Resilient neighborhoods, active travel and urban planning

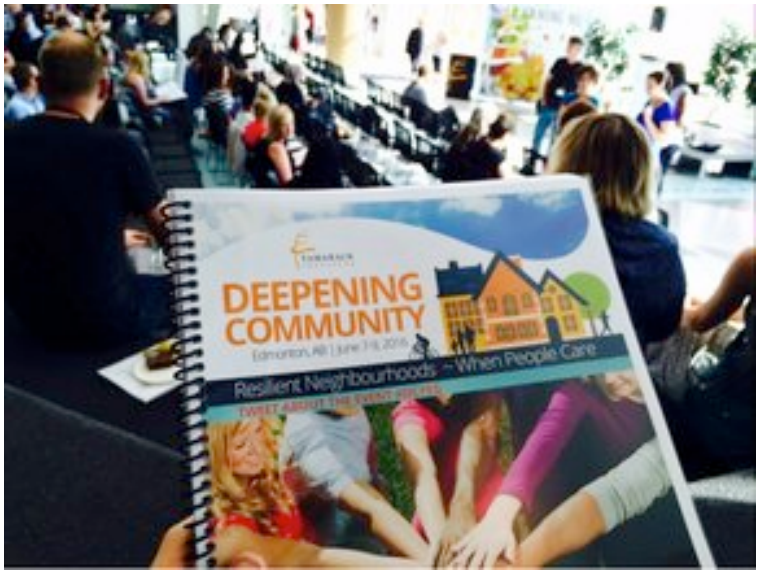
SONG Siqi (Grace)
PhD Candidate
Department of Geography, NUS

Outline

- **Resilient neighborhood & active travel**
- **Urban planning → Active travel → Resiliency**
- **Singapore case study**
- **Conclusions & policy implications**

Resilient neighbourhood

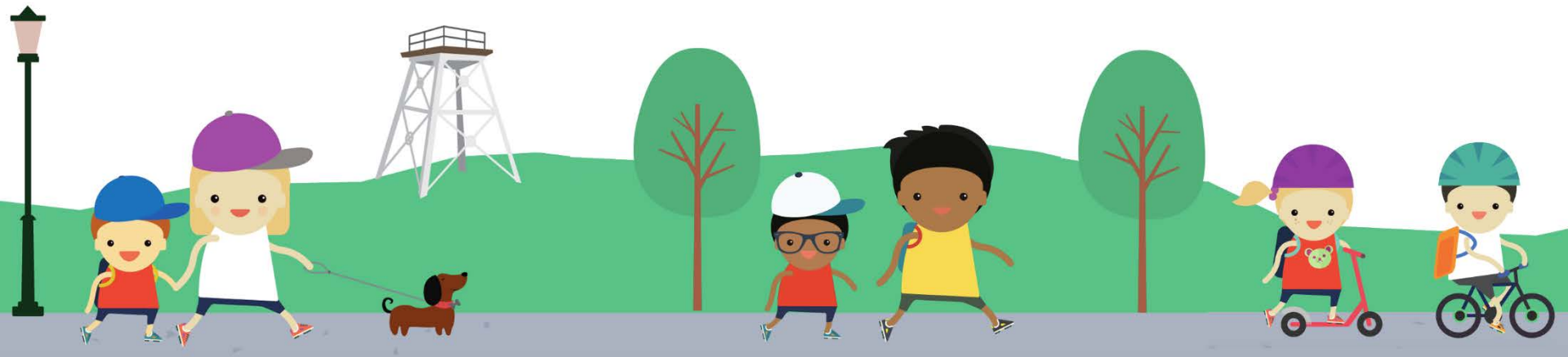
"True resiliency… and focuses on building local capacities today so that communities can become thriving places of strong connections where issues are proactively addressed."



-----Building Resilient Neighborhoods at the Deepening Community Conference

Resilient neighbourhood & active travel

- **Active travel: walking, cycling and public transport**
- **Active travel promotes social connection and enhanced community life by increasing opportunities for social interactions within a neighborhood.**
- **From the standpoint of transportation, a resilient neighborhood should encourage active travel rather than driving.**



Active travel promotes social cohesion and enhanced community life by increasing opportunities for social interaction within a neighborhood.

