

Agglomeration Near and Far: San Francisco and Los Angeles Metropolitan Areas

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Abstract: People (and businesses) in cities want two things, access and space. This presents difficult trade-offs. There are many circumstances and many trade-offs and many resulting choices. This explains commuting near as well as far. When it comes to the spatial arrangements prompted by agglomerative forces, less is known. Despite the label, the many suggestions concerning “clustering” strategies are unclear on suggested spatial layouts. This research relies on firm-level location data for the Los Angeles and San Francisco areas for selected industries and plant sizes. We find that there is agglomeration *near as well as far*—no matter the region, the industry or the plant size. “Clustering” strategies and discussions must be wary of suggesting (as the name seems to imply) tightly packed spatial arrangements. That is too simple.

Keywords: Spatial agglomeration, clustering, co-location of firms

1. INTRODUCTION

The basic ideas of this paper are straightforward. They are (1) sustained economic growth is a fundamental¹ objective; (2) economic growth requires innovation; (3) among the prerequisites for innovation are opportunities for interacting and exchanging ideas; (4) interaction opportunities involve a spatial settlement dimension. In short, our astonishing well-offness has, in large part, a spatial explanation. Just as supply chains are emergent, so are their spatial configurations.

Beyond this, things are less clear. Agglomeration economies are part of the story and it is agreed that they have a spatial dimension. Is there such a thing as a preferred spatial arrangement? There is much talk about the importance of “clusters”² and “density” but specifics, degree of dimensionality, layout, are left unclear. Map 1 shows the locations of software establishments in the San Francisco Bay area. Whereas there is much discussion of Silicon Valley, it appears that these firms are all over the Bay Area—at all sorts of densities. There are also numerous assertions about “sprawl” and “urban containment” but these too are often vague and/or contentious. Most of them are also too broad brush.

Human design capabilities have limits. Designers (subject to competitive forces) create all of the products we can

put our hands on, even the buildings and facilities that house all these items. Designers have also tried their hand suggesting the best layout of major facilities, including commercial and industrial centers. But there are limits to what human design can accomplish. Scaling-up capabilities only go so far. Jane Jacobs told her readers that “a city cannot be a work of art.” Monumental buildings have been important for a long time. But at some scale, human action, not human design, takes over. *Emergent orders*—those based on voluntary interactions—denote the arrangements that result. Beyond some threshold, knowledge is so complex and so dispersed that trial-and-error learning (usually best in a competitive setting, with inevitable errors made along the way) is the only way to bring about beneficial designs and outcomes.

There are many examples. The ones most widely cited are language, science, common law, art, and culture. Cities also. Jane Jacobs had famously noted that neighborhoods and cities are also examples of what sounds like an emergent order. In her words, “Their intricate order—a manifestation of the freedom of countless numbers of people to make and carry out countless plans—is in many ways a wonder” (Jacobs 1961).³ Agglomeration opportunities are *realized* if spatial arrangements congenial to entrepreneurial trial-and-error are permitted. This requires that a degree of open-endedness is allowed by land use planners.^{4 5}

Everyone tries to make the best of the situation they face. Everyone plans. Large numbers of individual plans coalesce into orders that may *appear* to be somehow fashioned top-down but, following Jacobs, we now know that such top-down success is an impossible dream. Anyone can see Jacobs’ “intricate order” but what do they make of it? Looking down at a city from an airplane, we claim, one looks down on the spatial layout of a large number of overlapping supply chains, *including supply chains for things and supply chains for ideas*. Where does any supply chain begin? With a chain of ideas.

Can we clarify agglomeration (and cities) by probing the meaning and importance of supply chains? Arnold Kling has argued that the idea of production functions is superseded by “paths of production.” New things and new ideas feed and enhance each other. Carter (1989) has touched on a similar idea. When there is production, there is very likely to be information exchange and learning.

Ronald Coase famously observed that plant managers decide what to make vs. what to buy. They must also decide what to buy (and sell) *where*. Supply chains have a spatial layout. Consider that everyone in cities, people or businesses, wants two things: space and accessibility(ies). This describes the choice problem faced by all locators as well as the mediation problem that we expect land markets to handle. Add to all of this the important fact that most locators participate in supply chains for things as well as supply chains for ideas. We each make it our business to seek and find *useful* knowledge⁶—useful to our enterprise or our mission. The use and application of the knowledge is likely to add value to it. It can even provide first-mover advantage and, thereby partial excludability. “Partial excludability is a beautiful thing”.⁷

There is purposeful entrepreneurial search and action on the demand side along with reputational (and other) rewards on the supply side. These observations challenge the textbook concerns over free-riding on ideas that are simply “in the air.”⁸

Supply chains for ideas can involve physical access as well as electronic access. Many people work remotely some of the time as well as at a workplace. Most of us are keen to find the *blend* of access modes that works for our enterprise or project. Death-of-distance dreams were premature. Establishing and maintaining trust relationships requires some physical presence. “The problem with the internet is that he cannot look her in the eye through a screen, and she cannot ‘feel’ or ‘touch’ him. It is a medium that may help to sustain relationships, but it does not establish deep and complex contacts” (Leamer and Storper 2001). Social capital is enhanced along with other capital. Trust and cooperate (trade) and prosper.

