Cities and innovation

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SMART CITIES: CONTEXT, POLICY & GOVERNMENT: LECTURE 6

BARTLETT CENTRE FOR ADVANCED SPATIAL ANALYSIS

UCL

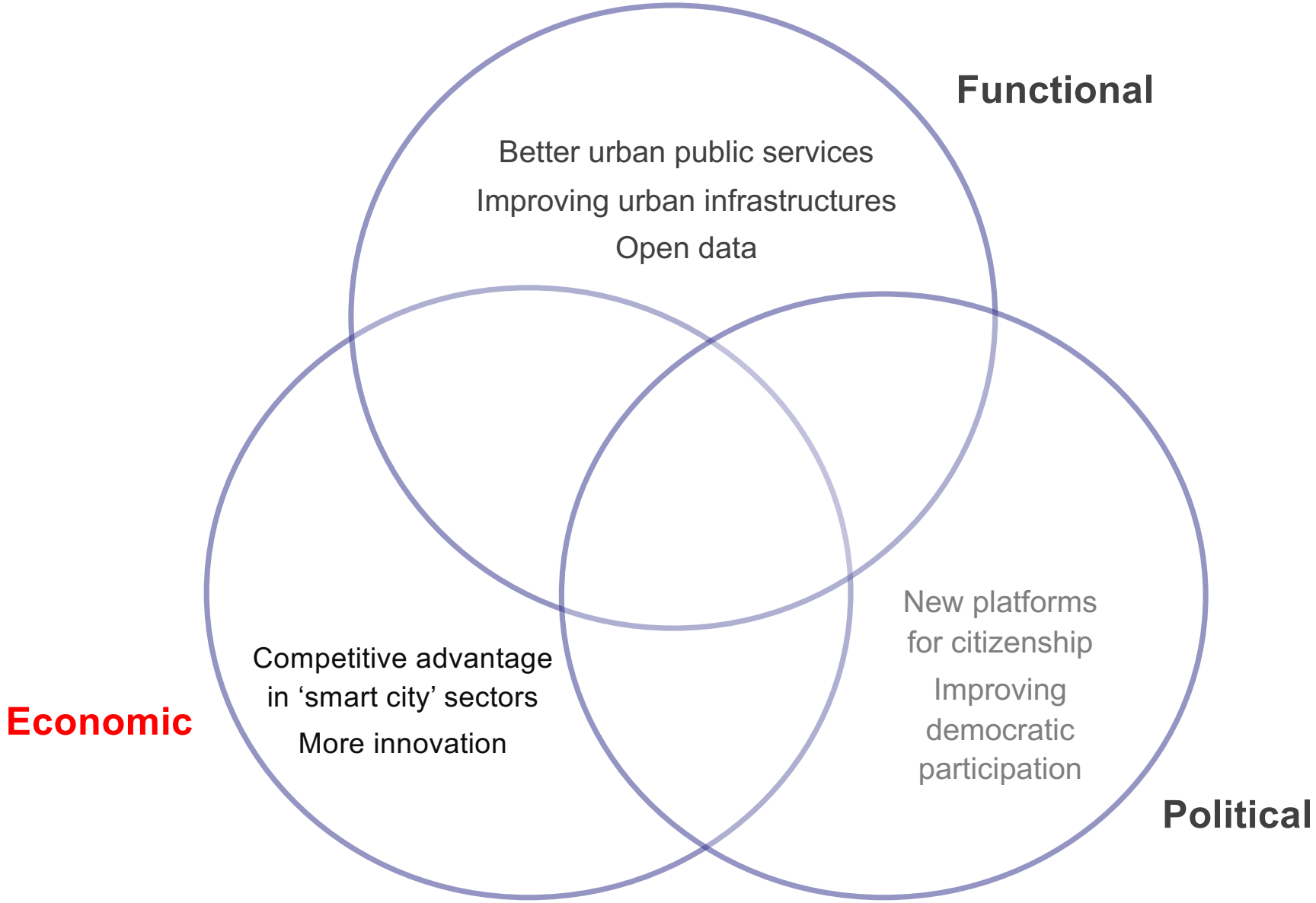
Recap

- Part 1: smart city building blocks:
  - Technology stack
  - Players: entrepreneurs, companies, cities, citizens
  - Policy agendas, development and mobilities
  - Data: access, standards, privacy

- Focus on cities and citizens as technology *users*

- We're now going to shift the focus to cities as *producers* of technology, and producers of innovation more broadly

Recap: smart city policy types



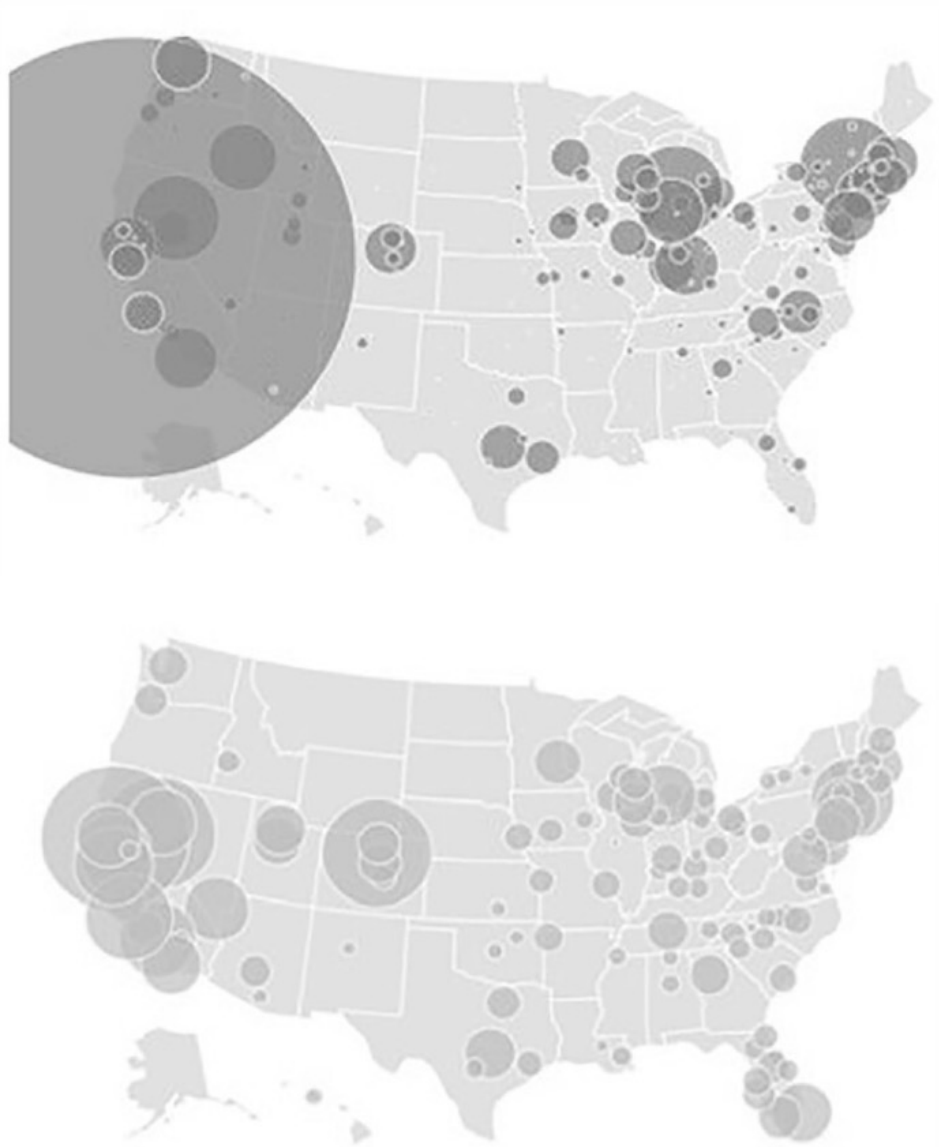
Recap: smart city technology production is urbanised

Table 1. Leading urban tech clusters, 2010–19.

