The Built Environment and Motor Vehicle Ownership & Use

Evidence from Santiago de Chile

Chris Zegras
Assistant Professor
Dept. of Urban Studies and Planning
MIT
czegras@mit.edu

Outline

- Built Environment and Travel: A Rapid Overview
- Empirical Case: Santiago de Chile
  - Snapshots of Urban Structure, Form, Design
  - A Few Transportation Indicators
- The Built Environment and Household Travel
  - Influence on Motor Vehicle Ownership
  - Influence on Motor Vehicle Use
- Implications and Research Extensions

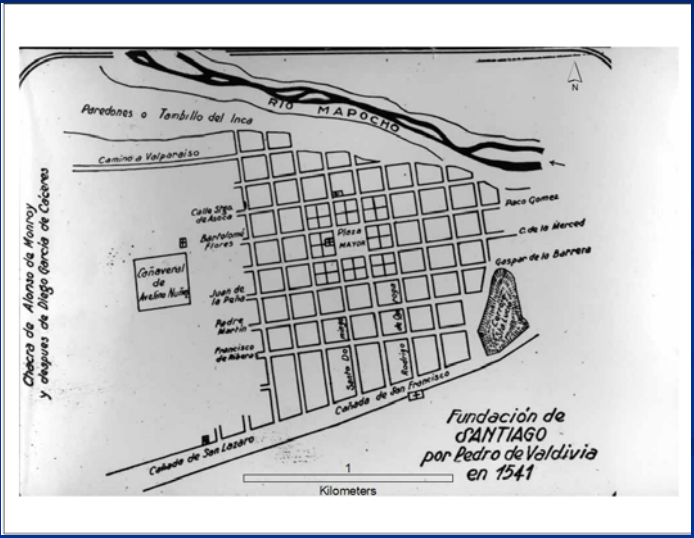
The Built Environment and Travel Behavior… "Nothing New"

- Mitchell & Rapkin (1954): *Urban Traffic: A Function of Land Use*
- Simulations in the 1960s, Pushkarev & Zupan (1977), Cheslow & Neels (1980), Newman & Kenworthy (1989), Cervero & Kockelman (1997), Boarnet & Crane (2001), etc.
- Variations due to:
  - Scale of analysis, analytical techniques, built environment measures, data type, travel outcome measured

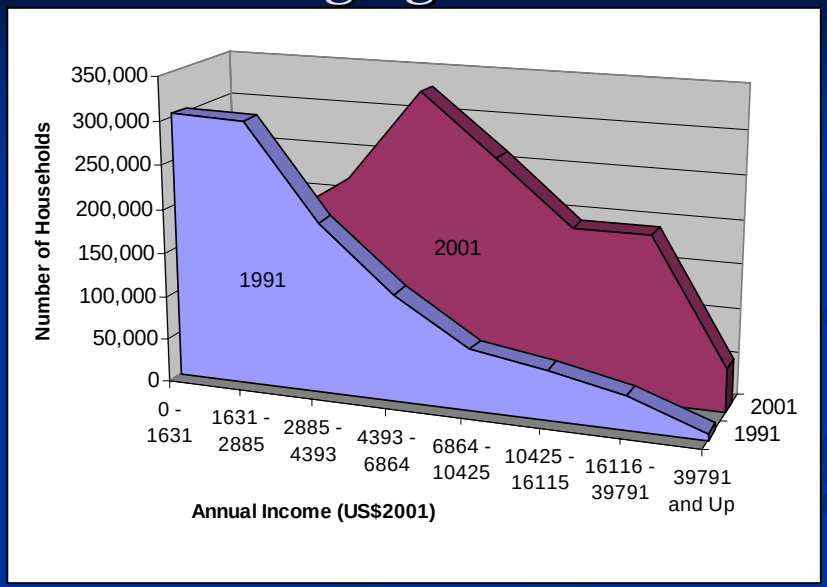
Built Environment and Motor Vehicle Ownership & Use: Direct Precedents