Access, reduced access costs, distance and place enter this discussion. Knowledge is exchanged for money (or for other tangible rewards) *via carefully cultivated networks*. Within these, reputations for careful and truthful attribution are established, honed, and maintained. This applies especially to non-codified (tacit and also not easily patented) knowledge which may require extended conversations, even face-to-face interaction, acquaintanceship and geographic proximity. Knowledge involves learning. Learning is hard. Conversation establishes context which can make all the difference.⁹

Networking is a popular idea but is *fashioning and managing supply chains for ideas* more apt (Figure 1)? We know that new ideas are new combinations of old ideas. This refers to forming new neural connections in our cortex, the “aha” moments.¹⁰ The number of possible combinations is uncountable but as our brains become embedded and part of a networked network, as we network with others, the combinatorial possibilities expand dramatically. Intelligence expands dramatically. The bigger the network, the better. We can describe innovation and the benefits of accessibility, connectivity and agglomeration in this way.

2. THIS RESEARCH

Spatial agglomerations have been explained via a variety of impulses. There are plausibly gains from locating near firms of the same industry (specialization; Marshall, 1890); there are also plausible gains from locating near firms that represent complementary (diversification opportunities; Jacobs, 1969) sectors. Are the worthy spillover ideas the ones that are highly specific and specialized? Or not? There is no simple answer. Complementarities can reach across sectors and disciplines.

There are also likely gains from the sheer nearby availability of possible substitutes if/when existing relationships of any sort are disrupted or deemed inadequate. Locating near diverse labor pools confers similar benefits—for the present or the uncertain future.

We studied the co-location of firms for selected industries in the San Francisco and Los Angeles metropolitan areas.¹¹ The sectors chosen represented entertainment (NAICS 512: Southern California’s presumed current growth engine); various sectors that represent “tech” and engineering (the Bay Area’s growth engine NAICS 4147); a combined information sector including computer programming, software, and information retrieval services (NAICSS 541511, 511210, 517210, 517919); a finance sector that presumably includes venture capital groups (NAICS 523910); a large technology-based manufacturing sector that includes 43 (six-digit NAICS) sectors.¹² These are sectors that presumably have good reasons to “cluster.”

Ideas and capital have a natural synergy; either one without the other is almost useless. We should emphasize *people* with capital and ideas. *Nearby* venture capital people and firms accentuate the complementarity by being available to mentor as the young firm develops.

We also combined all five of our sectors into one. Table 1 presents summary data on these sectors. Maps 2a -2d show firm locations in the two regions.

A recent study that also compared these two regions is by Storper, et al (2016). These authors tried to explain how and why the Bay Area outpaced LA’s growth in recent years. They focused on what they saw as better regional coordination by major actors. But it may be simpler. The Bay Area includes the world’s premier “tech” center. Moreover, the dominance of Silicon Valley has been shown to have had little to do with top-down regional planning choices (Saxenian, 1998). Both, the Los Angeles and San Francisco metropolitan areas, have had most of their development at the outer edges for many years.¹³

We began by looking at the pairwise co-locations of firms, here defined as observed correlations of jobs at the census block group level.¹⁴ There were 8,248 and 3,978 CBGs in the Los Angeles and Bay Area regions, respectively. “A Census Block Group is a geographical unit used by the United States Census Bureau which is between the Census Tract and the Census Block. It is the smallest geographical unit for which the bureau publishes sample data, i.e. data which is only collected from a fraction of all households. Typically, Block Groups have a population of 600 to 3,000 people.” (U.S. Census Bureau, 2018). Writers prefer to remain open as to the dimensions of a “cluster” (see, for example, Cortright, 2006 p.6). But the word can easily lose its meaning and usefulness. The clear implication of the term, however, denotes fairly proximate spatial arrangements. “Clustering” advocates usually make clear their desires for high densities. Our empirical tests start with the question of whether CBGs are meaningful “clusters” of firms. We will henceforth use observed co-locations in place of vaguely defined “clusters.”

Our first step was to test the extent to which the observed pairwise co-locations are explained by sales and purchase coefficients from U.S. input-output models.¹⁵ Regional scientists have looked to input-output relationships to form the basis for planning strategies. Hirschman (1958) saw production linkages as the

basis of a development strategy.¹⁶ Actual (and conceivably potential) backward- and/or forward- linkages among the rows or columns of input-output models would guide planners in their search for appropriate industries to try and attract. We tested whether U.S. input-output coefficients can explain variation in the observed co-location correlations.

Four regression results are shown in Tables 2a-2d. We expected that greater sales or purchases between any pair or sectors would favor more proximate locations. The two estimated coefficients are indeed significant with the correct positive signs in three of them. But in all four regressions, the proportion of dependent variable variation (for co-locations at this level of spatial detail) explained via industrial linkages was very low, usually less than two percent. Note that this test involves the level of spatial detail often suggested by clustering strategy advocates. Our candidate for other explanations for observed co-location and agglomeration is the importance of information exchange. Depending on the nature of the exchange, this activity can involve co-location near or far. Near and far commuting is well known (Figure 2). Recall that the big cities continue to grow mostly by spreading outward.¹⁷ This is how urban scale diseconomies have been avoided; there continue to be *net* growth advantages via the discovery of propitious urban spread—which many deride as “sprawl.” It suggests we also have near and far agglomeration. There are a variety of interaction opportunities and accommodations to a variety of situations. They need not involve *close* or nearby co-location.

3. FINDINGS

Our data on firms and jobs by sector, location, and size of firms enabled us to estimate Ripley’s K-functions (Dixon 2002) for our five sectors in each of the two regions. There were separate estimations for all firms as well as the largest firms. The Ripley’s K plots are shown in Appendix 2.

In this research, we try to learn from the spatial arrangements that we see on the ground. To avoid the problems of identifying centers and subcenters—and leaving out all the other jobs—we relied on the Ripley’s K-functions estimated on location data for *all* the firms. To give “clustering” some meaning, we investigated the degree and extent of observed co-location of firms via Ripley’s K-function results.

