Data collection and modeling for next generation infrastructure

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Outline

- Introduction of next generation infrastructure
- Examples of analysis
  - Probe data
  - Electricity usage
  - Reservation system
- Conclusions

Next generation infrastructure

- Council for Science and Technology Policy, Japan states the need for next generation infrastructure

- Features of next generation infrastructure
  - **Smart**: information technology to forecast, control and optimize
  - **System**: added value as system in addition to strength of products and technology itself
  - **Global**: business strategy toward global deployment

Images of next generation infrastructure

- Smart energy community
  - Energy management system utilizing information technology
  - Renewable energy, decentralized generating plant, etc.
- Intelligent transport system
  - Communication networking among people, vehicles and road utilizing information technology
  - Navigation system, car sharing, LRT, etc.
- Next generation infrastructure in other areas
  - Water supply, distribution, medical care, etc.
  - Integrated system

History of transport data collection

- Manual traffic count
- Person trip survey
- Activity survey
- Probe data
- “Big data”

Detailed information

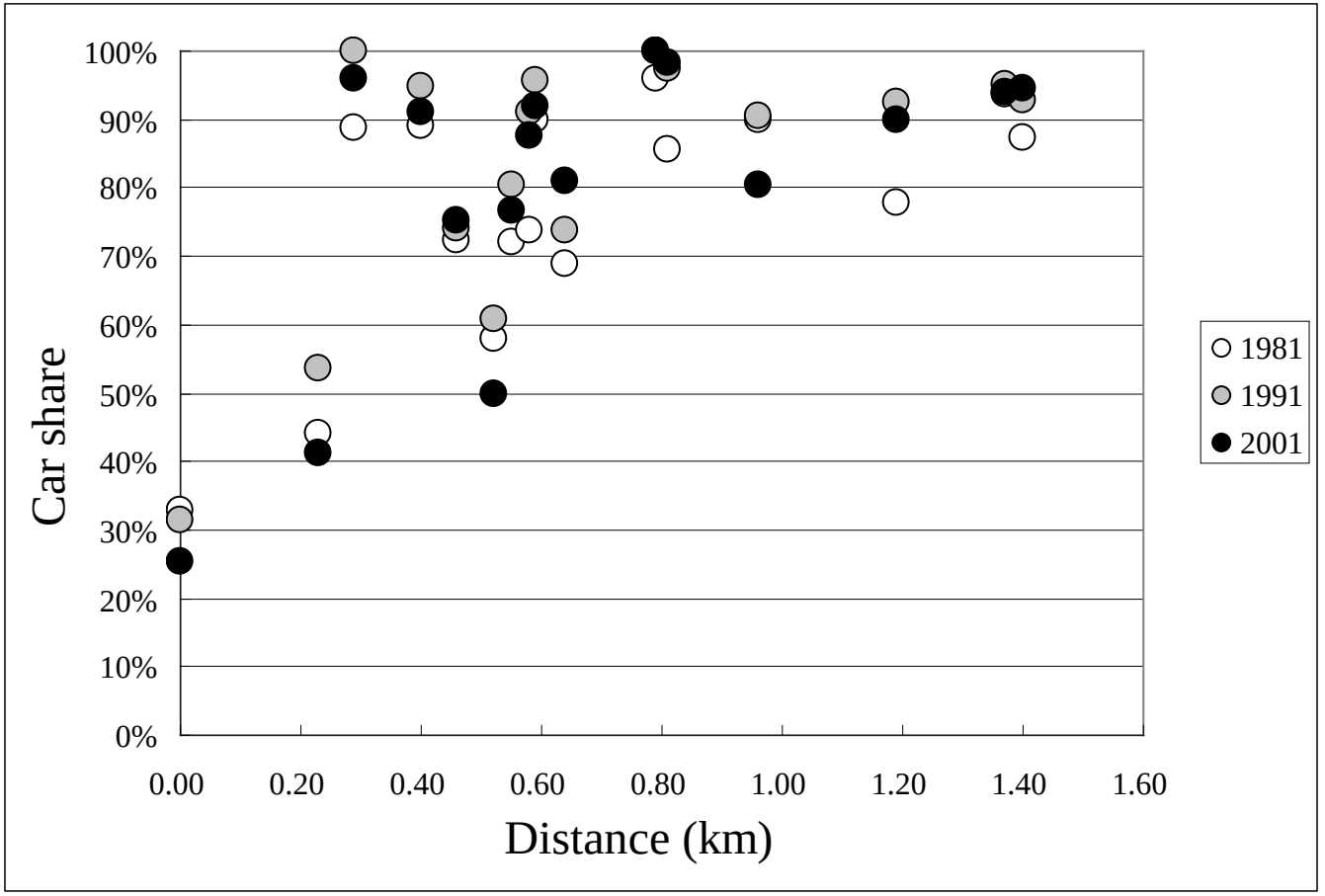
- Precision of space and time
- Continuous observation

