Transforming Regional Economies: A Comparative Study

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1. Introduction

The economic landscape changes what it produces, who produces, and where it produces, over time in an ongoing reshuffling of the cards of output, employment and development. Once prosperous regional economies face periods of crisis and decline, while regions once peripheral to the production of core economic activities can prosper and grow. Within the U.S., the relative underperformance of the Rustbelt following World War II, coupled with the rise of Sunbelt cities is a classic case in point. The fortunes of individual economies rise and fall over time. Among larger cities in the US in 1970, in terms of per capita incomes Detroit ranked as the 14th richest "Combined Statistical Area" (CSA) -- the scale of a functionally-integrated urban region.-- ; in 2015 it was ranked 29th. By contrast, in 1970 Houston was the 29th richest larger CSA region in the country; by 2015 it ranked 10th.[i] In contrast to this turbulence, some regional economies, such as Chicago and New York in the US, and London and Paris in Europe, have been able to preserve their status near the top of urban hierarchies for extended periods of time. What explains these wide variations in economic outcomes at the regional scale, which can be observed not just in the US, but in many high-wage countries around the world (Moretti, 2012)? Regions are highly identified with, and their development shaped by, the industries in which they specialize. Regions are more affluent when they specialize in activities characterized by cognitively complex and non-routine tasks featuring high levels of information and innovation. Enduring prosperity is determined by a region's ability to transform its industrial base towards such activities .

Our grasp of the factors that shape these transformations is therefore crucial to understanding economic success and failure.

There is a broader economy-wide background to the fates of individual regions. Since the Industrial Revolution, market economies have been characterized by 40-60 year waves of major changes in technologies and the associated rise of highly-dynamic leading-edge industries, and with the concomitant restructuring and maturation of previously-existing sectors. The Industrial Revolution began by revolutionizing textiles, through the harnessing of water power and mechanical innovations in weaving in the 18th century; a later wave involved the use of steam power that facilitated industrial production with iron and steel in the 19th century; still another wave involved the invention of the internal combustion engine and advances in mechanical engineering in the first half of the 20th century; and most recently, the rise of information technologies in the latter part of the 20th century has been center stage. For each major innovation and wave of technological change, there has been a detailed new pattern of growth and decline in the incomes, employment and population of regions, as well as between countries. This pattern reflects how new industries are created, captured, and agglomerated in certain places more than others.

Thus, in the US, the one-hundred year period from 1880-1980 was a time of income convergence across US states and metropolitan regions. Over this period, the income gap between the average individual in Connecticut and Mississippi more than halved. Not coincidentally, convergence over this period occurred as ‘old economy’ industries – initially concentrated in the Midwest and Northeastern states – matured and dispersed throughout the economy. However, this equalizing epoch did not last forever.

Scholars observe that income convergence in the US came to an end around 1980, and was replaced by growing dispersion between the income of states and metropolitan regions (Ganong and Shoag, 2012; Moretti, 2012; Drennan and Lobo, 1999; Yamamoto, 2007). The present period of inter-regional income divergence – with inter-state income per capita now 30% greater than it was in 1980 -- can be explained in large part by the geography of 'new economy' industries – namely, the growth of knowledge-based services industries – that emerged from the 1970s onward, and whose key skilled functions are highly concentrated in a set of metropolitan regions.

Mainstream economic theories of regional development – namely, development economics, regional science and urban economics, and the new economic geography– identify factors that account for the general pattern of development and its structural determinants. In the present context, such accounts tell us much about why such activities are highly agglomerated and urban. But they tell us little about precisely which metropolitan areas capture them and why some other urban areas are left behind and suffer ongoing stagnation or even decline in population and employment. The purpose of this paper is to improve our understanding of why regional economies display different abilities to transition their industrial bases across eras of industrial change (Saxenian 1996; Glaeser, 2005; Binelli, 2013; Michaels et al, 2013; Cowell, 2014, Storper et al. 2015).

Outside of mainstream economics, there are a number of prominent hypotheses about the forces that determine how specialization of regions changes over time. An especially prominent theme in economic geography is that previous technological endowments have a strong role in shaping the subsequent capture or creation of new ideas and technologies within regional economies. Evolutionary economic geography holds that the capacity for regional economic evolution is governed by a regional economy's ability to move into cognate technologies, which they dub "related variety" (Frenken et al, 2007, Scott 2017; Martin 2016). Benjamin Chinitz (1961) made a more subtle argument about the qualities of antecedents. He argued that dominant industries tend to monopolize talent, factor supplies and attention, potentially crowding out other activities, and hence they can channel the evolution of regional economies down distinctive pathways. A somewhat different version of such evolutionary arguments combines technological and organizational antecedents. Saxenian's (1996) seminal comparison of the electronics industries in Route 128 and Silicon Valley identifies regional culture, such as types of entrepreneurship, industrial systems and cooperation as primary factors in shaping the ability of regional economies to generate and capture new high-value activities.