The estimation results denote the extent to which *encountering another firm of the same (or designated) sector is greater than random, as distances between designated (same-sector or other-sector) firms increase*. The algorithm considers ever larger concentric rings around all firms. As the circles get bigger, the odds of encountering a designated-sector firm grow. Are the actual encounters greater-than-random? Greater-than-random is denoted by displacement of the estimated function above the 45-degree line. Our Ripley’s K estimation results are summarized in Table 3. The estimated functions are shown in Appendix 2. The plots Observed K represent the observed pattern of co-locating or dispersion. The plots Expected K which are the 45-degree lines represents a random spatial pattern. When an Observed K value is larger than the Expected K value for a particular distance, the distribution denotes more co-locating than a random distribution at that inter-firm distance. When the Observed K value is smaller than the Expected K, the distribution is more dispersed than a random distribution—at that inter-firm distance. LwConfEnv and HiConfEnv represent lower confidence and higher confidence envelopes, respectively. When the Observed K value is larger than the HiConfEnv value, spatial co-locating for that distance is statistically significant. When the Observed K value is smaller than the LwConfEnv value, spatial dispersion for that distance is statistically significant (ArcGIS Pro 2017).

The Ripley’s K estimations help us address this question: as distances between (designated sector) firms increase, are the odds of encountering a co-locating firm greater than random? Are estimated Ripley’s K functions above the rising 45-degree plot? A rising 45-degree line shows the expected increasing odds of an encounter with co-locating firms as distances from sector firms increase. Are the actual encounters greater than random? Measuring the areas of the bulge above the 45-degree line summarizes all this.

Table 3 reports the results. All of the percentages are above zero indicating strong co-location. Note that the plots are all outside the 95-percent confidence bands. For all of the 24 estimations, we see this type of “clustering” all the way to distances about equal to edge of observed plant locations (30-40 km), almost equal to the distances to the edges of major settlement. Consider also that these co-location distances are much greater than, say, the 5km edge of a large downtown cluster. We find this for both regions, all five sectors, all plant sizes. In most cases, less co-locating by the largest (perhaps more independent) firms.

According to bulges above the 45-degree line, most clustering is among LA-area entertainment firms (Row 1)—where smiles and handshakes matter most. In both regions, there are least clustering among computer programming (Row 4) firms—where considerable electronic data exchange most likely. Row 2 involves more “tech” firms; the results are broadly similar for the two regions, with less clustering for the largest firms—that are expected to be less dependent on outside help. Row 3, venture capital firms shows the same type of clustering, but the largest firms cluster more. The biggest regional differences are for the largest sector studied (Row 5). This may be the outlier. Combining all five sectors (Row 6) shows that overall spatial layouts are remarkably similar in the two regions.

The final row refers to the sector that combines data for all the sectors studied. These results address co-locating across sectors. As the Jacobs hypothesis suggests, there is *not* less “clustering” when we go beyond a single industry. Complementary matters. Supply chains can involve many sectors and many specializations.

4. DISCUSSION

“... [A] central paradox of our times is that in cities, industrial agglomerations remain remarkably vital despite ever easier movement of goods and knowledge over space” (Glaeser 2010). We say no paradox. We have shown that there are firm co-locations that suggest agglomeration benefits *near and far*. This makes sense, especially in light of the fact that more than one kind of information is communicated and exchanged, the codified and the tacit. Locators pick a suitable *blend* of interaction channels which helps them select their preferred location-networking choices. Over a half-century ago, Mel Webber noted “community without propinquity.” Even in pre-internet days, he saw that people chose to link in a variety of ways. The choices that individuals make in their personal spheres obviate the many grand plans, including the many “cluster strategies.” Networking has seemingly edged out hierarchy.¹⁸

The co-location of workers and employers is well known. Employers as well as employees have an interest in avoiding high commuting costs.¹⁹ Firms, likewise, have reasons to be strategic about choosing a location vis a vis other firms. We have tried to be more precise than simply alluding to “density”, “clustering”, “agglomerating.” We have argued and shown that co-location by firms near as well as far makes sense and, in fact, happens. “Local brain drain” refers to spin-offs, a widespread phenomenon in the tech sectors.²⁰ The progeny often locate relatively nearby where they know people and places. Nearby as in the same metropolis (Map 1) can mean agglomeration near or far, but not too far. Distributions derived from gravity models explain commuting near and far; they probably apply to all human interactions near and far, including those involved in the exchange of goods and ideas, but to various degrees.

Cities are defined by their peculiar land use arrangements. These are emergent even though constrained by topography, history, and development rules. The city will only grow and prosper (and contribute to general human advancement) if the emergent spatial patterns are congenial to the formation and functioning of very large numbers of supply chains—for goods as well as for ideas. “Emergent” is quite distinct from the many discussions focused on “cluster strategies.” “Efficient” may be a fraught term but economic growth is clear enough.

