An agent-based simulation model of inter-provincial migration in the Mekong Delta, Vietnam

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joint work with:
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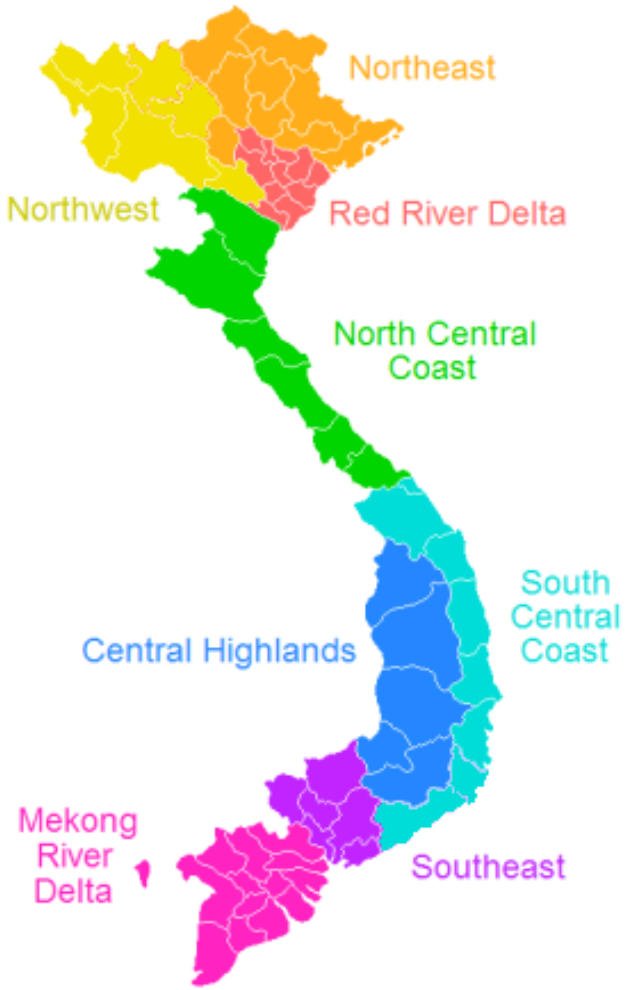
Overview

Outline

Dynamics of Migration Flows

- Mekong River Delta (MKD)
  - "Rice Bowl of Vietnam"
  - Welfare issues
  - Impacts of climate change
- Main migrant-sending region [1]
  - The largest migration corridor: MKD to Southeast
  - Important destinations: Ho Chi Minh city and Binh Duong
  - Migration within the delta, Can Tho city
- MKD - Determinants of migration [1–3]
  - Economic reasons
  - Education
  - Family-related issues
  - Others



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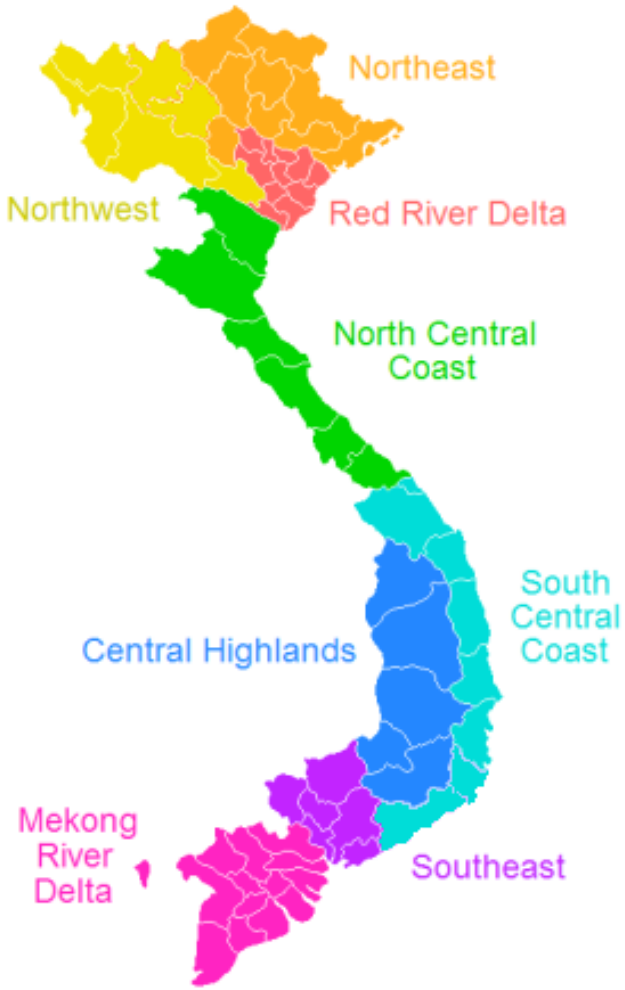