From paper & pencil to computer assisted, then mobile device (information technology)

Modeling of travel behavior

- Analysis on zone to zone trip by person trip survey data
  - imprecise to analyze the short trip, access to mass transit
- Analysis on point to point trip by probe data
  - Chosen routes are easily observed

Car share of trips to government offices by distance from station in 1981 to 2001



Effects of preciseness of egress info.
（zone system is used for access）

Estimation results of mode choice model

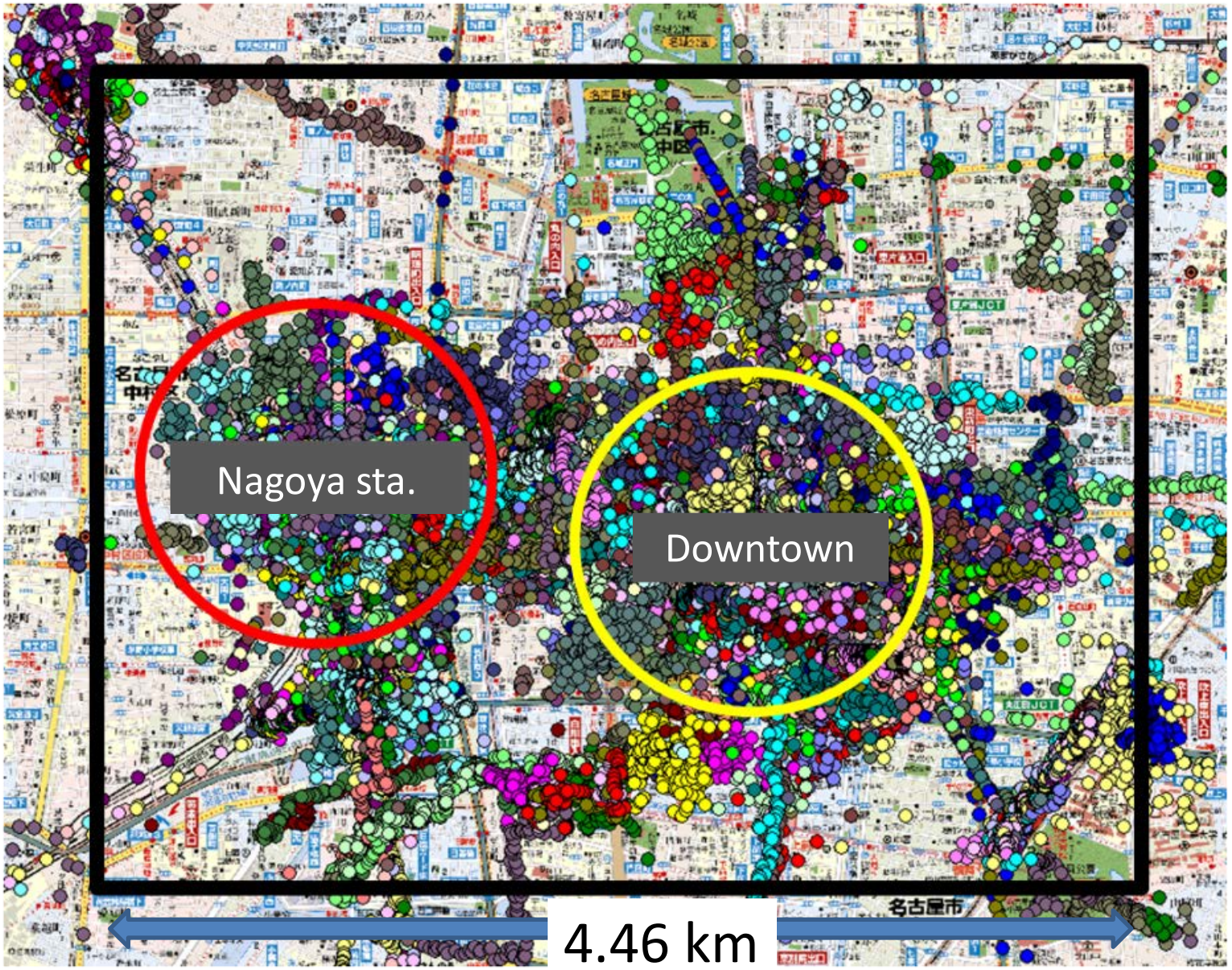
Coefficient estimate and t-stat. in parenthesis

