Understanding Heterogeneous Spatial Production Externalities

Connection between Land-use Planning and Economic Development

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What we can observe from business locations.

- preference of business districts (clusters of firms) despite rising land rents and ability to work from home;
- growing popularity of shared workspaces such as WeWork;
- "creative city" hype.

Placemaking for business district that people want to work in and increases productivity is an important planning task. How do we find a theory to guide the practice?

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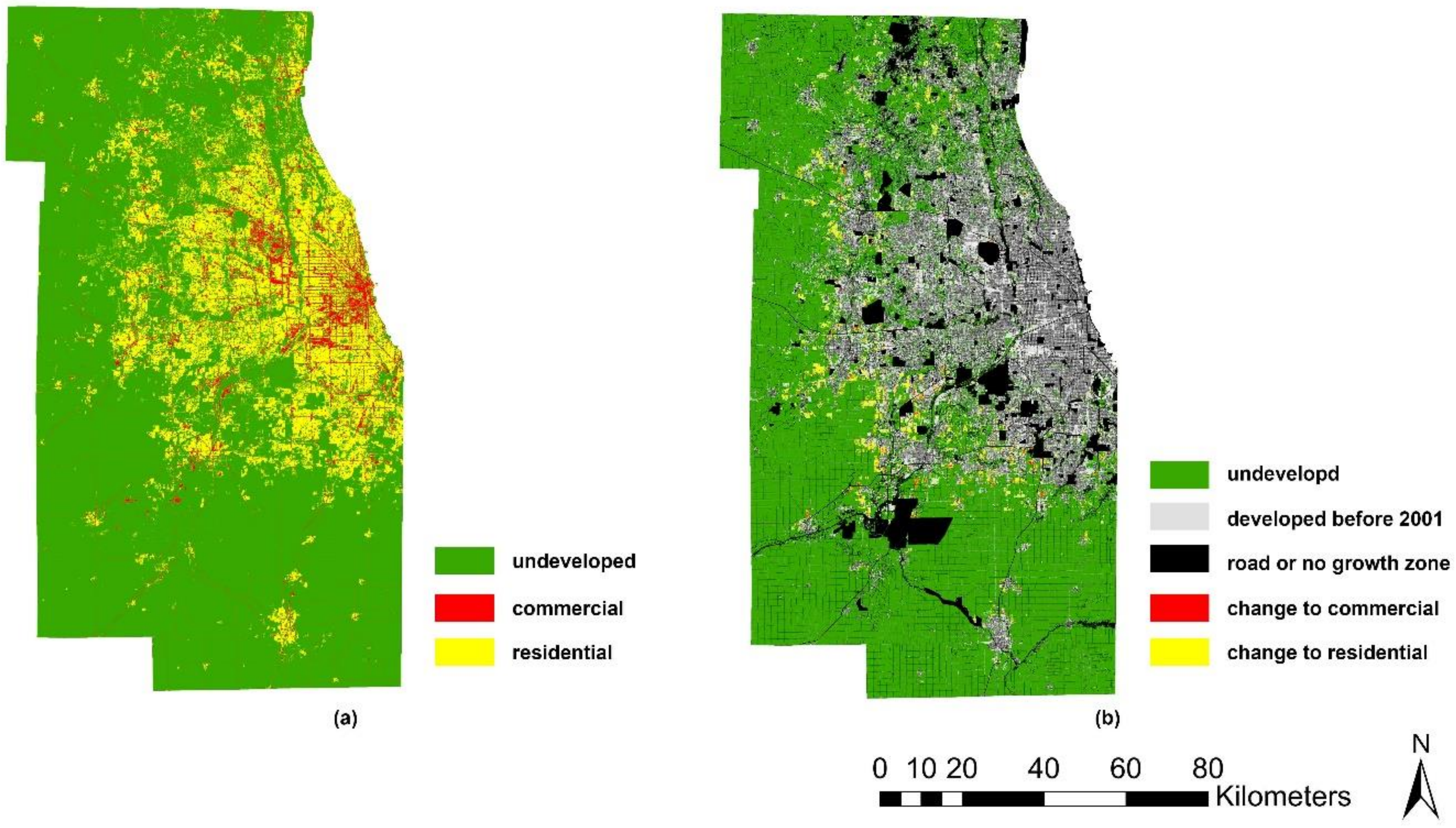
The theories of spatial production externalities