- Why Motor Vehicle Ownership & Use?
- Aggregate-level analyses
  - Kain, Beesley & Kain (1960s), Cheslow & Neels (1980), Miller & Ibrahim (1998), Holtzclaw et al (2002)
- Disaggregate-level analyses
  - Vehicle Ownership: Cambridge Systematics (1997; 2002)-Philadelphia & San Francisco; Hess & Ong (2002)-Portland; Kitamura et al (2001)-Southern California; Bento et al (2004)-US cities
  - Vehicle Use (VKT): Cervero & Kockelman (1997); Kitamura et al (2001) Bento et al (2004)
- Crucial to explicitly link the two (ownership and use): endogeneity, selectivity bias

Santiago de Chile: A "Two-Minute Tour"

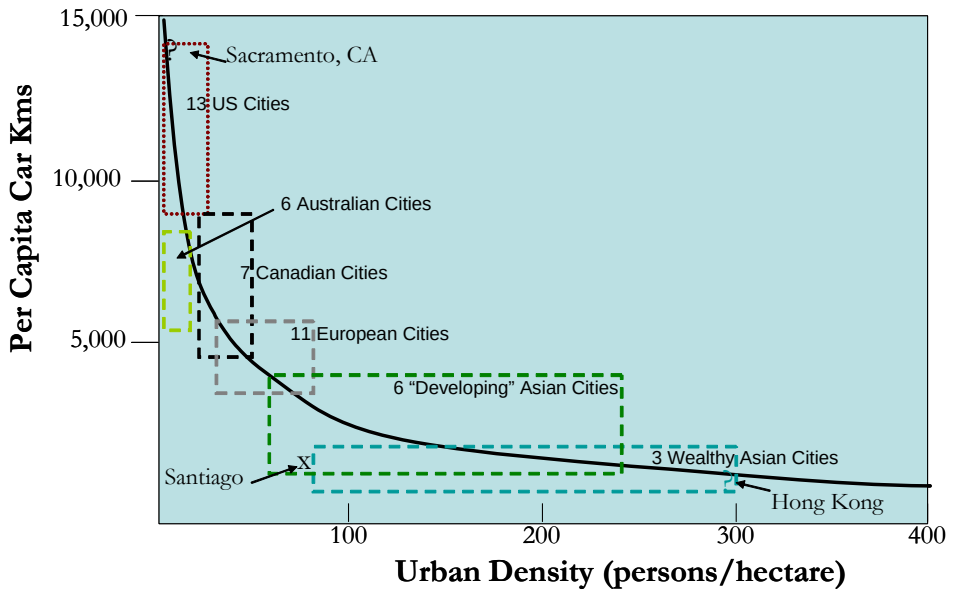


The Emerging Middle Class



Sources: Derived from SECTRA, 1992; 2002

Urban Structure



Kenworthy & Laube, 1999 (except Santiago)

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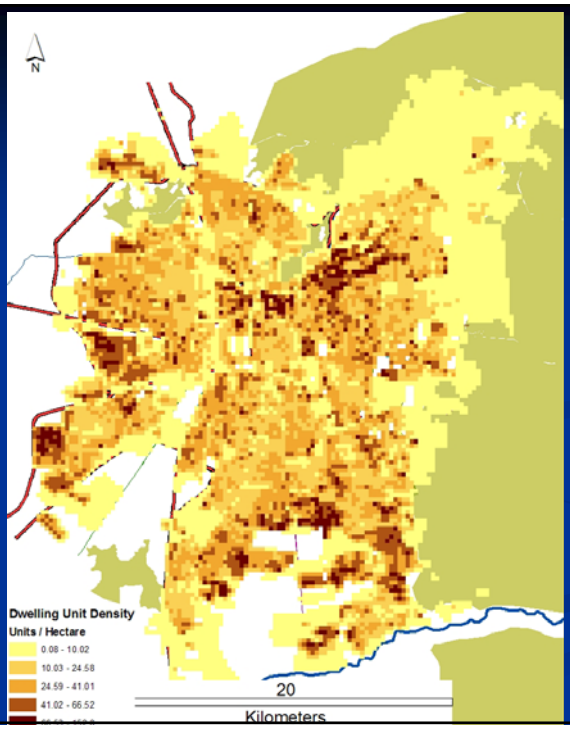