REFERENCES

- Angel, Shlomo, Jason Parent, Daniel L. Civco, and Alejandro M. Blei. 2011. The Persistent Decline in Urban Densities: Global and Historical Evidence of Sprawl. Working Paper WP10SA1, Lincoln Institute, Cambridge, MA.
- ArcGIS Pro. n.d.. Retrieved August 25, 2017, from <http://pro.arcgis.com/en/pro-app/tool-reference/spatial-statistics/multi-distance-spatial-cluster-analysis.htm>
- Anas, Alex. 2012. Discovering the efficiency of urban sprawl. In: *The Oxford Handbook of Urban Economics and Planning*, eds. N. Brooks, K. Donaghy, and G. J. Knaap. New York: Oxford University Press.
- Carter, A. P. 1989. Knowhow Trading As Economic Exchange. *Research Policy*. 18:3:155-163.
- Cortright, J. 2006. *Making Sense of Clusters: Regional Competitiveness and Economic Development*. Washington, D.C.: The Brookings Institution Metropolitan Policy Program.
- Cowen, Tyler. 2018. *Stubborn Attachments*. San Francisco: Stripe Press.
- Dixon, Philip M. 2002. Ripley's *K* function. In: *Encyclopedia of Environmetrics*, Abdel H. El-Shaarawi and Walter W. Piegorsch (eds.) Chichester: Wiley, pp. 1796-1803.
- Glaeser, Edward. 2010. Introduction, *Agglomeration Economics*, E. Glaeser (ed.) NBER: The University of Chicago Press.
- Gurri, Martin. 2018. *The Revolt of the Public*. San Francisco: Stripe Press.
- Ferguson, Niall. 2018. *The Square and the Tower: Networks and Power, from the Freemasons to Facebook*. New York: Penguin Press.
- Hirschman, Albert. 1958. Interdependence and Industrialization Strategy of economic development. *The Strategy of Economic Development*. New Haven: Yale University Press
- Huggins, Robert and Piers Thompson. 2017. Networks and regional economic development of knowledge ties. *Environment and Planning A*, 1-19.
- Isard, Walter and Eugene W. Schooler. 1959. Industrial Complex Analysis, Agglomeration Economies, and Regional Development. *Journal of Regional Science*, Vol. 1(2): 19-33.
- Jacobs, Jane. 1961. *The Death and Life of American Cities*. New York: Random House.
- _____. 1969. *The Economy of Cities*. New York: Random House.
- Kling, Arnold. 2013. *Memoirs of a Would-be Macroeconomist*. <http://arnoldkling.com/essays/papers/macromemoir.pdf>
- Leamer, Edward E. and Michael Storper. 2001. The Economic Geography of the Internet Age. NBER Working Paper 8450.
- Marshall, Alfred. 1890. *Principles of Economics*. London: Macmillan.
- McAfee, Andrew. 2019. *More from Less*. New York: Scribner.
- McCloskey, Deirdre H. 2019. Hayekian Liberalism Expressed in Speech Made Us Rich and Free. *Journal of Law & Liberty* Vol. No.: pages
- Mokyr, Joel. 2007. The Market for Ideas and the Origins of Economic Growth in Eighteenth Century Europe. *Tijdschrift Voor Sociale en Economische Geshiedenis*, 4.
- Moretti, Enrico. 2012. *The New Geography of Jobs*. New York: Houghton Mifflin Harcourt.
- Paytas, J and D. Berglund. 2004. Technology Industries and Occupations for NAICS Industry Data. Center for Economic Development and State Science & Technology Institute.
- Pollakowski, Henry O. and Susan M. Wachter. 1990. The Effects of Land Use Constraints on Housing Prices. *Land Economics*, 66:3, 315-324.
- Porter, Michael E. 2000. Location, competition, and economic development: Local clusters in a global economy. *Economic Development Quarterly*, 14(1): 15-34.
- Romer, Paul M. 1994. Economic growth and investment in children. *Daedalus* 123(4):141-154
- Rosenthal, Stuart S and William C. Strange. 2004. Evidence on the Nature and Sources of Agglomeration Economies. In: *Handbook of Regional and Urban Economics*, vol 4, pp. 2119-2171.
- Saxenian, A. 1998. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press.
- Storper, M., Thomas Kemeny, Naji P. Makarem, and Taner Osman. 2016. *The Rise and Fall of Urban Economies: Lessons from San Francisco and Los Angeles*. Stanford: Stanford University Press.
- Watson, Peter. 2001. *The Modern Mind*. New York: Harper Collins.
- Webber, M. M. 1963. Order in Diversity: Community without Propinquity. In: *Cities and Space*. L. Wingo (ed.). Baltimore: Johns Hopkins University Press.
- U.S. Census Bureau. 2018. Block Groups for the 2020 Census-Final Criteria, Federal Register, vol. 83, No. 2019.