- 1) Specialization (MAR) and diversity (Jacobs) debate.
- 2) Glaeser (1992) adds temporal dimension to the spatial production externalities (externalities as a driver of local economic growth)
- 3) Spatial equlibrium models (Lucas and Rossi-Hasberg, 2002; as early as Alonso, 1964)

Basically, 1) and 2)-type studies focus on county-level externality measures (what are the planning implications?);
3) types of model have the finest spatial granularity but treat "employments" and "commercial lands" as one sector.

Our Research Goal

- 1) extend and augment a theory of understanding spatial externalities on fine-grid scale with sectoral heterogeneity;
- 2) examine spatial heterogeneity in Chicago on 100x100m land-use cells with industry sector specification (close to 2-digit NAICS) for 2010 and 2013 (land-use data is manually cleaned and match to economic sectors).



(a) Existing land-use map of Chicago. (b) Land-use change map of Chicago from 2001 to 2011

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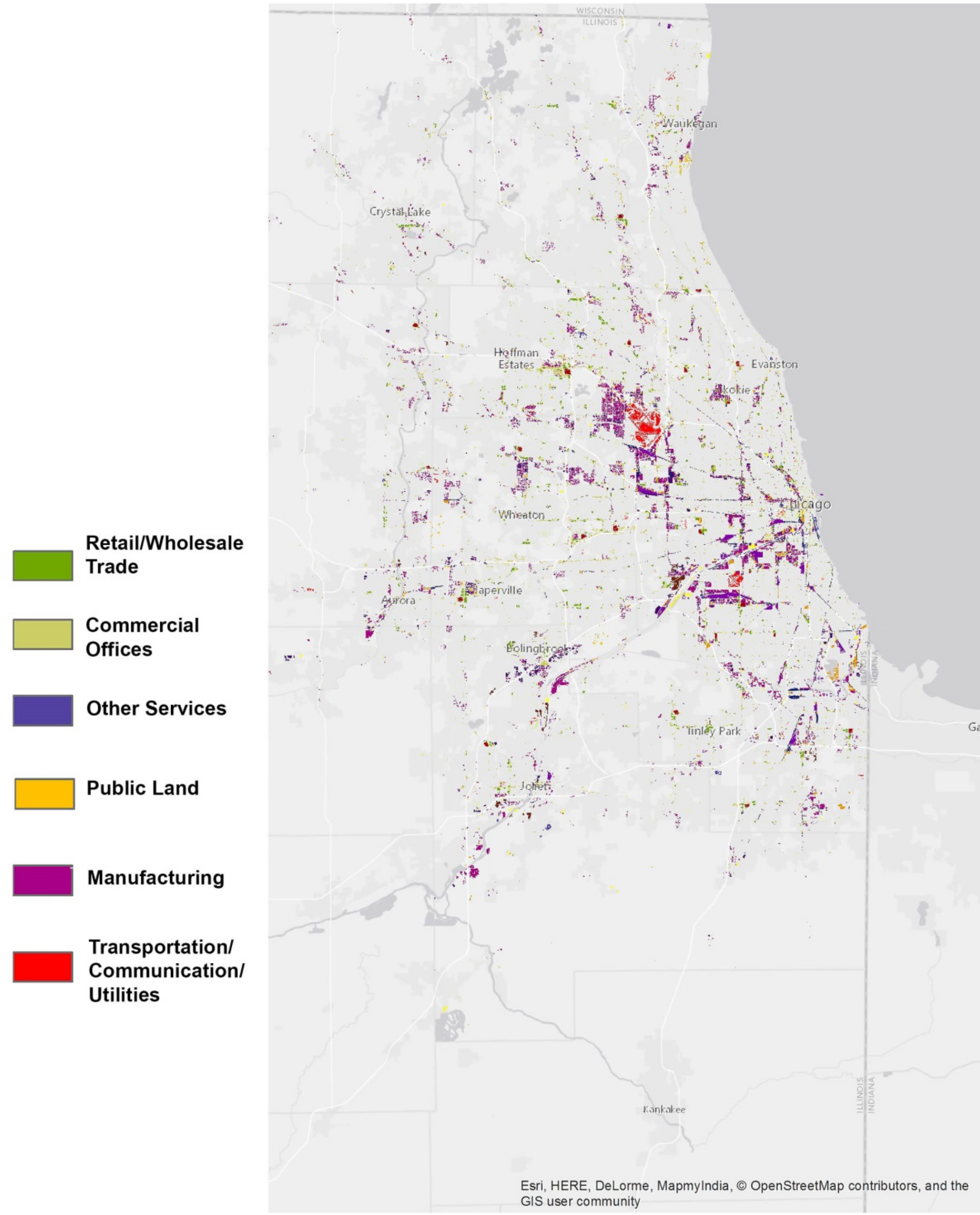
Research questions