An older theme is that more diversified economies have a greater probability of successful transitions across eras of industrial change than narrowly specialized ones. This idea, often attributed to Jane Jacobs (1961), holds that evolution is a probabilistic process, so that having more irons in the fire will enable more likely recombination into success. Theoretical models of "nursery cities" draw from this logic (Duranton and Puga, 2001). In contrast to these theories, (Scott and Storper, 1987) identify "windows of locational opportunity" where regions that lack technological and industrial antecedents can become home to new industries, as has been the case with California during the 20th century. According to this view, ruptures in technological relatedness largely obviate the advantages of pre-existing agglomeration economies and create a relatively level playing field in the early phases of a technology's existence.

In this paper, we make a different argument about such transitions. Major regional specialization transitions are better explained by the respective regions' institutional landscape, which we label the "relational infrastructure" found in each place. To illustrate this point, we closely examine two regional economies: Los Angeles and the San Francisco Bay Area. We select these two regions because San Francisco and Los Angeles shared a great many characteristics in 1970. Most importantly, they exhibited strong similarities in their factor endowments, the level of sophistication of their industrial bases, and the roots of these industries to the emergent new economy. As a result, in 1970 the two regions had very similar levels of per capita income – Los Angeles ranked fourth and the Bay Area first by per capita income among US metropolitan regions with more than 500,000 residents. Despite these similarities, their adaptation and structural transformation into the new economy differed markedly. In 2015, per capita incomes were 44 percent higher in San Francisco than in Los Angeles, and Los Angeles had slipped to 17th place among large metropolitan regions. In what follows, we explore the divergence of these two regions through the lens of the geography of two emblematic industries of the post-1970 period: information technology (IT) and biotechnology. These two industries follow different pathways in the two regions because of differences in the regions' relational infrastructures, with the Bay Area's infrastructure better at sustaining growth and innovation than that of its southern neighbor.

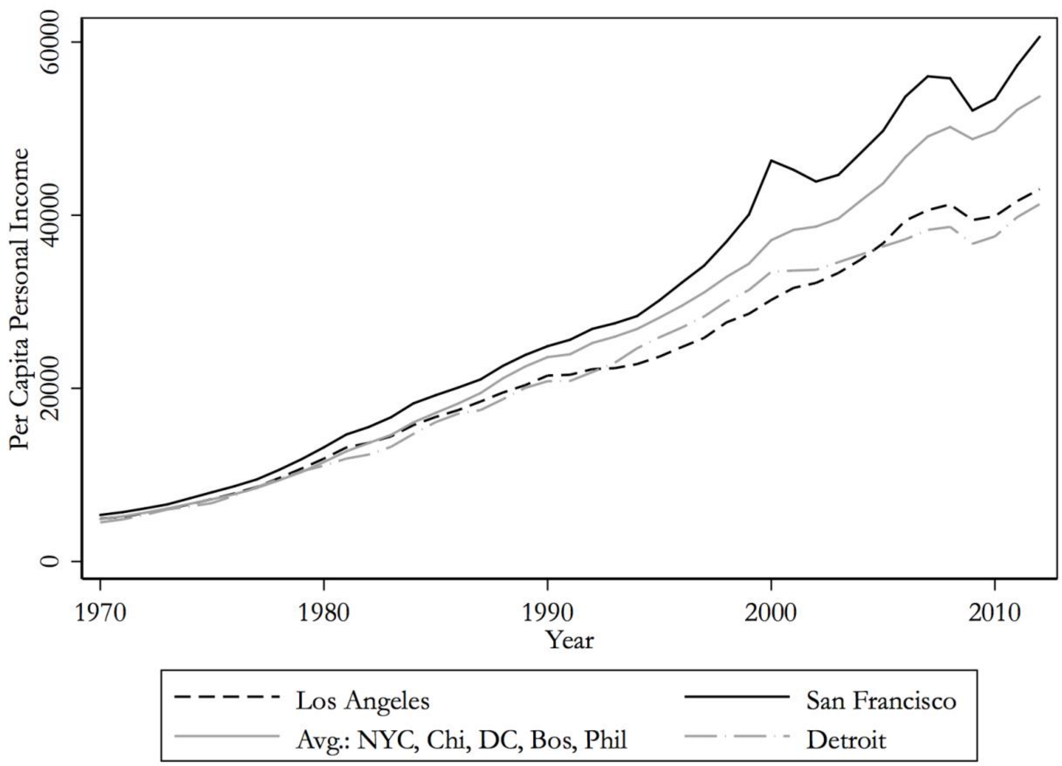
2. An introduction to Los Angeles and San Francisco

