Participatory Approach to Community Based Water Supply System

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Outline

- Research Background & Objective
- Spatial Probit Model
  - Model formulation
  - Model estimation
- Case Study
- Conclusion & Future Perspectives
Lack of access to clean water due to improper water institution

There exists a kind of collaborative action on community based water supply system

Necessitate of better understanding about local community structure and network

Objective:
  - To investigate interdependent preference in a choice of clean water of the community on a field survey of Indonesian's water supply system
Discrete-choice model for whether an household joins HIPPAM conditional on that household's characteristics

\[ z = X\beta + \theta + \varepsilon \quad \varepsilon \sim N(0, I_n) \]

\[ \theta = \rho W \theta + u \quad u \sim N(0, \sigma^2 I_n) \]

\[ y_i = \begin{cases} 
1 & \text{when household } i \text{ belongs to HIPPAM } z > 0 \\
0 & \text{when household } i \text{ does not belong to HIPPAM } z \leq 0
\end{cases} \]

- \( \theta \): spatial interaction term
- \( X \): households’ attribute
- \( \rho \): degree of spatial dependence across households
- \( W \): spatial weight matrix about households’ network
Model Estimation

- It is difficult to estimate spatial probit model by maximum likelihood since this model has complicated form.
- Then, we use the Bayesian inference approach to estimate each parameter of equation by using the Markov Chain Monte Carlo (MCMC) method.
- MCMC algorithm arrives at the target distribution of the unknown parameters by sequentially sampling from a set of conditional distributions of the parameters.

**Bayes theorem** \( p(\theta | y) \propto L(y | \theta) \cdot \pi(\theta) \)

- \( p(\cdot) \): posterior distribution
- \( L(\cdot) \): likelihood function
- \( \pi(\cdot) \): prior distribution
Case Study

- Field survey: December 2008
- 500 households living at Toyomarto village (TY) and Candi Renggo village (CR), Singosari district, East Java province
- The respondents are the husband, the wife or the head of family
- There exists two public water providers, HIPPAM (community based water supply system) and PDAM (Indonesia local water company)
- The dependent variable was defined as following:

\[ y_i = \begin{cases} 
1 & \text{when household } \ i \text{ belongs to HIPPAM } \ z > 0 \\
0 & \text{when household } \ i \text{ belongs to PDAM } \ z \leq 0 
\end{cases} \]
Explanatory Variables

- **FAM**: number of people in household
- **GENDER**: dummy variable which equals 1 if respondent is male
- **AGE**: age of respondent
- **EDU**: dummy variable which is recorded as 1 if respondent has educational background in the level of elementary school or junior school and recorded as 0 if high school or university.
- **OCCU**: dummy variable which is coded as 1 if occupation of respondent is Agriculture or manufacturing and coded as 0 if service or unemployment
- **INCOME**: household’s monthly income which is divided into 7 items (less than 0.5, 0.5–1.0, 1.0–1.5, 1.5–2.0, 2.0–2.5, 2.5–3.0, more than 3.0 million Rupiah), and we use the medians of each item.
- **LENGTH**: years of living in the area for respondent
- **COST**: water charge per day (Rupiah)
Hypothesis: households with stronger community tie have ability to organize community based on management system.

Therefore, we define a spatial weight matrix using the data about community networks.

\[ w_{ij}^{g_k} = \begin{cases} 
1 & \text{if household } i \text{ and household } j \text{ join the same social group } k \\
0 & \text{otherwise} 
\end{cases} \]

\[ w_{ij} = \sum_{k=1}^{4} w_{ij}^{g_k} \]

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>TY</td>
<td>138</td>
<td>28</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>CR</td>
<td>87</td>
<td>36</td>
<td>41</td>
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## Estimation Results (TY)

### Spatial Probit Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>p.Mean</th>
<th>p.Std.Dev</th>
<th>90% Credible Interval</th>
<th>Geweke</th>
</tr>
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<tbody>
<tr>
<td>constant</td>
<td>3.620</td>
<td>1.545</td>
<td>1.212</td>
<td>6.200</td>
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<tr>
<td>FAM</td>
<td>-0.085</td>
<td>0.204</td>
<td>-0.415</td>
<td>0.246</td>
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<tr>
<td>GENDER</td>
<td>0.035</td>
<td>0.509</td>
<td>-0.801</td>
<td>0.861</td>
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<tr>
<td>AGE</td>
<td>-0.031</td>
<td>0.023</td>
<td>-0.069</td>
<td>0.006</td>
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<tr>
<td>EDU</td>
<td>-0.136</td>
<td>0.579</td>
<td>-1.112</td>
<td>0.788</td>
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<tr>
<td>OCCU</td>
<td>-0.234</td>
<td>0.485</td>
<td>-1.062</td>
<td>0.561</td>
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<tr>
<td>INCOME</td>
<td>0.228</td>
<td>0.367</td>
<td>-0.364</td>
<td>0.844</td>
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<tr>
<td>LENGTH</td>
<td>0.026</td>
<td>0.014</td>
<td>0.003</td>
<td>0.049</td>
</tr>
<tr>
<td>COST(\tilde{\sigma}^2)</td>
<td>-0.004</td>
<td>0.001</td>
<td>-0.005</td>
<td>-0.003</td>
</tr>
<tr>
<td>(\sigma^2)</td>
<td>0.128</td>
<td>0.027</td>
<td>0.092</td>
<td>0.177</td>
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<td>(\rho)</td>
<td>-9.016</td>
<td>5.486</td>
<td>-17.345</td>
<td>0.175</td>
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</tbody>
</table>
Conclusion

In this paper, we show the spatial probit model with using Bayesian estimation method in order to investigate resident's spontaneous collaboration to manage community based water supply system.

From the estimation results, we can say that the length of living in the area and the price of monthly water usage have an important meaning for respondent to make a decision to join community based water supply system.

Future perspectives:
- Another approach to get weight matrix through geographical neighbors
- Social Network Analysis
Thank you for your attention