The economic resilience of a city

:THE EFFECT OF RELATEDNESS ON THE SURVIVAL OF AMENITY SHOPS DURING THE COVID-19 PANDEMIC

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01

Introduction

THE ECONOMIC RESILIENCE
OF A CITY

The concepts of economic resilience

1. The engineering concept of resilience

Focusing on the regions' ability to return to the previous steady-state after a shock (Martin, 2012)

2. The ecological concept of resilience

Focusing on the ability of the system to absorb the shock, re-structuring itself to reach another steady-state. The shock can leave a permanent effect and regions where the impact is positive is more resilient (Boschma, 2015; Martin, 2012).

The concepts of economic resilience

3. The evolutionary concept of resilience

Focusing on regions' ability to overcome the disturbance and move towards a new development path (Saviotti et al., 1996; Saviotti and Freemen, 2008; Hassink, 2010; Simmie and Martin, 2010; Xio et al., 2018).

The ability that makes a region resilient is embedded in the system of economy (Bristol and Healy, 2014).

The historical path dependency is emphasized in this perspective, because the region's ability to create a new path relies heavily on its pre-existing capabilities in the system (Boschma, 2015)

Related variety as a source of region's resilience

Region with high level of related variety is

- the region currently has a wide range of related industries for developing new industries by inter-industry learning (Frenken et al., 2007)
- the related variety can increase the regions' ability to grow (Frenken et al., 2007)
- the related variety can decrease the chance of exit of current industries from the region (Neffke et al., 2011)

Empirical findings (Labor dimension)

- Diodato and Wetering (2015). Netherlands labor market. Skill relatedness.
- Eriksson et al. (2016). West Germany and Sweden. Ship building industry. Skill relatedness
- Cainelli et al. (2019). European Union.

How to measure the related variety

Entropy measure

Frenken et al. (2007), Holm and Østergaard (2015), Liang (2017)
Industry-specific information is often lost by aggregating the industry level data into one variable for one region

Density measure

The Principle of Relatedness (Hidalgo et al., 2018)
Density measure allows us to see the effect of related variety without losing the industry-specific information

Relatedness

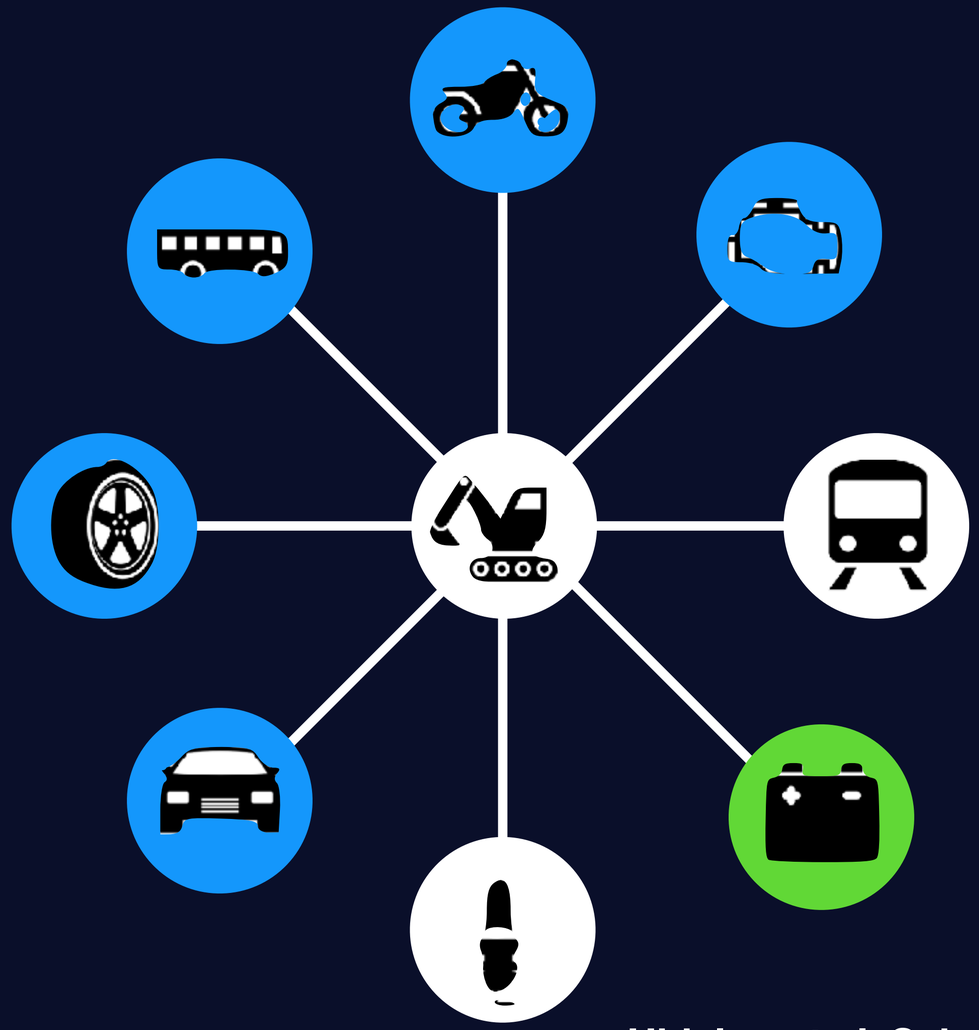
Density measures how much knowledge on doing something you already have

Country A =1/8

Low Relatedness
to Heavy Machinery

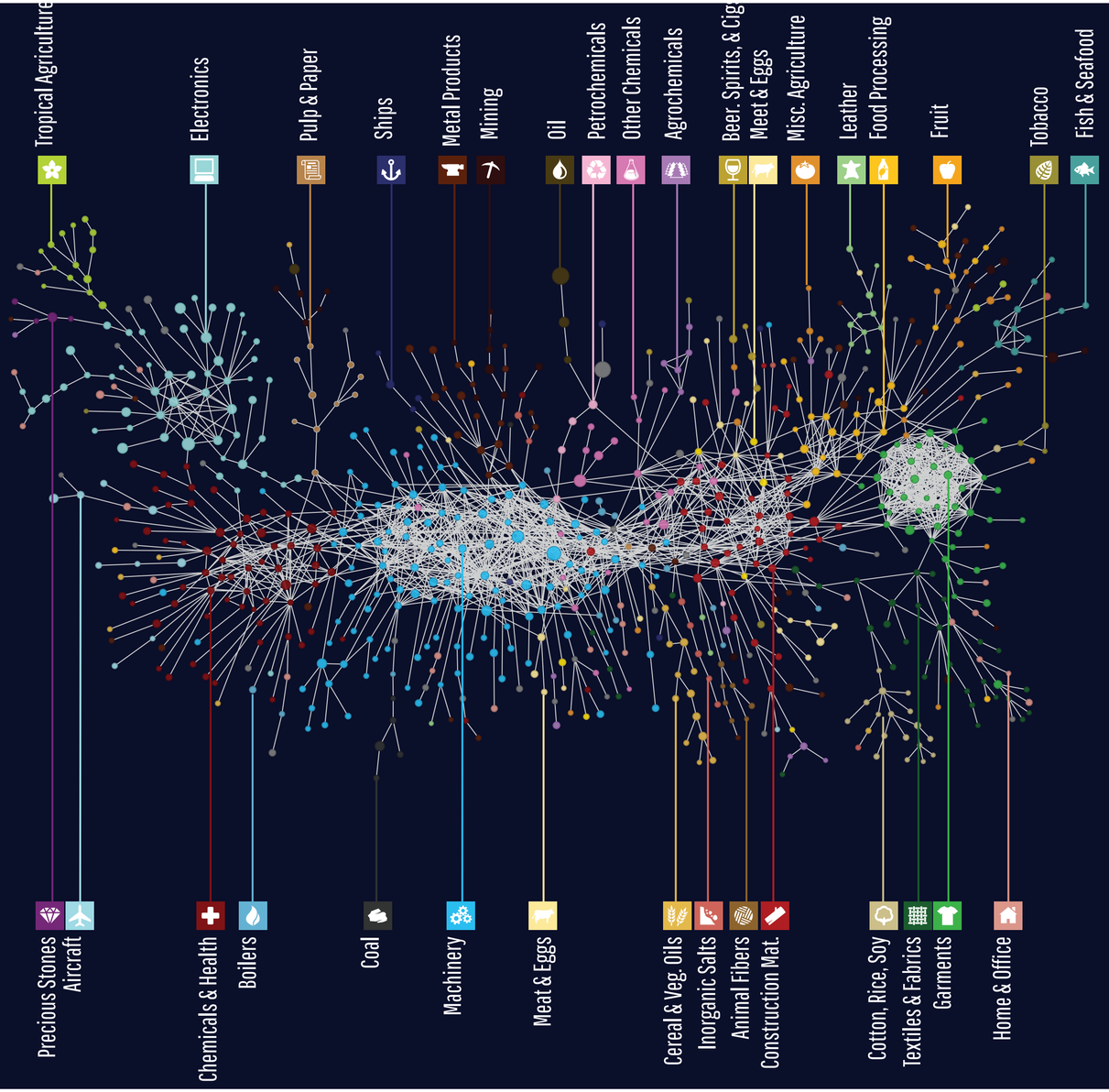
Country B =5/8

High Relatedness
to Heavy Machinery



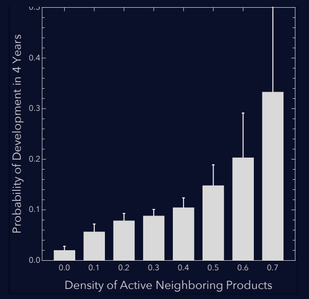
Hidalgo et al. Science (2007)