	GIS based	Zone system
Upper level		
Bus egress	-2.0 (-3.4)	-1.7 (-4.2)
Lower level		
Station egress	-2.8 (-18.9)	-1.8 (-17.8)
Log-likelihood	-2944	-3063

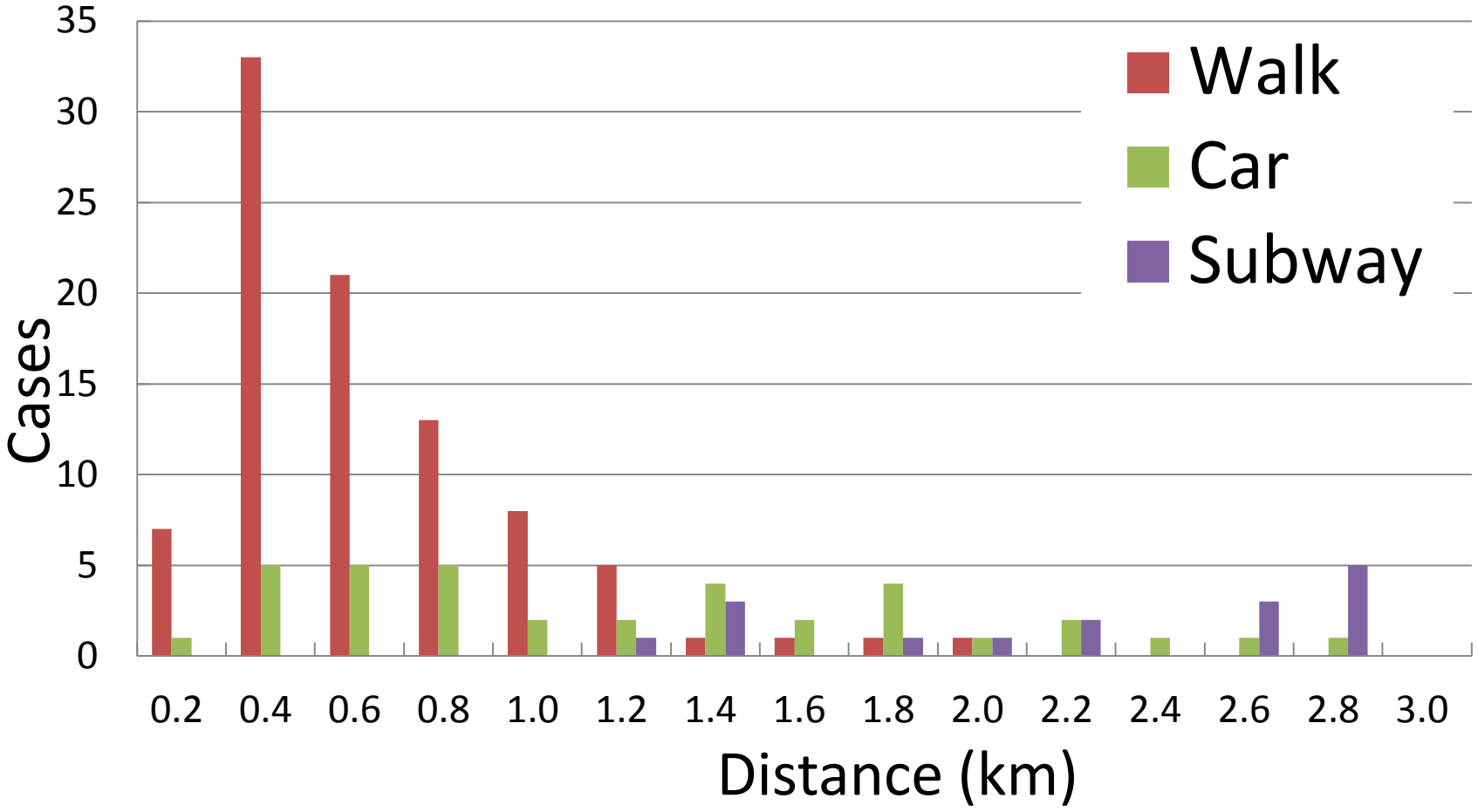
GIS based egress has

- Better log-likelihood