Urban Form: Residential patterns

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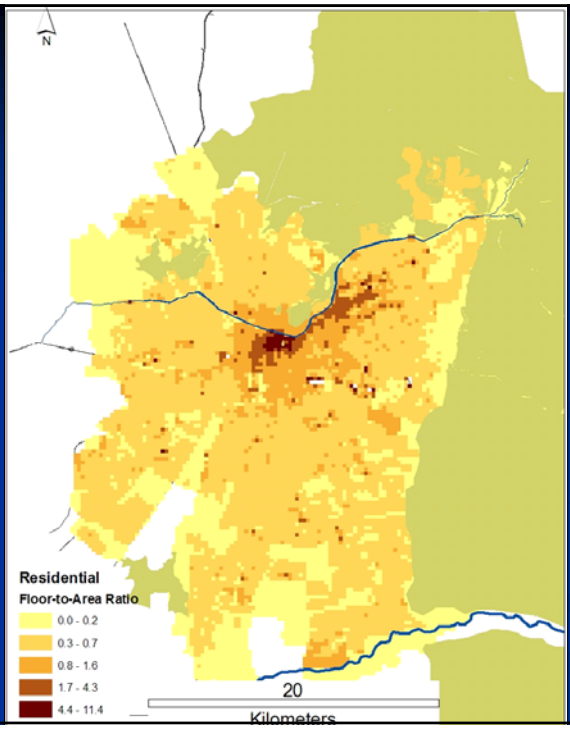

Urban Form: Residential patterns

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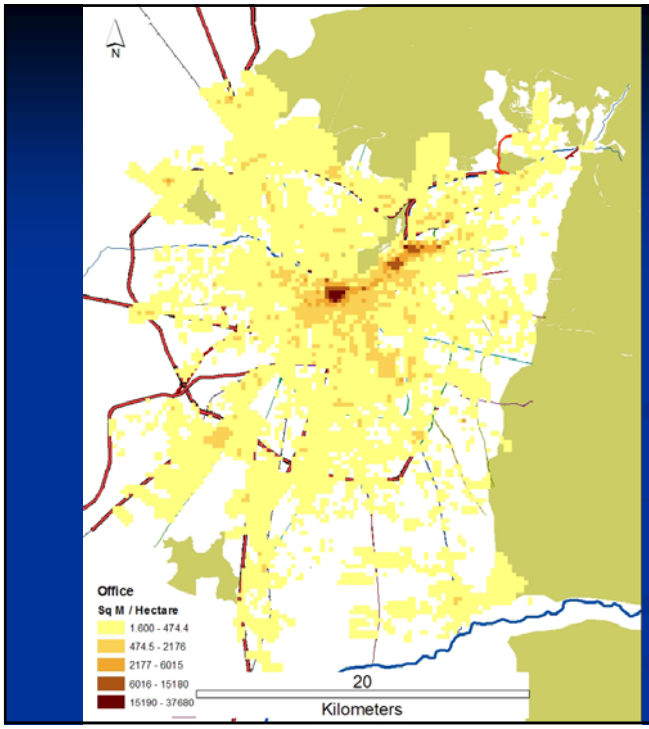
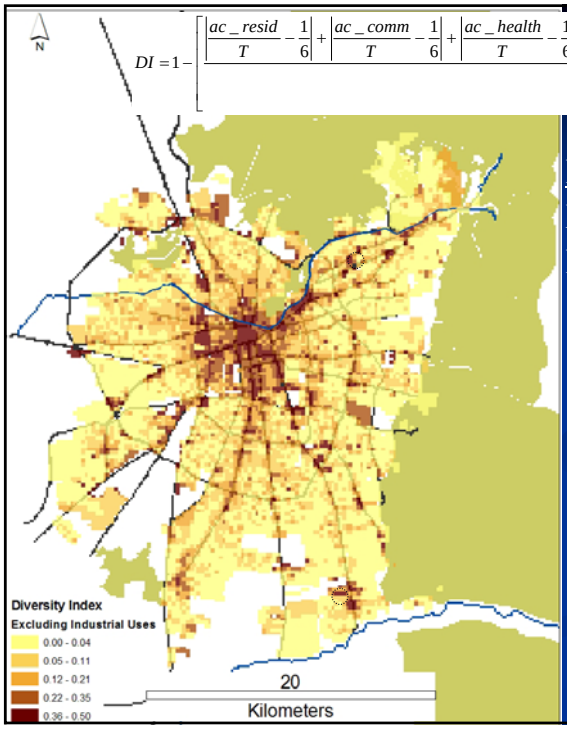


