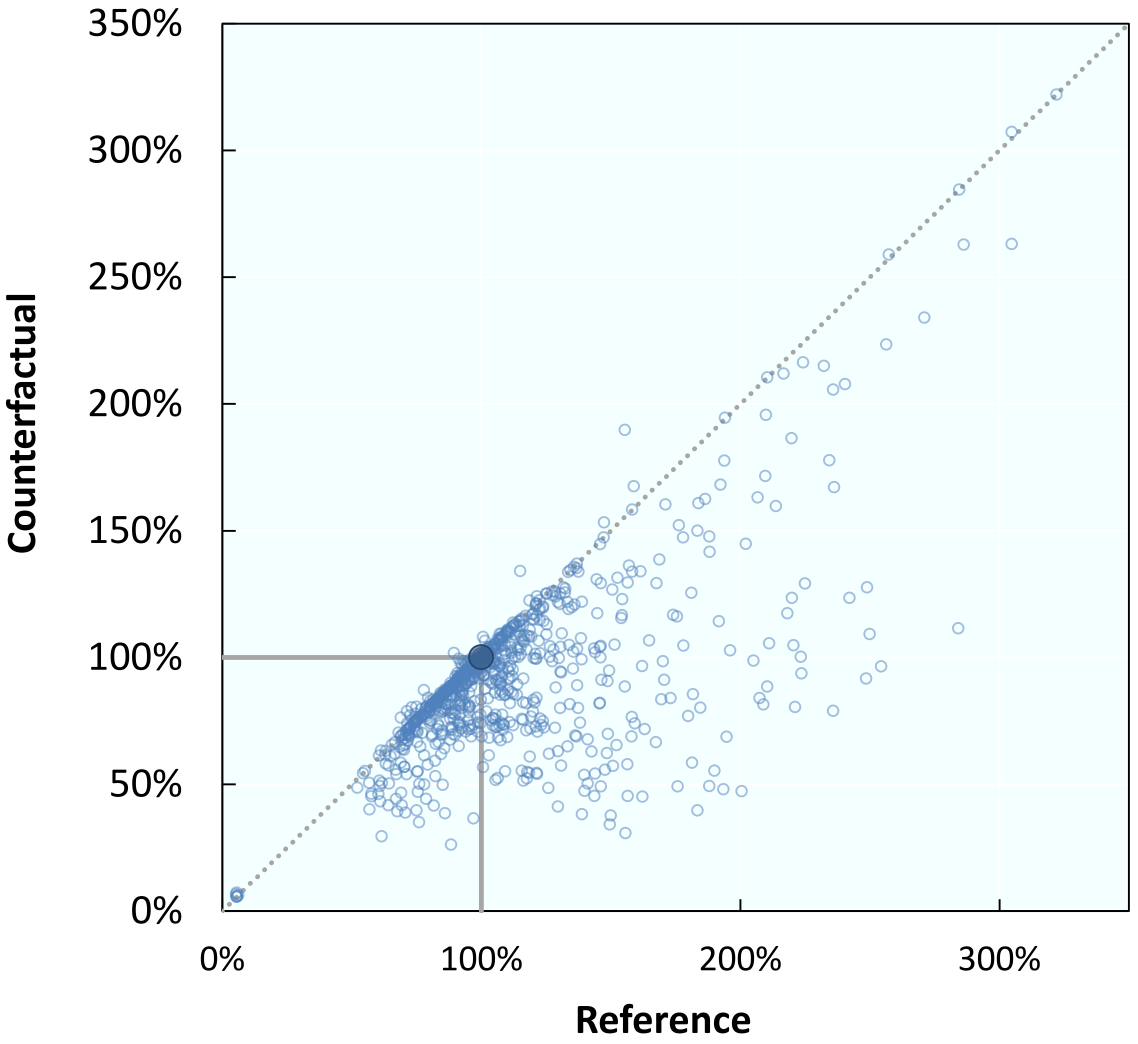

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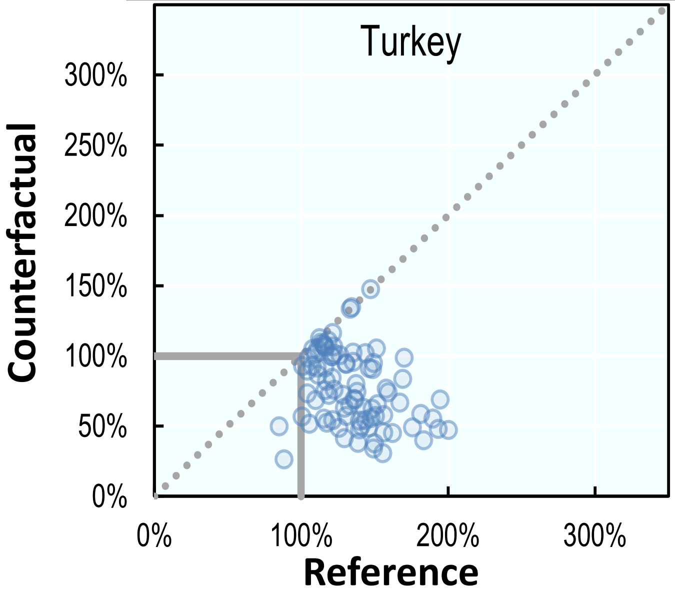
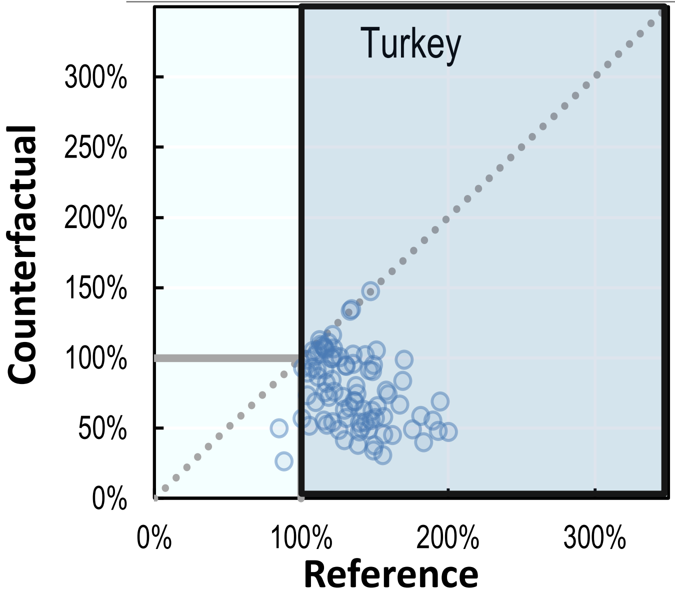
