

共同研究集会「官民オープンデータ利活用の動向 及び人材育成の取組」

Intra-metropolitan spatial patterns of female labor force participation and commute times in Tokyo

<https://doi.org/10.1016/j.regsciurbeco.2017.11.003>

Nov. 16, 2018

統計数理研究所

河端瑞貴(慶應大)・安部由起子(北大)

女性就業の地域差

- 先行研究：分析の空間単位—比較的大きい
 - 都道府県 (Abe, 2011, 2013)
 - county(郡) (Fogli and Veldkamp, 2011, *Econometrica*)
 - 都市圏 (Black et al., 2014, JUE)
- 女性就業の地域差と通勤時間：実証研究少ない
 - Black et al (2014)：負の関係—都市圏単位の分析
 - 都市圏内の女性就業の地域差および通勤時間との関係？

Research Questions

1. Are there specific **intra**-metropolitan spatial patterns of female labor force participation?
2. Are the spatial patterns of female participation related to commute times (CT)?
3. Do the spatial patterns of female participation and their associations w/ CT differ by marital status and the presence of children?

For women aged 25-54 in the Tokyo metropolitan area

•

•3

Methods: spatial patterns of female participation

- Global Moran's I (Moran 1950)
 - Global measure of spatial autocorrelation
 - Spatial patterns are random, clustered, or dispersed?

$$I = \frac{n}{\sum_{i=1}^n \sum_{j=1}^n w_{i,j}} \frac{\sum_{i=1}^n \sum_{j=1}^n w_{i,j} (x_i - \bar{X})(x_j - \bar{X})}{\sum_{i=1}^n (x_i - \bar{X})^2}$$

- Getis-Ord G_i^* (Getis and Ord 1992; Ord and Getis 1995)
 - Local measure of spatial autocorrelation
 - Locations of spatial clusters of high values (**hot spots**) and low values (**cold spots**)

$$G_i^* = \frac{\sum_{j=1}^n w_{i,j} x_j - \bar{X} \sum_{j=1}^n w_{i,j}}{S \sqrt{\frac{[n \sum_{j=1}^n w_{i,j}^2 - (\sum_{j=1}^n w_{i,j})^2]}{n-1}}}$$

- w_{ij} : first-order binary contiguity matrix

•4

Methods:

Commute times and female participation

- Spatial Durbin model (SDM)
 - includes spatial lags of dependent variable as well as explanatory variables

$$y = \rho W y + \alpha \iota_n + X \beta + W X \theta + \varepsilon$$

W : first-order binary contiguity matrix

- Total effects (direct & indirect effects)
- When ρ is nonsignificant, spatial lag of X (SLX) model