Rank	Metro	Deals (*n*)	Global (%)	Investment (US$ '000s)	Mega-deals (%)
1	San Francisco, CA, USA	1527	4.86%	49,011	15.26%
2	New York, USA	1085	3.45%	22,080	11.71%
3	London, UK	908	2.89%	5205	3.08%
4	Los Angeles, CA, USA	537	1.71%	10,631	11.17%
5	San Jose, CA, USA	503	1.60%	9454	15.11%
6	Beijing, China	454	1.44%	62,498	32.82%
7	Paris, France	436	1.39%	2174	2.52%
8	Boston, MA, USA	411	1.31%	3898	9.00%
9	Seattle, WA, USA	279	0.89%	1971	6.09%
10	Bangalore, India	279	0.89%	7369	14.70%
11	Delhi, India	253	0.80%	10,819	15.42%
12	Shanghai, China	250	0.80%	24,514	34.00%
13	Chicago, IL, USA	232	0.74%	877	2.59%
14	Washington, DC, USA	226	0.72%	1589	4.42%
15	Austin, TX, USA	193	0.61%	1934	9.84%
16	Berlin, Germany	192	0.61%	5504	18.75%
17	Tel Aviv, Israel	165	0.52%	2926	13.33%
18	Moscow, Russia	149	0.47%	466	2.68%
19	Barcelona, Spain	142	0.45%	795	3.52%
20	Denver, CO, USA	135	0.43%	1037	8.89%

Adler and Florida 2021

Recap: innovation is urbanised …

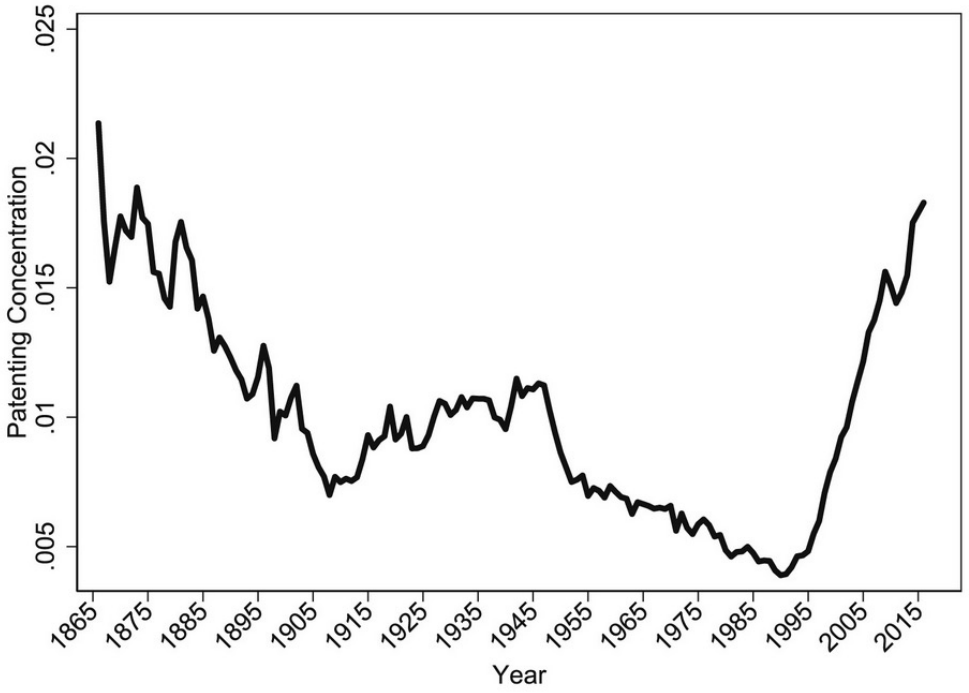


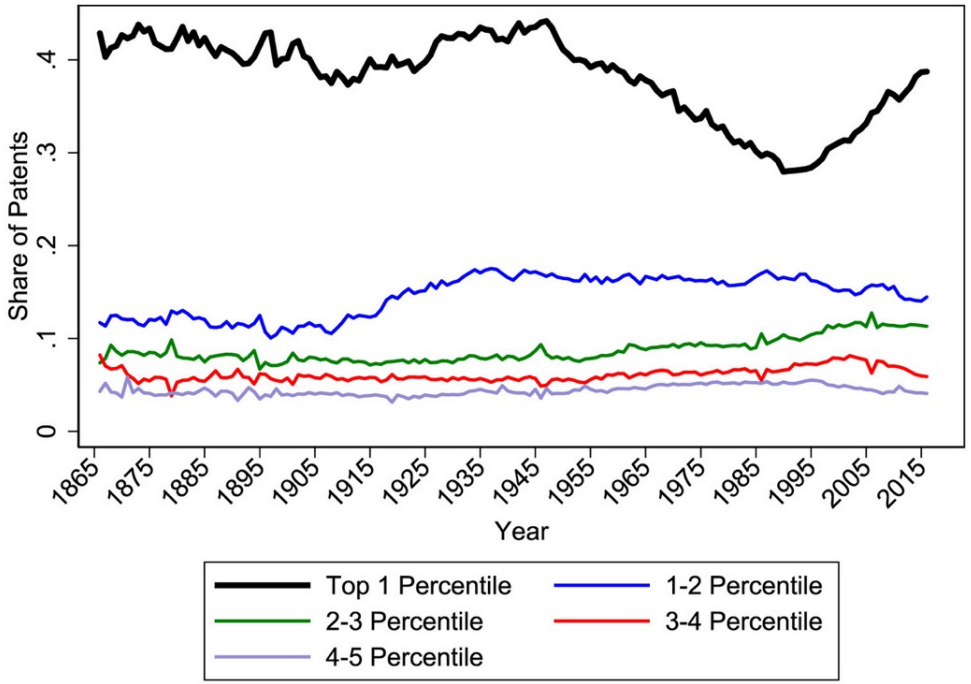
How you measure, matters. Location quotients for patents (top), and trademarks (bottom)

MSAs, 2010-2015 averages

Source: Castaldi 2023

Innovation gradually diffuses; but clustering is persistent. Why?