Results by country and region



Turkey

Results by country and region



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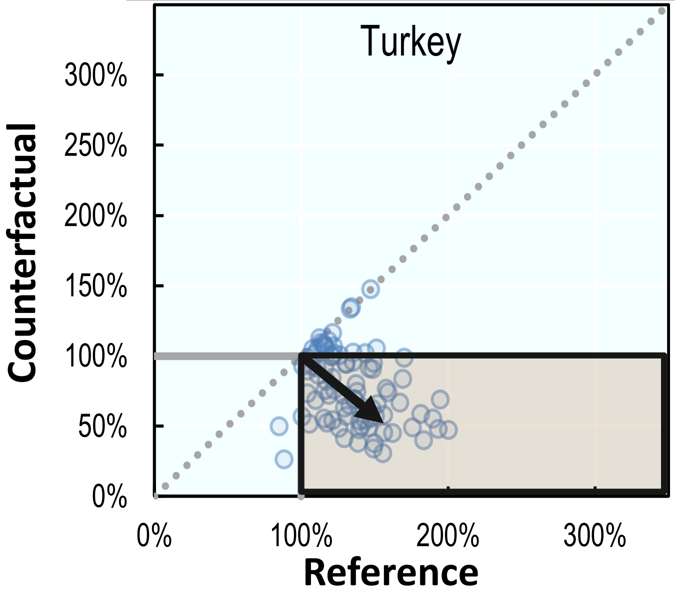

