Relationship between Commute Distances of Spouses in Two-Earner Households Considering Intra-Zonal Commutes

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Background

- **Increase in daily mobility** has negative externalities as well as positive effects on quality of life

- **Increasing commute distance** has been concerned for many years

- The concept of **job-housing balance** has been debated

- One of the issues is the effect of **dual-earner household**

Objective

- Relationship between commute distances of spouses in Japan is empirically explored

- Obstacle: Commute distance isn't observed accurately by conventional person trip survey
  - Measured by centroid-to-centroid at zones
  - **Intra-zonal trips**

- Ignoring intra-zonal trips may cause biased results

Methodology

- Diameter of the zone is used as maximum of intra-zonal commute distance

- **Tobit approach** is used to consider intra-zonal commutes properly

- Direct effects of commute distance of spouse and error correlation are investigated by **bivariate Tobit model**
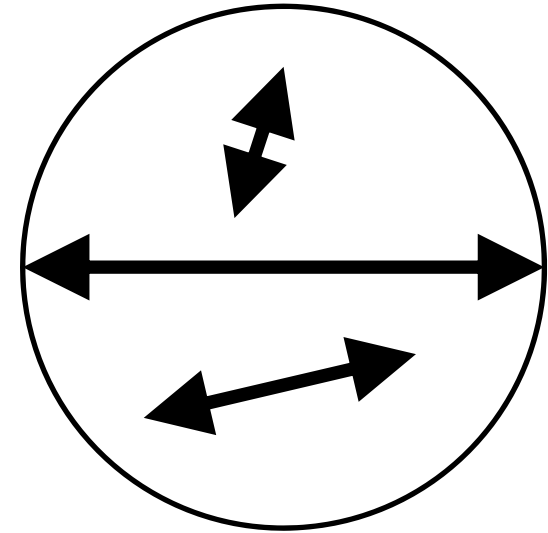
Bivariate Tobit model

- Logarithm of commute distance is used as dependent variable

Commute dist. of husband (D_h)

Interaction

Commute dist. of wife (D_w)

Husband distance

$$\ln(D_h^*) = \beta_h X_h + \gamma_h \ln(D_w^*) + \varepsilon_h$$

Inter-zonal commute

$$\ln(D_h) = \ln(D_h^*) \text{ if } \ln(D_h^*) > \ln(Z)$$

Intra-zonal commute

$$\ln(D_h) = \ln(Z) \text{ if } \ln(D_h^*) \leq \ln(Z)$$

Wife distance

$$\ln(D_w^*) = \beta_w X_w + \gamma_w \ln(D_h^*) + \varepsilon_w$$

Inter-zonal commute

$$\ln(D_w) = \ln(D_w^*) \text{ if } \ln(D_w^*) > \ln(Z)$$

Intra-zonal commute

$$\ln(D_w) = \ln(Z) \text{ if } \ln(D_w^*) \leq \ln(Z)$$

Z: Diameter of zone, $\rho = \text{corr}(\varepsilon_h, \varepsilon_w)$

Comparison with improper treatment for intra-zonal commute

- Proposed approach: Bivariate Tobit model

- **Discarding**:
  - Discarding the cases with intra-zonal commute
  - Bivariate regression model

- **Imputing**:
  - Diameter of the zone is used as intra-zonal commute distance
  - Bivariate regression model