Spatial clustering of patenting in the USA, 1866-2016
Left: Concentration across *all* commuting zones (CZs)
Right: Shares for top-patenting CZs

Source: Andrews & Whalley 2022

Structure

- **Lecture 6 – overview** of cities as “innovation producers”
  - **Part 1:** definitions + key frameworks
  - **Part 2:** theory + evidence, case studies
  - **Seminar: the rise of urban tech, discussing Adler and Florida**
- **Coming up**
  - **Lecture 7 – strategy + policy tools** for urban innovation
  - **Lecture 8 – winners and losers** in urban innovation
  - **Lecture 9 – possible futures** for urban innovation systems

Part 1: overview

Defining innovation

- **Innovation is a multi-stage process:** ideas generation + commercialisation into products, services + diffusion in society (Fagerberg 2005)

- **Innovation involves many actors.** Firms, entrepreneurs and inventors are central to innovation, but other institutions, regulations and norms also shape innovative activity

- **Some ideas matter more than others. Key class of ideas = General Purpose Technologies.** Very widely used. Building blocks = enable other innovation (Bresnahan 2010)

General Purpose Technologies

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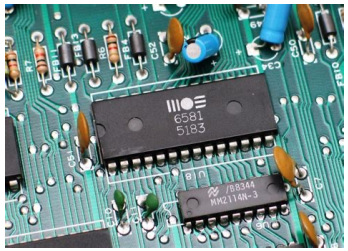

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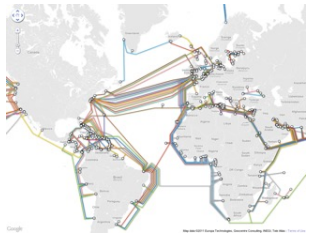

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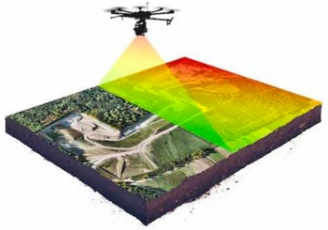
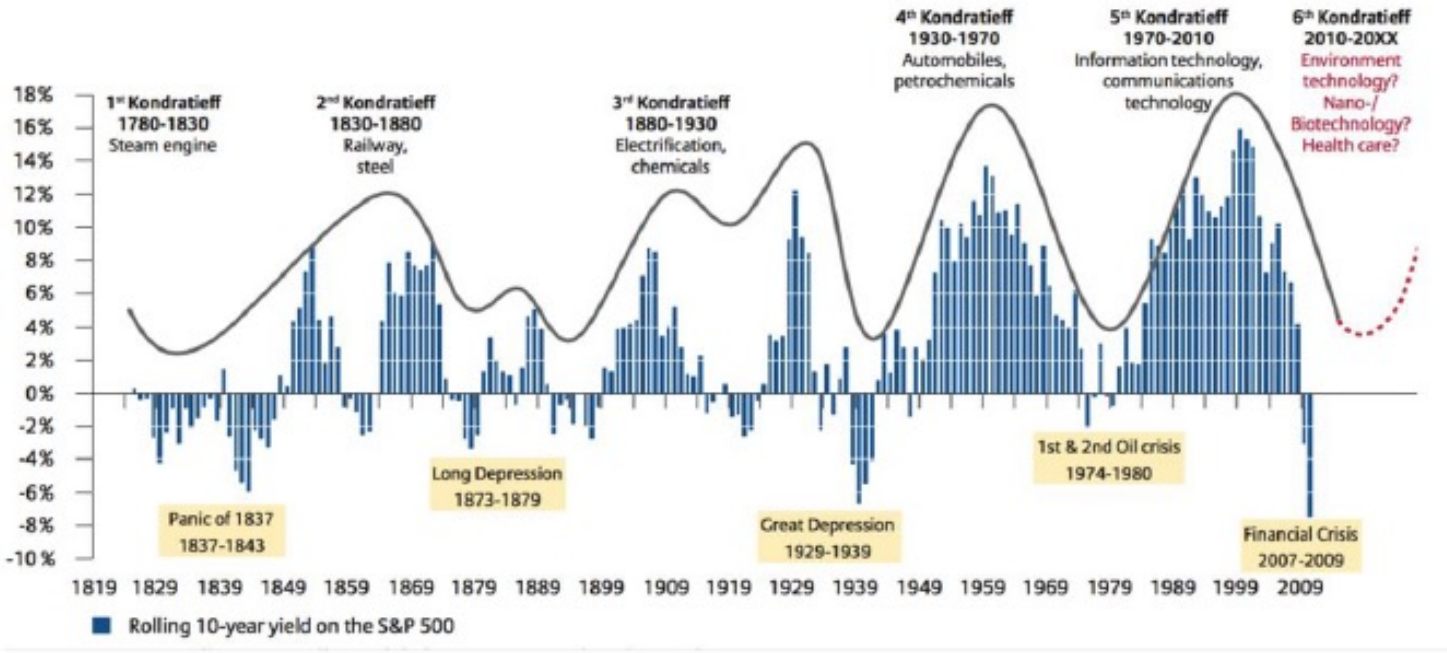


=> “Smart City”

https://en.wikipedia.org/wiki/General-purpose_technology

Innovation and growth



- Innovation drives ‘long waves’ of economic growth (Kondratieff 1925)
- Technological revolutions (Perez 2010)
  - **S-curves** as the tech is deployed, becomes mature
  - **Technology system** emerges around it [organisation / industry / policy shifts]
  - Shifts in systems = **revolutions**
  - New **paradigms** emerge – importance of visions, key actors in shaping these