APPENDIX 1

Comparisons, Two Urbanized Areas (UZAS), 1950-2010

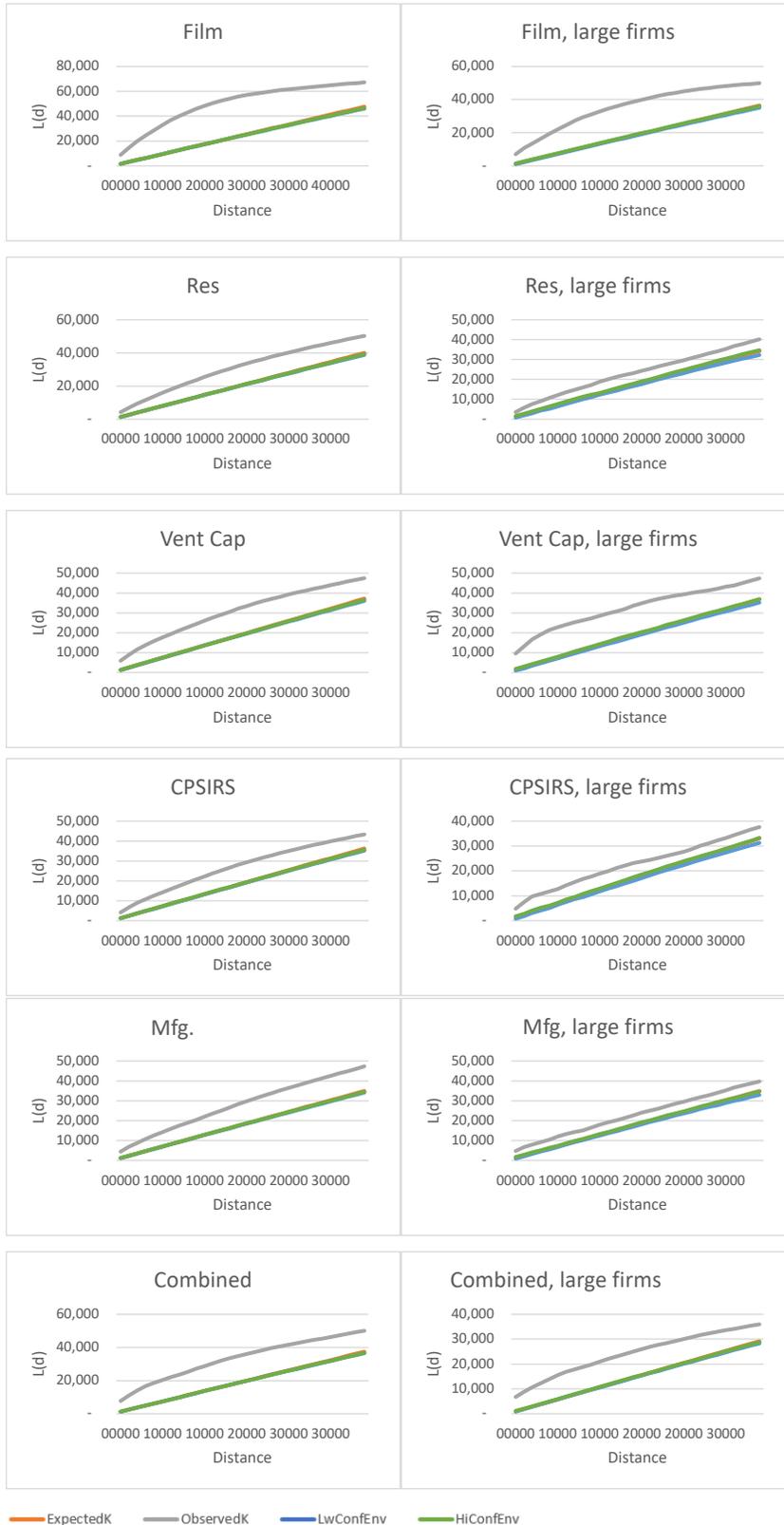
	1950	1960	1970	1980	1990	2000	2010
POPULATION (1,000s)							
Los Angeles, CA	3,997	6,489	8,351	9,479	11,402	11,789	12,151
San Francisco–Oakland, CA	2,022	2,431	2,988	3,191	3,630	3,229	3,281
URBANIZED LAND AREA (sq mi)							
Los Angeles, CA	871	1,370	1,572	1,827	1,966	1,668	1,736
San Francisco–Oakland, CA	287	572	681	796	874	527	524
DENSITY (pop/ sq mi)							
Los Angeles, CA*	4,589	4,736	5,312	5,188	5,800	7,068	6,999
San Francisco–Oakland, CA	7,045	4,250	4,388	4,009	4,153	6,127	6,266

* LA densest in U.S. since 1990

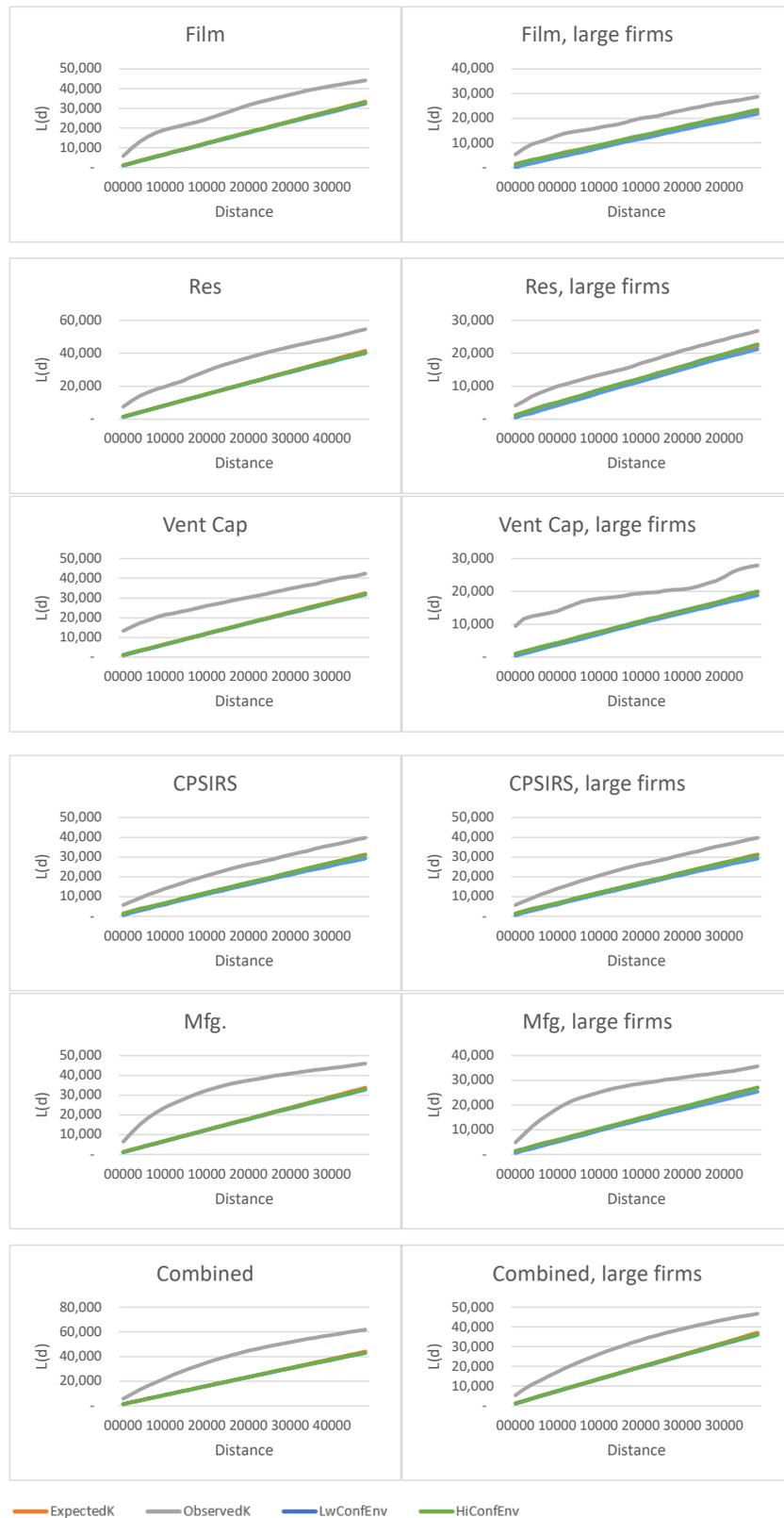
Source: <http://www.demographia.com/db-uza2000.htm>