- 1) How can we measure spatial production externalities by fine spatial grid and understand sector heterogeneity at the same time?
- 2) How to define the spatial production externalities for different economic sectors?
- 3) How do spatial production externalities affect urban economic growth?
- 4) How to help planning to deliver physical urban change and economic growth?

2010 and 2013 CMAP land use inventories are mapped into a "sort of" NAICS 2-digit sectors by 100x100m land use grids.

A between-sector "closedness" matrix is extracted from the "neighborhood matrix" of the land-use map.



Measuring growth and spatial production externalities

A version of the commonly used GLAESER et al. (1992) model:

$$\log \frac{A_{i,r,t+1}}{A_{i,r,t}} = \log \frac{w_{i,r,t+1}}{w_{i,r,t}} - \log \frac{f'(l_{i,r,t+1})}{f'(l_{i,r,t})} \quad (1)$$

set $\log \frac{A_{i,r,t+1}}{A_{i,r,t}}$ to g(within industry spillover for sector i at location r, cross industry spillover for sector i at location r, regional industry technology growth,urbanization economies) and set $f(l) = l^{(1-\alpha)}$ and $(0 < \alpha < 1)$

Measuring growth and spatial production externalities cont.

We yield

$$\alpha \frac{l_{i,r,t+1}}{l_{i,r,t}} = -\log \frac{w_{i,r,t+1}}{w_{i,r,t}} + g(\blacksquare) \quad (2)$$

where $A_{i,r,t+1}$ is technology factor for sector i at location r at time $t+1$, w is wage and $f(l)$ is labor input.

Variables: (2010 and 2103)

Labor:

Sector Employment (Chicago regional econometrics input-output model database)

Sector Dummy

Wage:

Location wage (U.S. Economic Census)

Sector average wage (Chicago regional econometrics input-output model database)

g()

Regional/National:

Sector Employment (Illinois regional econometrics input-output model)

Urbanization:

Connectivity (See the next figure)

Employment Density (Economic census)