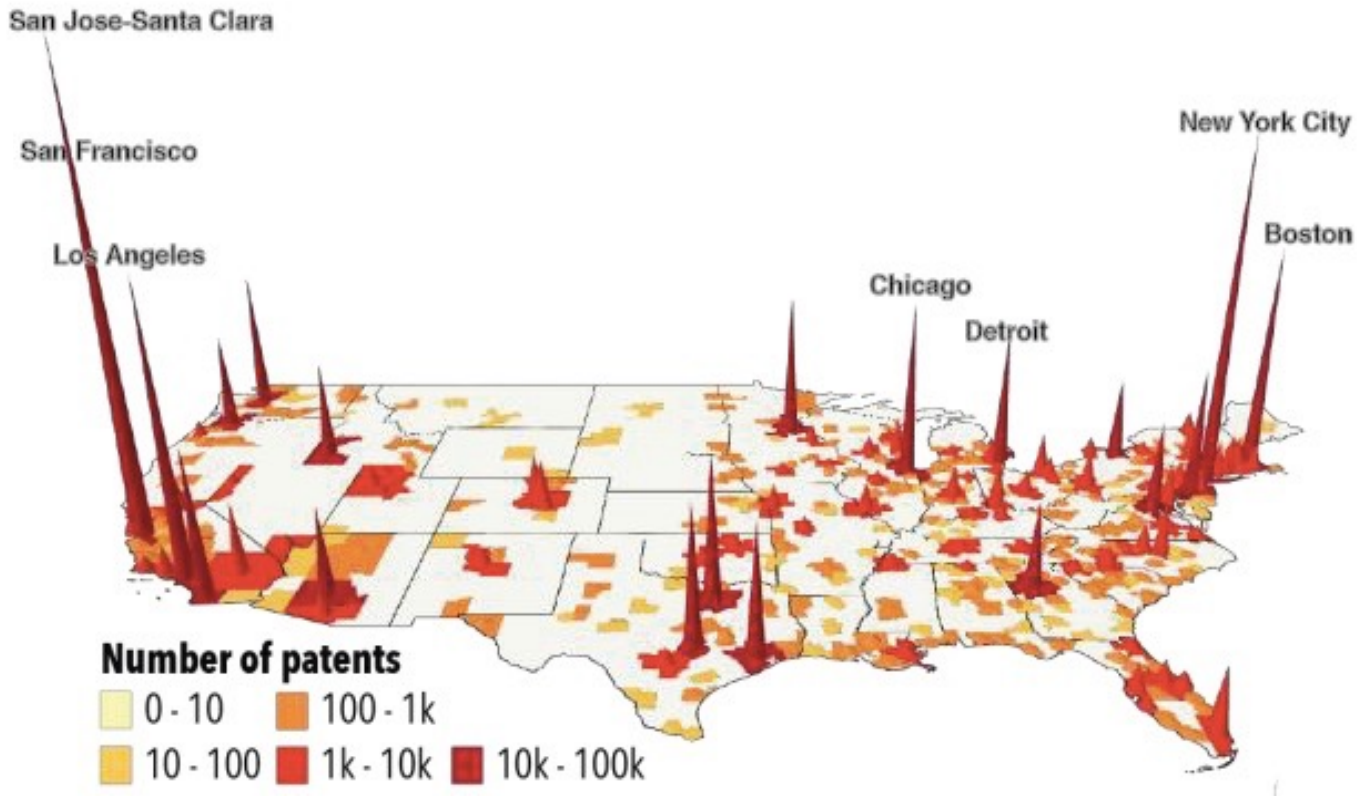
Innovation and growth

- **Schumpeterian view** – innovation drives growth through ”creative destruction”
  - Winners and losers when new products/services go on the market
  - Entrepreneurs [startups!] are carriers of new ideas (Schumpeter 1939)
  - Q; an essentially random process? Or can policy shape it?

- **Endogenous growth theory** – human capital + research drives growth, through generation and diffusion of new ideas
  - As firms innovate, they become more productive
  - Other firms learn from this; knowledge ‘spills over’ => growth
  - This allows further investment in R&D, education, etc (Romer 1990)
  - Clearer roles for public policy

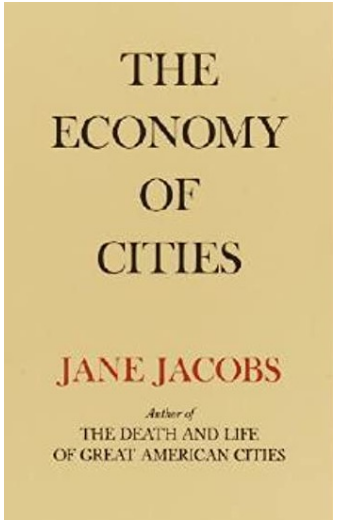
Innovation and cities

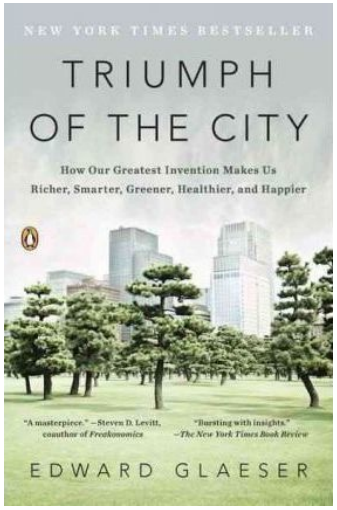
- Innovation is highly urbanised (Balland et al 2020). City leaders often seek to use this as a lever for growth



Innovation, growth and cities

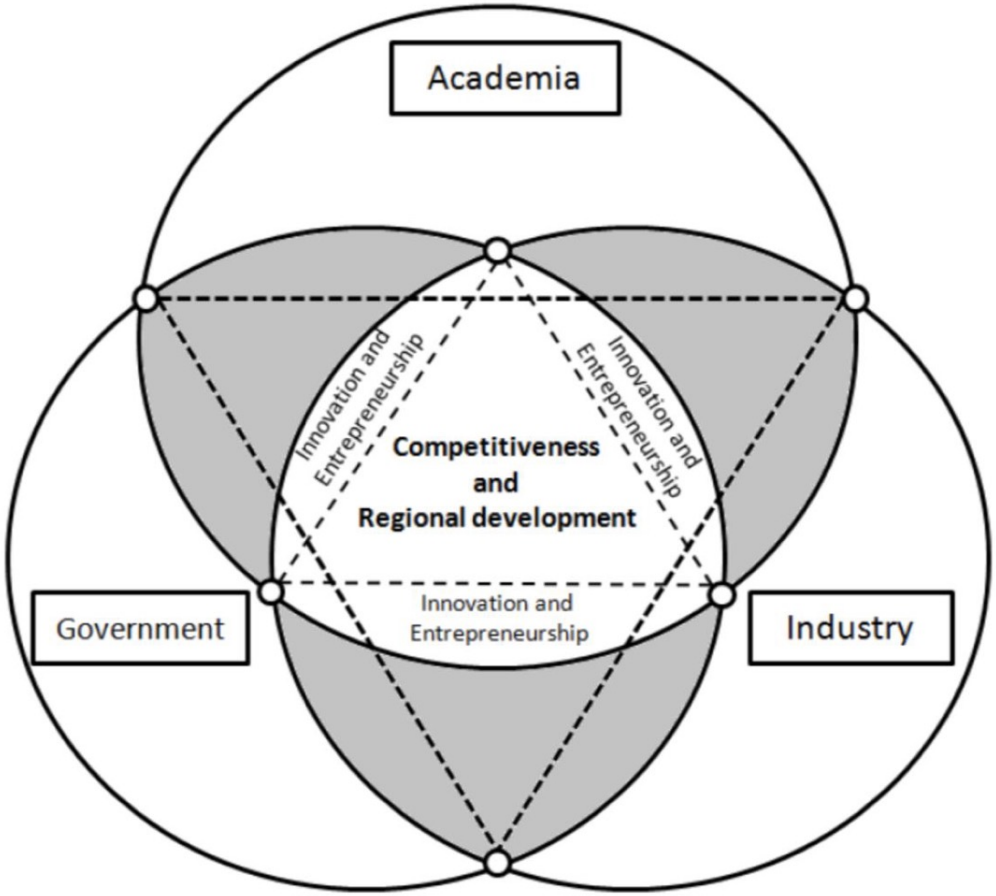
- **Urban economics describes the 'microfoundations**': that is, the underlying processes that support innovation
- **Key idea = cities help firms and workers become more productive**. 'Agglomeration economies' make this happen
- This helps drive urban *and national* innovation, entrepreneurship and growth
- These ideas also underpin **urban systems** and **urban scaling frameworks**