Urban Form:
The CBD and its Eastern "migration"

$$DI = 1 - \left[\frac{\left|\frac{ac\_resid}{T} - \frac{1}{6}\right| + \left|\frac{ac\_comm}{T} - \frac{1}{6}\right| + \left|\frac{ac\_health}{T} - \frac{1}{6}\right| + \left|\frac{ac\_offic}{T} - \frac{1}{6}\right| + \left|\frac{ac\_pubadm}{T} - \frac{1}{6}\right| + \left|\frac{socserv}{T} - \frac{1}{6}\right|}{\frac{5}{3}} \right]$$



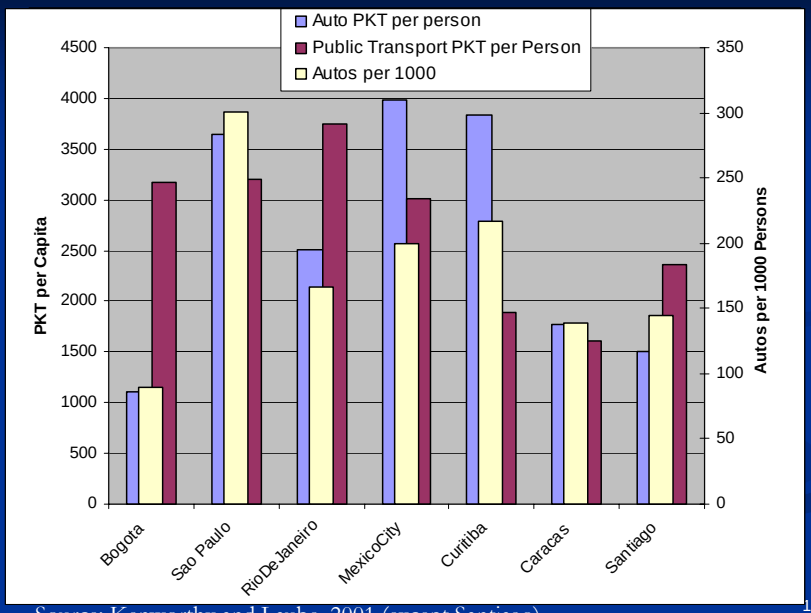
Internal Patterns
Diversity/Dis-Similarity Index

Household Transportation: What Role of the Built Environment?

A Note on Data Sources

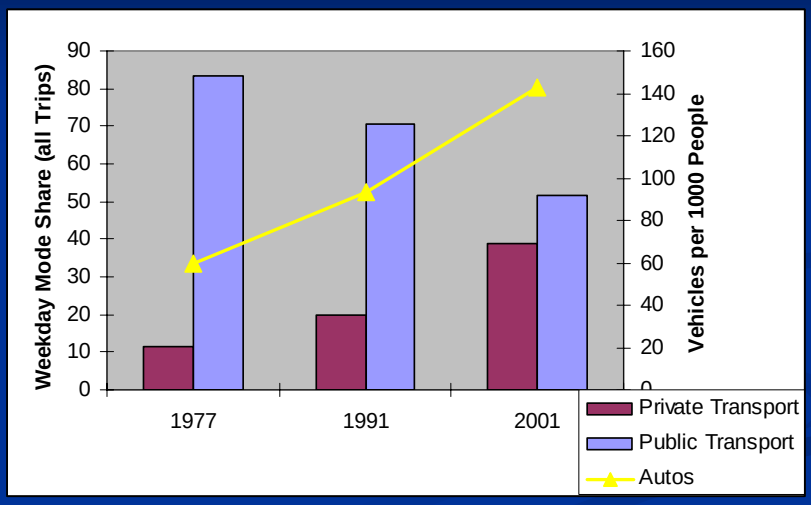
- Primary: Household travel survey (2001)
- 15,000 households (1% sample)
  - 12,000 during "normal season"
  - 3,000 during summer
  - Geo-coded at census block centroid
- 38 Municipalities; 780 Traffic Analysis Zones (TAZs)
- All Trips in public space, by all individuals in HH
- Trip origins and destinations geocoded at nearest street corner