The Principle of Relatedness



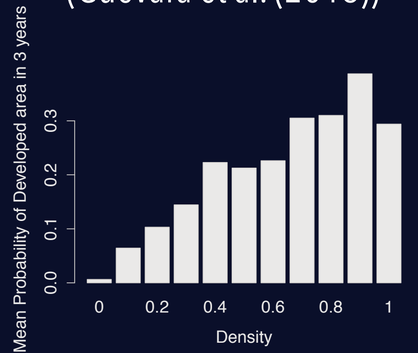
PRODUCTS

(Hidalgo et al 2007)



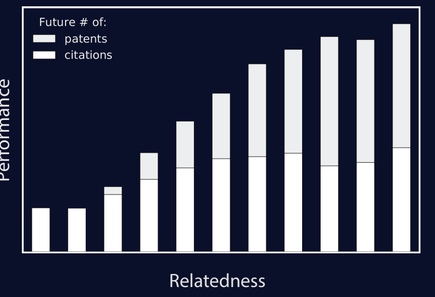
RESEARCH AREAS

(Guevara et al. (2016))



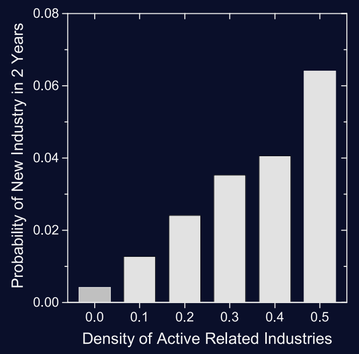
PATENTS

(Kogler et al. (2013), Boschma et al. (2015), Alstott et al. (2016))

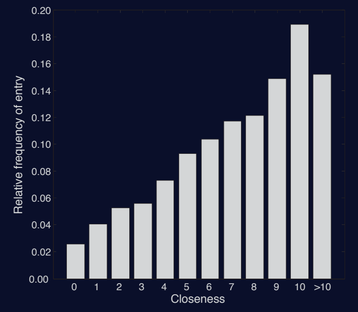


INDUSTRIES

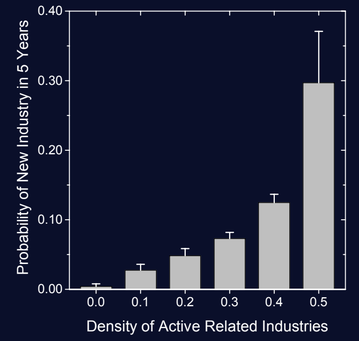
BRAZIL (Gao et al. 2017)



SWEDEN: (Neffke, Henning, Boschma 2011)

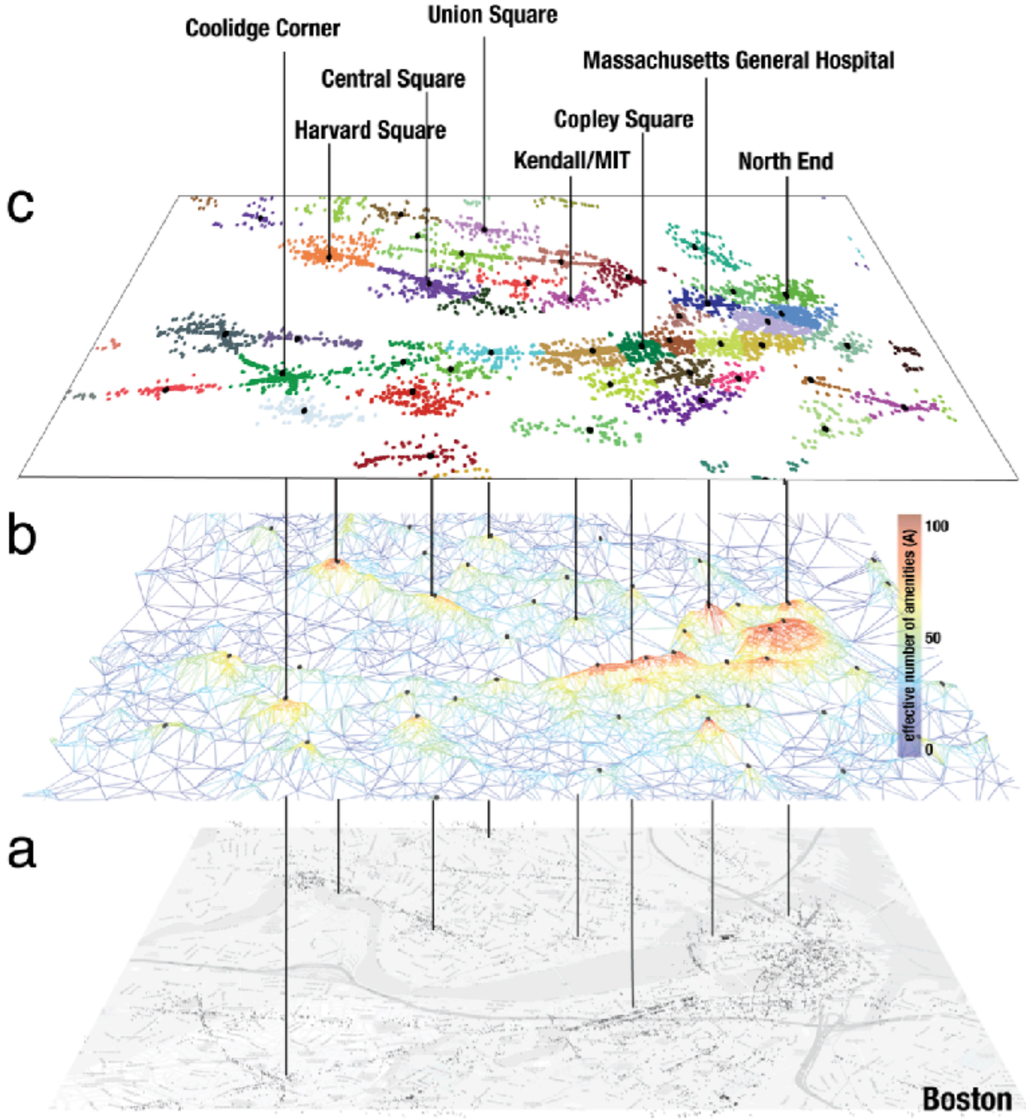


CHINA: (He et al. 2017 Gao et al. 2017)

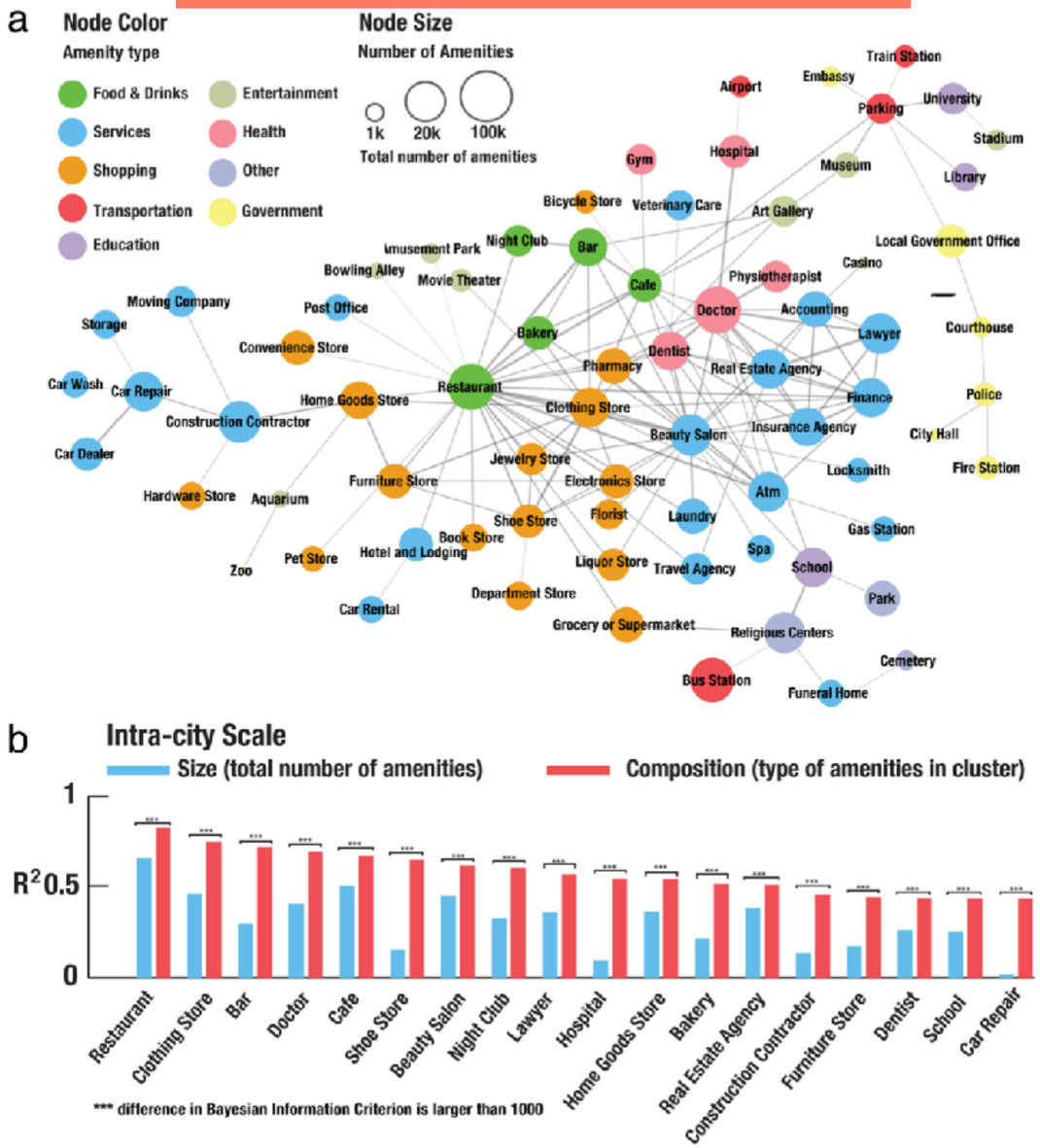


Amenity space (Hidalgo et al., 2020)