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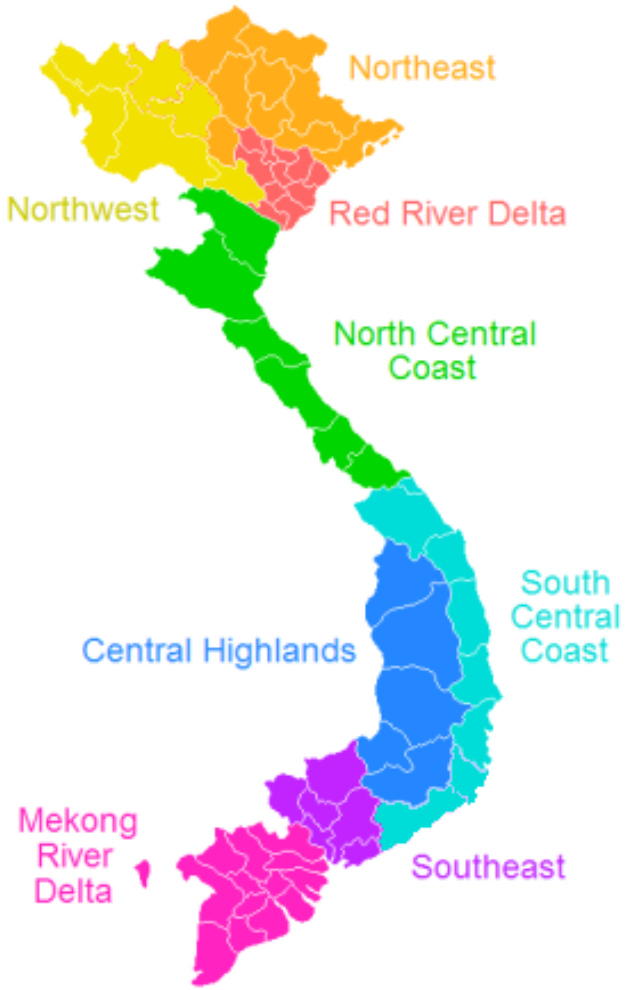

Dynamics of Migration Flows

Table: The average in-, out-, and net-migration rates of cities and provinces in Mekong Delta and neighboring region in 12 year period from 2005 to 2016 [4]

Province	Net-Migration	Out-Migration	In-Migration
Mekong Delta			
Ca Mau	-9.14	-11.00	1.87
Bac Lieu	-7.20	-9.11	1.92
An Giang	-7.02	-9.45	2.43
Ben Tre	-6.94	-10.52	3.58
Soc Trang	-6.49	-8.89	2.40
Dong Thap	-5.90	-8.70	2.82
Hau Giang	-5.07	-9.39	4.32
Kien Giang	-5.05	-8.95	3.88
Vinh Long	-4.20	-8.87	4.67
Long An	-3.55	-8.02	4.47
Tra Vinh	-2.77	-7.74	4.95
Can Tho	-1.86	-8.68	6.83
Tien Giang	-1.09	-7.55	6.47
Southeast			
Binh Duong	41.84	-13.97	55.82
Ho Chi Minh	13.03	-7.60	20.65
Dong Nai	8.90	-8.28	17.22
Vung Tau	2.69	-7.42	10.11
Binh Phuoc	-2.35	-9.44	7.10
Tay Ninh	-2.93	-6.34	3.41