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- Emissions are projected to increase by 2050 in the reference scenario
- In most cases, ride sharing services can reverse this trend
  - Similar services already exist
  - Shared mobility may be more likely to be taken up

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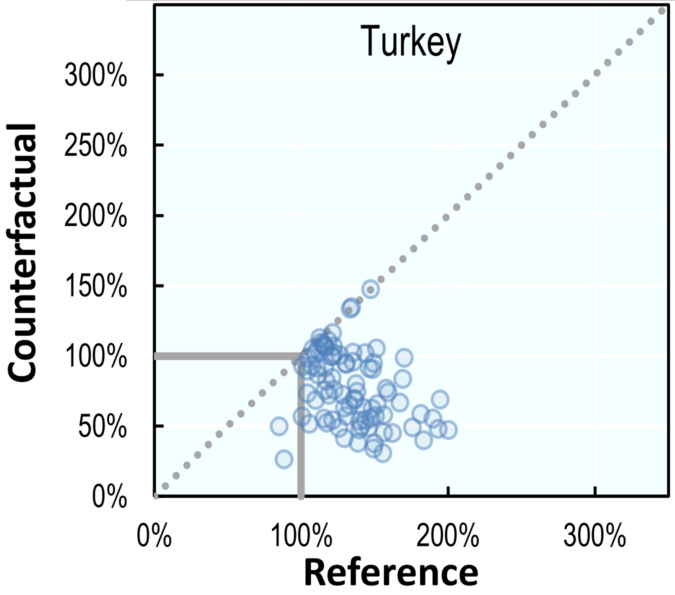

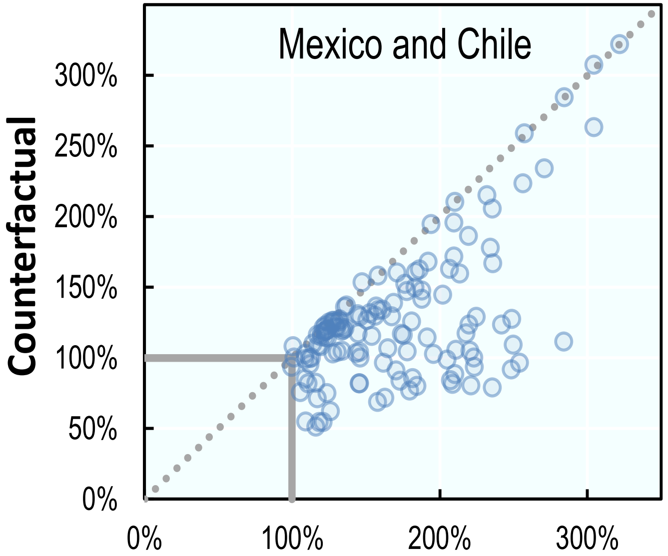

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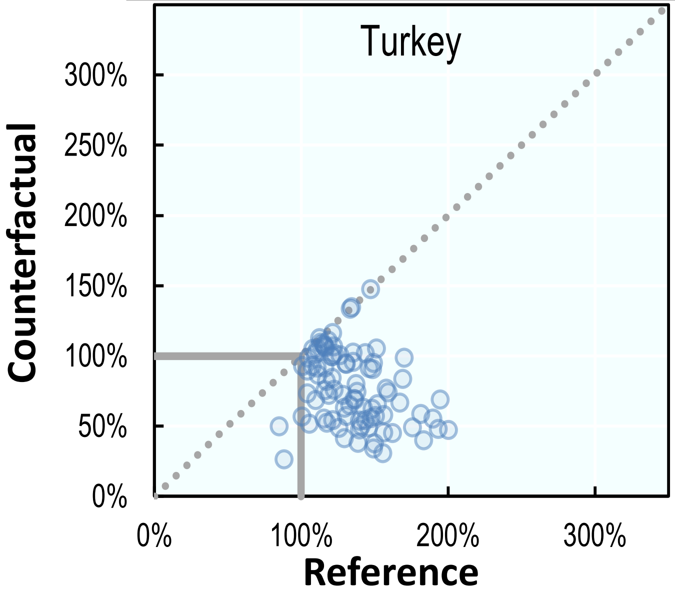