Innovation, growth and cities II

- Remember: innovation isn't just what firms do!
- **Innovation systems takes a broader view, emphasising the role of public sector actors**
  - It's the Triple Helix again
  - Universities, research labs
  - Urban, national government
  - Public~private sector links



Source: Farinha & Ferreira (2012)

Part 2: theory + evidence

Theory: urban economics

- **Key idea = cities help firms and workers become more productive**. 'Agglomeration economies' make this happen
- Duranton and Puga (2004) divide these into three types
  - **Sharing** – benefits of shared infrastructure, e.g. public transport
  - **Matching** – deep labour markets help workers and firms find the best job / people at any point
  - **Learning** – generating new ideas, learning from others
- **Production side**: cities connect people; help them observe, learn from each other
- **Consumption side**: urban scale supports a rich set of products, services, experiences

Evidence: cities and innovation

- Innovation is higher in cities (Carlino & Kerr 2015, Storper & Venables 2004)
- Doubling the jobs density in a city raises patenting/head by 22% (Carlino et al 2007)
- Most innovation happens outside city centres …
- But dense cores are more important for unconventional ideas (Berkes & Gaetani 2020)

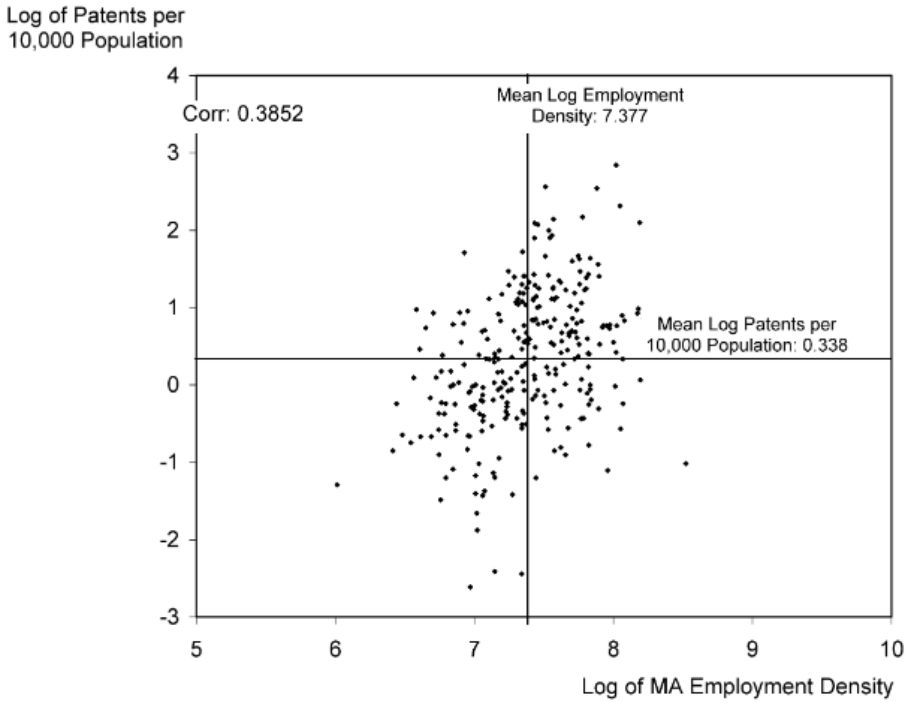
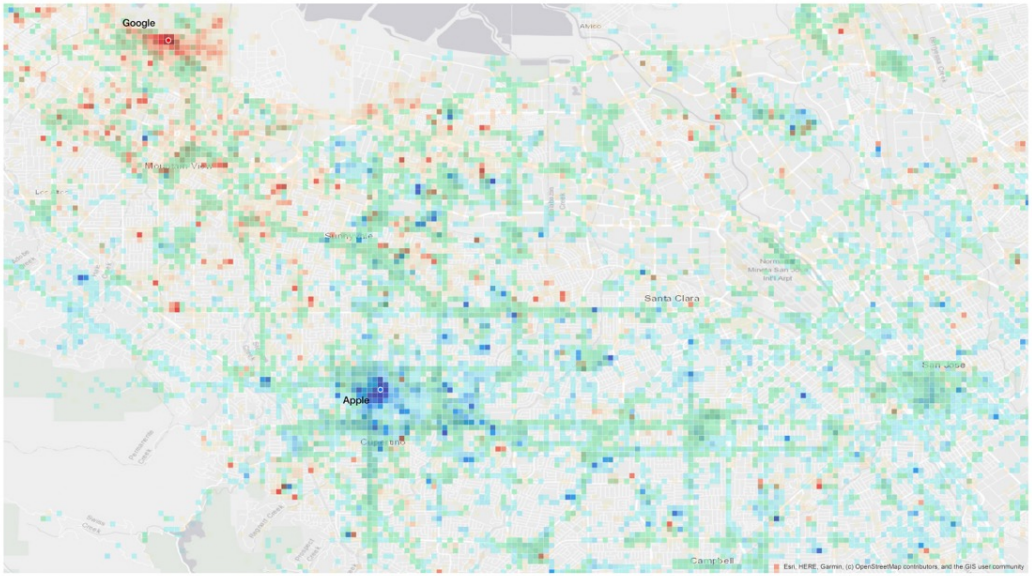


Fig. 2. Patents per capita & MA employment density.

Carlino et al 2007

Evidence: which bits of cities?

- **Spillovers can be highly localised**
- Historically, face to face interaction has been fundamental to urban innovation (Crookston & Reades 2021)
- Silicon Valley: meetings between workers at nearby firms raise knowledge spillovers between those firms (Atkin et al 2022)



Notes: Figure shows overlays of pings for workers at Google headquarters (marked with a red circle) and Apple headquarters (marked with a blue circle). Green denote overlapping pings, darker shades show the number of pings.

Atkin, Chen, Popov 2022

Evidence: which bits of cities?