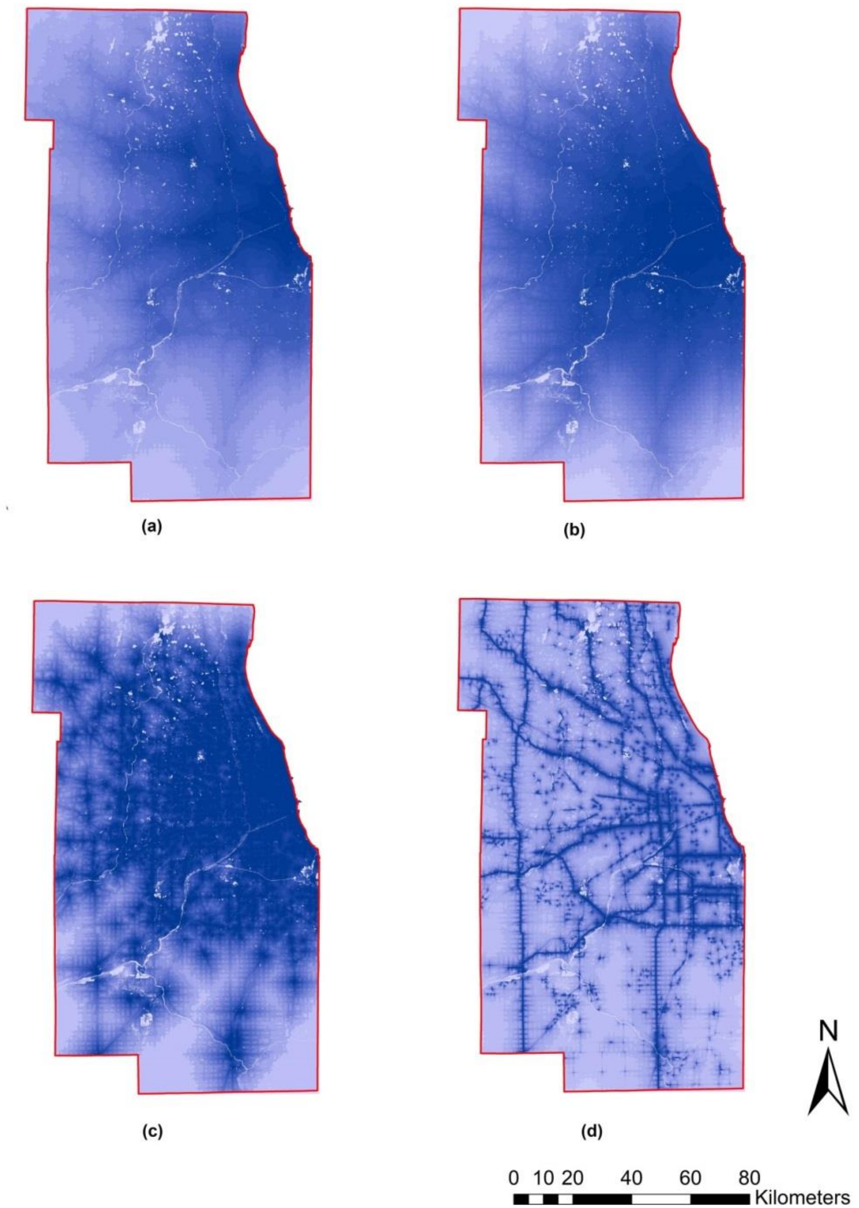
Within-sector spillover:

See the next next figure

Cross-sector spillover::

See the next next next figure

Connectivity maps of land-use cells to 4 urban attractors: a) employment; 2) population; 3) quality-of-life amenities; 4) transportation network. Darker color indicates higher connectivity



Connectivity Calculation

$$a_{i,k} = \sum_{j \in \mathbb{S}} \frac{p_j}{S(k,j)} \tag{3}$$

where $a_{i,k}$ is the connectivity of land-use cell k on grid with attraction type i; $\mathbb{S}$ is the set of all cells within threshold distance; p_j is the weights of attractors (for example, number of population), $S(\cdot)$ is the function of finding shortest travel time between k and j.