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Main Entities of the Agent-Based Model

- Province Agent
  - Population attribute: population, birth and death rates
  - Socioeconomic attribute: employment, education, average income and expenditure
  - Environmental impacts
- Person agent
  - Quintile income group
  - Location

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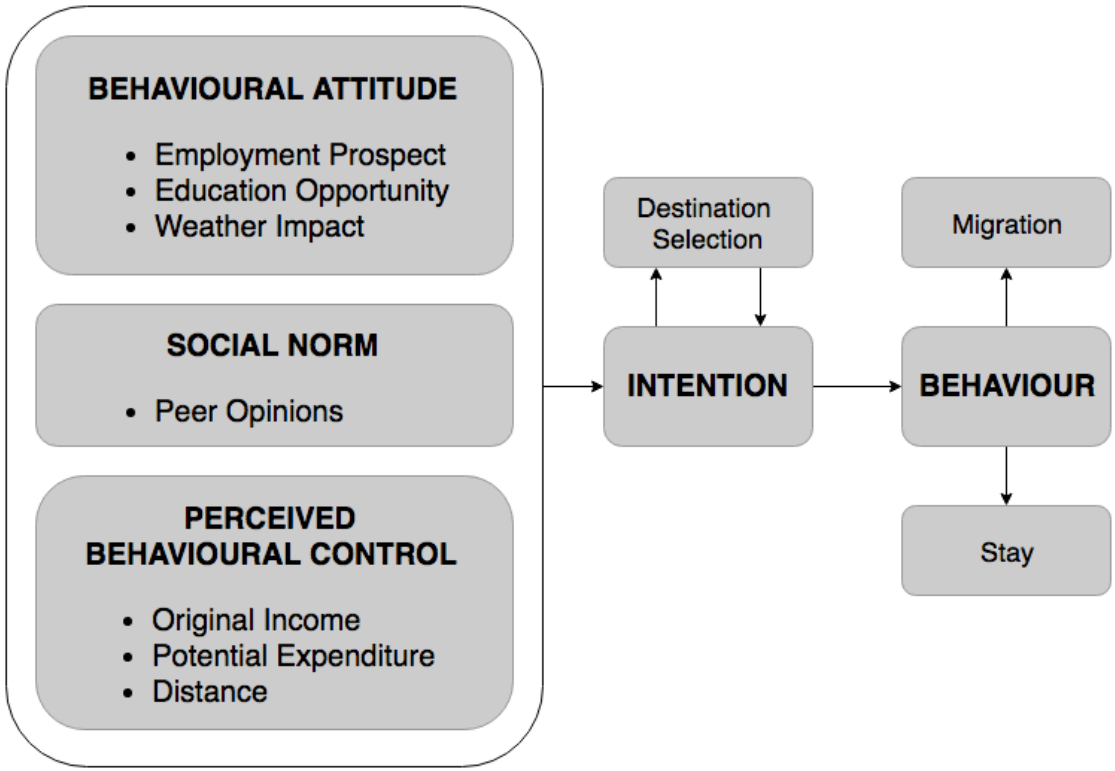
Migration Decision Process

- Migration assessment - Theory of Planned Behavior [5]
  - Behavioral Attitude
  - Social Network
  - Perceived Behavior Control
- Final migration behavior [6]