$$y = \alpha \iota_n + X \beta + W X \theta + \varepsilon$$

- OLS for comparison

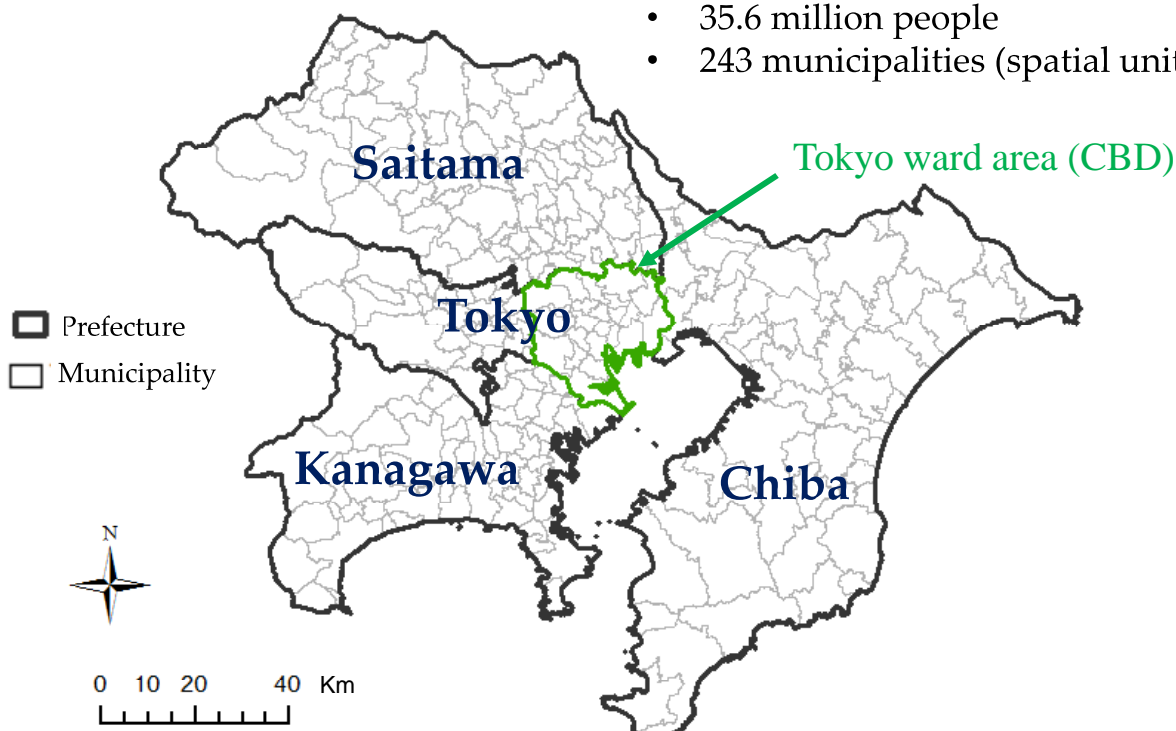
•

•5

Study area: Tokyo metropolitan area

2010

- 35.6 million people
- 243 municipalities (spatial unit of analysis)



•6

Data

- 2008 person trip survey (special tabulations)
- 2010 census (publicly-available & order-made tabulations)
- Men and women in the samples are 25-54 yrs old

In regression models

- Dependent variables:
 - 3 participation measures (female LFP, regular EMP, part-time EMP rates)
 - by marital status, education, and presence of children
- Independent variables:
 - Commute time (for men)
 - Control variables: residential land price, unemployment rate (for men), households with 2 or more children, availability of childcare centers

•7

Summary statistics

	Median	Mean	Std. Dev.	Min.	Max.
Commute time (min)					
Men	49.9	47.7	10.4	21.4	67.6
Women	38.8	37.0	9.2	11.7	59.7
Labor force participation rate (%)					
Unmarried women	84.0	82.9	5.2	61.7	94.0
Married women					
No children	64.8	65.5	5.2	56.1	85.7
With children	55.1	57.4	8.7	40.5	79.6
Regular employment rate (%)					
Unmarried women	45.8	45.5	5.0	32.5	66.7
Married women					
No children	26.0	26.2	4.4	14.3	40.0
With children	14.9	16.2	4.5	10.4	37.9
Part-time employment rate (%)					
Unmarried women	17.3	17.3	4.2	6.0	32.1
Married women					
No children	23.9	24.3	6.3	8.5	46.2
With children	31.6	31.0	6.6	9.2	47.5

Note: The men and women in the samples are 25–54 years old. *Commute time* is the average one-way travel time to work. The number of observations (municipalities) is 243, except for married women without children, in which case that figure is 242.

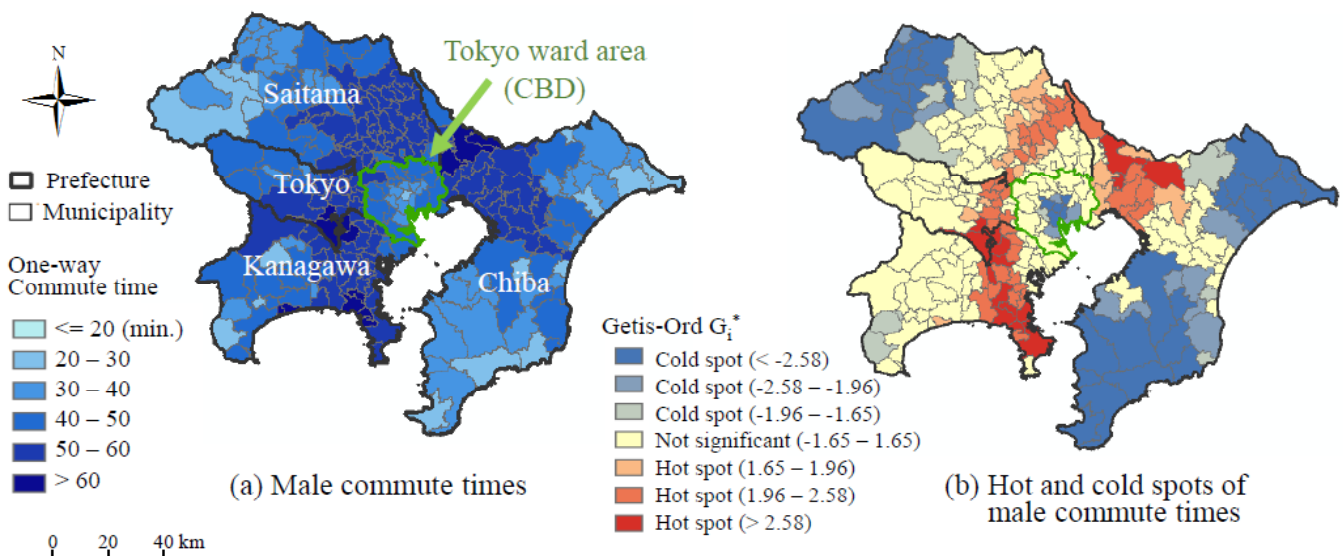
Global Moran's I

	Moran's I	z-score	p-value
Labor force participation rates			
Unmarried women	0.48	11.77	0.00
Married women			
No children	0.33	8.13	0.00
With children	0.76	18.77	0.00
Regular employment rates			
Unmarried women	0.31	7.72	0.00
Married women			
No children	0.15	3.82	0.00
With children	0.70	17.46	0.00
Part-time employment rates			
Unmarried women	0.49	12.01	0.00
Married women			
No children	0.56	13.76	0.00
With children	0.76	18.81	0.00