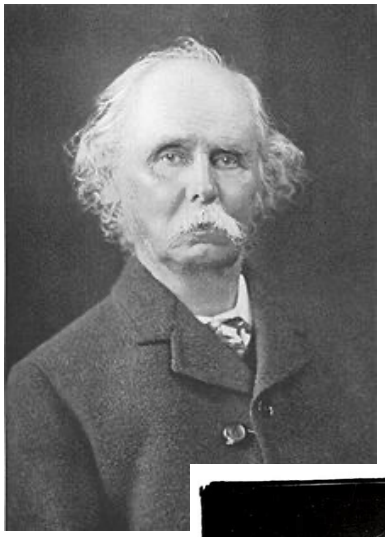
- **Spillovers can be highly localised within cities**
- So, how might we help people meet, exchange ideas, observe each other, collaborate … ?
  - **Physical infrastructure:** Roche (2020) finds (very) small positive links from walkable streetscapes to patenting
  - **Social infrastructure:** both Roche and Andrews (2019) find that spaces for interaction, e.g. bars and cafes <~> higher patenting
  - **Economic infrastructure:** encouraging co-location and interaction of firms, skilled workers
- More formally, academics talk about **clusters** as local systems for these processes

Clusters

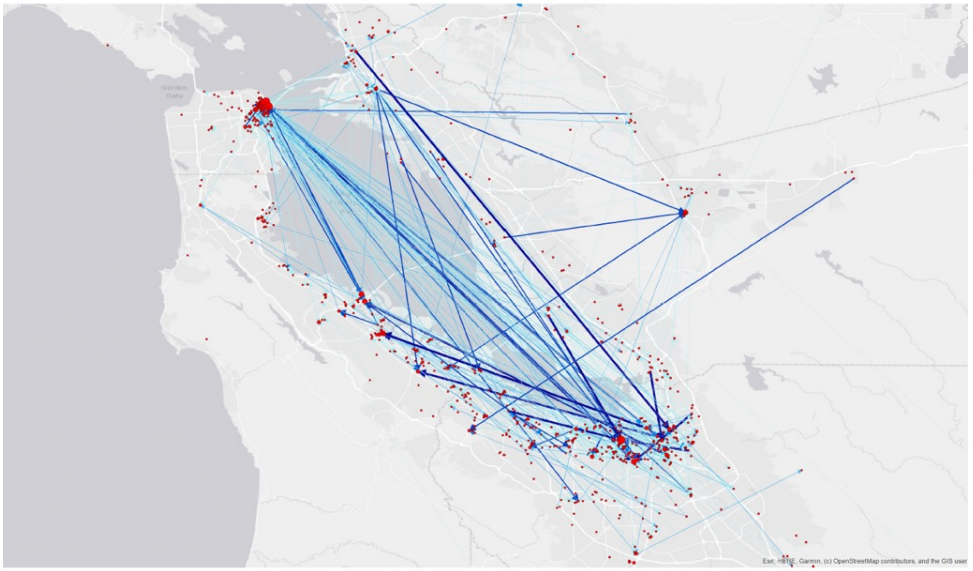
- Key idea: **colocation, interaction and collaboration by firms in cities** fosters innovation, growth (Marshall 1918)

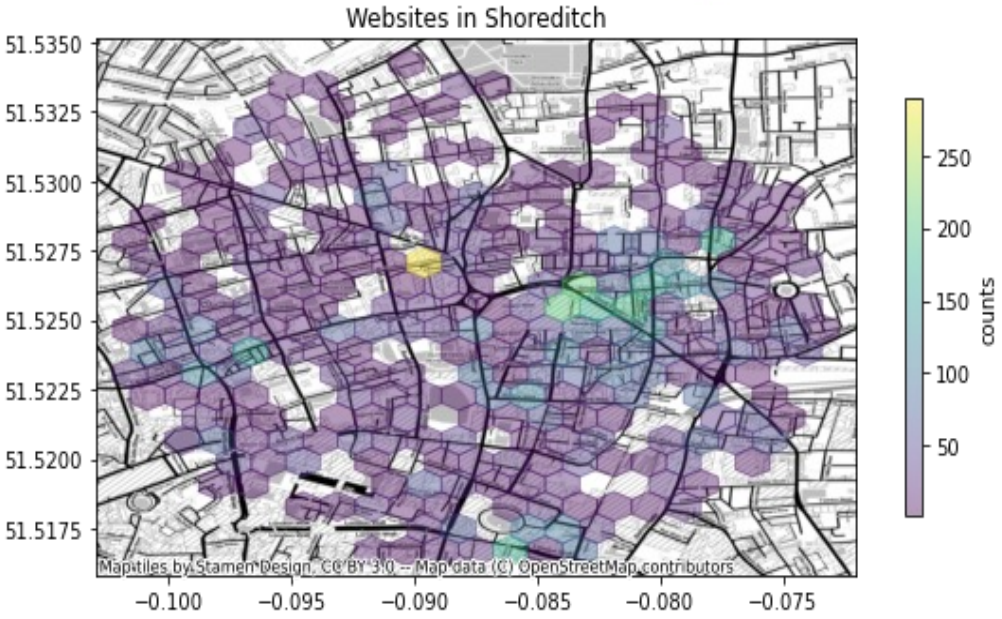
- In the jargon, ‘industrial production districts’ or ‘milieux’ in cities

  - **Clusters may involve firms in the same industry** (Marshall)
  - **… or involve knowledge spillovers across industry** (Jacobs, 1969)



Clustering at different scales





Top: Patenting in Silicon Valley, Atkin, Chen, Popov 2022. 50-mile distance ring around Stanford University

Bottom: Micro-clustering in East London, Stich, Tranos, Nathan 2022. Geolocated websites, 1km distance ring

(c) Max Nathan

Evidence: what kinds of interaction?

We looked at lots of places, and there were a couple of companies in this area already, and we moved here because the other companies were here. And you know … the first weekend we were here we went out and got some sandwiches and sat in the park … and I ran into some friends who worked at [redacted]. And that was, you know we talked about some possible ways we could work together … . (F3)

Nathan, Vandore, Voss 2019

- Many types of interaction going on here!
  - Planned and chance interaction
  - Rich interaction [exchanging detailed / tacit information]
  - Interaction in the same industry space [vs different industries]
  - Interaction with people you already know [vs people you don't]
- Lots of questions about which of these matter more?

Diversity or specialisation?

- **Both! But evidence tells us industrial diversity is especially important for urban innovation** (Glaeser 2011)

- **Why? Learning across (more or less related) industries**
  - **Social media** <= technology + communication + media
  - **Fintech** <= finance + technology + security + crypto
  - **Cleantech** <= energy + environment + technology

- **Why? It helps insulate cities against shocks**
  - Example = a major employer closes down, or 'jumps' production to another country => lots of other types of activity and work available

Theory: innovation systems

- **So far, we've focused on what firms and workers do**

- Innovation system = 'the set of institutions directly concerned with scientific and technical activities' (Freeman 1991)
- In practice, these systems may be sub-national

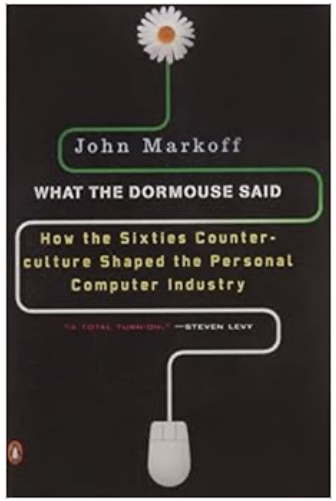
- **Regional innovation (eco)system** (Cooke et al 1997)
  - Productive system = what firms do
  - Financial system = private and public support for R&D
  - State system = budgets, policy levers, ability to use them
  - Social system = how actors interact, learn from each other
  - Institutional structure – tacit conventions, formal rules of the game

