GEOGRAPHICAL ECONOMICS B

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ELTE Faculty of Social Sciences, Department of Economics

Geographical Economics "B"

week 12

AGGLOMERATION AND PRODUCTIVITY

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Outline

Agglomeration and the productivity of firms

- Ciccone, A., and R. E. Hall (1996), Productivity and the density of economic activity, American Economic Review, 86: 54–70.
- Start-up - differences in average labor productivity across US states are large
  - Output per worker in the most productive state was two thirds larger than in the least productive state.
  - Output per worker in the top ten productive states was one third larger than in the ten states ranked at the bottom
- The spatial density of economic activity is the source of aggregate increasing returns.
  - Spatial density = intensity of labor or capital / km^2
  - Transport costs depend on distance (technology for the production have increasing returns – the ratio of output to input will rise with density: FC production, MC transportation)
- Two explanations
  - Spatial externalities
  - Diversity of business services

Ciccone-Hall (1996)

- At which level?
- output, input: state level, density: county level
- Results: capital accounts for some of the differences in productivity but leaves most of the variation unexplained
- The density of economic activity is crucial for explaining the variation of productivity
- There is no first geography, evenly distributed space
- Simple production function (labor and land, but no capital)

$$f(n, q, a) = n^{\alpha} \left(\frac{q}{a}\right)^{(\lambda-1)/\lambda} \tag{1}$$

- quantity of goods produced on an area of $1km^2$ space in a given county; n denotes labor, q represents total output of the county and a is the size of the county

Theoretical model

- The labor employed in a county c, n_c, is distributed equally among all the km^2 in the county. The output of the county q_c
- Technology of the county can be written in the following simple form:

$$\frac{q_c}{a_c} = \left(\frac{n_c}{a_c}\right)^{\gamma} \tag{2}$$

- where $\gamma = \alpha\lambda$ is the product of the production elasticity (α), and the elasticity of the externality (λ);
  - α – the effect of congestion
  - λ – the effect of agglomeration
  - γ – the common effect of two opposite forces - this can be identified in the data

Theoretical model

- Aggregating to the state level, then the total output of state s is Q_s
- Let N_s be the number of workers in the particular state, then the average labor productivity (output/labor) in the state:

$$\frac{Q_s}{N_s} = D_s(\gamma) \tag{3}$$

- $D_s(\gamma)$ – factor density index
  - D_s – the average number of workers per km^2 in a particular state
  - D – the average number of workers per km^2 in the US
  - d_c – the average number of workers per km^2 in a particular county

Theoretical model

In a given state the effect of density is the product of three factors

- national effect
- state effect (state vs US)
- inequality of density across counties within the state

If the density in a given state equals the density of the US, productivity hings on the distribution of employment within the state only.

- $\gamma < 1$ – congestion effects
- Externality is positive, if the agglomeration effect outweigh congestion

Estimation

Estimation

- A simple equation to estimate

$$\log Q_s / N_s = \log \phi + \log D_s + u_s \tag{4}$$

- $\log \phi$ deriving from the production function, a constant
- Data: US states and counties
- Result: 5.2%

Agglomeration and the productivity of firms

Ciccone, A. (2002), Agglomeration effects in Europe, European Economic Review, 46: 213–37.

- France, Germany, Italy, Spain and the UK
- Germany counties (Kreise): top 5/bottom 5 = 240%
- 628 Nuts3 region
- More and better data
- Estimating an extended model

Theoretical model

- The model – extension
- The firm is replaced by space. It can be said that each km^2 equals one firm.
- Considering jointly physical and human capital
- Labor and capital are distributed equally *within* the region
- There is no data on the quantity of physical capital
- Assume that the rental price of capital is the same everywhere within a county, then using the capital-demand function we can express the effect of the regional density of employment and human capital on regional productivity (θ).

$$\theta = \frac{\alpha\lambda - 1}{1 - \alpha\lambda(1 - \beta)} \tag{5}$$

Agglomeration effect

- θ = the effect of the regional density of employment and human capital on regional productivity
- = *Agglomeration effect*
- Recall: α - marginal products of labor and capital, λ - spatial (positive) externalities in the region
  - If the two effects are equal: $\alpha = 1/\lambda$, nor role for density
- If $\alpha\lambda > 1$, then the greater $(1-\beta)$ the greater θ. ($(1-\beta)$ is the exponent of capital)
  - The effect of an increase in total factor productivity - driven by an increase in the density of employment - on regional average labor productivity will therefore be reinforced by an inflow of physical capital (assuming free flow of capital)
  - This effect will become stronger as the role of capital $(1-\beta)$ becomes greater.

Empirical model

- Estimation

$$\log Q_{sc}/N_{sc} = \log \Lambda_c + \theta(\log N_{sc} - \log A_{sc}) + \\ +(\theta+1)H_{sc} + \omega \log \Omega_{sc} \tag{6}$$

$$\log Q_{sc}/N_{sc} = DUM_c + \theta(\log N_{sc} - \log A_{sc}) + \delta F_{sc} + u_{sc} \tag{7}$$

- *DUM* country and NUTS2 dummy, F - the fraction of workers with tertiary education
- u_{sc} - differences between total factor productivity in region and the country that contains those region;
- + the effect of neighboring regions $+\phi(\log N_{scn} - \log A_{scn})$

Empirical model

- Difficulty: θ is the common agglomeration effect
- in order to be an externality ($\frac{\lambda-1}{\lambda}$) it needs to be assumed, that
- $1-\alpha$ is the income share of land and
- $\alpha(1-\beta)$ is the income share of physical capital

$$\frac{\lambda-1}{\lambda} = 1 - \frac{\alpha+\alpha(1-\beta)\theta}{1+\theta} \tag{8}$$

Estimation

- Estimation
- 1. OLS
- If regional/country fixed effects do not capture exogenous differences in total factor productivity and if regions with higher exogenous total factor productivity attract more workers, the OLS yields inconsistent estimates
- 2. IV/2SLS
- IV = total land area of regions. Historically predetermined variable (in the 19. century), negatively correlated with modern differences in employment density (administrative shocks), not affected by modern differences in exogenous total factor productivity
- US (Ciccone-Hall) - IV
  - 1850 population of the state
  - railroad dummy, distance from the eastern seaboard of the US

Results

Results for France, Germany, Italy, Spain, and the UK with education controls and country dummies

	LS	2SLS
Estimate of θ	5.058%	4.55%
Standard error	(0.417%)	(0.507%)
	$R^2 = 63.6\%$	—

Note: Estimating equation in (8). All standard errors are White adjusted.

Table 2
Results for France, Germany, Italy, Spain, and the UK with education controls and *Nuts 1*-region dummies

	LS	2SLS
Estimate of θ	5.07%	4.445%
Standard error	(0.452%)	(0.55%)
	$R^2 = 66.93\%$	—

Note: Estimating equation in (8). All standard errors are White adjusted.

Results

- Effect: OLS - 5.1% , 2SLS - 4.5%
- NUTS1,2 dummies do not modify
- (compare US above - 5.2%)
- Differences in agglomeration effect across countries can be tested: there are no significant differences (the US may differ)
- The value of the capital-income share: 30%, income share of land: 1.5%, $\theta = 4.5\%$
- The effect of externality: $\frac{\lambda-1}{\lambda} = \mathbf{4.4\%}$
- Doubling the number of workers leads to 4.4% higher productivity