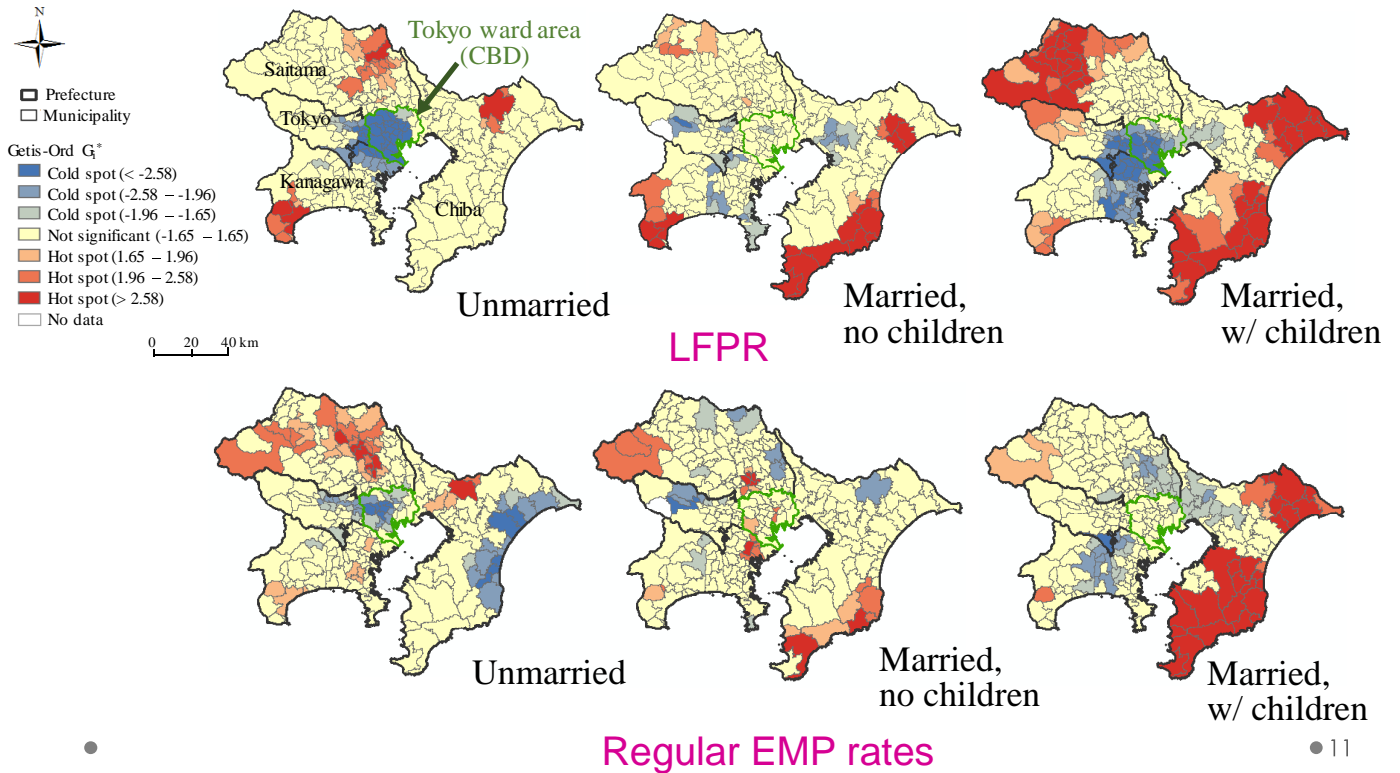
Male commute times

Hot spots: spatial clustering of high values

Cold spots: spatial clustering of low values

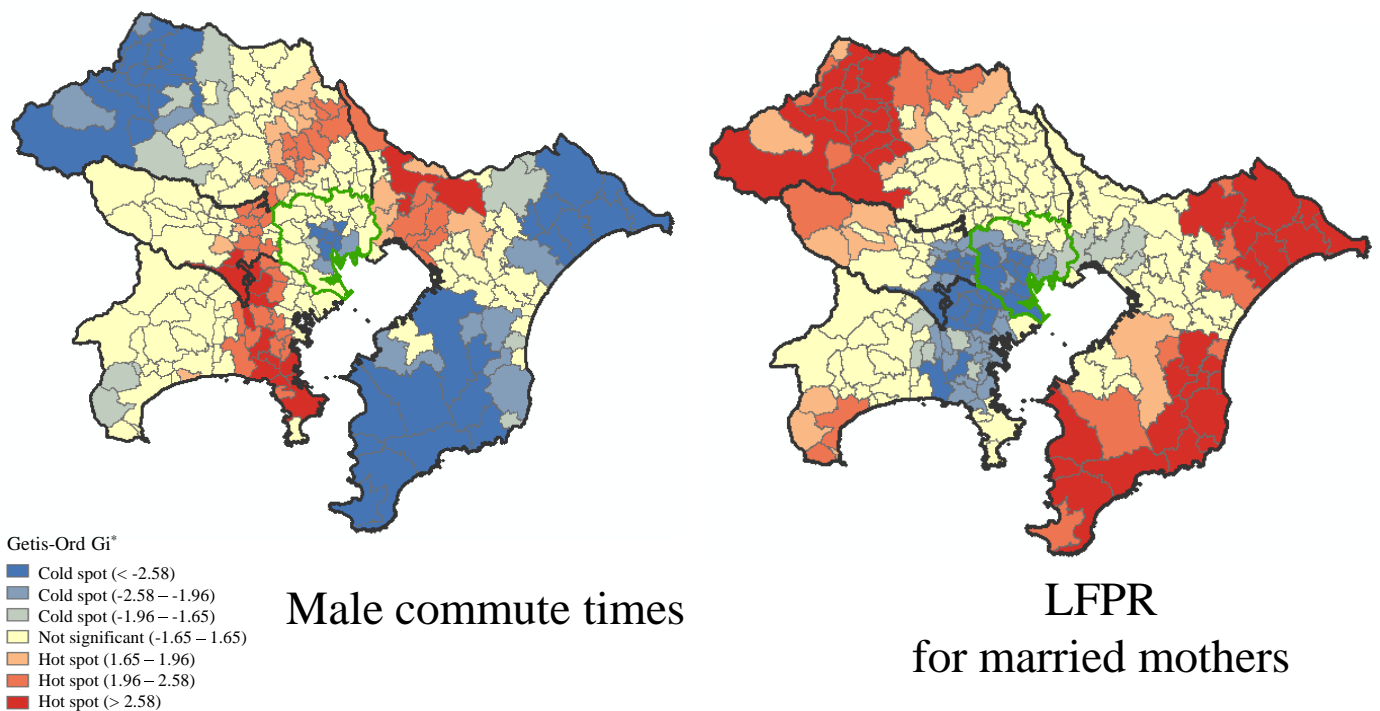


