Estimating co-patenting intensities between regions: some theoretical considerations

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Introduction

- The gravity model became a popular tool to examine research collaborations between regions.
  - see e.g. Maggioni et al., (2007); Broekel et al. (2014), Tóth et al. (2021)

- Most analyses lack a proper theoretical underpinning.

- Neglecting theory raises several questions:
  - How to specify the gravity model?
  - What should be considered as the "mass" of the region?
  - What to do with the zeros?
  - The model is not suitable for predicting

Core assumptions

- Researchers' human capital is the function of investment in own research and collaborations.

- Knowledge from different research collaborations are not perfect substitutes.

- Participants in collaborations face fixed and variable costs.

- Researchers do not form "joint research ventures".

Model

- Consider an economy with S regions and N identical researchers. Each region is inhabited by $N(r)$ researchers.

- Researchers maximize consumption (income – cost of R&D activity)

- Knowledge production:

$$h_i(r) = x_i(r)^\rho + \sum_{j \neq i}^{N(r)} X_{ij}(r)^\rho + \sum_{s \neq r}^{S} \sum_{j=1}^{N(s)} X_{ij}(r,s)^\rho$$

where

$$X_{ij}(r,s) = x_{ij}(r,s)x_{ji}(s,r)$$

r, $s \in S$ region,

$i \in N(r)$ researcher.

Model

- Cost of a collaboration:

$$c_{ij}(r, s) = \kappa(r, s)x_{ij}(r, s) + f(r, s)$$

- Two researchers collaborate only if

$$w(r)X_{ij}(r, s)^\rho > x_{ij}(r, s)x_{ji}(s, r) + f(r, s)$$

applies for both parties.

Co-patenting intensity

- Solving the model, the knowledge created by researchers *i* and *j*:

$$X_{ij}^*(r,s) = \rho^{\frac{2}{1-2\rho}} \left(w(r)w(s)\right)^{\frac{1}{1-2\rho}} \kappa(r,s)^{-\frac{2}{1-2\rho}}$$

if

$$f(r,s) < (1-\rho)\rho^{\frac{2\rho}{1-2\rho}} \left(w(r)w(s)\right)^{\frac{1}{2(1-2\rho)}} \kappa(r,s)^{-\frac{2\rho}{1-2\rho}}$$

- 0 otherwise!!!

- The lack of patents between two regions means that it is not profitable collaborate. → selection

Consequences

- What is the mass of the region?

  - wages $w(r)$ and number of researchers $N(r)$

- Selection bias is introduced into the gravity model when regions pairs with zero joint patents are excluded!

  - Selection into interregional collaborations should be estimated first!

- What predicts participation in interregional R&D collaborations?

  - wages $w(r)$, $\kappa(r,s)$ and $f(r,s)$

  - Suppose that $\kappa(r,s)$ depends on geographical distance. If we want to estimate distance decay, omitting zeros or misspecifying the selection equation ($\kappa(r,s)$ is not included) estimates will be biased.

  - Co-patenting intensities and selection are both a function of researchers' wages!

Consequences

- What happens if the fixed cost, of collaborations is reduced? $f(r,s)$
  - e.g. support networking, industrial trade meets, fairs
  - More region pairs will join (extensive margin)

- What happens if the variable cost of collaborations is reduced? $\kappa(r,s)$
  - Since co-patenting intensities and selection are both a function of variable costs,
    i) more region pairs will join (extensive margin)
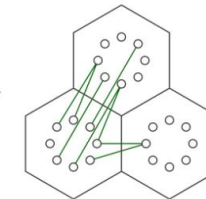   ii) More patents may occur where collaborations are formed previously (intensive margin)

What next…?

- Estimate the model on EPO's Patstat data

- Consider different distance measures

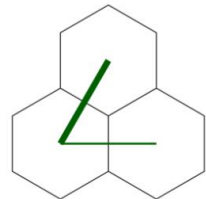- Recover model parameters

- Simulate the model
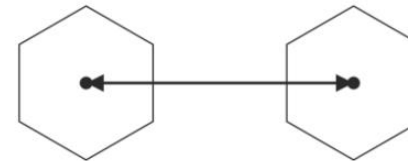

Step 1. Patent information from OECD RegPat

- Inventor(s)
- Location(s) of inventor(s)
- IPC class(es)
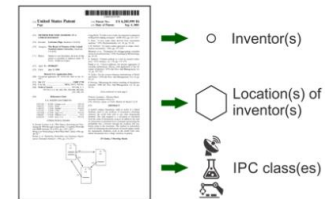
Step 2. Cross-region inventor collaboration

Step 3. Aggregation to EU regions

Proximity: inverse of physical distance between the centroids of region i and j.

Cosine: degree of overlap between the patent class portfolios of region i and j.