- Larger coefficient estimates in absolute value

Example of transport data collection



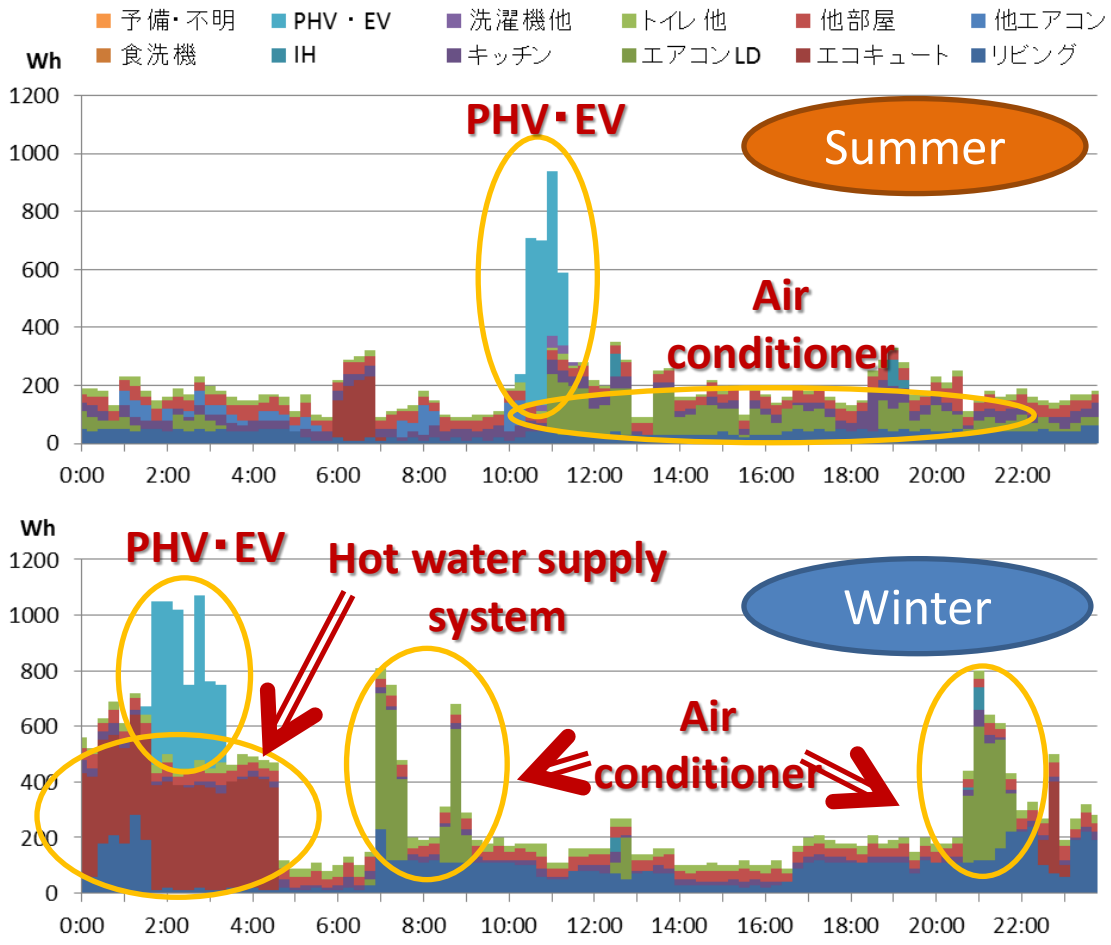
Sample distribution of trip distance



Walk route choice model (N = 91)

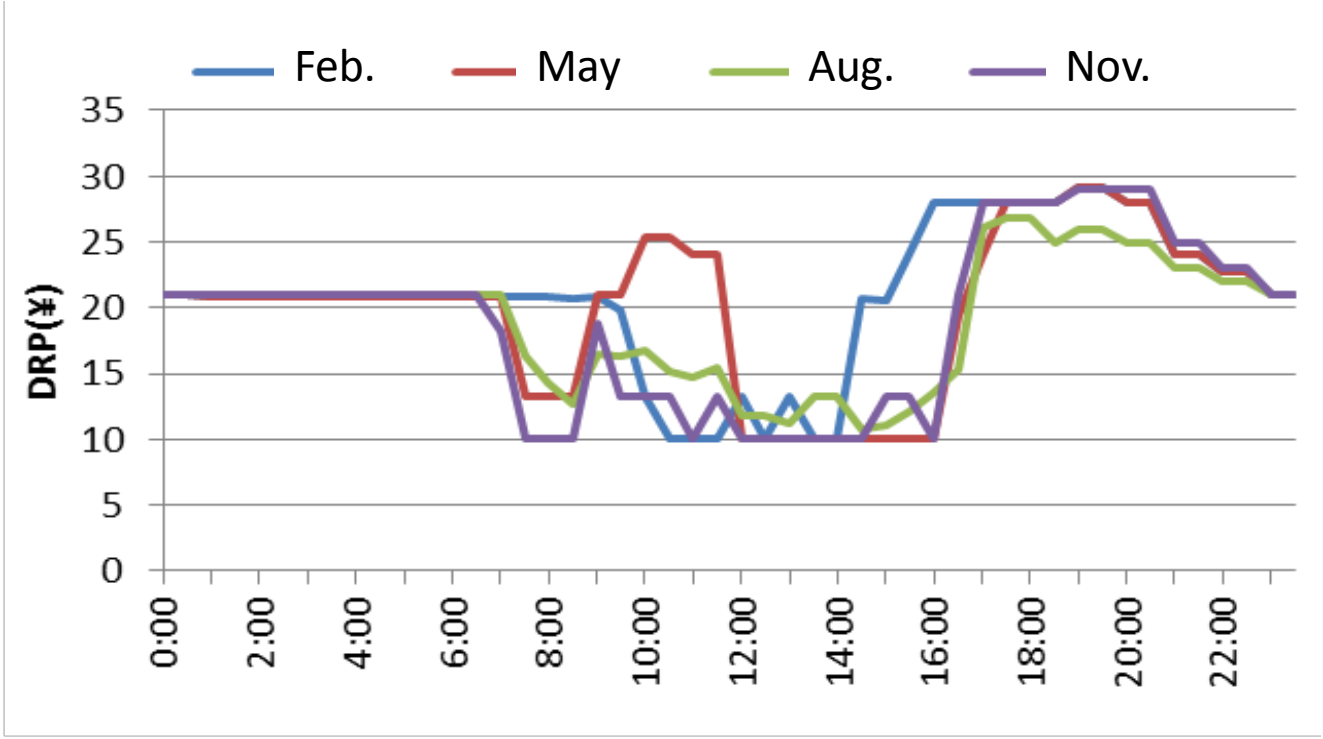
	Coef.	t-stat.
Distance (100 m)	-5.89	-4.30
Street with department stores for the elderly (100 m)	7.34	3.91
Street with restaurants on holidays (100 m)	4.61	2.60
Street without stores (100 m)	1.58	2.41
lnEPS	0.54	3.93
Heteroscedasticity of scale parameter (γ)	-0.56	-2.37