Hot spots and cold spots of female LFP and regular EMP rates



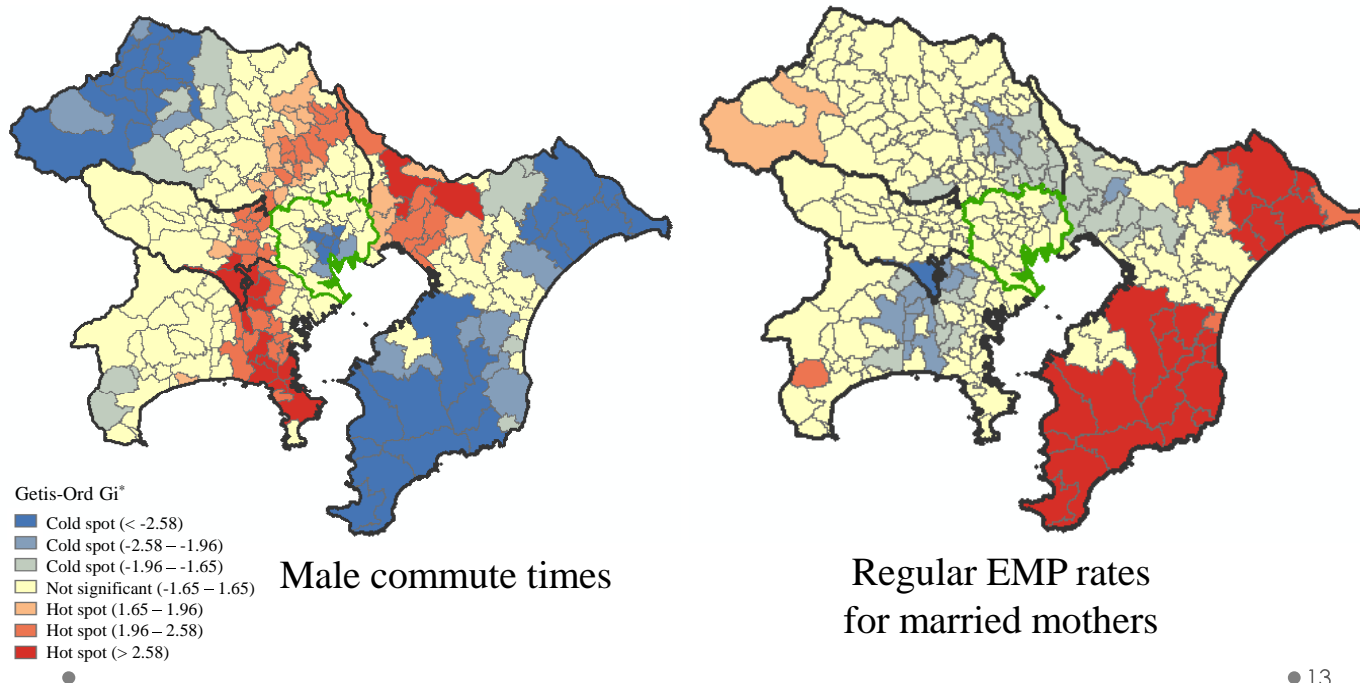
Many **cold spots** of LFP of married mothers overlap with **hot spots** of male commute times (and vice versa)