APPENDIX 2: RIPLEY'S-K FUNCTION PLOTS

Los Angeles/Orange Counties



San Francisco Bay Area



APPENDIX 3

The K function is

$$K(d) = \frac{1}{\lambda N} \sum_{i=1}^N \sum_{j=1, j \neq i}^N \frac{I_d(m_{ij})}{w_{ij}}$$

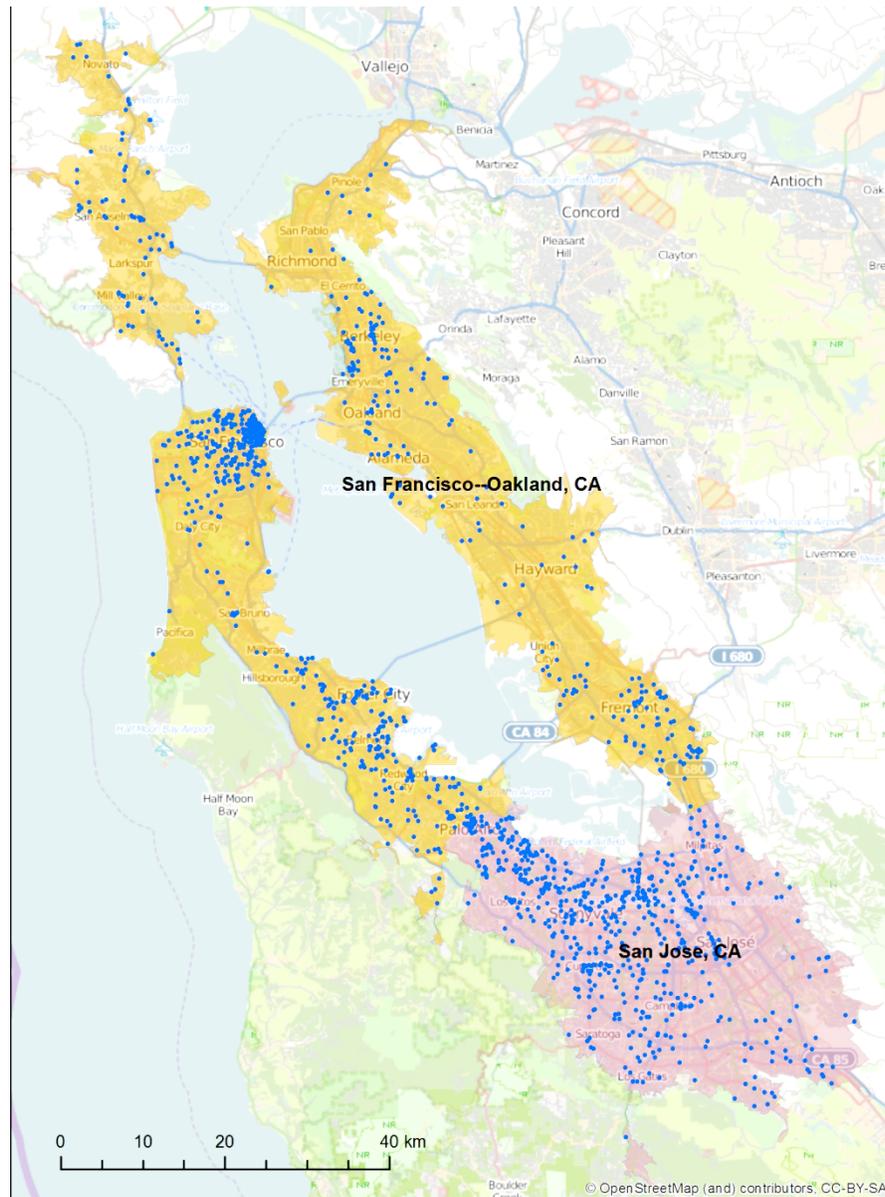
Where d is distance between firms in meters, λ is the density of firms in the study area, N is observed number of firms, $I_d(m_{ij})$ is an indicator function where it becomes 1 when $m_{ij} \leq d$ or 0 when $m_{ij} > 0$. m_{ij} is the distance between firm i and firm j . w_{ij} is a weight function for edge correction. Simulated outer boundary method is applied for edge correction (ArcGIS Pro, 2017).