Santiago's Travel in Context



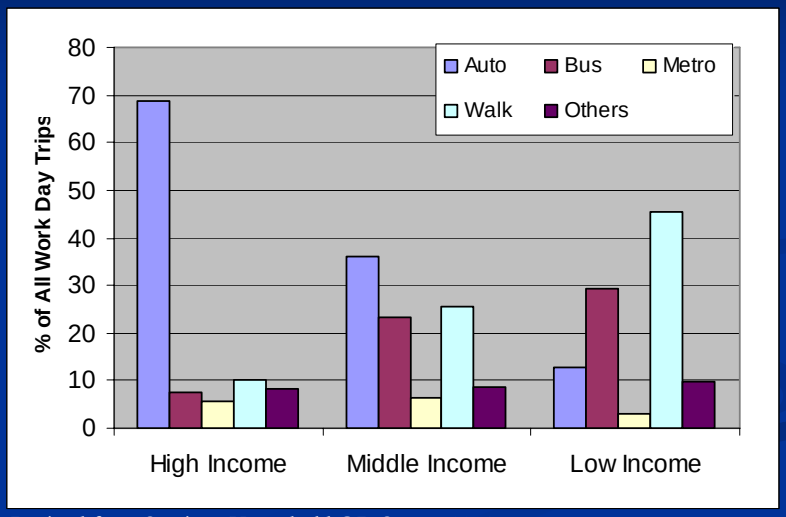
Source: Kenworthy and Laube, 2001 (except Santiago)

Motorization and Mode Share Evolution



SECTRA, 2002

Weekday Travel Mode Share
All Trips (2001)



Derived from Santiago Household OD Survey 2001.

What Role of the Built Environment?

- Discrete choice model (multinomial logit) of household vehicle ownership
  - Decision to own: 0, 1, 2, 3+ vehicles in the home
  - HH Vehicle Ownership:
    - 0 Vehicles: 59% of HHs
    - 1 Vehicle: 32% of HHs
    - 2 Vehicles: 8% of HHs
    - 3+ Vehicles: 2% of HHs

HH Motor Vehicle Ownership Choice

Charac-teristic	Variable	Number of Vehicles		
		1	2	3
HHs	Household Income	+	++	++
	# Persons	+	++	-
	# Adults	-	n.a.	+
Urban Form	Auto:Bus Accessibility	+	++	++
	CBD Dist	n.a.	+	+
Urban Design	Apartment	-	--	---
	Diversity Index	n.a.	-	--
	Dwelling Unit Density	n.a.	-	--

n=14729. Rho-Square = 0.451. n.a.means variable was not significant for the relevant choice. In all other cases, significance at ≥ 95%

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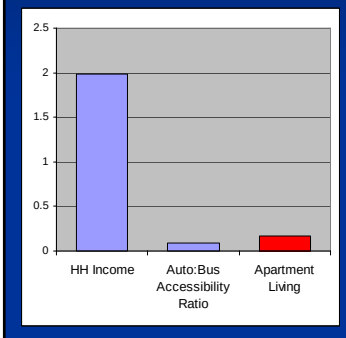
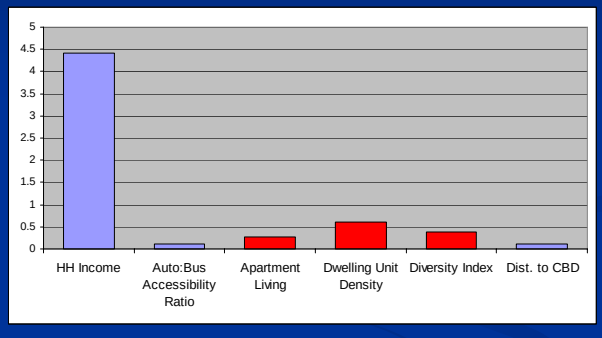
HH Motor Vehicle Ownership Choice



Choice to Own One Vehicle



Choice to Own Two Vehicles

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Auto Ownership Results

- At least one vehicle seems a certainty as soon as income allows; some dampening effect from apartment living
- *Micro-Level* BE:
  - Dwelling unit density and land use mixing (diversity index) have strongest BE effect on additional (i.e., after first) vehicle
  - Street patterns, block morphology, intersection density, etc. – **no detectable effect**
- *Meso-/Metro-Level* BE:
  - The "compact city" finds some support: distance to CBD effects
- ➢ Implication: Incorporate BE variables in auto ownership forecasting for travel modeling

What Role of the Built Environment on Automobile Use?