Clustering algorithm



Building amenity space



02

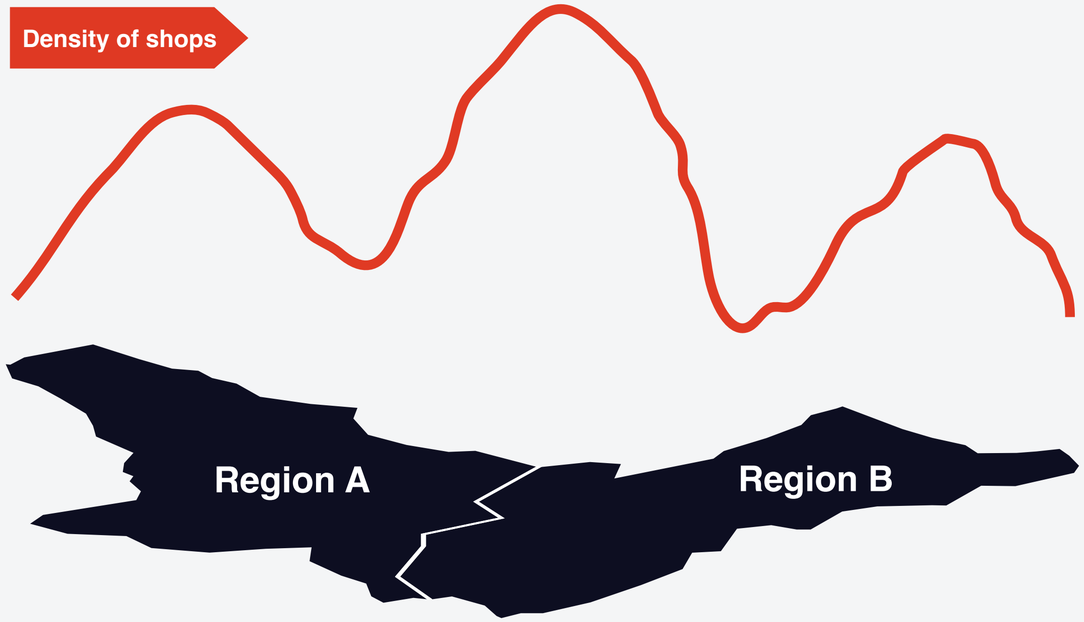
Methods

THE ECONOMIC RESILIENCE
OF A CITY

Detecting the spatial unit of analysis

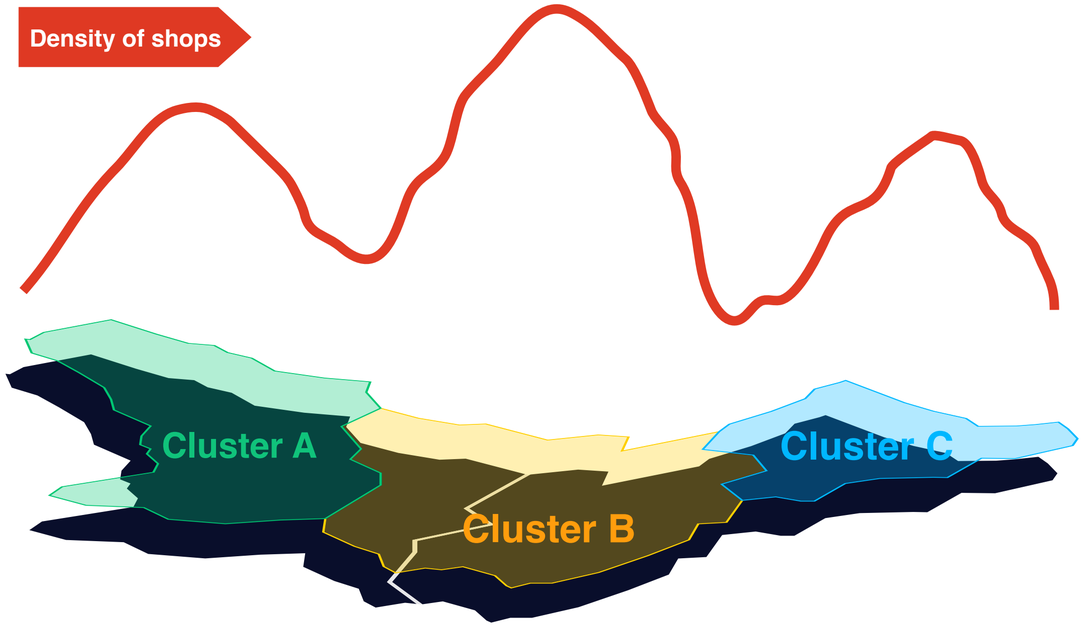
BEFORE

Using administrative district

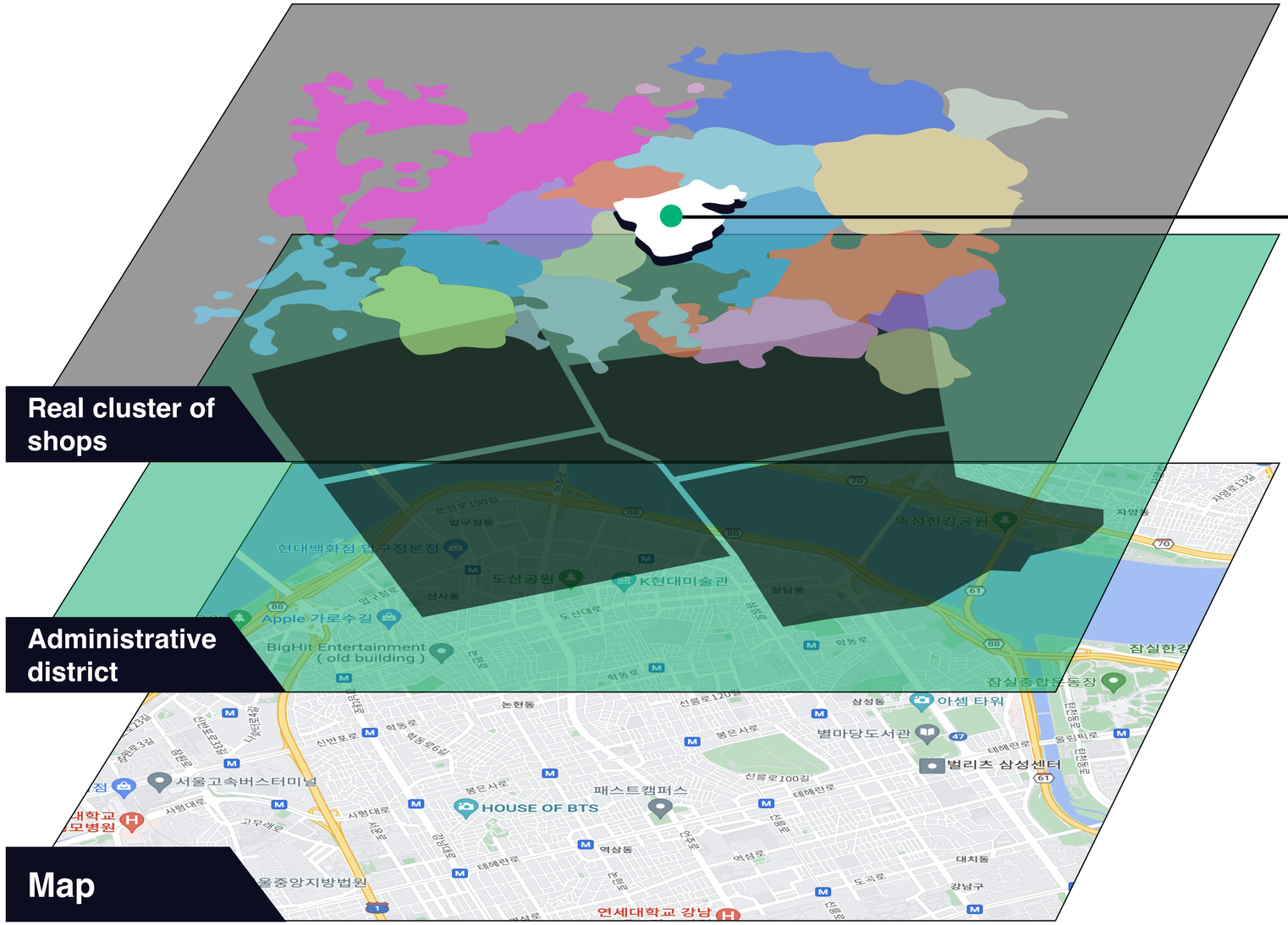


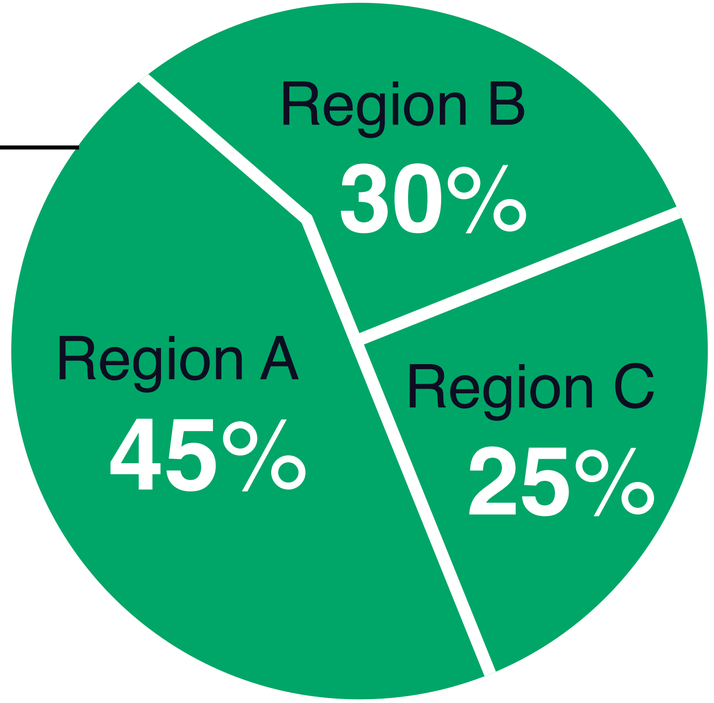
AFTER

Using the density of amenity shops



Detecting a meaningful spatial unit





Meaningful cluster of shops

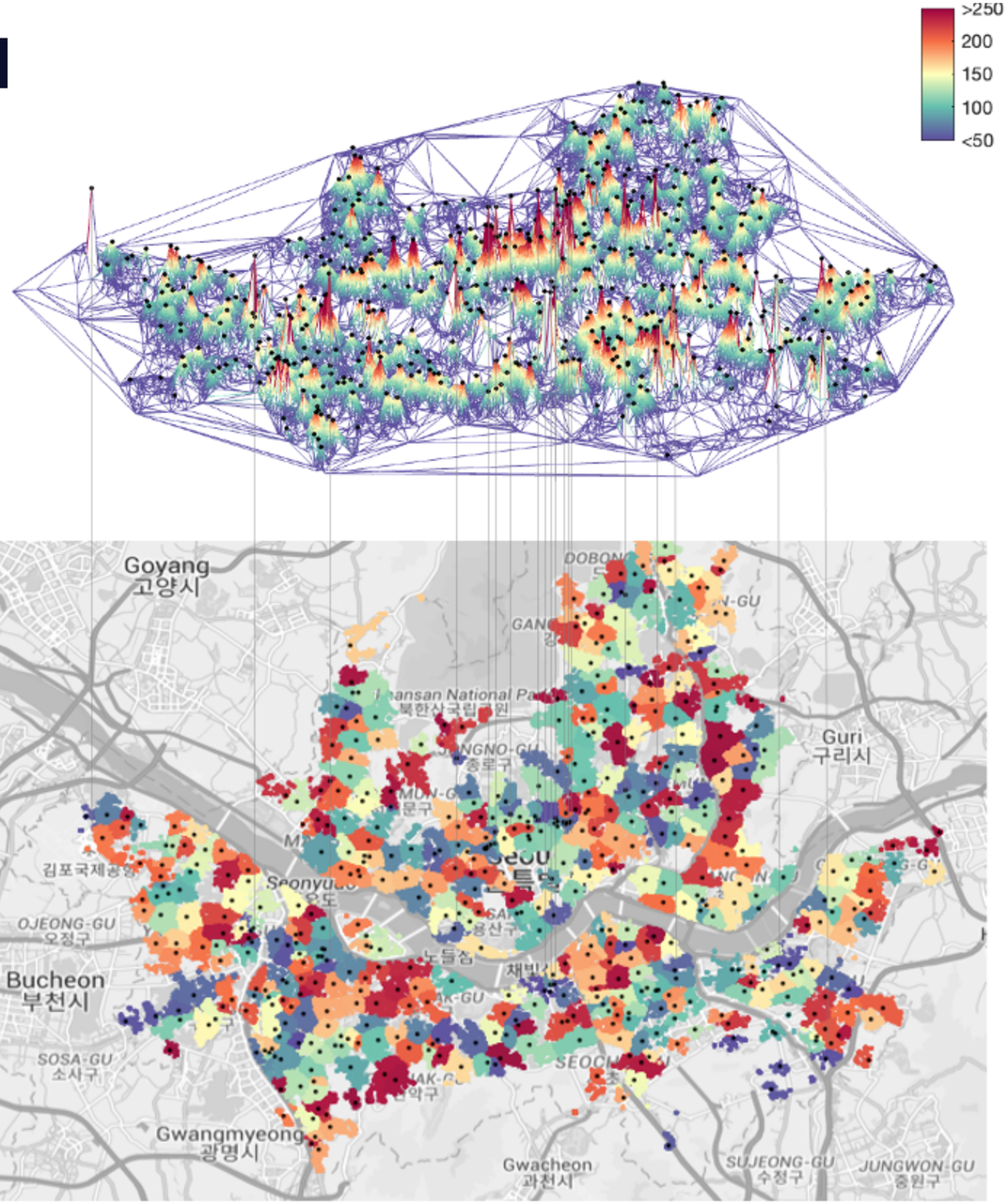
Detecting clusters of shops in Seoul

Calculating the effective number of amenities

$$A_i = \sum_{j=1}^{N} e^{-\gamma d_{ij}}$$

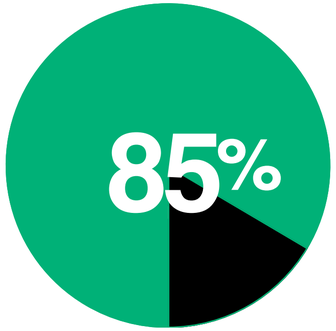
Where,
A_i : the effective number of amenity of shop i
γ : decay parameter
d_{ij} : distance between shop i and j
N : the total number of shops

We can control for the meaningful size of amenity clusters by using γ
When γ = 7.58, the average radius of the cluster is around 240m with detecting 523 clusters in Seoul

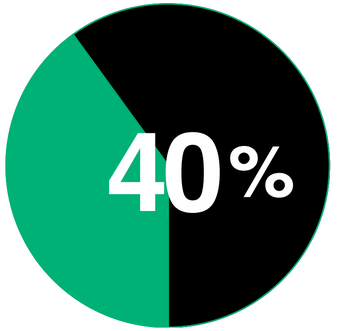


Data: Small enterprise in Korea

- The small enterprise in Korea is defined by the “Act on the Protection of and Support for Micro Enterprises.”
- Small enterprises: those in which the number of full-time workers is less than 10 and that operate in a business category where the number of full-time workers meets the standards prescribed by the Presidential Decree.



Number of businesses



Number of employee

- Small enterprises are subject to protection and support since the small businesses provide jobs to people as their last resort.