To make the $K(d)$ values easier to interpret directly, they are transformed to $L(d)$ so that $L(d)$ becomes d for a random distribution.

$$L(d) = \sqrt{\frac{K(d)}{\pi}}$$

MAPS, FIGURES, TABLES

MAP 1: Location of all software establishments in the San Francisco Bay Area, 2013: We see the dots but not the interconnecting networks; firms network near and far. (Source: Geographic Research Inc., 2014)



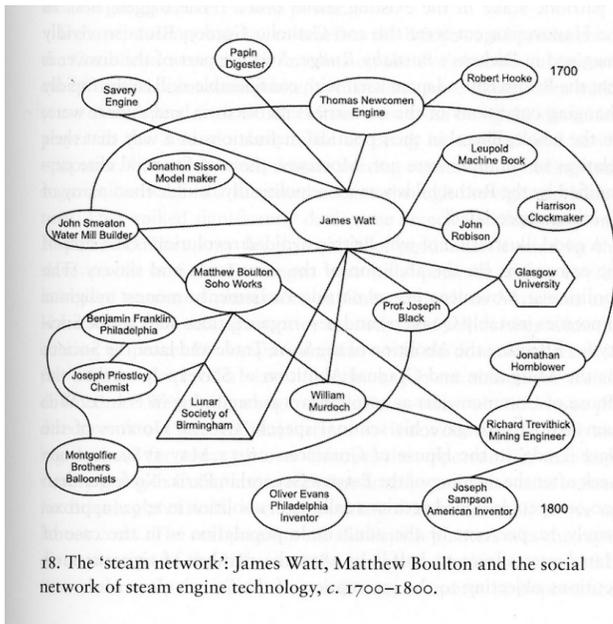
MAP 2c: San Francisco MSA plus Santa Clara County, Locations of technology based manufacturing sectors firms



MAP 2d: Los Angeles MSA (Los Angeles + Orange counties), Locations of technology based manufacturing sectors firms

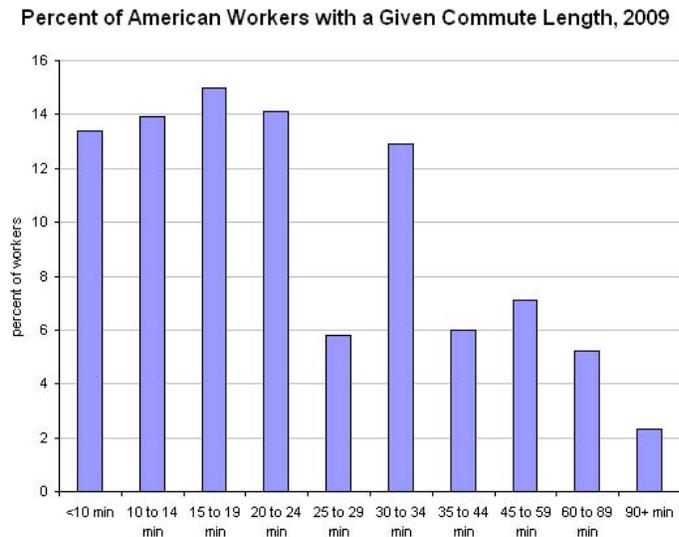


FIGURE 1: Network? Web of social relations? Supply chain for ideas?



Source: Niall Ferguson, *The Square and the Tower: Networks and Power from the Freemasons to Facebook* (2017, 147; includes more examples).

FIGURE 2: Cities spread outward; commuting near and far; why not agglomeration/clustering near and far?



Source: U.S. Census Bureau, American Community Survey, 2009

TABLE 1: Firms and Jobs, LA and SF areas, selected sectors

Region	Sector (NAICS)		Firms	% of total firms	Jobs	% of total jobs
Los Angeles County/ Orange County	Film: NAICS 512	Motion Picture and Sound Recording Industries	4,501	0.8%	72,847	1.2%
	Res: NAICS 5417	Scientific Research and Development Services	1,832	0.3%	28,316	0.5%
	Vent Cap: NAICS 523910	Venture Capital Companies	1,680	0.3%	11,953	0.2%
	CPSIRS: NAICS 541511, 511210, 517210, 517919 ²¹	Computer Programming, Software, and Information Retrieval Services	1,761	0.3%	21,080	0.3%
	Mfg.: NAICS 32-33 ²²	Technology-based manufacturing industries	2,114	0.4%	109,113	1.8%
	Combined	Five sectors combined	11,888	2.1%	243,309	4.0%
		All Sectors	563,326	100.0%	6,034,164	100.0%
SF 6 County	Film: NAICS 512	Motion Picture and Sound Recording Industries	1,158	0.4%	10,678	0.3%
	Res: NAICS 5417	Scientific Research and Development Services	1,629	0.6%	41,990	1.3%
	Vent Cap: NAICS 523910	Venture Capital Companies	1,261	0.4%	11,365	0.3%
	CPSIRS: NAICS 541511, 511210, 517210, 517919	Computer Programming, Software, and Information Retrieval Services	1,738	0.6%	55,039	1.7%
	Mfg.: NAICS 32-33 ¹¹	Technology-based manufacturing industries	1,605	0.6%	158,574	4.9%
	Combined	Five sectors combined	7,391	2.6%	277,646	8.5%
	All Sectors	280,332	100.0%	3,264,760	100.0%	