Migration Assessment

- Itention [7]:
  - $I_{i,j}(t) = \alpha_1 \, BA_{i,j}(t) + \alpha_2 \, SN_i(t) + \alpha_3 \, PBC_{i,j}(t)$
  - α_1, α_2, α_3 - parameters for model calibration
- Behavioral Attitude [8]:
  - $BA_{i,j}(t) = \beta_i^1 \, emp_{i,j}(t) + \beta_i^2 \, edu_{i,j}(t) + \beta_i^3 \, env_{i,j}(t)$
  - $\beta_i^1 + \beta_i^2 + \beta_i^3 = 1$
  - $env_{j,t} = P\left(\overline{hazards}_j + 1, \, hazards_j + t/steps\right) \, vul_j$
- Social Norm: proportion of neighbors ever migrated [7]
- Perceived Behaviour Control:
  - $PBC_{i,j}(t) = inc_i(t) - exp_{i,j}(t)\,(1 + dis_{i,j})$

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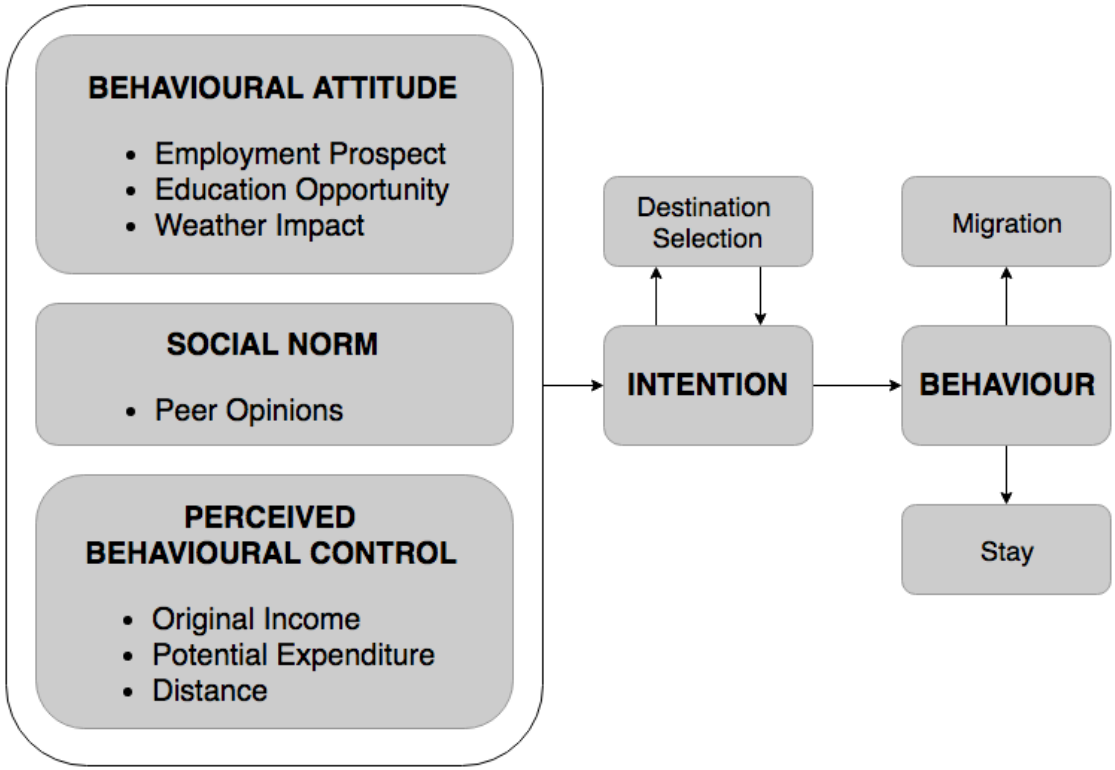
Final Migration Behavior

- Consider list of potential provinces with intention scores
- Compare the (following) highest intention score with a random number $\in [0, 1]$
- Stay if none potential provinces chosen



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Experiment Setup

- Implementation:
  - MASON framework [9] and geoMASON spatial extension[10]
  - Temporal scale: 144 steps - 12 year period from 2005 to 2016
  - Spatial scale: 17 cities and provinces in MKD and South East region
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- *Outputs: in-, out-, and net-migration rates of each province each year*