- In a city, amenity clusters that consist of small businesses such as coffee shops and restaurants improve urban life and are a source of employment for city dwellers.
- **During the pandemic, Korea hasn’t had a lockdown or border closure but had a social-distancing policy that regulated the size of public/private assemblies and the operating hours of stores.**

Seoul, the mega city

- Area: 605.2 km^2
- Population: around 10 million
- Capital of South Korea but most of the Administrative functions moved to the other city (Sejong city)

사진 출처:연합뉴스

Data: Geolocation data of small businesses

- Compiled by the Korean Small Enterprises and Market Service
- Available from 2016
- The list of small enterprises: 1.8 million stores from 2016-2021
- Stores that belong to one of the 9 categories(high-level class.)

  1. Travel/leisure/entertainment, 2. Real estate, 3. Retail, 4. Accommodation, 5. Sports facilities

  6. Restaurants, 7. Other living-related services, 8. Health, 9. Education

상가업소번호	상호명	지점명	상권업종대분류코드	상권업종대분류명	상권업종중분류코드	상권업종중분류명	상권업종소분류코드	상권업종소분류명	표준산업분류코드	표준산업분류명	시도코드	시도명
19911397	커피빈	코리아선릉로93길점	Q	음식	Q12	커피점/카페	Q12A01	커피전문점/카페/다방	I56220	비알콜 음료점업	11	서울특별시
19911801	프로포즈		Q	음식	Q09	유흥주점	Q09A01	호프/맥주	I56219	기타 주점업	11	서울특별시
19912201	싱싱커피&토스트		Q	음식	Q07	패스트푸드	Q07A10	토스트전문	I56192	피자, 햄버거, 샌드위치 및 유사 음식점업	26	부산광역시
19905471	와라와라호프		Q	음식	Q09	유흥주점	Q09A01	호프/맥주	I56219	기타 주점업	11	서울특별시
19932756	가락사우나내스낵		F	생활서비스	F09	대중목욕탕/휴게	F09A02	사우나/증기탕/온천	S96121	욕탕업	11	서울특별시
19975850	허술한집		Q	음식	Q04	분식	Q04A01	라면김밥분식	I56194	분식 및 김밥 전문점	11	서울특별시
19976567	씨유씨로지스틱스		D	소매	D03	종합소매점	D03A01	편의점	G47122	체인화 편의점	11	서울특별시

...