Over-reliance on cars

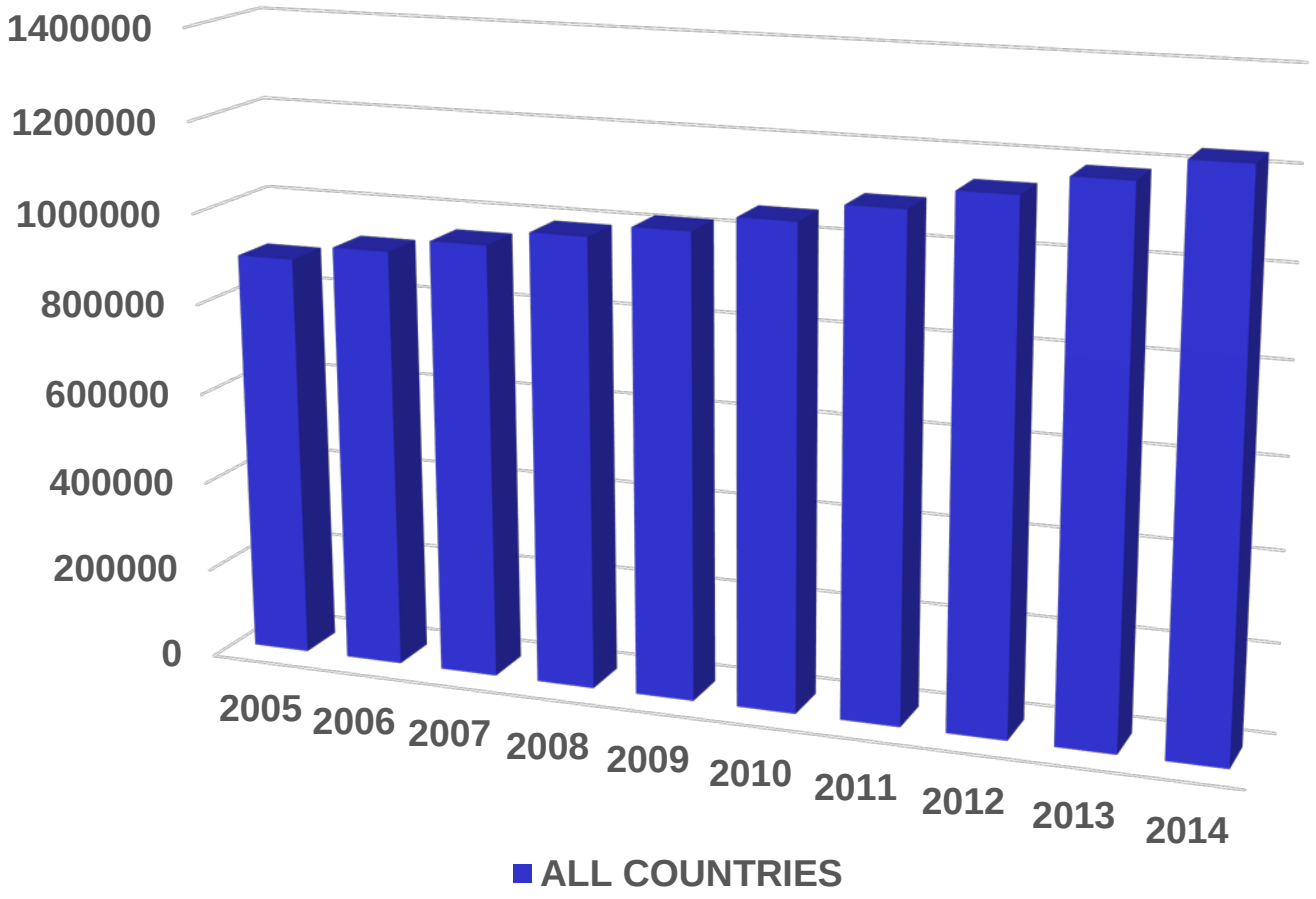
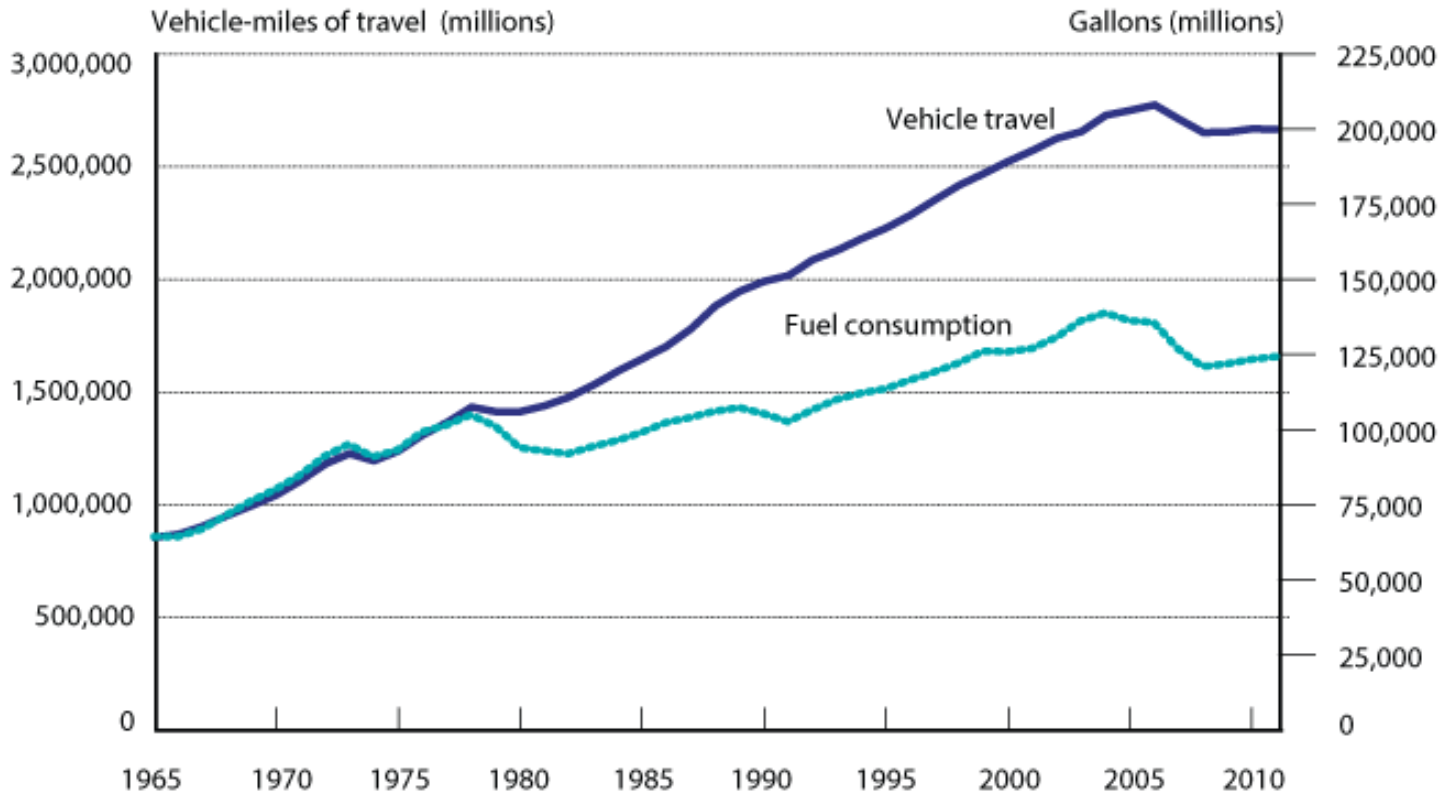