Data

Nagoya
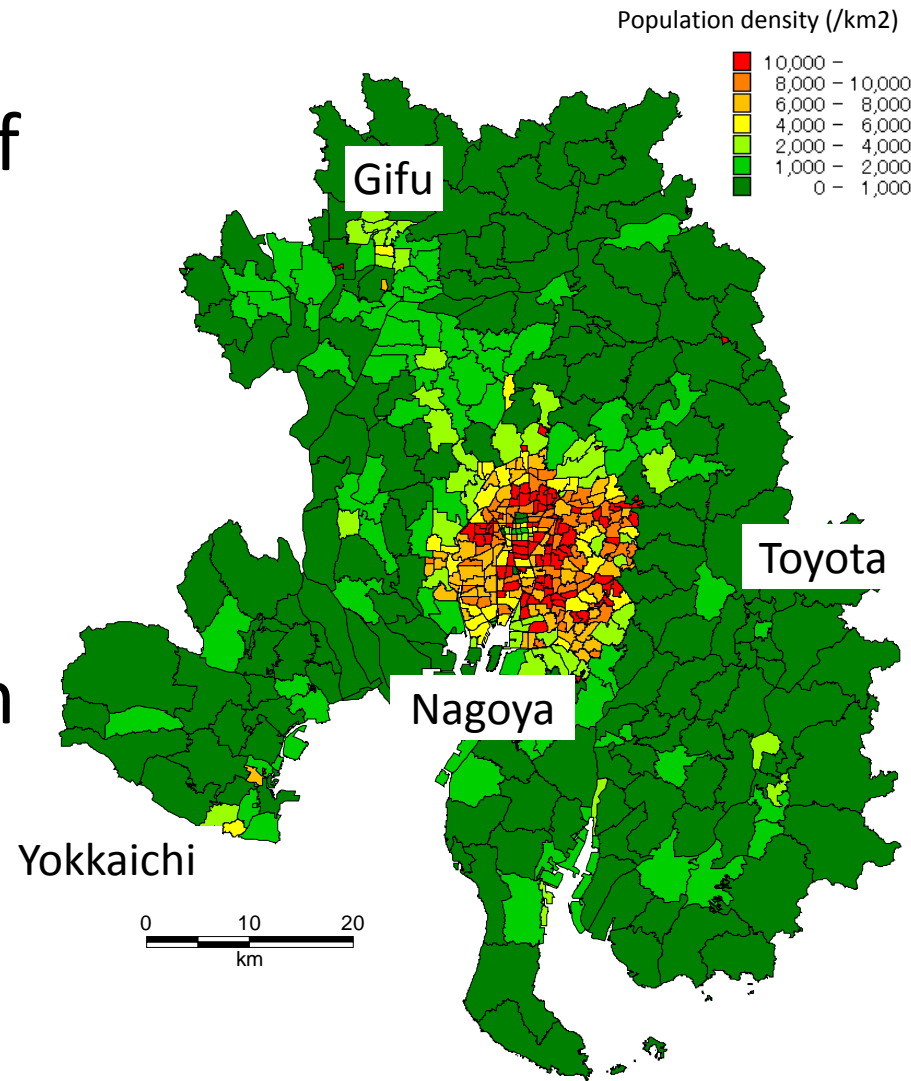
- Conventional 1 day person trip survey data

- Obtained at Nagoya Metropolitan area, Japan in 2001

- Home & work locations are collected at zonal level

- 23,394 two-earner households within 224,618 sampled households are used for estimation

Zone size

- Average diameter of zone is 2.7km

- Densely populated zones have smaller sizes

- Ranges 0.8 to 10 km

Population density (/km2)

- 10,000 –
- 8,000 – 10,000
- 6,000 – 8,000
- 4,000 – 6,000
- 2,000 – 4,000
- 1,000 – 2,000
- 0 – 1,000

Gifu

Toyota

Nagoya

Yokkaichi

0   10   20
km

Explanatory variables

- Person
  - Job type, driver license
- Household
  - Number of children, number of elderly, number of vehicles
- Location
  - Distance between city center and home, distance from station to home, city of home zone & work zone

Sample distribution of commute distance
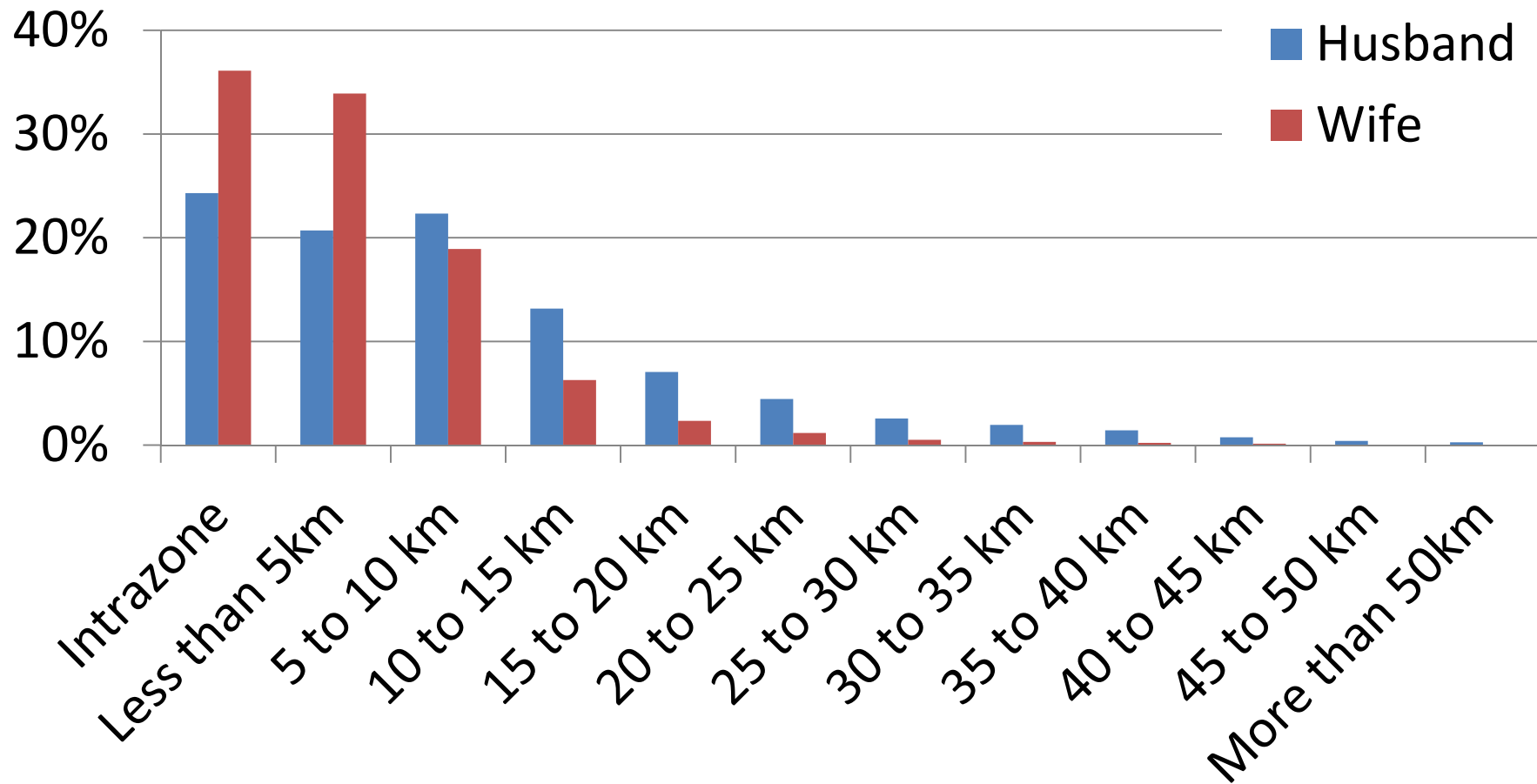
Intra-zonal commute consists of 24% of husband and 36% of wife