	건물본번지	건물부번지	건물관리번호	건물명	도로명주소	구우편번호	신우편번호	동정보	층정보	호정보	경도	위도
강남구 선릉로93길	6		1168010100106960042022041		서울특별시 강남구 선릉로93길 6	135080	6149				127.047883157395	37.505675040058
금천구 가산로	34	6	1154510200101620001017748		서울특별시 금천구 가산로 34-6	153010	8545		1		126.899220370682	37.4717112331268
사상구 괘감로	37		2653010400105780000002037	산업용품유통상가	부산광역시 사상구 괘감로 37	617726	46977		1	26	128.980455279266	35.1597741758499
강남구 남부순환로	2933		1168010600106040000014378	대치상가	서울특별시 강남구 남부순환로 2933	135280	6280		1		127.061026050567	37.4939223326479
송파구 가락로	71		1171010500102560005010490		서울특별시 송파구 가락로 71	138846	5690		1		127.104070564081	37.5002486691845
강서구 공항대로3길	9		1150010800100450031005883		서울특별시 강서구 공항대로3길 9	157812	7619		1		126.809957472555	37.5620126925293
중구 서소문로	89		1114016800100050002022586	순화빌딩	서울특별시 중구 서소문로 89	100731	4516			1501	126.970812578037	37.5625874808617

Building an amenity space of Seoul

By looking at the **collocation of amenities** in a cluster, we can calculate the proximity between amenities.

$$\phi_{a,a'} = minP(RCA_a \mid RCA_{a'}), P(RCA_{a'} \mid RCA_a)$$

Where,

$\phi_{a,a'}$ indicates the proximity between amenity a and a'

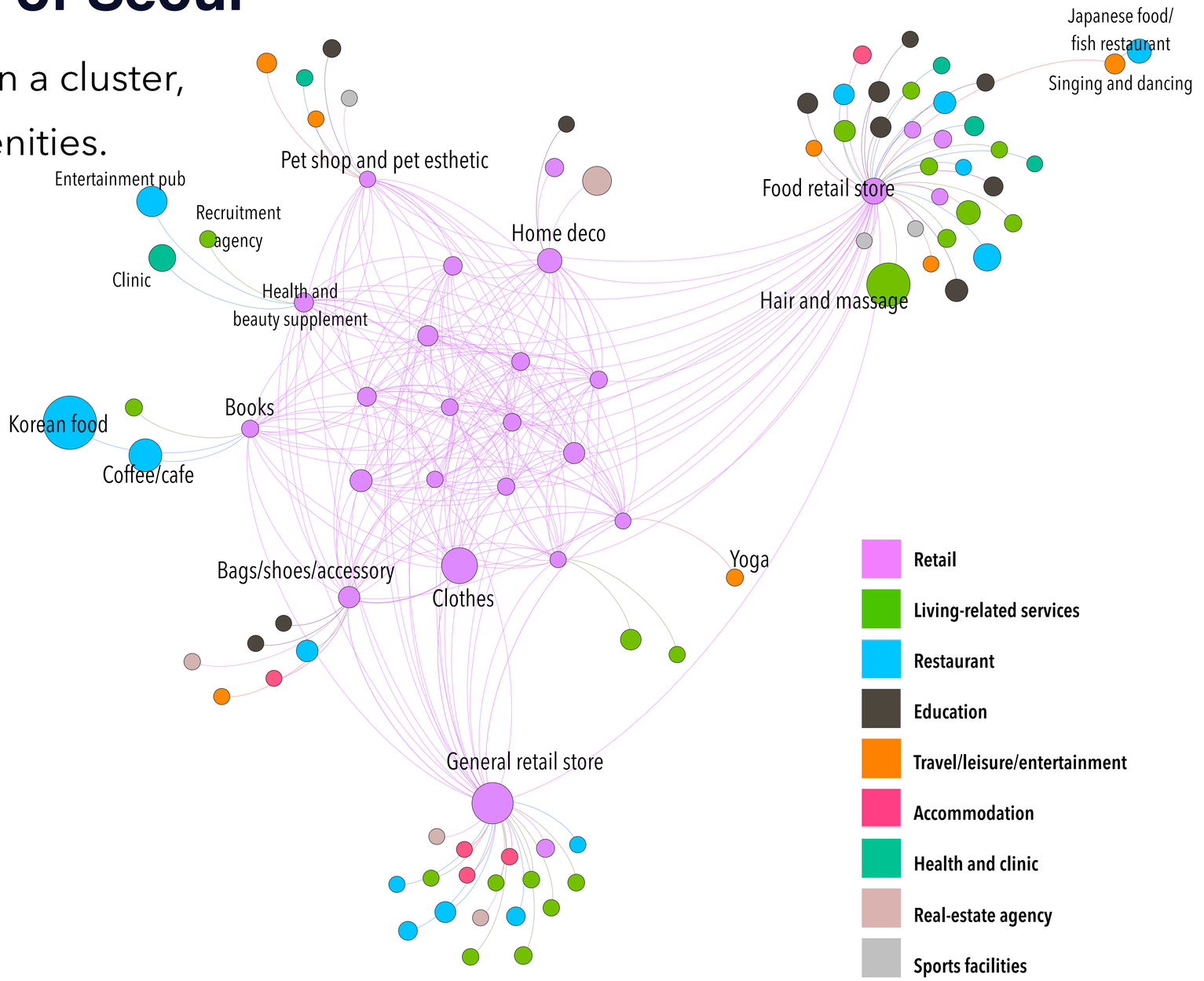
RCA_a is the Revealed Comparative Advantage of a

$$RCA_{c,a} = \frac{x_{c,a}}{\sum_a x_{c,a}} \Big/ \frac{\sum_c x_{c,a}}{\sum_{c,a} x_{c,a}}$$

Where,

$x_{c,a}$ is the number of shops that provide amenity a in cluster c

$$\omega_{c,a} = \sum_{a'} \frac{\phi_{a,a'}}{\phi_a} \cdot \frac{x_{c,a'}}{x_c}$$



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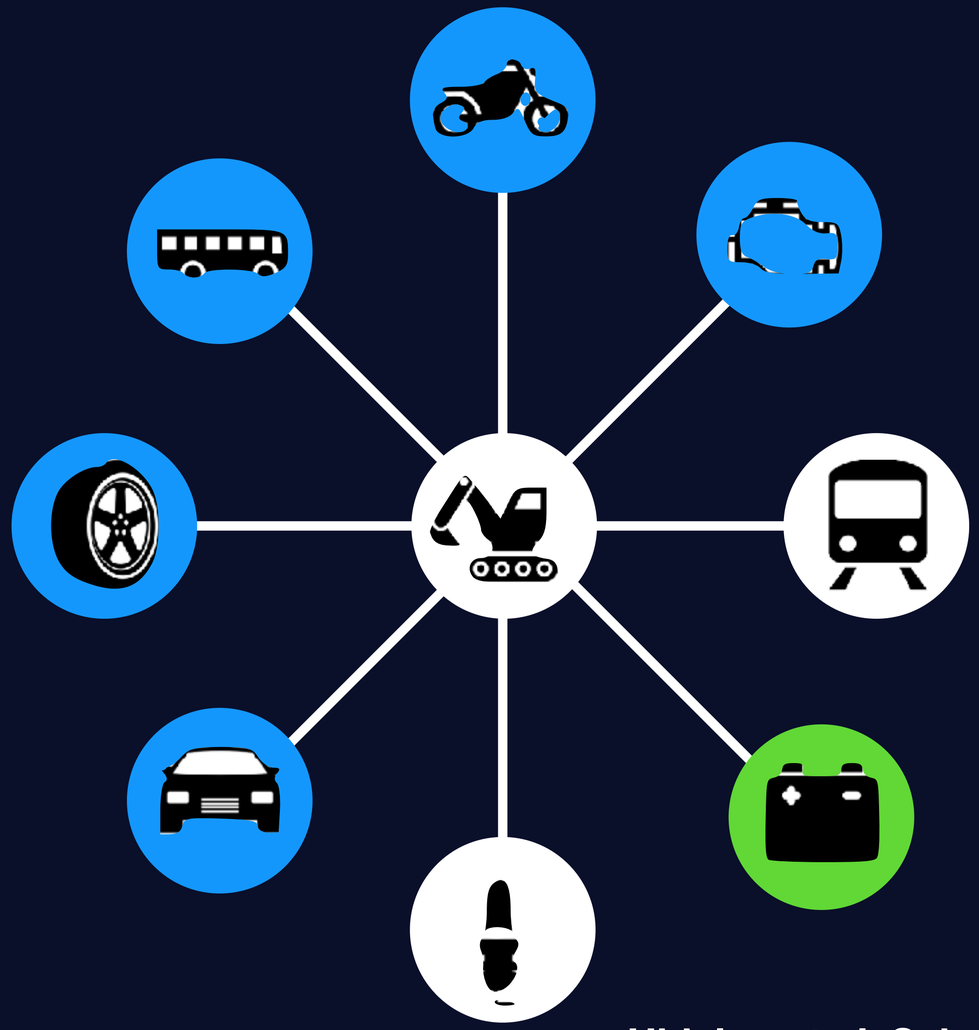


Hidalgo et al. Science (2007)