Correlation coefficient: -0.71



Many **cold spots** of regular EMP rates of married mothers overlap with **hot spots** of male commute times (and vice versa)

Correlation coefficient: -0.78



• 13

G_i^* : correlations w/ male commuting time

Labor force participation rates

Unmarried women	0.02
Married women	
No children	-0.59
With children	-0.71

Regular employment rates

Unmarried women	0.22
Married women	
No children	-0.20
With children	-0.78

Part-time employment rates

Unmarried women	-0.26
Married women	
No children	-0.27
With children	-0.25

• 14

Table 4: Regression of LFP

	Married men		Unmarried women		Married women													
							No children				With children under 6				With children, none under 6			
	Stand. model	SDM	Stand. model	SDM	Stand. model	SDM	HS or less	College	SLX	HS or less	College	SLX	HS or less	College	SLX			
Intercept	109.08 ** (4.71)	50.45 ** (9.53)	85.83 ** (7.53)	57.06 ** (4.63)	129.70 ** (11.42)	116.40 ** (20.53)	95.82 ** (17.60)	68.53 ** (23.03)	66.25 ** (12.55)	36.39 * (17.89)	94.30 ** (17.88)	121.18 ** (22.68)	97.83 ** (8.00)	88.23 ** (11.78)	174.35 ** (14.70)	140.06 ** (18.96)		
Commute time (for men)	0.02 (0.02)	-0.02 (0.03)	0.04 (0.03)	-0.07 (-1.57)	-0.13 (0.05)	0.00 (0.07)	-0.01 (0.07)	0.01 (0.11)	-0.25 ** (0.05)	-0.05 (0.07)	-0.31 ** (0.07)	-0.12 (0.11)	-0.11 ** (0.03)	-0.04 (0.05)	-0.31 ** (0.06)	-0.16 (0.09)		
Log of residential land price	-1.98 ** (0.31)	-1.28 * (0.57)	-1.36 ** (0.50)	0.83 (0.86)	-3.57 ** (0.76)	-1.57 (1.65)	-0.87 (1.14)	-3.93 (2.93)	-2.14 * (0.82)	-4.35 * (1.75)	-2.68 * (1.15)	-4.70 (2.82)	-2.36 ** (0.53)	-2.62 * (1.12)	-7.62 ** (0.95)	-9.17 ** (2.36)		
Unemployment rate (for men)	0.35 * (0.14)	0.32 * (0.13)	0.35 (0.23)	0.44 * (2.04)	-0.81 * (0.34)	-0.61 (0.34)	-0.06 (0.53)	-0.69 (0.59)	-0.01 (0.36)	-0.03 (0.36)	-0.36 (0.54)	-0.22 (0.57)	0.07 (0.25)	0.10 (0.25)	0.51 (0.45)	0.55 (0.48)		
Households with two or more children	0.29 ** (0.05)	0.16 ** (0.05)	0.48 ** (0.08)	0.38 ** (3.85)	-0.61 ** (0.13)	-0.43 ** (0.16)	-0.47 * (0.19)	-0.72 ** (0.25)	0.08 (0.14)	-0.03 (0.17)	-0.39 * (0.19)	-0.25 (0.25)	-0.03 (0.09)	-0.03 (0.11)	-0.23 (0.16)	-0.31 (0.21)		
Availability of childcare centers	-0.01 (0.01)	0.00 (0.01)	-0.01 (0.02)	0.02 (0.93)	-0.06 (0.03)	-0.05 (0.04)	-0.02 (0.07)	0.03 (0.09)	0.22 ** (0.03)	0.16 ** (0.04)	0.24 ** (0.07)	0.39 ** (0.08)	0.10 ** (0.02)	0.06 * (0.02)	-0.04 (0.05)	-0.15 ** (0.05)		
W * Commute time (for men)		0.03 (0.03)		0.13 * (2.11)		-0.19 (0.10)		-0.15 (0.15)		-0.37 ** (0.10)		-0.42 ** (0.15)		-0.08 (0.07)		-0.14 (0.12)		
W * Log of residential land price		0.57 (0.67)		-2.14 (-1.91)		-1.72 (1.89)		5.01 (3.28)		4.63 * (2.01)		1.47 (3.10)		0.94 (1.30)		3.52 (2.60)		
W * Unemployment rate (for men)		-0.03 (0.26)		-0.55 (-1.26)		-0.30 (0.69)		2.14 * (1.00)		0.04 (0.74)		-0.39 (0.97)		-0.46 (0.51)		-0.29 (0.86)		
W * Households with two or more children		0.08 (0.08)		-0.06 (-0.43)		-0.12 (0.24)		0.47 (0.36)		0.52 * (0.25)		-0.22 (0.35)		0.14 (0.17)		0.43 (0.28)		
W * Availability of childcare centers		-0.01 (0.02)		-0.02 (-0.68)		-0.03 (0.06)		-0.17 (0.14)		0.12 (0.07)		-0.37 ** (0.11)		0.12 ** (0.04)		0.35 ** (0.09)		
ρ		0.48 ** (0.07)		0.40 ** (0.08)		0.20 * (0.09)												
N	243	243	243	243	239	239	206	206	238	238	209	243	243	218	218			
Log-Likelihood	-571.8	-544.0	-686.0	-667.8	-768.1	-761.4	-768.1	-713.0	-778.9	-767.9	-733.3	-723.9	-700.6	-694.1	-730.4	-718.2		
LR test		55.7 **		36.2 **		13.3 **		110.3 **		22.1 **		18.9 **		13.1 *		24.3 **		