Example of data collection on electricity usage

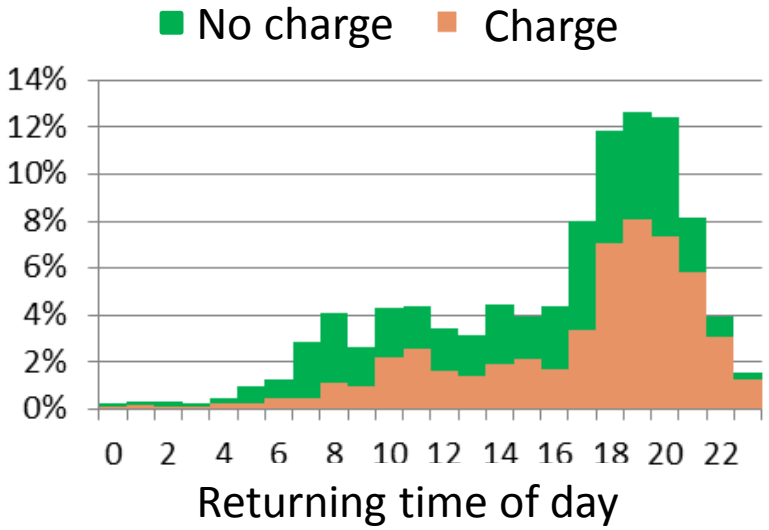


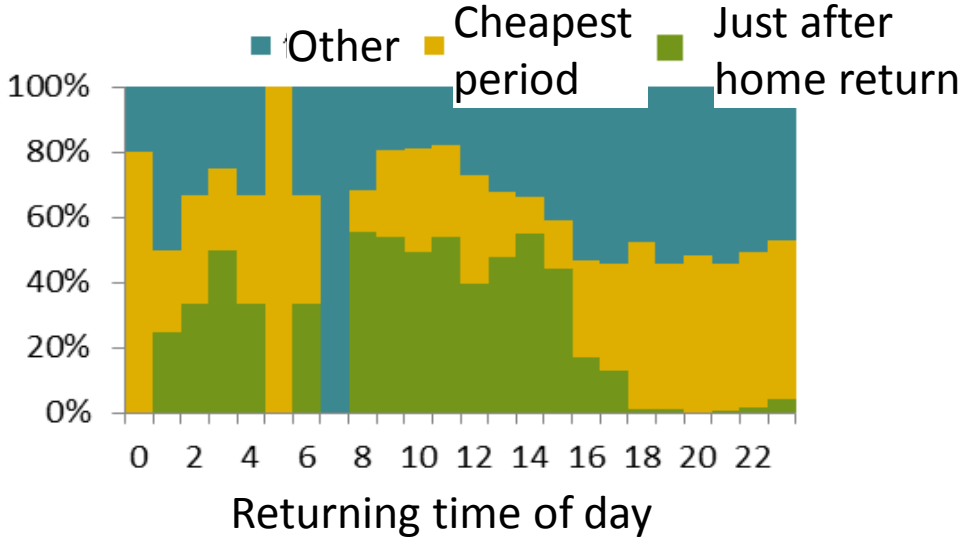
Demand response point system in Toyota city smart house experiments