03

Results

THE ECONOMIC RESILIENCE
OF A CITY

Cluster level analysis

Does relatedness help amenity clusters increase their number of shops?
Does the principle of relatedness hold for the amenity space during the pandemic?

$$\Delta x_{c,a,t+2} = \beta_0 + \beta_1 \omega_{c,a,t} + \beta_2 x_{c,a,t} + \beta_3 x_{c,t} + \mu_c + \lambda_t + \eta_a + \varepsilon_{c,a,t}$$

$\omega_{c,a,t}$	The density of amenity a in cluster c at time t
$\Delta x_{c,a,t+2}$	The difference in the number of stores that provide amenity a in cluster c between time t and t+2
$x_{c,t}$	The number of stores with the same amenity, $x_{c,t} = \sum_a x_{c,a,t}$
μ_c	Cluster fixed effect
λ_t	Time fixed effect
η_a	Amenity fixed effect using the largest classification

	Dependent variable: $\Delta store_{c,a,t+2}$				
	2016-2018	2017-2019	2018-2020	2019-2021	2016-2021
	(1)	(2)	(3)	(4)	(5)
$\omega_{c,a,t}$	0.014***	0.042***	−0.0003	−0.002**	0.015***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
$x_{c,a,t}$	−0.375***	−0.158***	0.101***	−0.231***	−0.197***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.0004)
$x_{c,t}$					−0.001***
					(0.00001)
Year f.e.					✓
Amenity f.e.	✓	✓	✓	✓	✓
Cluster f.e.	✓	✓	✓	✓	✓
Observations	406,894	406,894	406,894	406,894	1,627,576
Adjusted R^2	0.447	0.105	0.070	0.278	0.168
Residual Std. Error	2.387	2.682	1.877	2.088	2.428
Note:					*p<0.1; **p<0.05; ***p<0.01

Shop level analysis

Can more related amenities around individual stores help them survive during the pandemic?

- Our latest data is for the end of June 2021.
- Checking the two-year survival rate by looking at June 2019 and June 2021.

$$
\begin{aligned}
survival_{i,c,a,r,t+2} = {} & \beta_0 + \beta_1 \omega_{c,a,t} + \beta_2 store_{c,a,t} + \beta_3 totalstore_{c,t} \\
& + \beta_4 numBiz_{r,t} + \beta_5 employment_{r,t} \\
& + \beta_6 population_{r,t} + \beta_7 popDensity_{r,t} + \beta_8 agingIndex_{r,t} + \beta_9 lowIncome_{r,t} \\
& + \mu_c + \eta_a + \varepsilon_{c,a,t}
\end{aligned}
$$

	Dependant variable: $survival_{i,c,a,r,2021}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
log $\omega_{c,a,2019}$	0.0444***	0.0404***	0.0428***	0.0406***	0.0405***	0.0407***	0.0404***
	(0.0088)	(0.0089)	(0.0089)	(0.0087)	(0.0088)	(0.0087)	(0.0088)
log $store_{c,a,2019}$		0.0254***		0.0255***	0.0255***	0.0255***	0.0255***
		(0.0036)		(0.0036)	(0.0)	(0.0036)	(0.0036)
log $totalstore_{c,2019}$			0.0333				
			(0.0223)				
log $numBiz_{r,2019}$				-0.1400***		-0.1395***	-0.1412***
				(0.1107)		(0.0120)	(0.0120)
log $employment_{r,2019}$					-0.1031 ***		
					(0.0087)		
log $population_{r,2019}$						0.0039	-0.0024
						(0.0094)	(0.0107)
log $popDensity_{r,2019}$						0.0170**	0.0177**
						(0.0079)	(0.0079)
$agingIndex_{r,2019}$							0.0002***
							(0.00007)
$lowIncome_{r,2019}$							-0.0014
							(0.0011)
Amenity f.e.	✓	✓	✓	✓	✓	✓	✓
Cluster r.e.	✓	✓	✓	✓	✓	✓	✓
observation	276804	276804	276804	276804	276804	276804	276804
log likelihood	-156017.05	-155992.79	-156015.94	-155913.33	-155923.55	-155910.85	-155905.61
Note:							*p<0.1; **p<0.05; ***p<0.01