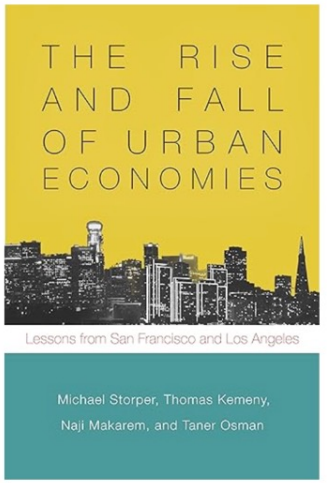
Example: Silicon Valley

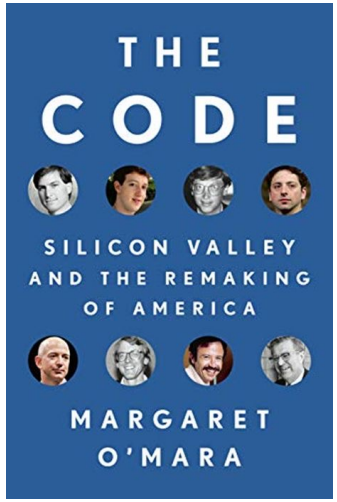
- **Most important tech cluster in the world?** Many places and policymakers want to build ‘the next Silicon Valley’
- **Four core phases of development, with ‘branching’ from sets of related technologies**
  - **Transistors, 1950s:** Hewlett Packard, Fairchild
  - **Integrated circuits, 1960s-70s:** Intel, AMD
  - **Personal computing, 1970s-90s:** Xerox PARC, Apple, Adobe
  - **Web and social media, 1990s-10s:** Alphabet, Meta, Twitter/X
- **Broader diversification** from IT into software, web/social media, plus life sciences, biotech and ‘cleantech’

Example: Silicon Valley

- **Key socio-economic features** (Markoff 2006, O'Mara, 2020; Storper et al, 2015; Atkin et al, 2022)
  - **Startup culture:** rapid company formation, serial entrepreneurs
  - **Very large VC system:** allows vast scaling without profit
  - **Networking:** informal, intensive. Importance of informal / chance interactions in shaping knowledge flows
  - **Culture:** utopian / anarchist / libertarian
  - But also …

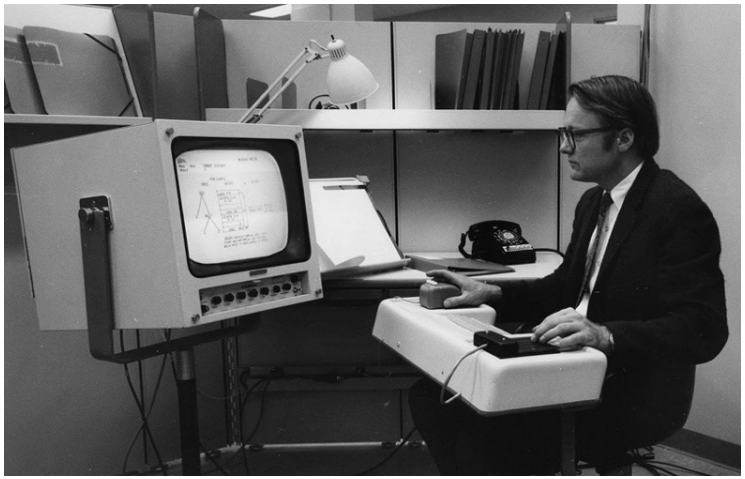






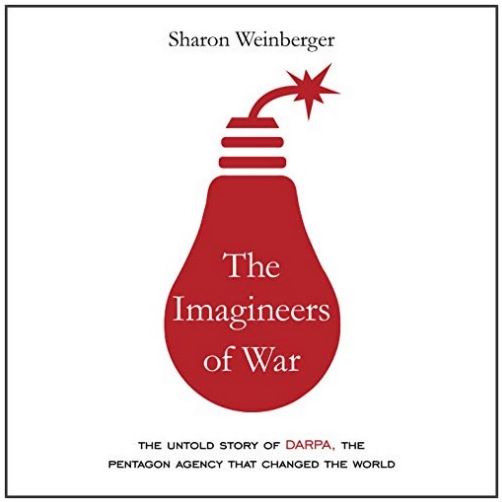
Example: Silicon Valley

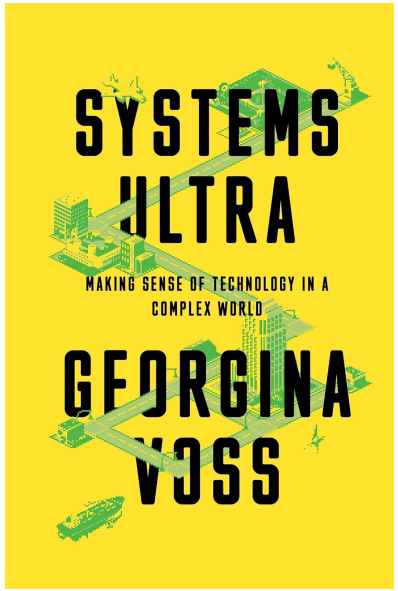
- Ecosystem with a **'hidden developmental state'** (Block, 2008)
- **University researchers, often funded by Government**
  - Fred Terman founds Stanford Research Park in 1951
  - 'Mother of all demos' by Doug Engelbart at SRI in 1968
  - Stanford grads found Hewlett-Packard (1939), Google (1998)



Example: Silicon Valley

- Ecosystem with a **'hidden developmental state'** (Block, 2008)
- **Military-industrial complex**
  - Deep roots: Bay Area naval base and shipyards (Voss, 2024)
  - GPTs: radar, transistors, circuits
  - Public sector as lead client: Fairchild, Lockheed, DARPA (Weinberger 2017)
  - Come back to this in Lecture 7!