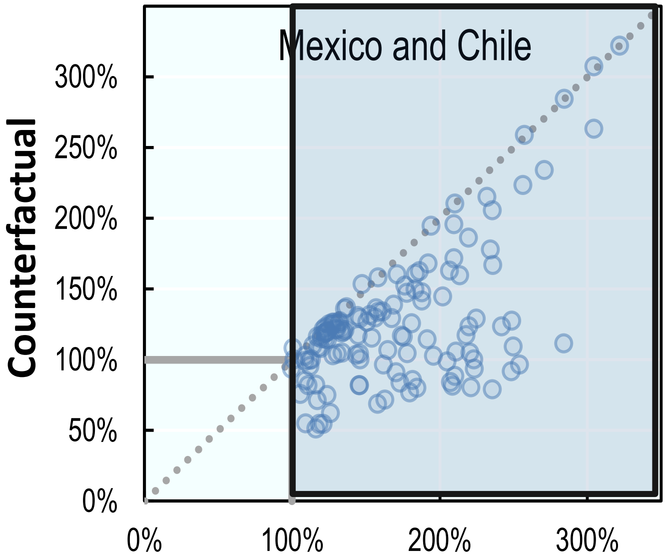

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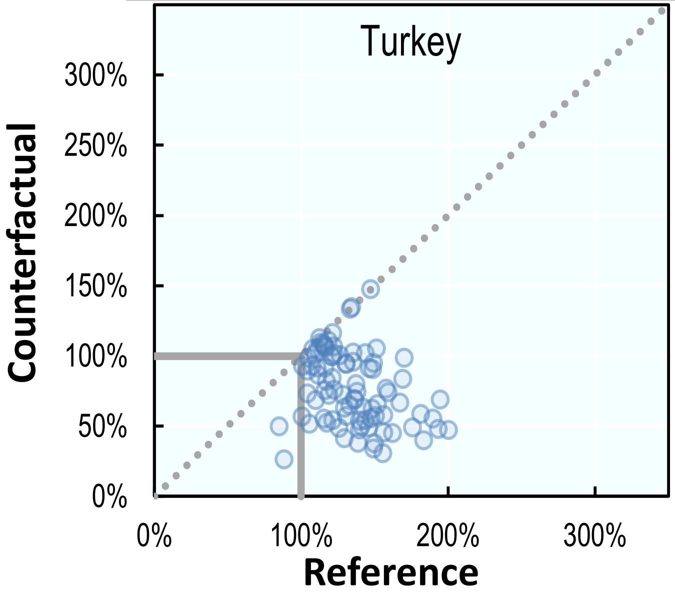