04

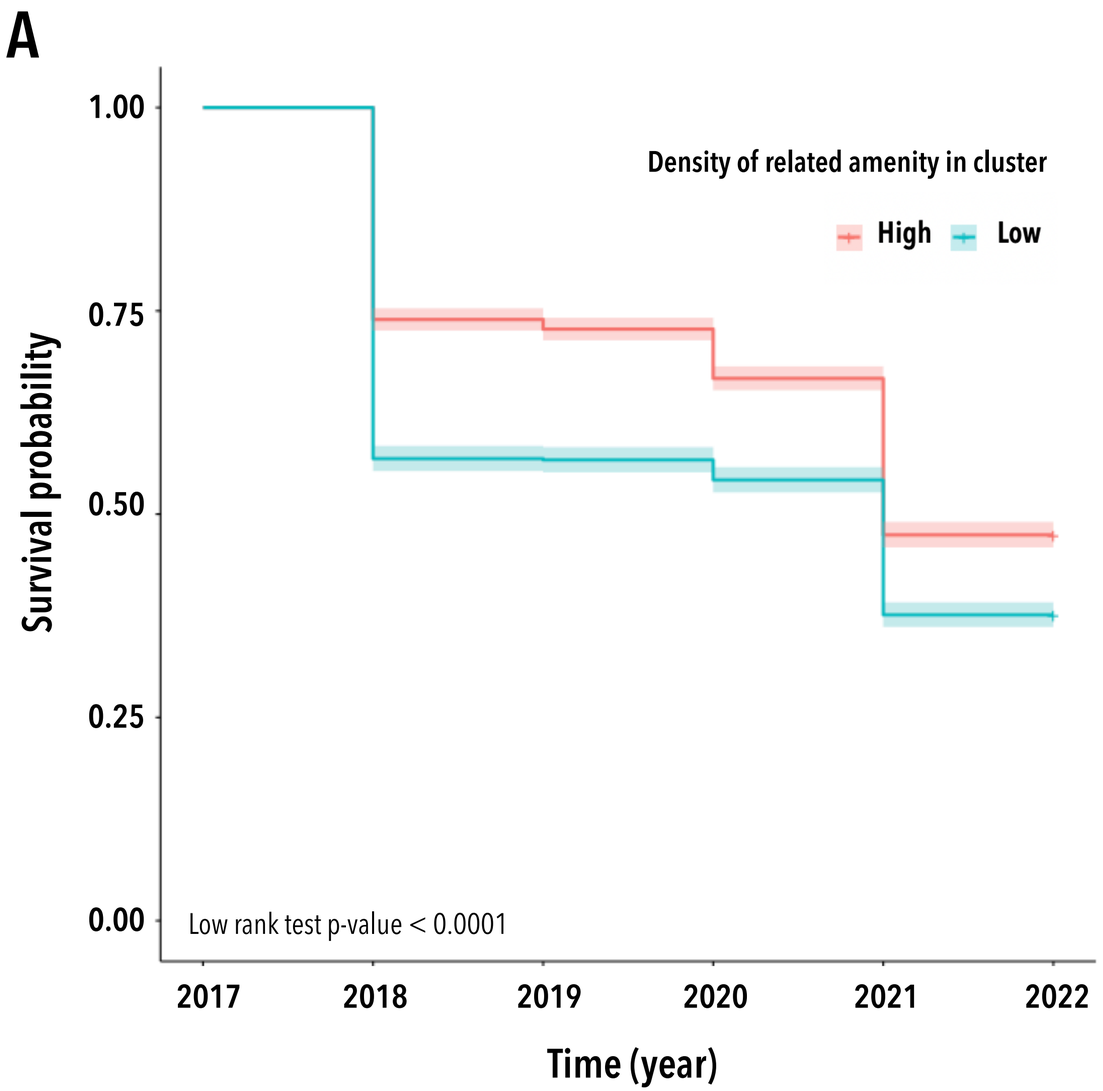
Robustness check

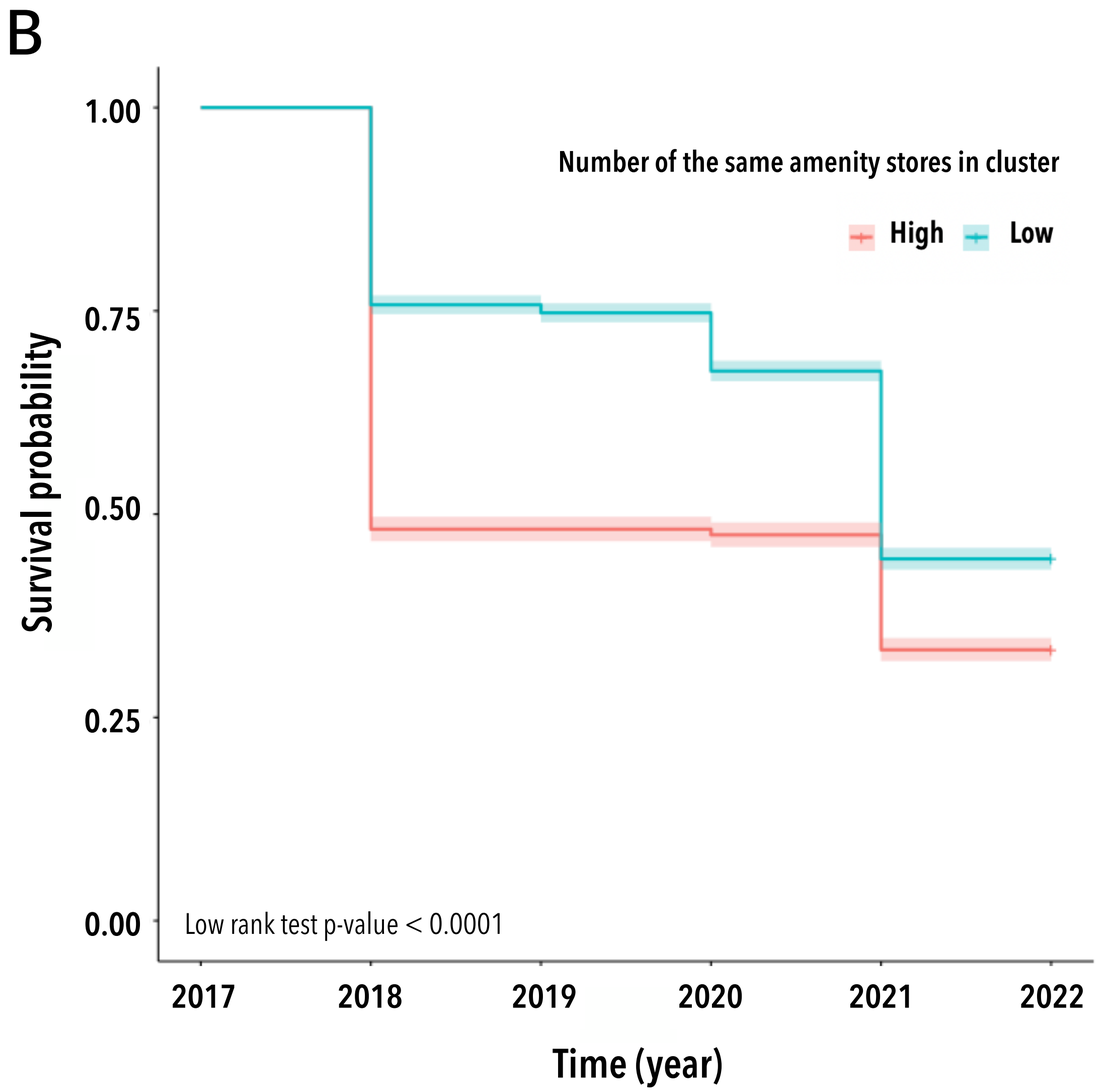
THE ECONOMIC RESILIENCE
OF A CITY

Changing spatial scale of amenity clusters

	Dependent variable: survival$_{i,c,a,r,2021}$					
	Small level classification			*Mid level classification*		
	(1) 187 *m*	(2) 241 *m*	(3) 310 *m*	(4) 187 *m*	(5) 241 *m*	(6) 310 *m*
log $\omega_{c,a,2019}$	0.1850***	0.0404***	0.0814***	0.3067***	0.1843***	0.1089***
	(0.0381)	(0.0088)	(0.0128)	(0.0439)	(0.0207)	(0.0191)
log store$_{c,a,2019}$	0.0620***	0.0255***	0.0228***	0.0174***	0.0067	0.0112**
	(0.0036)	(0.0036)	(0.0043)	(0.0041)	(0.0119)	(0.0053)
log numBiz$_{r,2019}$	-0.1460 ***	-0.1412***	-0.1402	-0.1253***	-0.1358***	-0.1378***
	(0.0121)	(0.0119)	(0.0.0119)	(0.0111)	(0.0119)	(0.0119)
log population$_{r,2019}$	-0.0012	-0.0024	-0.0033	0.0106	-0.0028	-0.0025
	(0.0108)	(0.0108)	(0.0108)	(0.0102)	(0.0108)	(0.0107)
log popDensity$_{r,2019}$	0.0172**	0.0177**	0.0176**	0.0072	0.0179**	0.0178**
	(0.0080)	(0.003)	(0.0079)	(0.0075)	(0.0079)	(0.0080)
agingIndex$_{r,2019}$	0.0002***	0.0002***	0.0002***	0.0002***	0.0002***	0.0002***
	(0.00007)	(0.00007)	(0.00007)	(0.00007)	(0.00007)	(0.00007)
lowIncome$_{r,2019}$	-0.0015	-0.0015	-0.0015	0.0011	-0.0014	-0.0014
	(0.0011)	(0.0012)	(0.0011)	(0.0011)	(0.0012)	(0.0011)
observation	275995	276804	276804	273139	276804	276804
log likelihood	-155265.52	-155992.79	-155905.49	-154355.5	-155900.54	-155923.54

Logistic discrete hazard frailty model





Logistic discrete hazard frailty model

- Using the logistic discrete hazard frailty model (Tutz and Schmid, 2016) to estimate the survival/ death rate with the discrete time-to-event data
- We look at stores that started between 2016 and 2017 (79420 stores) and estimate their survival rate every year
- Hazard function:

$$\log\left(\frac{\lambda(t|\mathbf{x})}{1-\lambda(t|\mathbf{x})}\right) = \mu_c + \beta_0 + \mathbf{x}^T\beta,$$

Where, $\mu_c \sim N(0, \sigma^2)$

Begin	End	Period	N	Events	Censored	Hazard	$S(t)$
2017	2018	$[0, 1)$	79420	22245	0	0.280	0.720
2018	2019	$[1, 2)$	57175	530	0	0.009	0.713
2019	2020	$[2, 3)$	56645	4183	0	0.074	0.661
2020	2021	$[3, 4)$	52462	15692	0	0.299	0.463
2021	-	$[4, \infty)$	36770	0	36, 770	0	0.463

(Estimated life table)

- Odds ratio that captures the effect of relatedness on the survival of shop in their first year:

$$2.13697 - 0.06985 \cdot \omega$$

- Odds ratio that captures the effect of relatedness on the survival of shop during the pandemic:

$$2.37155 - 0.05296 \cdot \omega$$

- Both results shows a negative and significant effect of relatedness, implying that the relatedness decreases the death rate

	Dependent variable: Death Event			
	(1)	(2)	(3)	(4)
Intercept	-3.30509***	-3.32351***	-3.32666***	-3.32012***
	(0.02563)	(0.02588)	(0.02551)	(0.02592)
First year	2.15642***	2.17356***	2.13707***	2.13697***
	(0.01697)	(0.01727)	(0.01739)	(0.01739)
COVID-19 period	2.35639***	2.38047***	2.37113***	2.37155***
	(0.01791)	(0.01819)	(0.01817)	(0.01818)
$\omega_{c,a,t}$	0.01776***	0.07687***	0.06918***	0.06986***
	(0.00298)	(0.00436)	(0.00438)	(0.00438)
First year $\times$ $\omega_{c,a,t}$		-0.07733***	-0.06983***	-0.06985***
		(0.00396)	(0.00401)	(0.00400)
COVID-19 period $\times$ $\omega_{c,a,t}$		-0.05191***	-0.05318***	-0.05296***
		(0.00431)	(0.00433)	(0.00433)
$\text{Store}_{c,a,t}$			0.00111***	0.00109***
			(0.00006)	(0.00006)
$\text{numBiz}_{r,t}$			0.00001**	0.00001**
			(0.00000)	(0.00000)
log population				-0.08183***
				(0.03006)
log popDensity				0.03941**
				(0.01915)
Aging Index				0.00043***
				(0.00014)
Low Income				-0.00005*
				(0.00003)
Amenity f.e.	✓	✓	✓	✓
Cluster r.e.	✓	✓	✓	✓
observation	245702	245702	245702	245702
BIC	191705.1	191329.93	191000.5	191007.32
Note:				*p<0.1; **p<0.05; ***p<0.01

05

Discussion
Conclusion

THE ECONOMIC RESILIENCE
OF A CITY

Conclusion and Discussion

Conclusion

- The Principle of Relatedness holds in clusters' entering a new type of amenity.
- During the exogenous shock of the COVID-19 pandemic, stores that are co-located with shops providing the related amenities, experienced the higher probability of survive.
- Relatedness brings economic resilience (that are associated with small businesses) to a region during the pandemic.

Limitation

- The long-term effect of the shock needs to be examined.
- We cannot show the micro-mechanism of relatedness in this study.
- We don't know whether the COVID-19 pandemic exhibits the general feature of shock.

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The economic resilience of a city: the effect of relatedness on the survival of amenity shops during the COVID-19 pandemic

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Amenity clusters consisting of coffee shops, restaurants and other small businesses improve urban life and are a source of employment for city dwellers. Although most small business clusters were hit hard by restrictions imposed during the COVID-19 pandemic, some were able to adapt. What determines the economic resilience of amenity clusters? Using store-location data for Seoul from 2016 to 2021, we identify spatial clusters of amenities, and from that build an *amenity space* to examine the effect of relatedness on the resilience of each cluster. We find that businesses are more likely to survive when located in clusters of related amenities.