Note: The men and women in the samples are 25-54 years old. Standard errors are in parentheses. *W* is the binary contiguity matrix. Each sample excludes municipalities with populations of less than 50 people or no neighboring municipalities.
**Significant at 1%; *Significant at 5%.

Table 5: Marginal effects of commute time on LFPR

	Total effect	Direct effect	Indirect effect	N
Married men	0.02 (0.37)	-0.01 (0.62)	0.03 (0.60)	243
Unmarried women	0.11 (1.41)	-0.06 (-1.44)	0.17 (1.95)	
Married women				
No children				
HS or less	-0.23 ** (-2.65)	-0.01 (-0.12)	-0.23 * (-2.12)	
College	-0.13 (-1.18)	0.01 (0.14)	-0.15 (-0.97)	
With children under 6				
HS or less	-0.41 ** (-5.47)	-0.05 (-0.62)	-0.37 ** (-3.52)	
College	-0.54 ** (-5.18)	-0.12 (-1.14)	-0.42 ** (-2.79)	
With children, none under 6				
HS or less	-0.12 * (-2.29)	-0.04 (-0.84)	-0.08 (-1.07)	243
College	-0.31 ** (-3.39)	-0.16 (-1.92)	-0.15 (-1.17)	218

For college-graduated married women w/ children <6 (range of LFPR: 64.6%) :
Range of commuting time: 46.2 min. → 24.9% point difference in LFPR

Note: **Significant at 1%; *Significant at 5%. *t*-values are in parentheses. *W* is the binary contiguity matrix. Each sample excludes municipalities with populations of less than 50 people or no neighboring municipalities.