Fig.1 Motor vehicle population worldwide Source: OICA from http://www.oica.net/category/production-statistics/

Over-reliance on cars



Vehicle-Miles of Travel and Fuel Use by Personal Vehicles: 1965-2011

SOURCES: ***Vehicle-Miles of Travel***: U.S. Department of Transportation

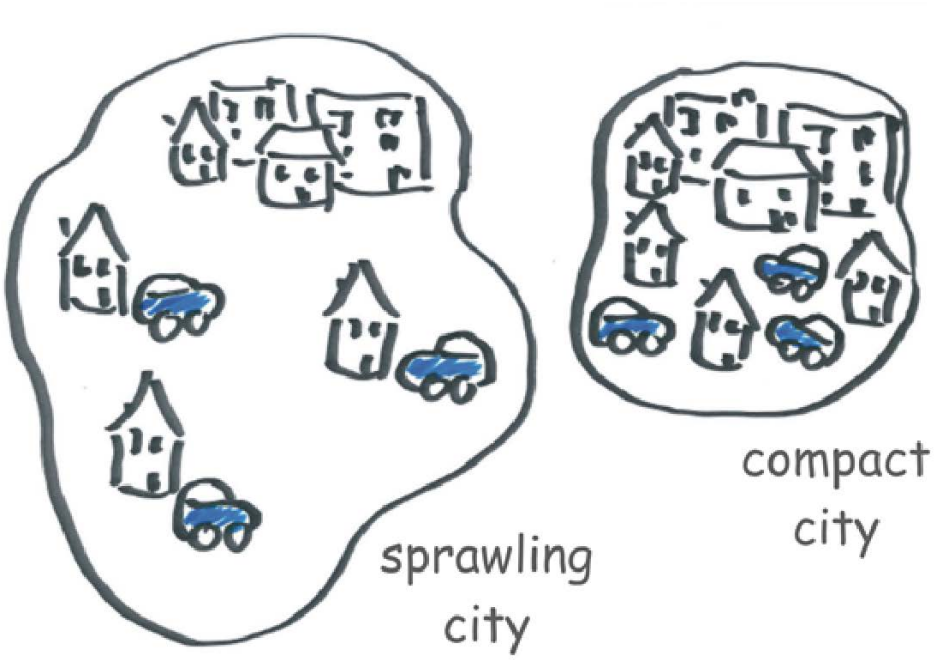
Land use planning

- **To redesign our living environment in a more sustainable way so that there is less need to drive, and if necessary, driving can be done over shorter distances and more efficiently (Cervero & Murakami, 2010)**

- **The most common land use strategies include densification, mixed land use development, public transport provision and neotraditional neighborhood design (Calthorpe, 1993; Boarnet & Crane, 2001a)**

- **The New Urbanism and Smart Growth in the US; Transit-oriented Development (TOD) and Compact City in Europe**

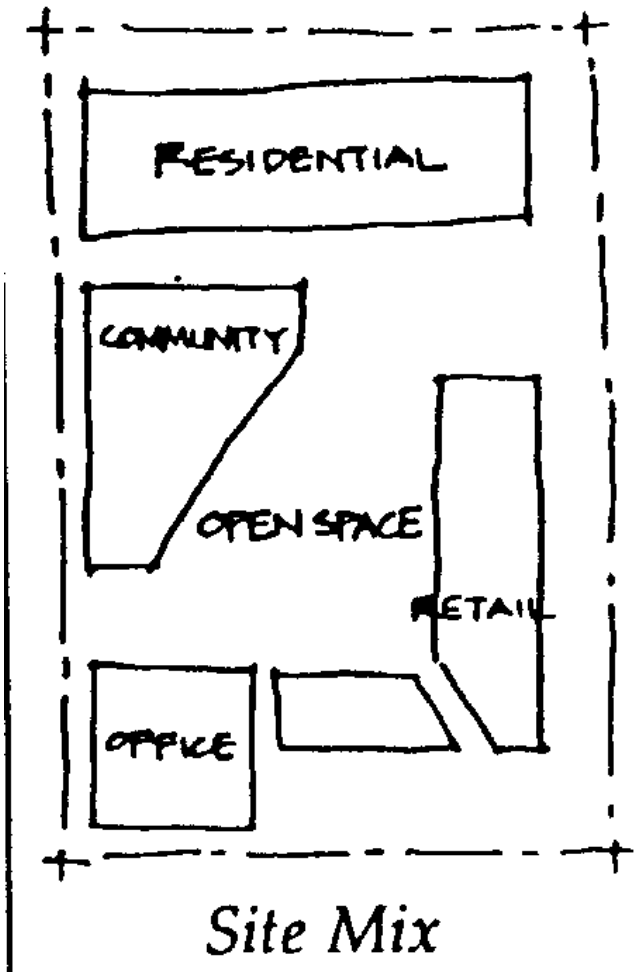
Densification



- **the number of destinations within a fixed range increases → shorter distances**
- **Higher frequency services of buses/ trains; on the contrary, car users face more congestion**

More active travel & less driving

Mixed land use



Mixed land use encourages a development pattern that integrates various types of land use close together

An even balance in various land uses decreases the average distances between activities, such as commuting to work, shopping, recreation or social networking

More active travel & less driving

Public transport supply

Improved public transport service coverage & frequency

More active travel & less driving

Walking/ cycling-friendly design

A ‘complete street’ in Malmö (Sweden) affording safe, comfortable opportunities for walking and cycling. Image: Nik Luka

Question

Will land use planning reduce driving and facilitate active travel in reality?