By any standard, the Los Angeles and San Francisco metropolitan regions are large, wealthy and economically dynamic. In this study, Los Angeles is defined as the Greater Los Angeles metropolitan region, a Census-defined Combined Statistical Area, encompassing five adjacent, continuously urbanized counties. Los Angeles had 18.7 million residents in 2015, making it the second largest metropolitan area in the United States. San Francisco is defined as the 10-county Consolidated Statistical Area, which had a population of 8.7 million people in 2015.

Figure 1 illustrates that in 1970, per capita personal income (PCPI) in Los Angeles was 92 percent of the level of income in San Francisco. By 2014, LA's PCPI amounted to only 71 percent of its northern neighbor.[ii] Figure 1 also demonstrates that, per capita income in Los Angeles has not only failed to keep pace with income levels in the Bay Area, but it has been unable to match the performance of other major American metropolises. In addition to our two California regions, Figure 1 tracks per capita income dynamics between 1970 and 2014 for the other Consolidated Statistical Areas whose populations were greater than five million in 1970: the New York; Chicago; Washington D.C.; Philadelphia; Boston; and Detroit CSAs.[iii] To make for a readable figure, incomes are averaged across New York, Chicago, Boston, Washington DC and Philadelphia, while the Detroit region is presented separately. Across these large regions, Los Angeles's per capita income trajectory most closely resembles that of Detroit, a region renowned for its degree of economic hardship over the past 30 years.

The larger story told in Figure 1 is that, when comparing the fortunes of the Los Angeles and Bay Area economies, it is not sufficient to observe that the Bay Area is an especially fortunate case among American cities. San Francisco has indeed outperformed the largest metropolitan areas, but Los Angeles, by that same standard, has underperformed many other regions. It should be further noted that Figure 1 displays data relating to nominal income divergence. In terms of real income divergence (incomes net of housing costs), the difference between the two economies is even starker. In 1970, real income in Los Angeles was 14% lower than real income in San Francisco, by 2012, it was 50% lower.

Figure 1. The Evolution of Per Capita Personal Incomes in Large Metropolitan Areas, 1970-2012



Source: Authors' calculations using Bureau of Economic Affairs Regional Economic Accounts data. Combined Statistical Area (CSA) definitions are used, with boundaries laid out by the Office of Management and Budget in bulletin no. 13-01 issued February

28, 2013. CSAs represented in this chart comprise the list of regions that had populations over 5 million people in 1970.

Why have the economies of the two regions diverged so markedly? After all, in 1970 Los Angles and San Francisco were part of the same ‘development club’. Both regions had more educated workforces than the USA as a whole, and hosted significantly higher proportions of Hispanics than the country as a whole (Storper et al. 2015). Both regions developed rapidly in resource-rich California, benefiting from business and financial links to the state's agricultural and natural resources hinterlands and a lucrative land-and-housing development sector. Both nurtured dynamic and variegated manufacturing and service economies. Both benefited from large-scale federal procurement of military hardware from their regional firms. Both were centers of innovation in knowledge- and technology-intensive sectors, producing iconic goods for global markets such as airplanes, semiconductors, communications equipment, and entertainment content. Both hosted major scientific research communities, consisting of six of the the world’s top 20 ranked research universities, as well as government research laboratories, independent institutes, large private firms with R&D operations, and research hospitals. Domestic migrants were attracted to economic opportunties, their natural beauty, excellent climates and high quality of life, thus sustaining high real estate prices and the continued expansion of local markets for non-tradable goods and services. Both shared California's relatively progressive governmental structure, institutions, infrastructure and education policies. Thus, given similar incomes and wages in 1970, and many common developmental characteristics, why did San Francisco surge forward and Los Angeles fall so far behind?