- OLS model of total Household vehicle kilometers traveled
  - On day of survey
  - Distance derived from trip x,y coordinates and shortest path on road network
- HH VKT = *f* (HH Socio-demographics, Trip-Making, Urban Form, Urban Design)
  - But, need to control for "selectivity bias"

Motor Vehicle Use Results

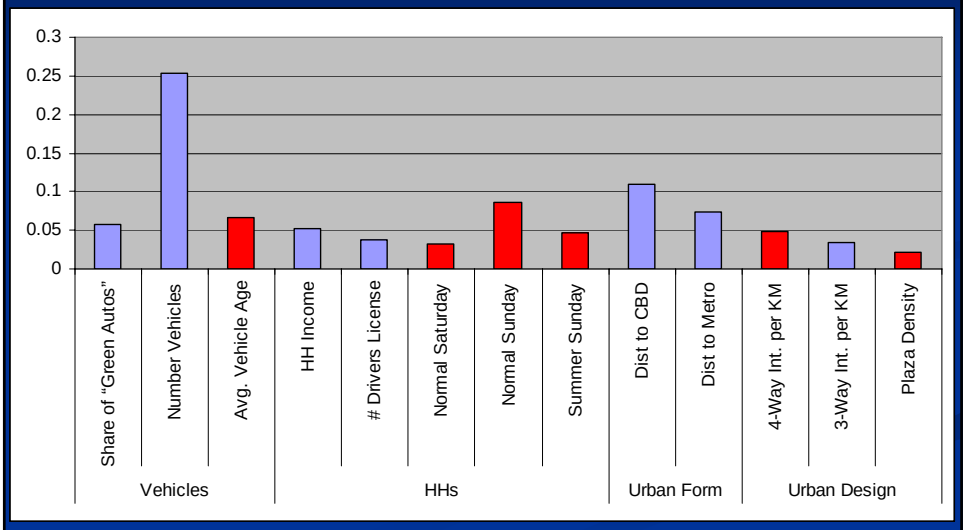
	Variable	B	Stdrzed	Sig.
Vehicles	Share "Green Auto"	3270	0.057	0.008
	# Vehicles	9130	**0.253**	0.000
	Avg. Veh. Age	-255	-0.067	0.001
HHs	**HH Income (US$)**	69.6	**0.052**	0.009
	# Drivers License	1029	0.037	0.056
Trips	**# Trips**	925	**0.281**	0.000
	No Distance coded	-1529	-0.089	0.000
	Normal Sat	-2670	-0.032	0.011
	Normal Sunday	-6749	-0.086	0.000
	Summer Sunday	-7346	-0.047	0.000
Urban Form	**Dist to CBD**	0.59	**0.109**	0.000
	Dist to Metro	0.61	0.074	0.002
	Foothills	3100	0.035	0.043
Urban Design	**4-Way Int. per KM**	-1569	**-0.048**	0.001
	3-Way Int. per KM	479	0.035	0.023
	Plaza Density	-16810	-0.022	0.029
	Select. Bias Correction	5603	0.056	0.007

Dependent variable: Total HH vehicle use (measured in meters traveled)

R-Squared = .27; N=4279.