Case study - Singapore

Fig.2 Location of Singapore (Source: Presenter)

Over-reliance on cars in Singapore

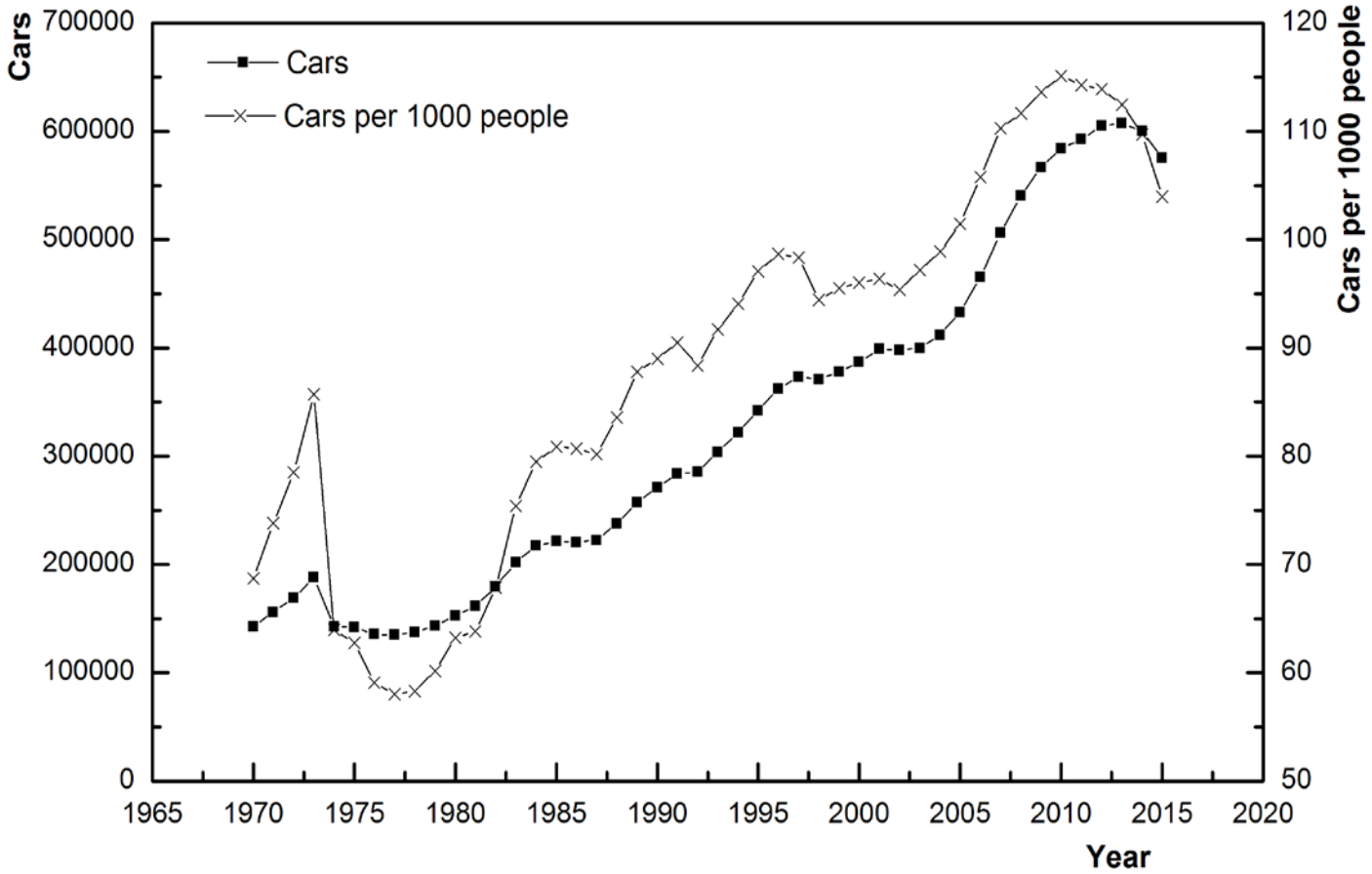


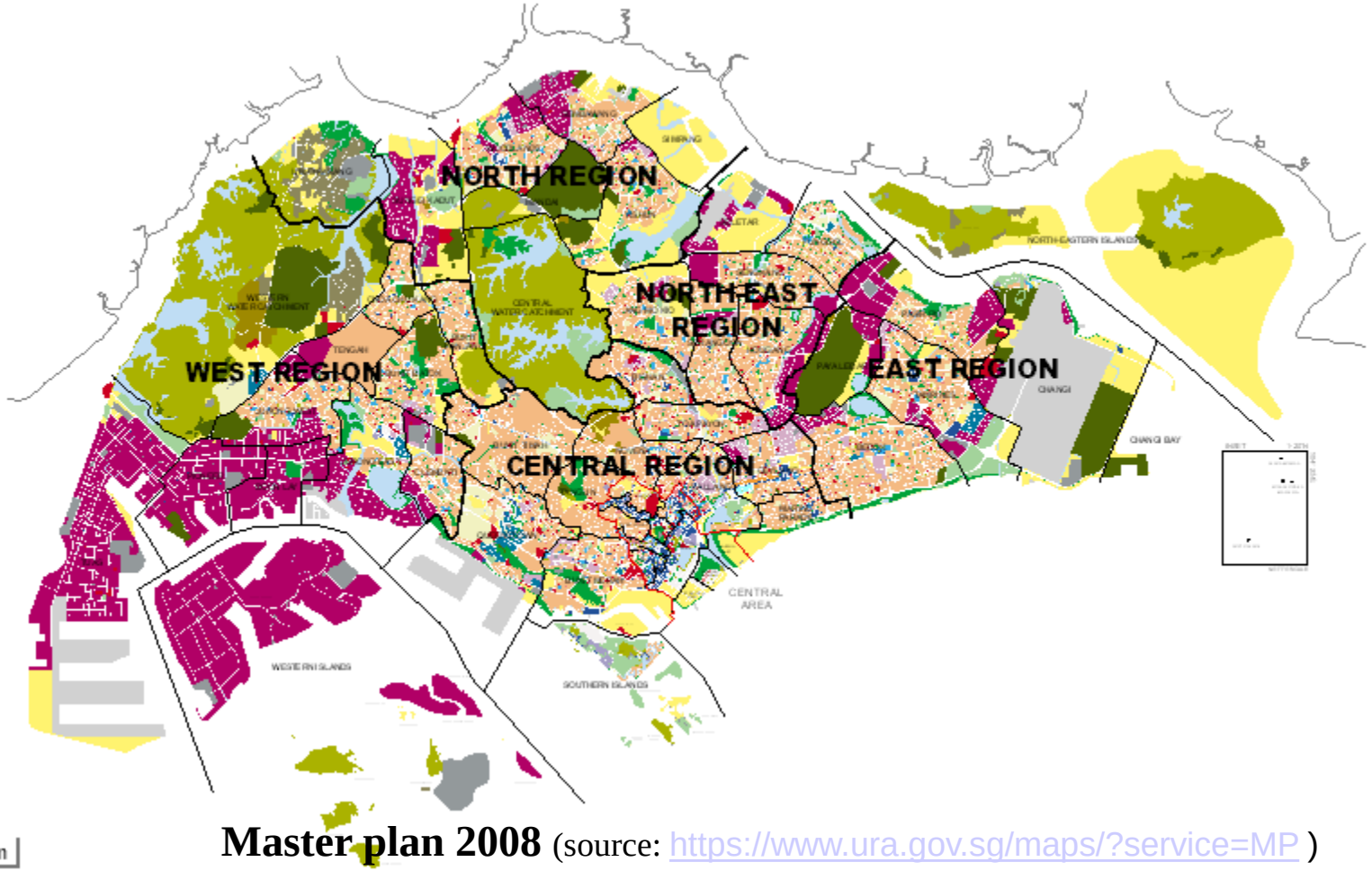
Fig.3 Passenger cars in Singapore from 1965 to 2015 (Source: Land Transport Authority, Singapore)

Land use policies in Singapore

- **Public transport provision**

Land use policies in Singapore

- **Mixed land use**



Master plan 2008 (source: https://www.ura.gov.sg/maps/?service=MP)

Data sources

- **Household Interview Travel Survey (HITS) 2004, 2008, 2012**
- **Land use data (Master Plan)**
- **Transport network (DataMall from https://www.mytransport.sg/content/mytransport/home/dataMall.html)**
- **Density (Census)**

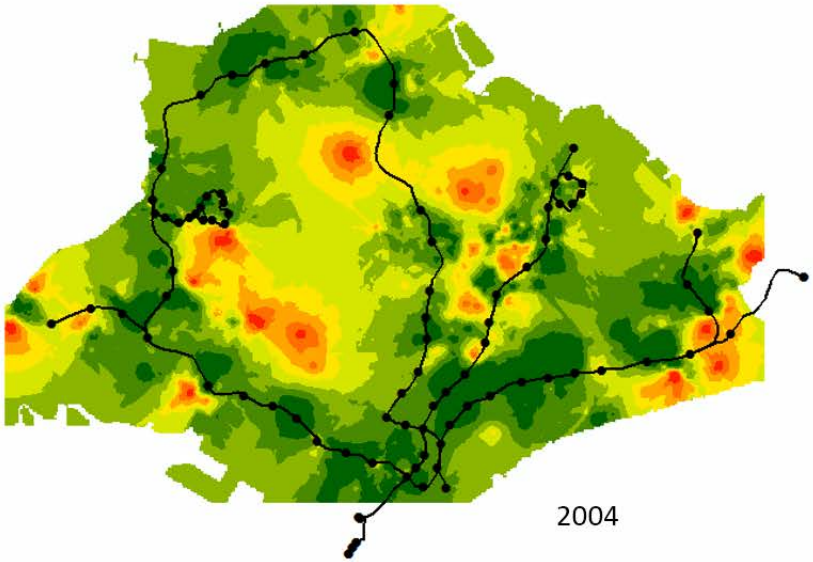
Table 1 Variables included in the pseudo panel data

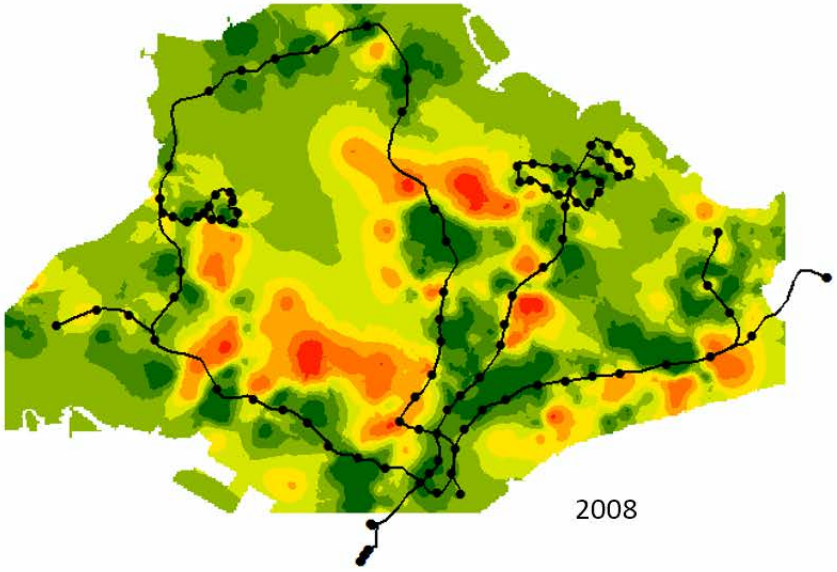
Variables (Unit)	Time frame	Source	2004	2008	2012
Vehicle usage					
Individual daily VMT (km)	2004/2008/2012	HITS	2.37	4.02	3.18
Transport pricing					
High-level COE premium (dummy)	2002 - 2012	COE bidding results	0	0	1
Medium-level COE premium (dummy)	2002 - 2012	COE bidding results	1	0	0
low-level COE premium (reference)	2002 - 2012	COE bidding results	-	-	-
Transport supply					
Distance to nearest expressway exit (km)	2004/2008/2012	Road network	3.53	3.42	3.36
Distance to nearest LRT/ MRT stations (km)	2004/2008/2012	Road network	1.65	1.41	1.30
Built environment					
Walking path density[a] (km/sq.km)	2014	Road network	7.66		
Land use entropy index[a]	2008	Master plan	0.70		
Population density[a] (1000/sq.km)	2004/2008/2012	Statistics Singapore	2.11	2.06	2.04
Socioeconomic & demographic variables					
Age	2004/2008/2012	HITS	44.43	49.78	49.77
Gender (male=1)	2004/2008/2012	HITS	0.50	0.50	0.50
Household size (count)	2004/2008/2012	HITS	4.24	3.95	4.03
Monthly personal income[b] (ordinal)	2004/2008/2012	HITS	2.98	3.53	3.56
Car ownership (count)	2004/2008/2012	HITS	0.40	0.48	0.44