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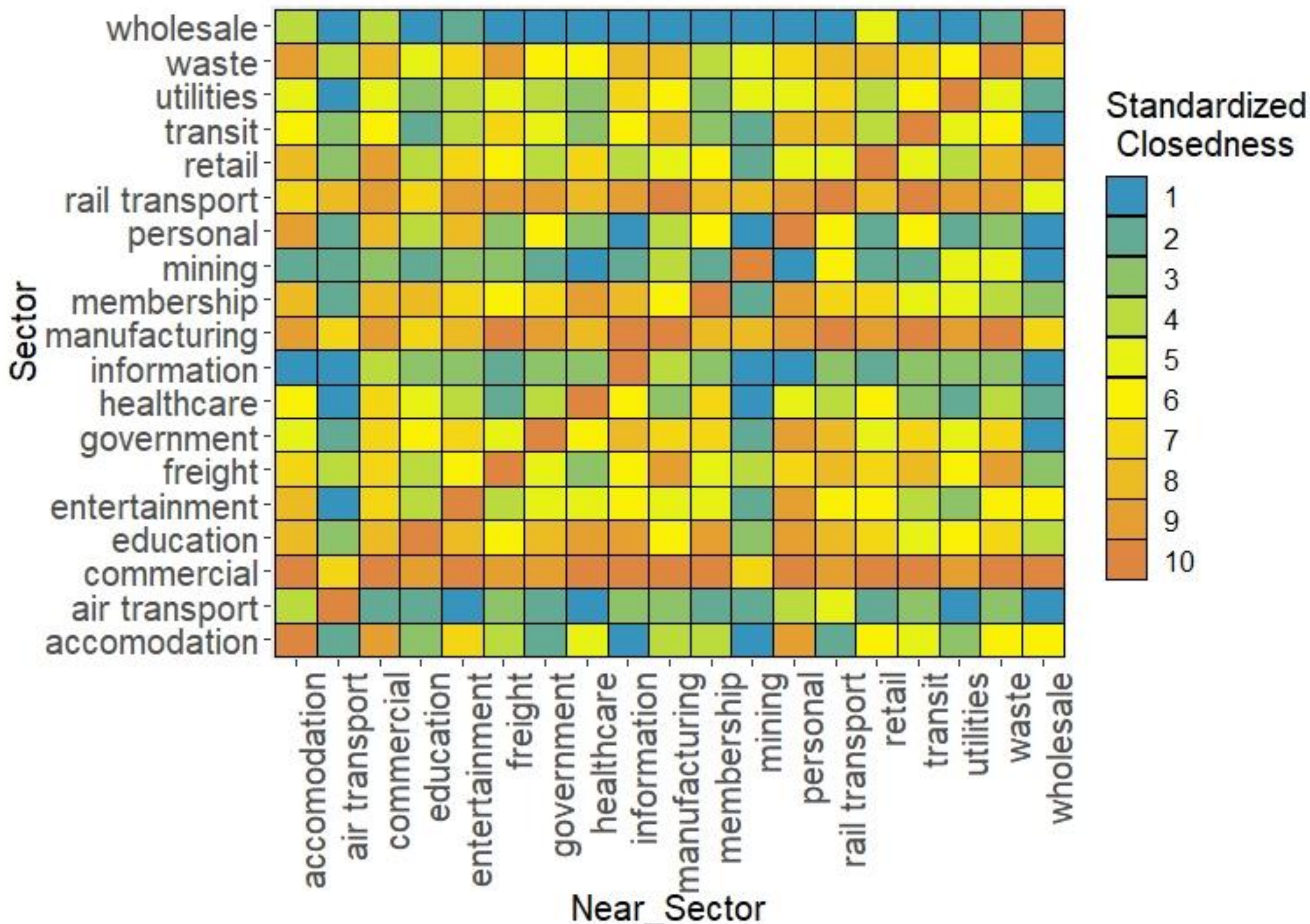
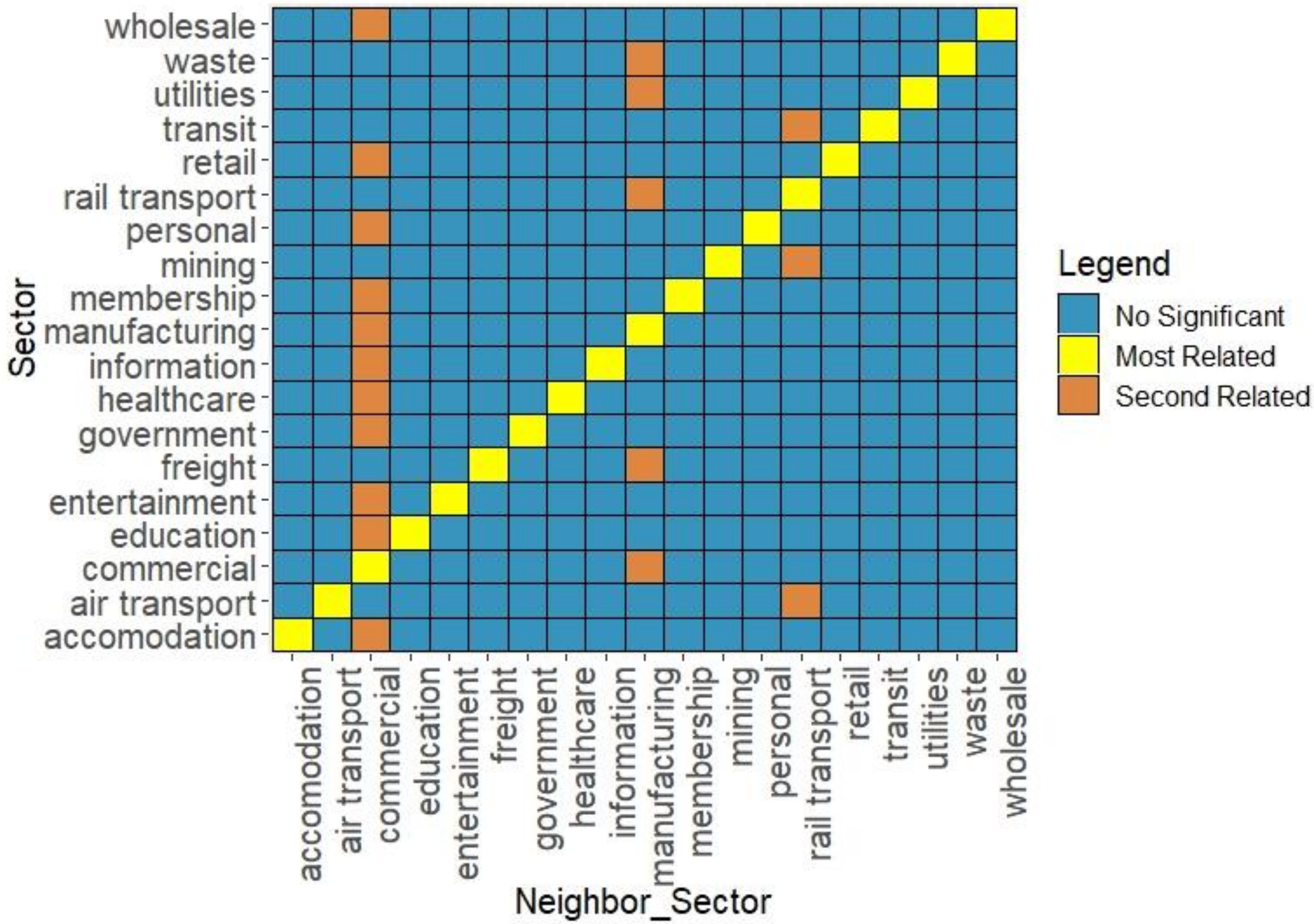