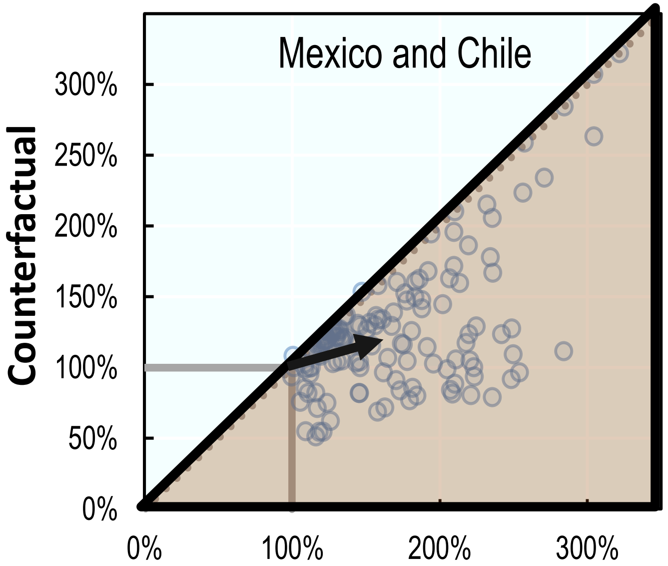

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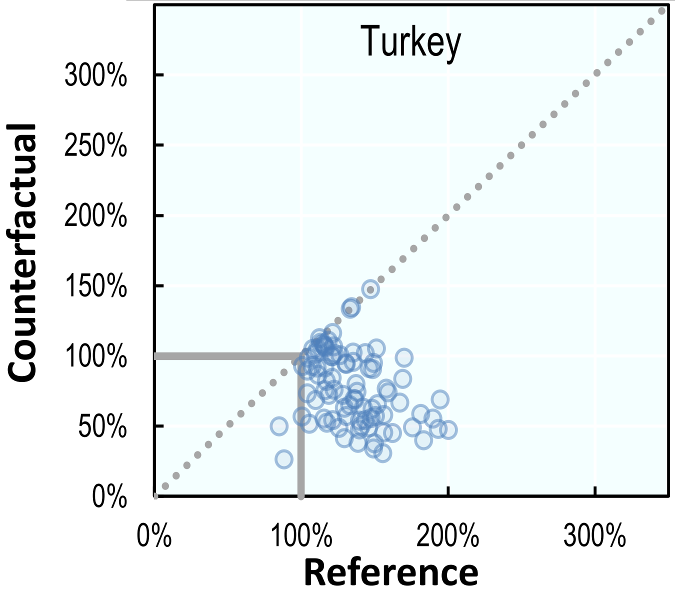

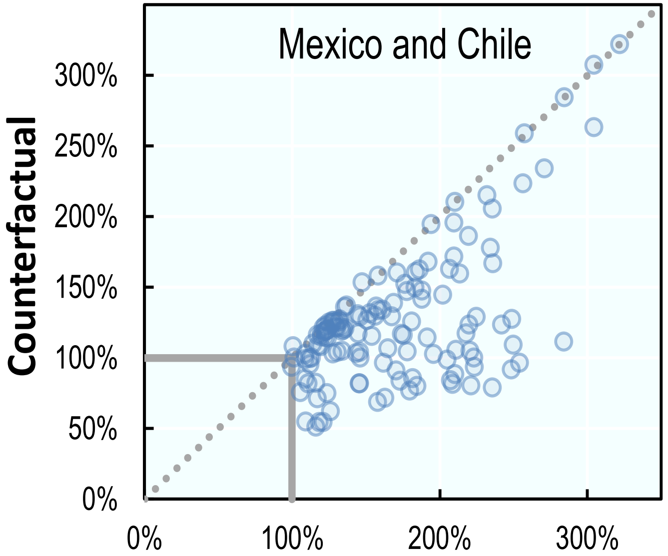

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Key message

- Population & income growth → increase in CO2 from transport
- Under certain urban conditions, SM can mitigate this growth