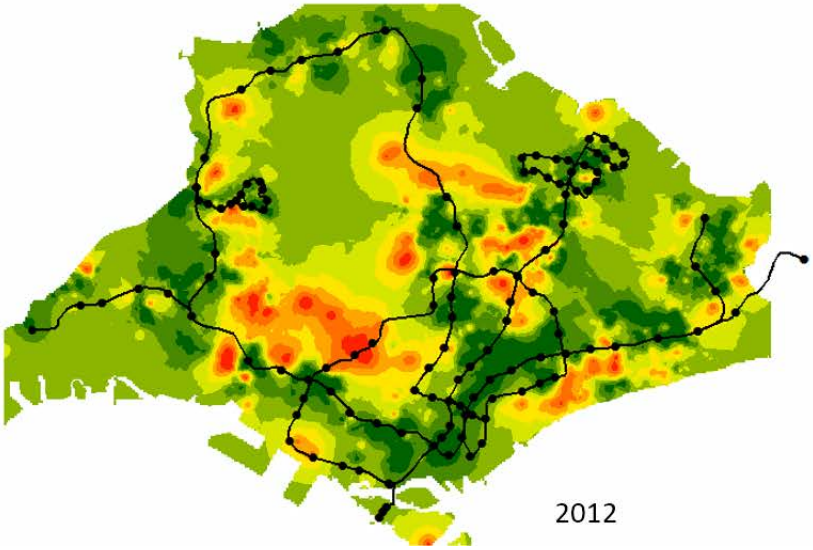
Table 1 Variables included in the pseudo panel data

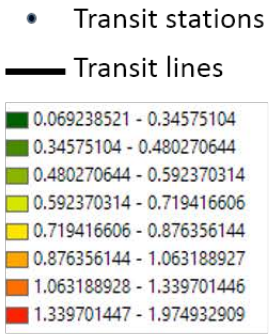
Variables (Unit)	Time frame	Source	2004	2008	2012
Vehicle usage					
Individual daily VMT (km)	2004/2008/2012	HITS	2.37	4.02	3.18
Transport pricing					
High-level COE premium (dummy)	2002 - 2012	COE bidding results	0	0	1
Medium-level COE premium (dummy)	2002 - 2012	COE bidding results	1	0	0
low-level COE premium (reference)	2002 - 2012	COE bidding results	-	-	-
Transport supply					
Distance to nearest expressway exit (km)	2004/2008/2012	Road network	3.53	3.42	3.36
Distance to nearest LRT/ MRT stations (km)	2004/2008/2012	Road network	1.65	1.41	1.30
Built environment					
Walking path density[a] (km/sq.km)	2014	Road network	7.66		
Land use entropy index[a]	2008	Master plan	0.70		
Population density[a] (1000/sq.km)	2004/2008/2012	Statistics Singapore	2.11	2.06	2.04
Socioeconomic & demographic variables					
Age	2004/2008/2012	HITS	44.43	49.78	49.77
Gender (male=1)	2004/2008/2012	HITS	0.50	0.50	0.50
Household size (count)	2004/2008/2012	HITS	4.24	3.95	4.03
Monthly personal income[b] (ordinal)	2004/2008/2012	HITS	2.98	3.53	3.56
Car ownership (count)	2004/2008/2012	HITS	0.40	0.48	0.44