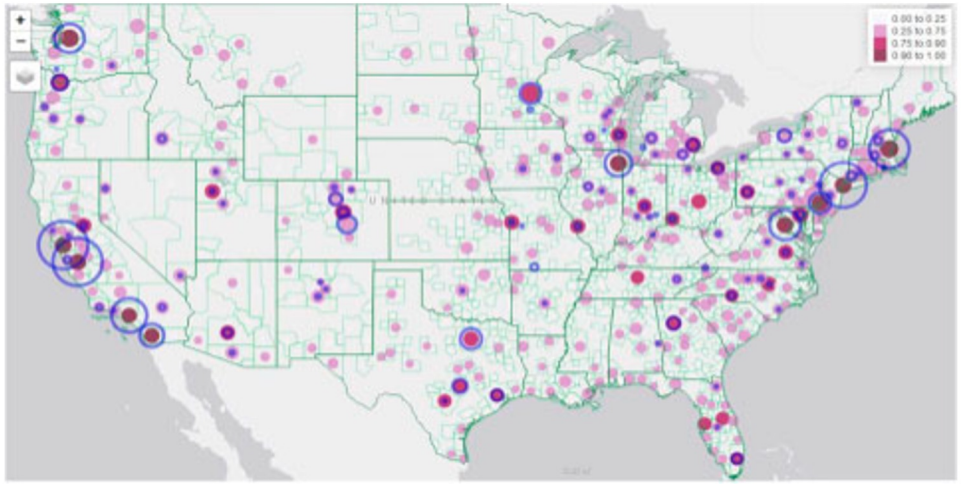


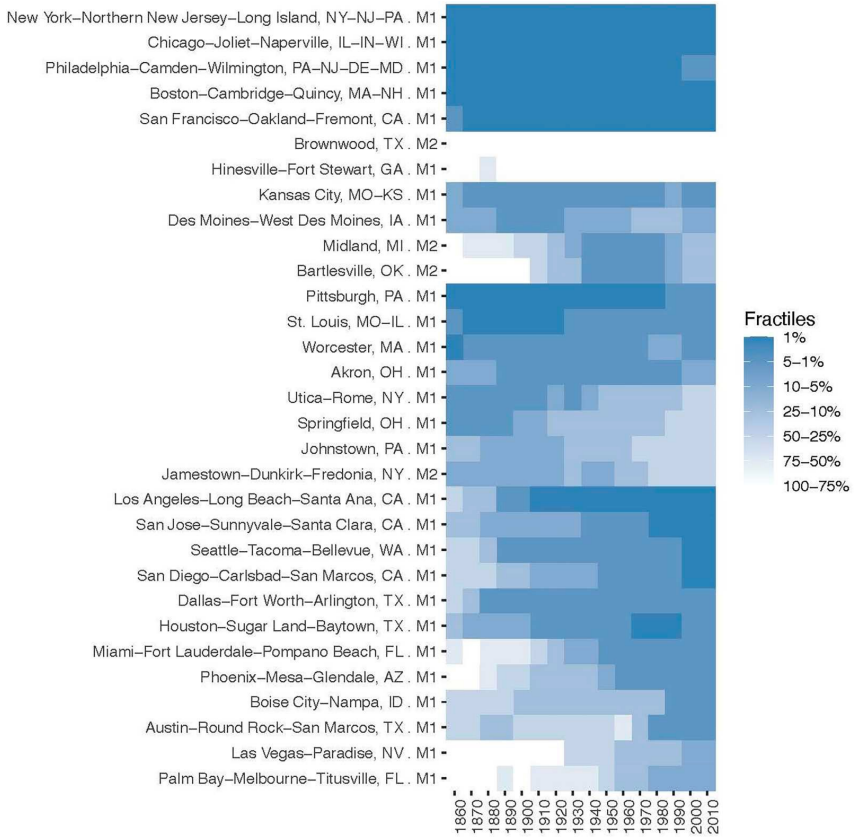


Big questions

Can places catch up?

- **Lecture 7:** what can policy do to promote catch-up/diffusion?



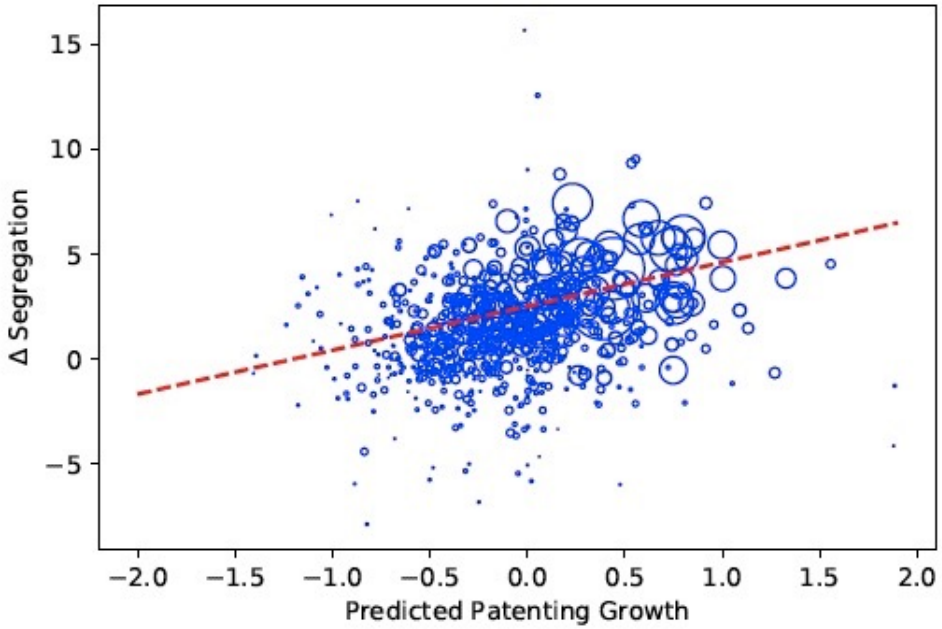


Left: New tech locations (blue) and related job vacancies, 21-30 years later (red)
Right: Local patenting trajectories 1860-2010

Sources: Kalyani et al 2025, Crespo & Peiró-Palomino 2025

Who wins, who loses?

- Disparities in innovation + wealth *between* and *within* places
- **Lecture 8:** are more innovative places more unequal? How do Big Tech firms play into this? (Zukin 2020, Berkes & Gaetani 2021)



Predicted patenting growth vs. change in neighbourhood income segregation, 1990-2010, US Commuting Zones. Weights = 1990 households.

Source: Berkes & Gaetani 2023

Will innovation stay urbanised?

- The ‘end of cities’ has been predicted more than once …
- … Big cities are resilient to macro shocks (Nathan and Overman 2020, Glaeser 2022)

- **What kinds of change might threaten big cities’ position?**
  - Health: future pandemics
  - Climate: most major cities are low-lying / coastal
  - Social: urbanised inequality + political blowback?
  - Economic: shift to hybrid working, consumption?
  - Technological: waves of automation?

- **We’ll come back to this in Lecture 9**

Summary

- Innovation = invention + commercialisation + diffusion
- Not just something firms do!

- Consensus on importance of innovation to long term economic growth – Schumpeterian view, Endogenous Growth Theory view
- General Purpose Technologies are building blocks in this innovation~growth process … and underneath a lot of core smart city technologies

- Consensus on the importance of urban areas in supporting innovation
- So, innovation helps produce the tools and infrastructures for Smart Cities

- Differences of opinion about how this happens – urban economics vs innovation systems
- Case studies suggest both perspectives have something to tell us

Summary

- Cities have been very resilient to past technological, economic or environmental shocks
- But I wouldn't want to put money on that being forever the case

- Three big questions for us to think about:

- Innovations diffuse, but clustering is also persistent. Can places catch up, and what can policymakers do?
- Who are the winners and losers from urbanised innovation? What are the challenges and tradeoffs facing policymakers and communities?
- Will innovation stay urbanised – and what might shift that?

- We'll discuss these issues in the coming weeks!

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