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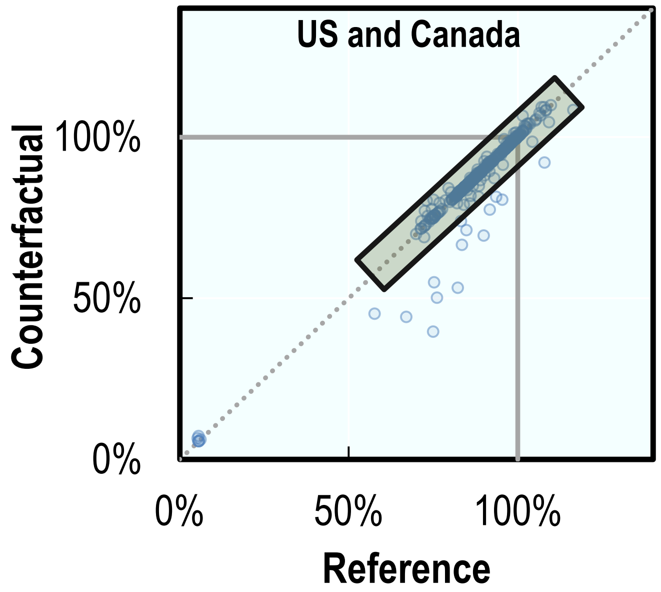
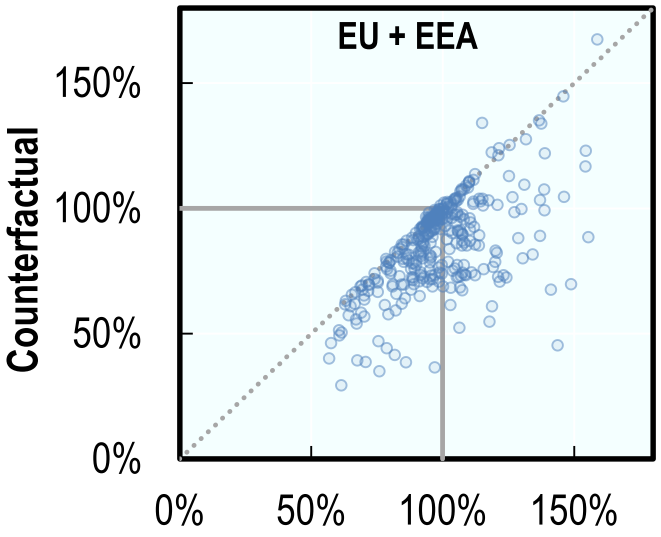


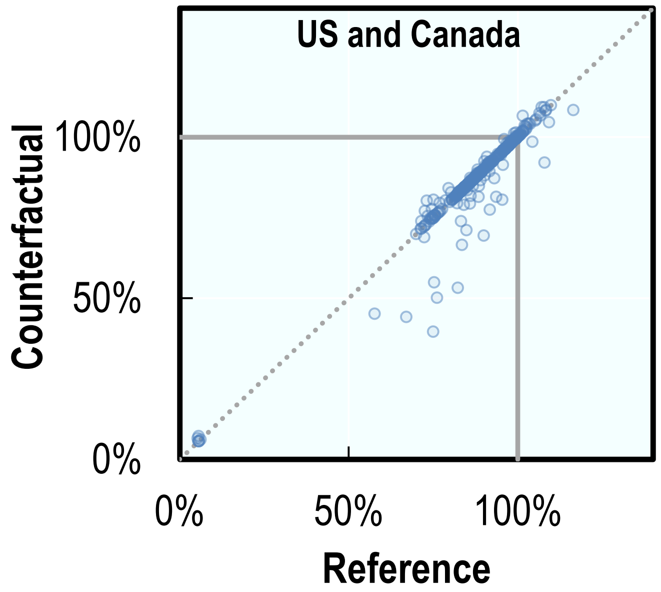
North America

- Transport emissions in most cities are projected to decline
- Most cities have little to gain from shared mobility, which could be due to:
  - Strong preferences for private vehicle travel
  - High provision costs in low-density areas