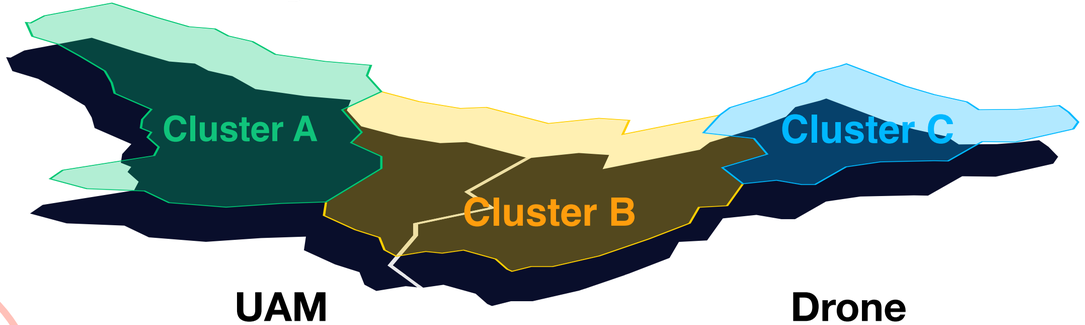
Keywords: resilience, amenity space, relatedness, Covid-19
JEL Classifications: O18, R12, R30

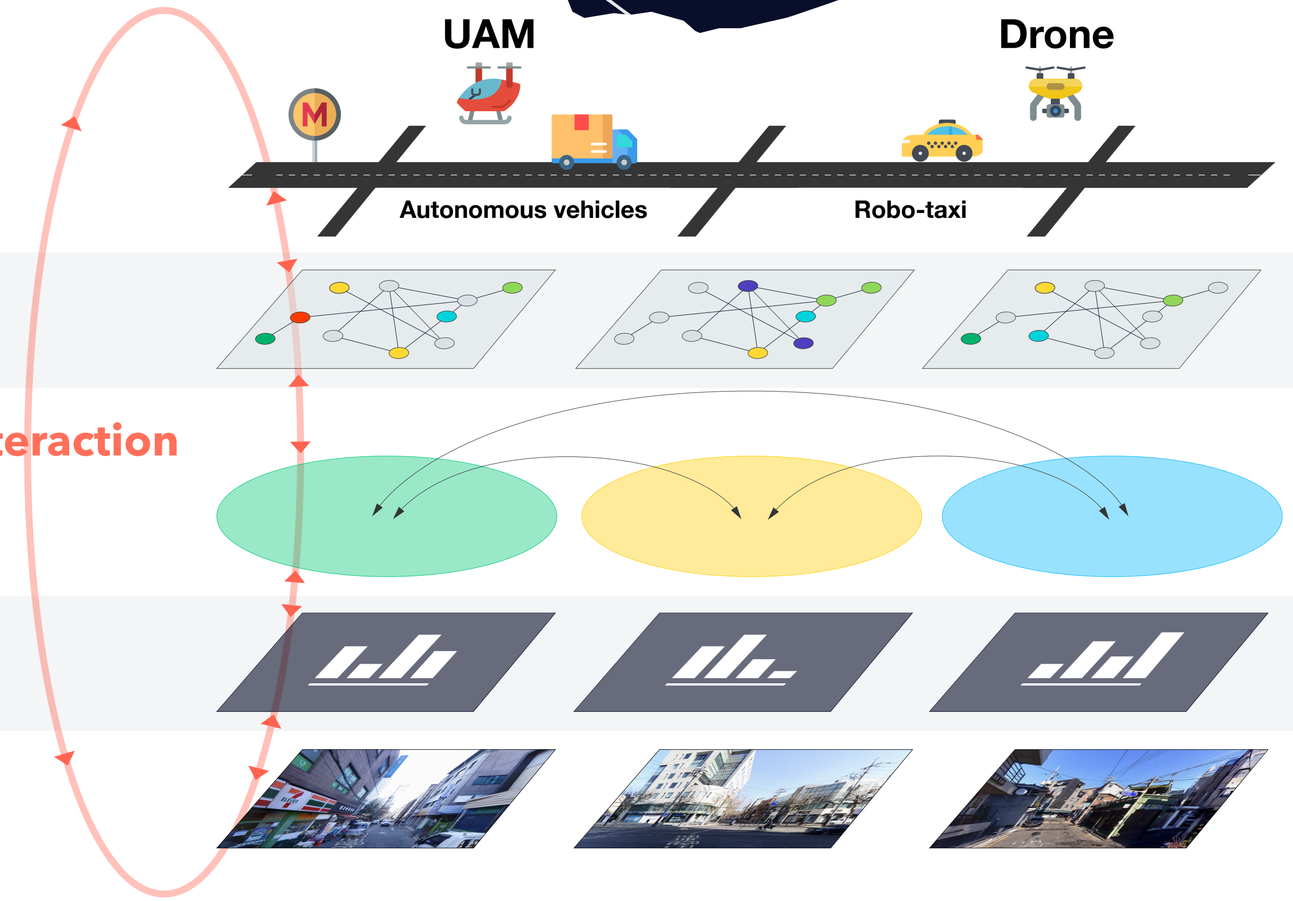
06

Future research

THE ECONOMIC RESILIENCE
OF A CITY

Small Businesses Ecosystem in the era of AI and DS





Transportation · logistics networks

Amenity space

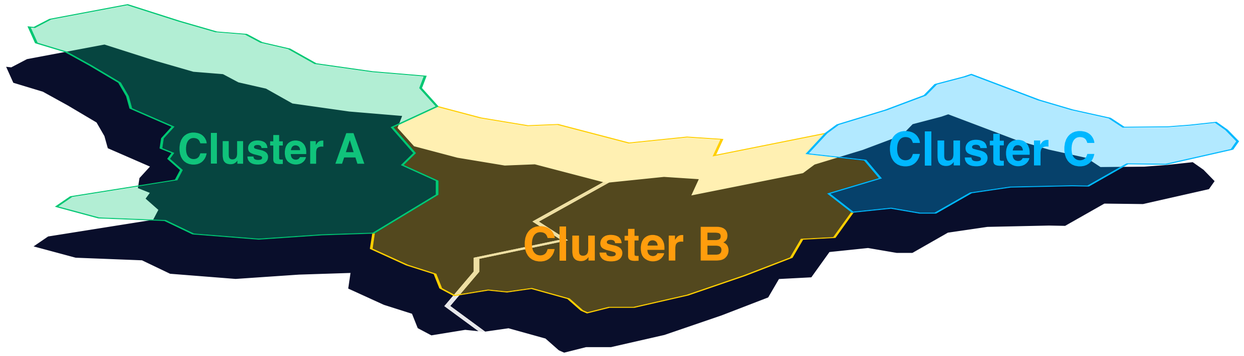
Cross-space interaction

Population flows network

Economic features
- Consumptions
- Employments

Street View data

Using various sources of big data



Population Flows

KT NICE지니데이타

Credit Cards

BC카드 NICE지니데이타

Travels

KT NICE지니데이타

Weather

케이웨더 나노웨더

On-demand Taxi

카카오 모빌리티

Aviation Big Data

항공 안전 빅데이터 연구

Logistics

CJ ONE 쿠팡

Street Views

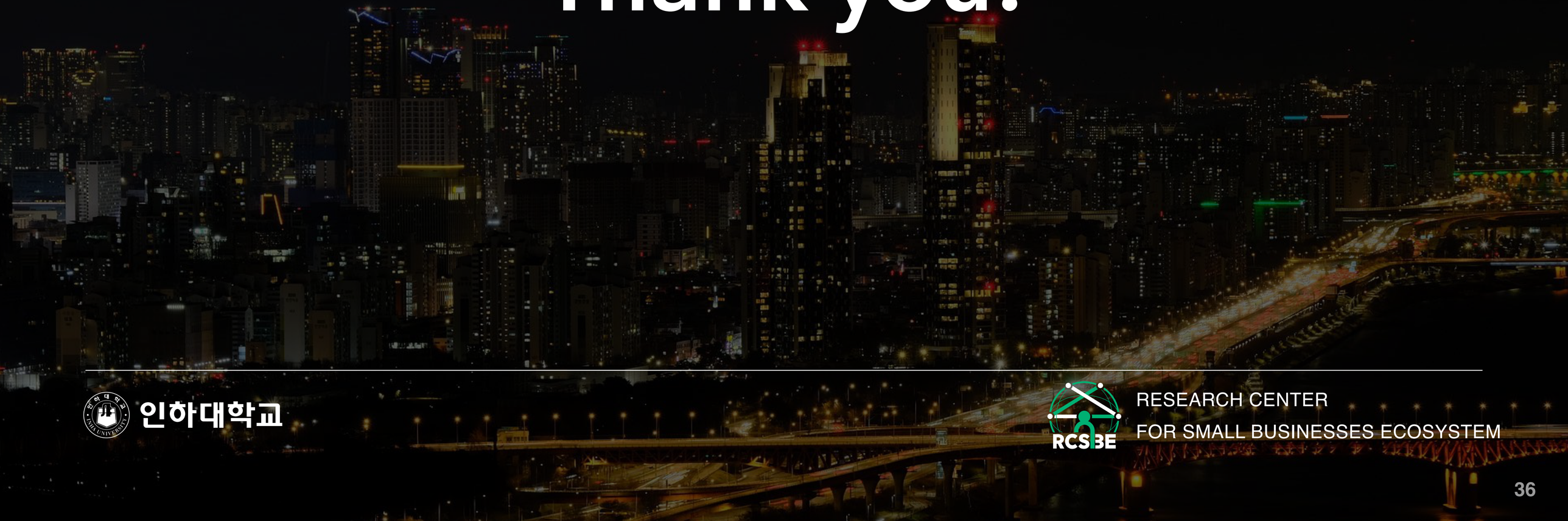
본 연구센터

Others

국토연구원

http://www.datakorea.io/

Thank you!



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