Car ownership

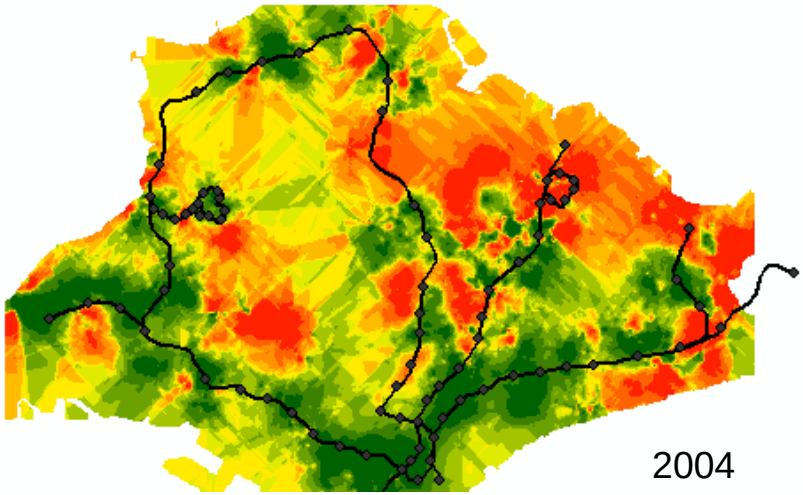




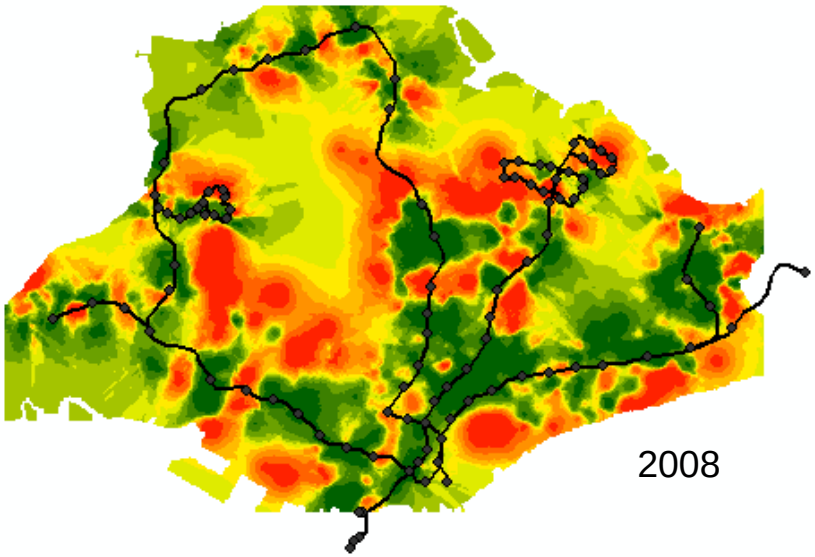




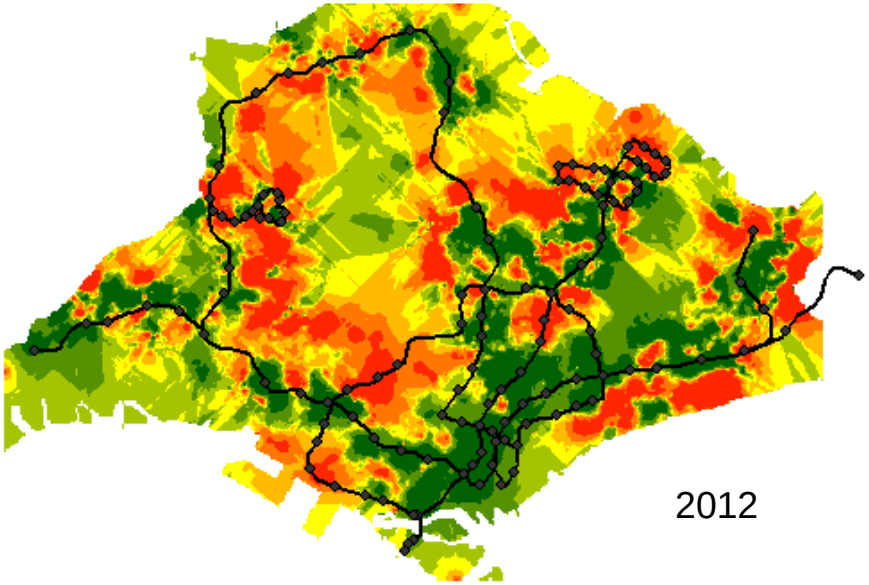
Car usage



2004



2008

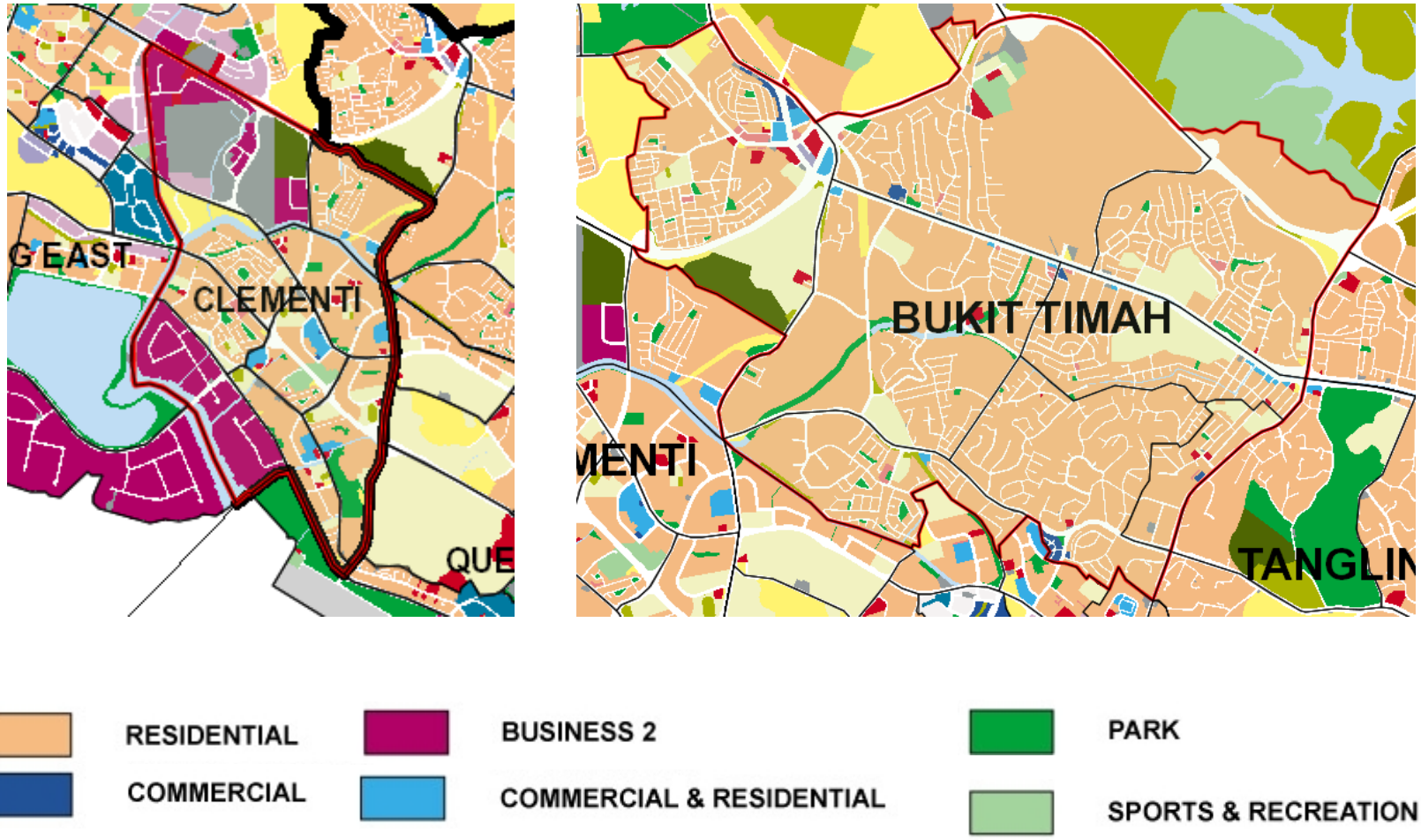


2012

- Transit stations
- Transit lines

- 1.05009377 - 4.728531795
- 4.728531796 - 5.329093106
- 5.329093107 - 5.554303597
- 5.554303598 - 5.779514088
- 5.779514089 - 6.079794743
- 6.079794744 - 6.680356054
- 6.680356055 - 20.19298553

Comparison between two neighborhoods



Methods

- **Fixed effect model**

$$VMT_{it} = \boldsymbol{\beta}_1 \boldsymbol{TP}_{it} + \boldsymbol{\beta}_2 \boldsymbol{TS}_{it} + \boldsymbol{\beta}_3 \boldsymbol{BE}_{it} + \boldsymbol{\beta}_4 \boldsymbol{SD}_{it} + \alpha_i + u_{it}$$

Where VMT_{it} is the daily VMT for observation *i* at time *t*; $\boldsymbol{TP}_{it}$,$\boldsymbol{TS}_{it}$,$\boldsymbol{BE}_{it}$ and $\boldsymbol{SD}_{it}$ represents the vector of transport pricing, transport supply, the built environment and socioeconomic characteristics for observation *i* at time *t* respectively; $\boldsymbol{\beta}$ is the corresponding vector of coefficients; α_i denotes all the other unobserved but time invariant variables that might influence VMT, including travel attitudes; and μ_{it} is the random disturbance of observation *i* at time *t*. In the fixed effects model, $\boldsymbol{TP}_{it}$,$\boldsymbol{TS}_{it}$,$\boldsymbol{BE}_{it}$ and $\boldsymbol{SD}_{it}$ are allowed to be associated with both α_i and μ_{it}.

Table 2 Estimation results of the fixed effects model

Dependent variables	Fixed effects model		
	TP	TP + TS	TP + TS + BE + SD
Transport pricing (TP)			
High-level COE	-0.262** (-4.49)	-0.289** (-4.93)	-0.259** (-4.29)
Medium-level COE	-0.462** (-8.23)	-0.380** (-3.64)	-0.096 (-0.46)
Transport supply (TS)			
Distance to nearest expressway exit		-0.311 (-0.27)	-1.763* (-1.71)