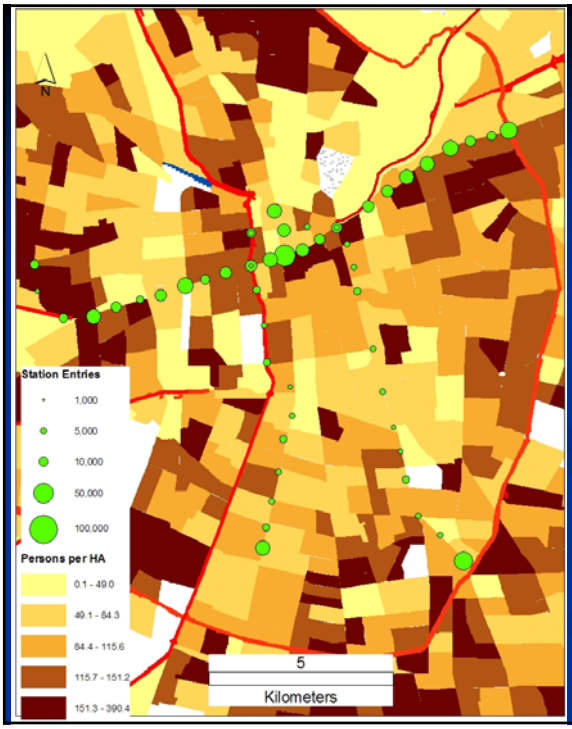
Heteroskedasticity-Consistent Standard Errors used to Determine Significance

HH Motor Vehicle Use



Implications for Planning/Design

- *Meso-Level* BE: Some support for:
  - The "compact city" (CBD effects)
  - Reducing development pressures in the foothills
  - "Transit-Oriented Development" (Metro proximity)
    - Auto-owning HHs within 1 km radius of existing stations, on average, travel ~2 kms less by auto than those living 4 kms from a station
- *Micro-Level* BE:
  - Local street network and public spaces (plazas) have some effect
  - No Apparent *Direct* Effect of Dwelling Unit Density, Land Use Mix



Metro Station Entries (Daily Average) and Population Density

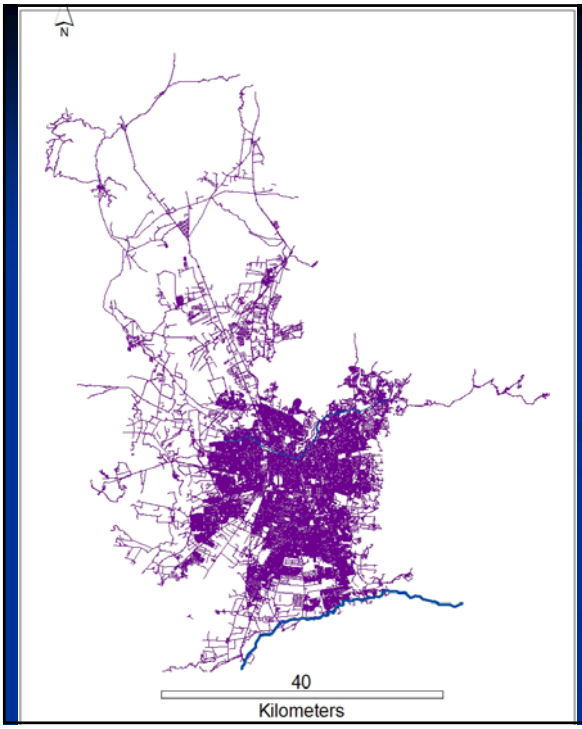
Analysis: In Summary

- Distance to CBD separately influences vehicle ownership and use
  - 1-KM further from CBD, increases use by ½ KM
- Relative attractiveness of auto use (to bus) influences additional vehicle purchases
- Dwelling unit density directly influences additional vehicle purchases; second-order impact on use
- Metro proximity influences vehicle use
- Local street design and public spaces influence vehicle use

Outlook for Santiago

Some Positive Signs

- Urban renewal (the "renovated" city)
- Impact Fees (slowing the sprawl, marginally)
- "New Town" regulations (*ZODUCs*)
  - Ostensibly will create a "poly-nucleated city"
- Some efforts focusing on renewing the de-industrializing swaths of the center city
- Strong technical capacity within centralized authorities (and universities) for transportation planning and evaluation and *fairly* good data



Outlook for Santiago …

Research Extensions

- Correct for Endogeneity
  - In vehicle choice model
  - *And* vehicle use model
  - Via development of a residential choice model
- Examine alternative spatial units of analysis
  - To assess potential effect of Modifiable Areal Unit Problem (MAUP)