Estimation results

	Husband Coef.	Wife Coef.
Constant	1.38**	0.78**
#children	0.04**	-0.03**
#elderly	0.05**	0.01
#vehicle	0.01*	0.02**
Driver lisence	0.16*	0.24**
Employment — Agriculture	-0.58**	-0.34**
Employment — Manufacturing	-0.01	-0.04**
Employment — Finance	0.14**	0.21**
Employment — Security	0.10**	0.19
Employment — Management	0.12**	0.17**
Employment — Government	0.07**	0.19**
Workplace zone — Nagoya	0.34**	0.47**
Workplace zone — Toyota	-0.18**	-0.04
Workplace zone — Gifu	0.00	0.22**
Workplace zone — Yokkaichi	0.07	0.25**
Workplace zone — Toyohashi	-0.08	0.07
Residence zone — Nagoya	-0.46**	-0.59**
Residence zone — Toyota	-0.13**	-0.11**
Residence zone — Gifu	-0.01	-0.13
Residence zone — Toyohashi	0.35**	0.46**

	Husband Coef.	Wife Coef.
ln(Distance between city center and home) (km)	0.25**	0.29**
Distance from station (km)	0.00	0.01**
ln(Commute dist. of husband) (km)		-0.07**
ln(Commute dist. of wife) (km)	-0.04**	
Error correlation	0.28**	
Sample size	23294	
Adjusted ρ^2	0.108	

Estimation results

	Husband	Wife
	Coef.	Coef.
Number of children	0.04**	-0.03**
ln(Distance between city center and home) (km)	0.25**	0.29**
ln(Commute dist. of husband) (km)		-0.07**
ln(Commute dist. of wife) (km)	-0.04**	
Error correlation	0.28**	

- Wife decreases the commute distance for children
- Living in suburb increases the commute distance
- Commute distance of husband has a larger effect on that of wife than vice versa

Comparison with discarding intra-zonal cases

	Proposed model		Discarding intra-zonal cases	
	Husband	Wife	Husband	Wife
	Coef.	Coef.	Coef.	Coef.
Number of children	0.04**	-0.03**	0.04**	-0.03**
ln(Distance between city center and home)	0.25**	0.29**	0.21**	0.32**
ln(Commute dist. of husband)		-0.07**		-0.26**
ln(Commute dist. of wife)	-0.04**		0.01	
Error correlation	0.28**		0.46**	

Comparison with imputing diameter of the zone for intra-zonal commute

	Proposed model		Imputing diameter of zone	
	Husband	Wife	Husband	Wife
	Coef.	Coef.	Coef.	Coef.
Number of children	0.04**	-0.03**	0.08**	-0.01**
ln(Distance between city center and home)	0.25**	0.29**	0.24**	0.36**
ln(Commute dist. of husband)		-0.07**		-0.14**
ln(Commute dist. of wife)	-0.04**		0.14**	
Error correlation	0.28**		0.34**	

Conclusions

- Commute distances of husband and wife have a direct negative effect on each other

- Commute distance of husband has a larger effect on that of wife than vice versa

- Improper treatment of intra-zonal commute results in biased parameter estimation