Europe and EEA

Results by country and region



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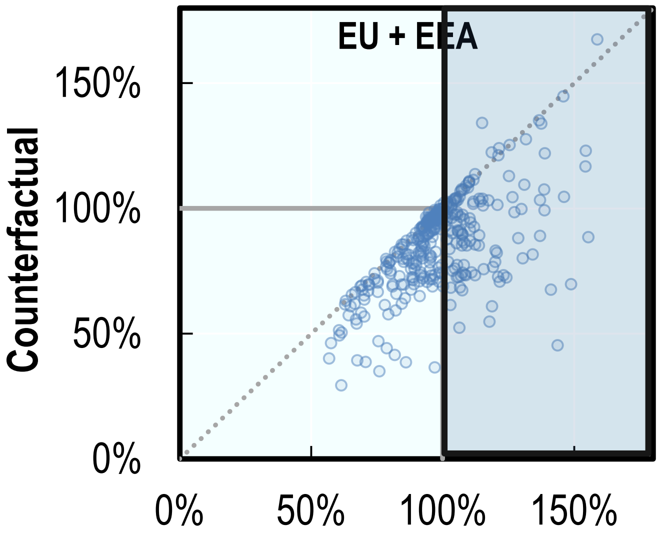

Europe and EEA

- Very diverse impacts
- Half of cities: transport-related CO2 is expected to increase in the reference scenario
  - Largest gains from shared mobility are to be had in these cases

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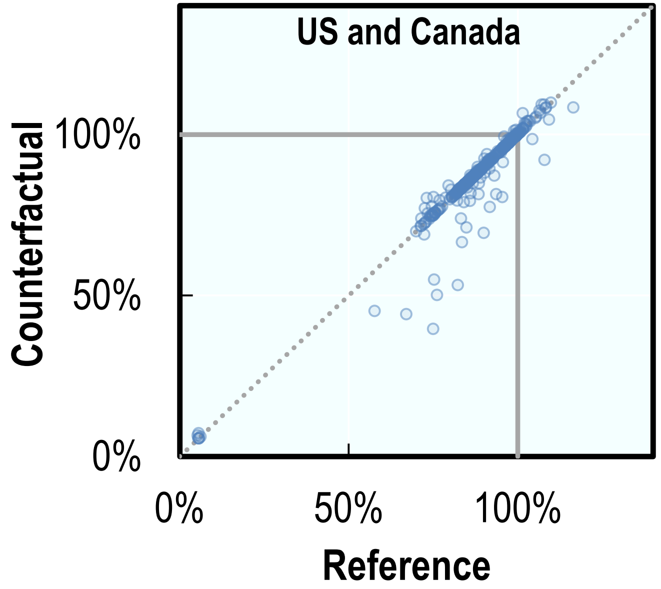

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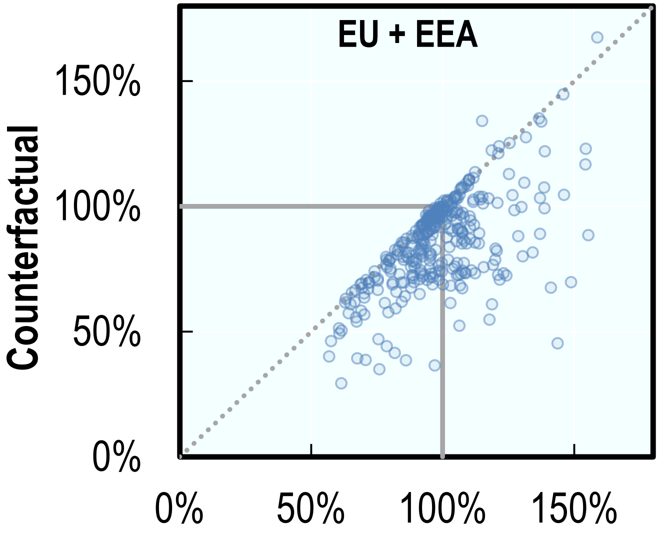