Table 6: Regression of regular EMP

	Unmarried women		Married women											
	Stand. model	SDM	No children				With children under 6				With children, none under 6			
			HS or less		College		HS or less		College		HS or less		College	
			Stand. model	SDM	Stand. model	SDM	Stand. model	SLX	Stand. model	SLX	Stand. model	SDM	Stand. model	SLX
Intercept	44.15 ** (8.32)	35.26 ** (11.72)	42.49 ** (9.49)	40.81 ** (14.16)	73.29 ** (21.69)	70.36 * (27.64)	42.03 ** (7.76)	42.11 ** (11.28)	76.89 ** (17.34)	112.69 ** (22.49)	39.81 ** (5.80)	27.31 ** (8.94)	122.50 ** (16.73)	113.05 ** (22.09)
Commute time (for men)	0.11 ** (0.04)	0.12 * (0.05)	-0.06 (0.04)	-0.02 (0.06)	-0.06 (0.09)	0.09 (0.13)	-0.11 ** (0.03)	0.00 (0.05)	-0.16 * (0.07)	-0.07 (0.11)	-0.10 ** (0.02)	-0.06 (0.03)	-0.32 ** (0.07)	-0.16 (0.10)
Log of residential land price	-0.44 (0.55)	-0.09 (1.07)	-0.90 (0.63)	-0.42 (1.38)	-0.70 (1.41)	-1.17 (3.41)	-1.51 ** (0.51)	-2.43 * (1.10)	-2.31 * (1.12)	0.57 (2.80)	-1.58 ** (0.39)	-2.34 ** (0.78)	-6.79 ** (1.09)	-9.71 ** (2.75)
Unemployment rate (for men)	-0.97 ** (0.26)	-0.73 ** (0.24)	-0.45 (0.28)	-0.35 (0.28)	-1.13 (0.65)	-1.46 * (0.68)	-0.81 ** (0.22)	-0.74 ** (0.23)	-0.43 (0.53)	0.20 (0.57)	-0.09 (0.18)	-0.11 (0.17)	-0.34 (0.51)	-0.10 (0.56)
Households with two or more children	0.36 ** (0.09)	0.16 (0.11)	-0.36 ** (0.11)	-0.25 (0.13)	-0.60 * (0.24)	-0.57 (0.30)	-0.24 ** (0.08)	-0.19 (0.11)	-0.72 ** (0.19)	-0.48 (0.25)	-0.30 ** (0.06)	-0.18 * (0.08)	-0.27 (0.18)	-0.12 (0.24)
Availability of childcare centers	0.03 (0.02)	0.08 ** (0.02)	0.01 (0.03)	0.01 (0.03)	-0.07 (0.09)	-0.12 (0.11)	0.04 * (0.02)	0.02 (0.03)	0.04 (0.07)	0.05 (0.08)	0.10 ** (0.01)	0.07 ** (0.02)	0.19 ** (0.06)	0.08 (0.06)
W * Commute time (for men)		-0.12 (0.07)		-0.05 (0.08)		-0.34 (0.18)		-0.18 ** (0.07)		-0.15 (0.15)		0.00 (0.05)		-0.15 (0.14)
W * Log of residential land price		-0.22 (1.23)		-0.65 (1.57)		1.80 (3.81)		1.29 (1.26)		-4.60 (3.07)		1.33 (0.92)		3.59 (3.02)
W * Unemployment rate (for men)		-0.50 (0.49)		-0.21 (0.58)		2.88 * (1.17)		-0.42 (0.47)		-2.33 * (0.96)		0.10 (0.35)		-0.96 (1.00)
W * Households with two or more children		0.24 (0.16)		-0.09 (0.20)		-0.25 (0.43)		-0.01 (0.16)		-0.34 (0.35)		-0.10 (0.12)		-0.09 (0.33)
W * Availability of childcare centers		-0.10 * (0.04)		-0.01 (0.05)		-0.08 (0.16)		0.04 (0.04)		-0.01 (0.11)		0.04 (0.03)		0.29 ** (0.10)
ρ		0.34 ** (0.08)		0.23 * (0.09)		-0.28 ** (0.11)						0.22 * (0.09)		
N	243	243	239	239	206	206	238	238	209	209	243	243	218	238
Log-Likelihood	-710.3	-690.6	-723.8	-719.9	-760.3	-751.4	-664.5	-658.0	-726.8	-722.1	-622.6	-613.4	-758.6	-751.5
LR test (SDM or SLX vs stand. model)		39.4 **		7.8		17.8 **		13.0 *		9.4		18.5 **		14.2 *

Note: The men and women in the samples are 25-54 years old. Standard errors are in parentheses. *W* is the binary contiguity matrix. Each sample excludes municipalities with populations of less than 50 people or no neighboring municipalities. **Significant at 1%; *Significant at 5%.

Table 7: Marginal effects of commute time on regular EMP

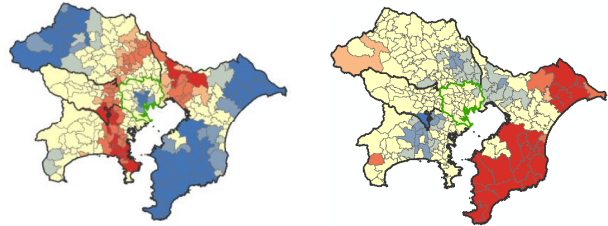
	Total effect	Direct effect	Indirect effect	N
Unmarried women	-0.01 (-0.15)	0.11 * (2.47)	-0.12 (-1.37)	243
Married women				
No children				
HS or less	-0.09 (-1.16)	-0.02 (-0.36)	-0.07 (-0.75)	
College	-0.19 (-1.82)	0.11 (0.78)	-0.30 (-1.73)	
With children under 6				
HS or less	-0.18 ** (-3.85)	0.00 (0.00)	-0.18 ** (-2.78)	
College	-0.23 * (-2.17)	-0.07 (-0.69)	-0.15 (-1.02)	
With children, none under 6				
HS or less	-0.08 (-1.74)	-0.06 (-1.80)	-0.02 (-0.40)	
College	-0.32 ** (-2.99)	-0.16 (-1.64)	-0.15 (-1.07)	218

For college-graduated married women w/ children aged 6 years or over:
Range of CT: 46.2 min. → 14.8% point difference in regular EMP rate

Note: **Significant at 1%; *Significant at 5%. *t*-values are in parentheses. *W* is the binary contiguity matrix. Each sample excludes municipalities with populations of less than 50 people or no neighboring municipalities.