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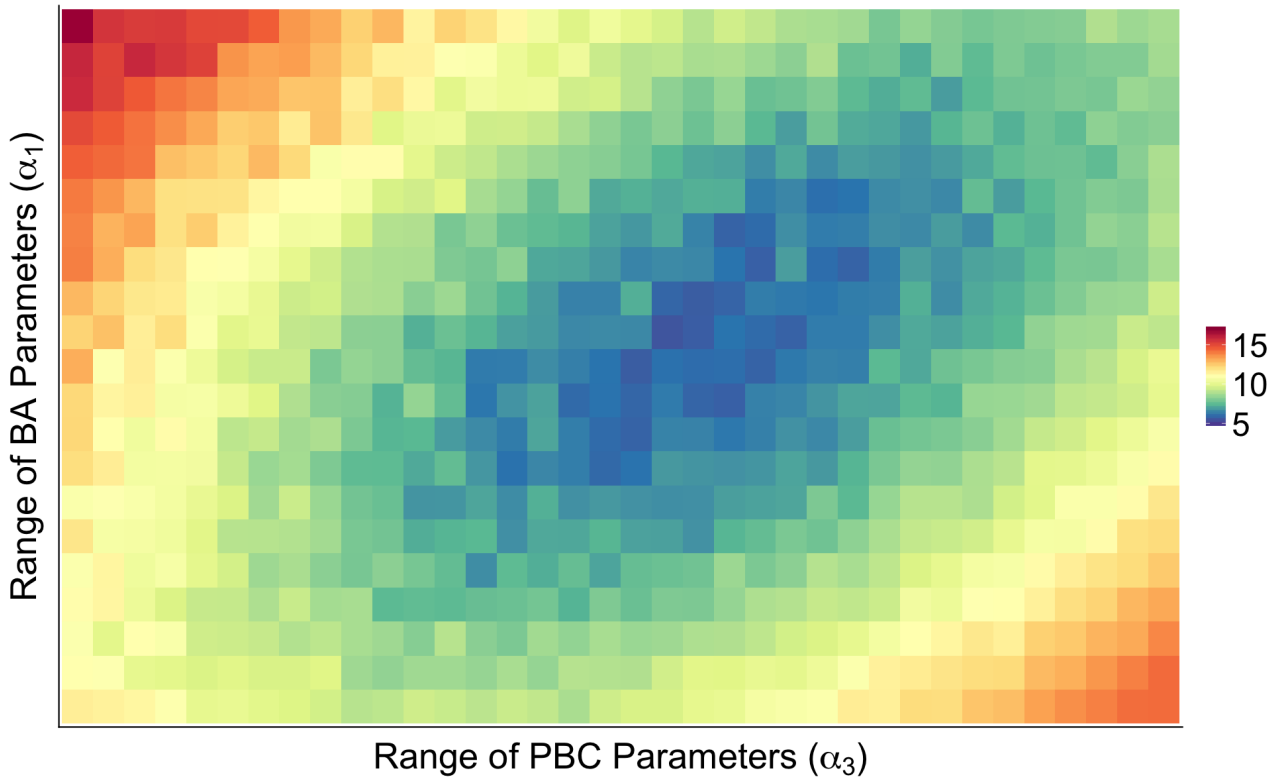
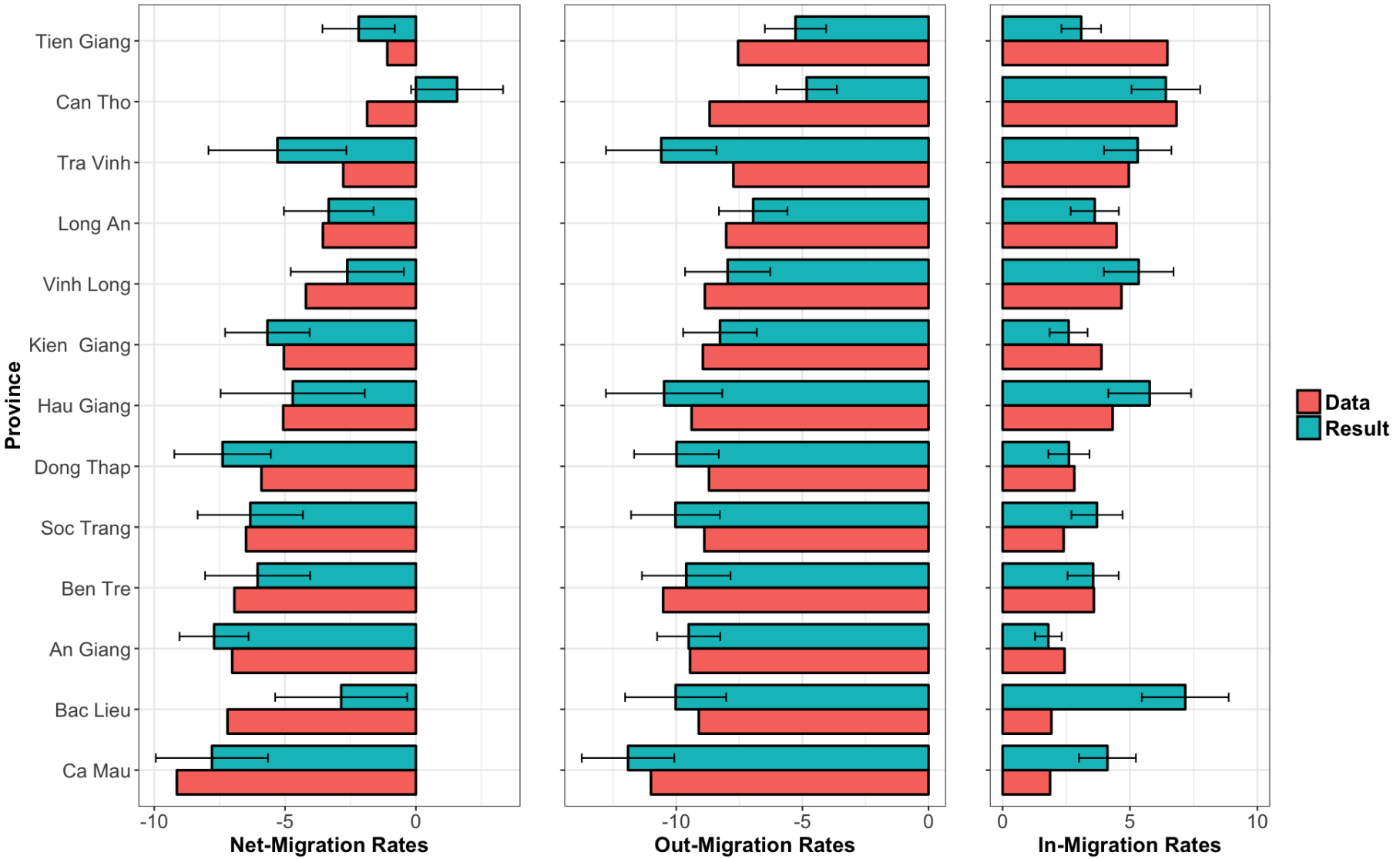
Model Calibration

- Systematically varied values of the three parameters α_1, α_2, α_3
- Reference values: actual averages in-, out-, and net-migration rates of each province from 2005 to 2016
- Root Mean Squared Error
- Heatmap of model fitness values from different combination settings



Model Validation



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Discussion

- An agent-based model of inter-provincial migration in the MKD region is proposed with the Theory of Planned Behaviour and different economic, social, and environmental circumstances.
- Through calibration and validation, observed values are captured within 95% confidence interval of simulated values in most of cases.
- Future works include migration behaviour study of different demographic group and examination of linkage between climate change and the large-scale migration flows in the MKD region.

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References

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Thank You!

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