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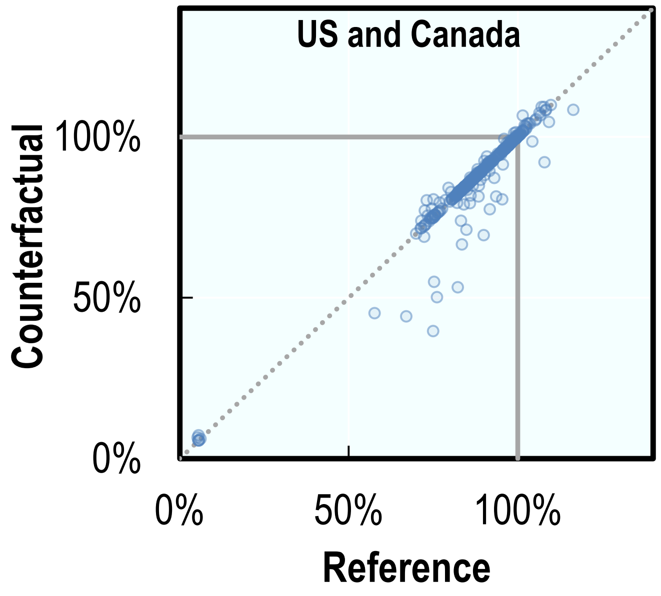

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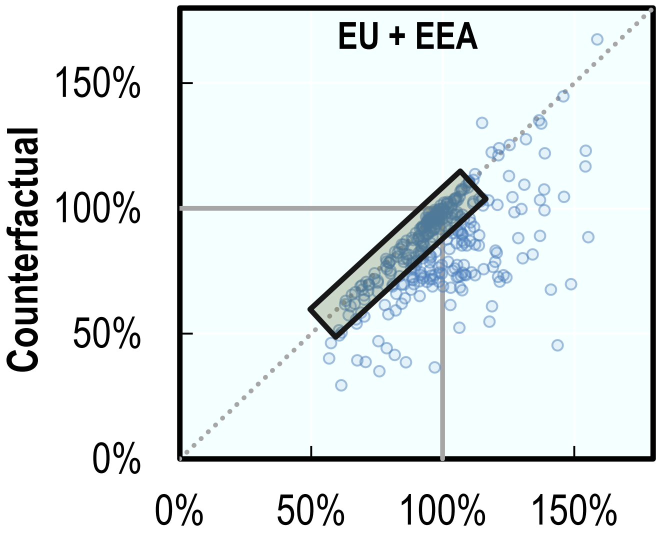

Europe and EEA

- Very diverse impacts
- Half of cities: transport-related CO_2 is expected to increase in the reference scenario
  - Largest gains from shared mobility are to be had in these cases
- A large share of cities appear to have little to gain from shared mobility

Implications of Covid-19

- Increases uncertainty of shared mobility uptake due to:
  - changes in exogenous constraints in the near- and long-term (e.g. travel restrictions, income)
  - potential shifts in preferences (e.g. risk preferences)

- Can we expect a return to pre-Covid mobility behaviours?
  - Yes: SARS-Covid in 2003 (Wang, 2014; IATA, 2020);
    Great Recession in 2008 (US EIA, 2020)
  - No: Self-reported anticipated changes in Dutch mobility habits (de Haas et al., 2020); public transit in Japan (Fujii et al., 2001); cycling in Switzerland (Moser et al., 2018)

- → Policy can shape constraints (e.g. cost, convenience); can influence expectations (e.g. via communications campaigns)

Summary

- **Key finding**: shared mobility services have the potential to deliver significant additional reductions in greenhouse gas emissions from urban transport: 6.3% of CO2

- Impact of varies by city due to differences in initial mode splits, emissions intensity, other factors underlying propensity to adopt
  - Cities with high mode shares of public transport and private car travel do not stand to substantially benefit from shared mobility services

- Policy implications remain the same in the context of the pandemic

- Avenues for future research:
  - What are the social costs of policies to support SM?
  - What measures (e.g. institutional, technological) increase SM use?

For more information:

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