Summary of findings

- Compared w/ unmarried and childless married women, married mothers exhibit more significant spatial clustering of high and low rates of LFP and regular EMP.



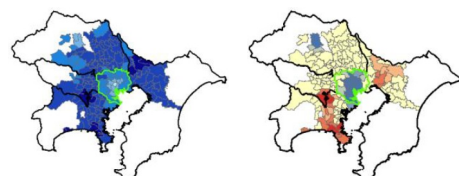
- For married mothers, spatial clusters of low LFP and regular EMP rates are largely located in the inner suburbs, many of which overlap with spatial clusters of long male commuting times.

•

• 19

Summary of findings

- For married mothers, a longer commute time is significantly associated w/ lower LFP and regular EMP rates, while for unmarried and childless married women, the associations are mostly insignificant.
- Mother's labor market participation is sensitive to commute time
- Highly-educated mothers are especially sensitive to commute time.

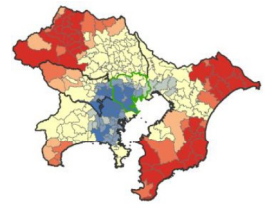


•

• 20

Residential decisions are endogenous

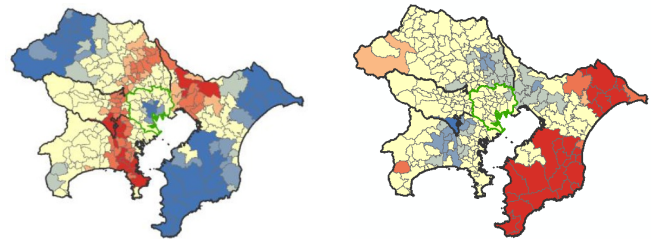
- Effect of commute time on participation is not causal
- Tokyo's circumstances induce households to simultaneously decide location and labor market participation for both spouses



- Typical choices
 1. Living close to CBD & both spouses work there
 2. Living in inner suburbs, whereby husband commutes to CBD and wife either stays home or works locally
 3. Living in outer suburbs & both spouses work in suburbs

•21

Implications

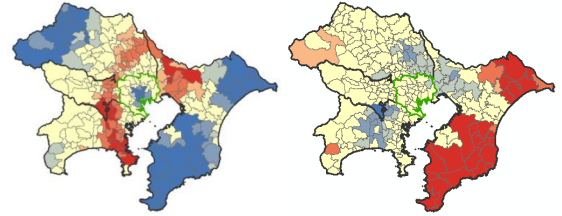


Commute time is not significantly associated w/ LFPR for married men (see Table 4)

- Suburban living that entails a long commute for the father intensifies household division of labor in which the father travels to CBD and the mother either stays home or works locally.
- Spatial transportation constraint induces this gender division, resulting in unique patterns for married mothers.

•22

Policy implications



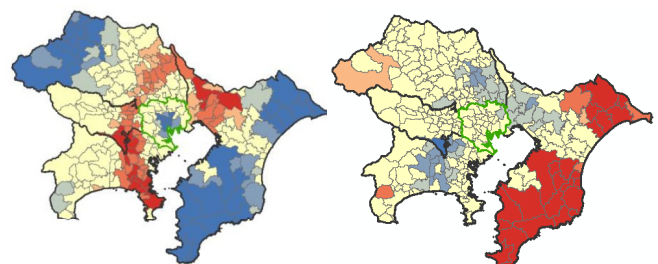
- Policies, which alleviate commuting constraints, could help women w/ children participate more actively in the labor market.
- (e.g.)
 - Improving EMP accessibility
 - Reducing congestion
 - Promoting flexible working hours
 - Increasing housing supply around EMP centers
 - Encouraging male commitment to do housework and childcare

•

•23

Directions of future research

- Spatio-temporal analysis using data after 2010
 - In recent years, # of dual-earner couples has risen dramatically in Japan
- Comparative analysis of Tokyo and other metropolitan areas



•

•24

Thank you!

This research was supported by JSPS KAKENHI Grand Number JP16K13363, JP26590045, and JP15H03358.

•

•25