Distance to MRT/LRT stations		0.730* (1.74)	2.305* (1.74)
Built environment (BE)			
Walking path density			-0.927** (-2.45)
Land use entropy			-0.502** (-2.60)
Population density			-0.740 (-0.73)
Socioeconomic & demographics (SD)			
Age			0.029 (0.18)
Income			1.334** (4.38)
Household size			-0.219 (-0.58)
Car ownership			0.897** (5.98)
R-squared	0.8737	0.8788	0.9085
Adjusted R-squared	0.8096	0.8159	0.8570
Root MSE	0.4765	0.4686	0.4130

Note: ** Significant at α=0.05; * Significant at α=0.10; t values are reported in parentheses.

Table 2 Estimation results of the fixed effects model

Dependent variables	Fixed effects model		
	TP	TP + TS	TP + TS + BE + SD
Transport pricing (TP)			
High-level COE	-0.262** (-4.49)	-0.289** (-4.93)	-0.259** (-4.29)
Medium-level COE	-0.462** (-8.23)	-0.380** (-3.64)	-0.096 (-0.46)
Transport supply (TS)			
Distance to nearest expressway exit		-0.311 (-0.27)	-1.763* (-1.71)
Distance to MRT/LRT stations		0.730* (1.74)	2.305* (1.74)
Built environment (BE)			
Walking path density			-0.927** (-2.45)
Land use entropy			-0.502** (-2.60)
Population density			-0.740 (-0.73)
Socioeconomic & demographics (SD)			
Age			0.029 (0.18)
Income			1.334** (4.38)
Household size			-0.219 (-0.58)
Car ownership			0.897** (5.98)
R-squared	0.8737	0.8788	0.9085
Adjusted R-squared	0.8096	0.8159	0.8570
Root MSE	0.4765	0.4686	0.4130

Note: ** Significant at α=0.05; * Significant at α=0.10; t values are reported in parentheses.

Conclusions & policy implications

- **Increasing transit accessibility through rail investment is an effective strategy to reduce vehicle travel.**
- **However, expressway expansion might induce additional car use, offsetting the congestion mitigation benefits of increased road capacity.**
- **Diversifing land use and increasing walking path density help reduce automobile travel.**

NUS National University of Singapore

Thank you for listening!