TABLE 2a: OLS Estimations: Pairwise co-location correlations explained by national IO coefficients, sales and purchases: Los Angeles county

Variable	Coefficient	Standard Error	Pr > t	R-Squared
Intercept	0.1233	0.0047	<.0001	0.0182
Tech_coef_ij	0.4407	0.1877	0.0190	
Tech_coef_ji	2.1427	0.3120	<.0001	

* Statistically significant

N = 2,980

TABLE 2b: OLS Estimations: Pairwise co-location correlations explained by national IO coefficients, sales and purchases: Orange county

Variable	Coefficient	Standard Error	Pr > t	R-Squared
Intercept	0.1962	0.0068	<.0001	0.0182
Tech_coef_ij	-0.0932	0.2382	0.6956	
Tech_coef_ji	1.7637	0.4477	<.0001	

* Statistically significant

N = 2,902

TABLE 2c OLS Estimations: Pairwise co-location correlations explained by national IO coefficients, sales and purchases: Los Angeles and Orange

Variable	Coefficient	Standard Error	Pr > t	R-Squared
Intercept	0.1239	0.0042	<.0001*	0.0182
Tech_coef_ij	-0.0749	0.1482	0.6132	
Tech_coef_ji	2.0550	0.2769	<.0001*	

* Statistically significant

N = 2,988

TABLE 2d: OLS Estimations: Pairwise co-location correlations explained by national IO coefficients, sales and purchases: San Francisco 6-county area

Variable	Coefficient	Standard Error	Pr > t	R-Squared
Intercept	0.1275	0.0053	<.0001*	0.0169
Tech_coef_ij	0.5456	0.2114	0.0099*	
Tech_coef_ji	2.3452	0.3534	<.0001*	

* Statistically significant

N = 2,951

TABLE 3: Summary of Ripley’s K function estimations, degrees of observed clustering

Sector (NAICS, SIC)	Description	Degree of observed clustering			
		LA/OC Counties		6 Bay Area Counties	
		All firms	Largest firms	All firms	Largest firms
Film: NAICS 512	Motion Picture and Sound Recording Industries	104% ²³	90%	71%	63%
Res: NAICS 5417	Scientific Research and Development Services	50%	32%	62%	44%
Vent Cap: NAICS 523910	Venture Capital Companies	60%	71%	76%	87%
CPSIRS: NAICS 541511, 511210, 517210, 517919	Computer Programming, Software, and information Retrieval Services	44%	33%	56%	53%
Mfg.: NAICS 32-33	Technology-based manufacturing industries	55%	28%	95%	88%
Combined	Five Sectors Combined	77%	60%	73%	61%

NOTES

1. Some prefer sustainable development but are often unclear by what they mean. Cowen (2018) makes the case of *sustained economic development* of “wealth plus” A key additional problem is that we may disagree about what to include in measures of wealth or well-being. He suggests “wealth plus” that expands what is measured as GDP, adding the value of leisure time, household production and environmental amenities. All three bring their own measurement controversies.
2. Porter (2000) has done substantial work elaborating strategies to promote spatial clustering.
3. “Death and Life is probably the most sensible book ever written about cities” (Watson 2001, 521).
4. A similar argument as ours with empirical results for the UK is in Huggins and Thompson (2017).
5. Considerable empirical literature shows that land use in cities is so heavily regulated as to cause housing shortage and housing “affordability” problems. See, for example, Pollakowski and Wachter (1990).
6. Mokyr (2007).
7. McAfee (2019, 233).
8. Kling (2013) argues for replacing the idea of a production function with the idea of a *production path*. This gets close to our thought that supply chains for ideas and supply chains for things are, together, involved in production.
9. McCloskey (2019) elaborates by citing all that we normally do in the way of persuasion and “sweet talking.”
10. Romer (1994).
11. We use the Los Angeles MSA, defined as Los Angeles plus Orange counties. The San Francisco MSA excludes Santa Clara county which we add to it to create a six-county area; leaving out the “Silicon Valley” growth engine would make no sense.

12. See Paytas and Berglund (2004)
13. San Francisco 1900-2012 dispersion, <https://www.newgeography.com/content/004165-the-evolving-urban-form-the-san-francisco-bay-area>, See Figure 2. Los Angeles <https://www.newgeography.com/content/002372-the-evolving-urban-form-los-angeles>. See Table 1.
14. From InfoUSA 2016.
15. US Implan, 2013, 536 sectors. Using regional model coefficients would have introduced two-way causation problems.
16. Isard and Schooler (1959) elaborated “industrial complex analysis” as a regional planning approach.
17. Angel (2011).
18. Gurri (2018) elaborates. He speculates that networks will replace hierarchies.
19. “The data on the largest U.S. MSAs show that commute times increase only slightly with city size: the elasticity of the average commute time with respect to the number of workers was about 0.1 in 1990 and 2000” (Anas 2012, 146).
20. Moretti (2012, 144).
21. Suggested by Rosenthal and Strange (2004).
22. The sector includes 43 technology-based manufacturing sectors defined by Paytas and Berglund (2004).
23. The following graph illustrates how the degree of observed clustering for the Film sector in Los Angeles/ Orange County is calculated: $(\text{Purple area}/\text{yellow area}) \times 100 = 104\%$