“Closedness” (100x100m) matrix for sectors with quantile values



"Closedness" (100x100m) matrix for sectors by top 2 selected "near-sectors". We use the nearest (always the sector itself) as "specialization" measure and the second nearest (another sector) as "diversity" measure.

	Dependent variable:
	log(Sector Employment Growth)
log(Sector Wage Growth)	-0.173***
	(0.002)
log(Regional Employment Growth)	0.587***
	(0.002)
2010 EMPDENS	0.032***
	(0.003)
POP Accessibility	-0.447***
	(0.068)
Road Accessibility	0.738***
	(0.050)
POI Accessibility	0.095***
	(0.011)
2010 Local Income	0.012**
	(0.006)
Near Related Sector Dummy	0.011***
	(0.001)
Near Same Sector Dummy	-0.035***
	(0.001)
Constant	-0.012***
	(0.001)
Observations	136,246
R^2	0.428
Adjusted R^2	0.428
Residual Std. Error	0.061 (df = 136236)
F Statistic	11,348.310*** (df = 9; 136236)
Note:	*p<0.1; **p<0.05; ***p<0.01

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Discussions

Sector wage growth is negative to labor growth, which is robust to our model derivation.

Being close to the similar sector is a "no-brainer" in location decision, but it is not always positive for growth.

The impacts of e-commerce on retail trade decline are obvious with less importance of pop-connectivity variables. What will be the impacts of next-generation of economic change?

Planning implicatons to deliver physical urban change and economic growth?

Conclusions and next steps

Including heterogeneous spatial externalities and digging to finer resolution preserve key model assumptions of spatial equilibrium and urban economic growth models.

We confirm the importance of diversity and relatedness as proposed by previous literature.

Block-level evidence and economic theory provide very explicit guidelines to planners as well as designers.

The next steps - endogeneity test, spatial auto-correltion test, and other robustness test.

The construction of $g()$ is still wide open.