- Demand response point system
  - Social experiments for dynamic pricing such as peak pricing



PHV charging behavior by returning home timing



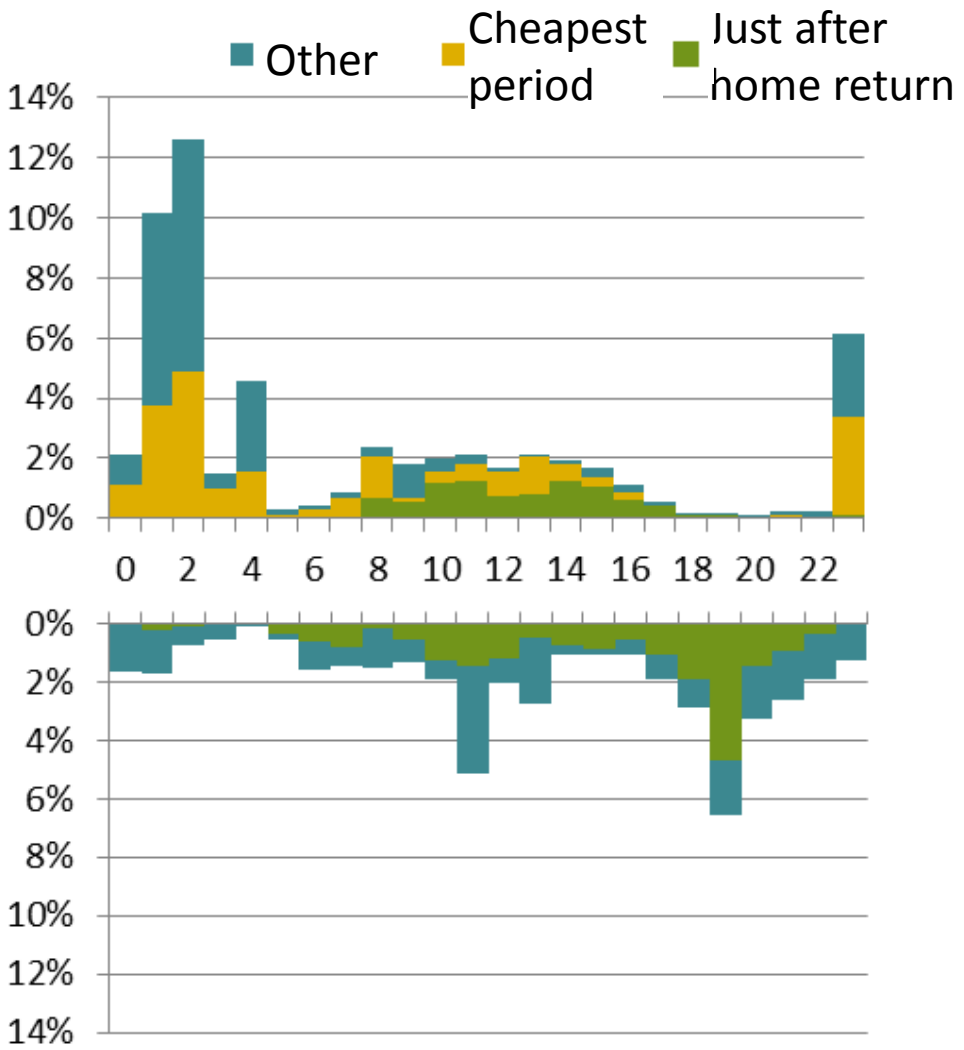


- Many cars return home at around 18 o'clock, which potentially cause peak demand

Charging time is distributed by the demand response point system

With demand response point

W/O demand response point



PHV charging timing choice model

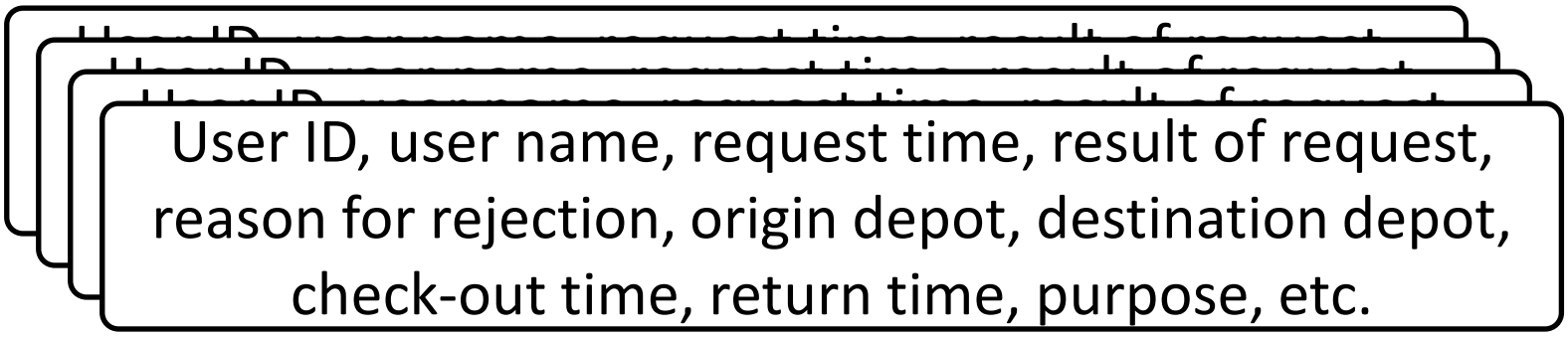
Alternative	Variable	Coef.	
No charge	Constant	1.34	**
	Travel distance (< 24 km)	-0.10	**
	Long travel dummy (>24km)	-0.38	**
Just after home return	**Price** for high energy conscious person	-0.044	**
	Price for low energy conscious person	-0.065	**
	Daytime (9-16) returning home	0.70	**
Cheapest period	Constant	-0.69	**
	Price for high energy conscious person	-0.016	**
	Price for low energy conscious person	0.001	
	Housewife dummy	0.66	**
	Nighttime (17-23) returning home	1.41	**
Other periods	Constant	-0.96	**
	Nighttime (17-23) returning home	0.65	**
	Previous charge timing dummy	2.21	**

** 5% significance

Example of “big data”

Logs of reservation requests at car sharing system

- It is not actually big, but secondary use of existing data stored for other purposes
- Rescheduling was identified by a request which was made after rejected request



Type of rescheduling by trip purpose

Purpose	Business	Shopping	Commute	Total
Sample size	456	206	165	1306
Re-request rate	**51%**	**53%**	**36%**	**49%**
Change of				
Start time	10%	10%	17%	10%
Return time	23%	28%	25%	23%
Dest. depot	5%	7%	7%	7%
Start & return	**37%**	**28%**	**26%**	**33%**
Start & dest.	3%	4%	1%	4%
Return & dest.	4%	8%	1%	5%
Start, return & dest.	7%	8%	1%	7%

Change in start time

	%
More than 1 hr. earlier	4.2
More than 30 min earlier	3.1
Within 30 min	74.5
More than 30 min after	6.8
More than 1 hr. after	**11.4**
Sample size	385

Regression model of change in start time suggests

- Reservation requested well in advance has a larger change in start time

Conclusions

- Software is combined with hardware at next generation infrastructure using information technology
- Information technology improves the accuracy of the analysis
- “Big data” might provide information on unexpected aspect of behavior