3. The Evolution of Specialization in SF and LA

At a high enough level of industrial aggregation, the San Francisco and Los Angeles economies appear to be similar. In 2015, services activities accounted for roughly half of the jobs in each region. Mirroring a trend evident throughout the richest economies in the world, manufacturing employment has declined in each region since 1970, due to the automation of tasks and the relocation of firms to regions in the South and West of the United States or offshore locations in developing countries (Grossman and Rossi-Hansberg, 2008; Blinder, 2009; Kemeny and Rigby, 2012). According to data from the Bureau of Economic Affairs, as of 2015, manufacturing in each region makes up about six percent of total employment.

With greater disaggregation however, we find that the two economies have developed along different trajectories since 1970. Table 1 displays the tradable sectors with the highest levels of employment for each region in 1970 and 2014. Owing to a shift in standards from the Standard Industrial Classification (SIC) system to North American Industrial Classification System (NAICS) in 1997, we use the 4-digit SIC codes in 1970, and 6-digit NAICS codes in 2014. These classifications represent the most disaggregated scale at which it is possible to examine industries for the respective periods.[iv]

ADD TABLE 1

In 1970, a number of high-technology and well-paying sectors were among the highest employing trade industries in each region. In Los Angeles, the “aerospace” agglomeration employed over 100,000 workers, nearly 3.5 percent of the regional labor force (“Aircraft” and “Aircraft Equipment”). The Bay Area was not significantly specialized in the aerospace industry at this time. Another distinction between the high-tech industries of the two regions in 1970 is found in the Bay Area’s relative strength in the production of semiconductors. These differences aside, there were significant similarities between the regions’ economies in 1970. Both regions were specialized in high-technology manufacturing, especially in sectors related to information technology (IT), including “Electronic computing equipment,” “Electronic components,” and “Communication transmitting equipment.” As befits major urban centers, Los Angeles and San Francisco were both focused on business services (“Business consulting services”), as well as some Old Economy manufacturing (“Truck equipment,” and in the case of San Francisco, “Commercial machines and equipment”).

When these disparate sectors are aggregated up to functional clusters, it is interesting to note that, in 1970, Los Angeles was home to a larger IT sector than the Bay Area. In 1970, the IT industry in San Francisco employed 38,621 workers, or 2.7 percent of the region’s workforce, while the industry in Los Angeles employed a comparable proportion of the region’s workforce, which amounted to just over 80,000 workers. Further aggregation into coherent clusters reveals that, in 1970, Los Angeles was specialized not only in the IT industry, but also logistics (“Trucking, except local”) and the motion picture industries (“Motion picture production, except TV”). Greater Los Angeles was also home to a large apparel industry, which had no single component large enough to be listed in Table 1. However, the cluster of interrelated apparel activities employed nearly 2 percent of Los Angeles's workforce in 1970. The Bay Area was also concentrated in the IT and logistics industries at this time. All in all, the Greater Los Angeles economy in 1970 had large clusters of knowledge-intensive industries such as aerospace, IT, and entertainment content.

Over the following decades, as we would expect given the evolution that has occurred within the US economy, a remarkable transformation occurred in the specialization patterns of each region. By 2014, seven of the ten largest six-digit NAICS industries in the San Francisco tradable sector were integral parts of the region's information technology cluster.[v] Over the period in question, the information technology agglomeration grew to account for over 250,000 jobs in the Bay Area, over 10 percent of total regional employment. By contrast, there remain only traces of Los Angeles' former strength in the aerospace and IT industries. Aerospace sectors no longer appear in Los Angeles' top-ten employing trade industries, although the region has preserved a presence in computer systems design and custom computer programming services. Moreover, unlike the highly specialized nature of the Bay Area's economy, Los Angeles's largest tradable industries encompass a diverse mix, including motion pictures, hotels and motels, insurance agencies and brokerages, freight transportation and clothing wholesalers.

Another way to capture the divergence of their core industries is to compare the wages of tradable sector, and especially of similar narrowly-focused occupations within each industry, but across regions. In 2014, nine of the top 10 tradable sectors in the Bay Area paid an average salary of more than $100,000 per year – five of which pay salaries greater than $150,000 per year. By contrast, only two of the leading sectors in Los

Angeles pay salaries of greater than $100,000 per year, and no sector pays a salary of greater than $150,000 per year. These wage differences persist even within the same narrowly-defined sectors, hinting at the ways in which even detailed sectoral classification can hide heterogeneity. For example, custom computer programming services firms pay an average salary of $124,024 in the Bay Area and $87,908 in Los Angeles; and the average wages in the computer systems design services sector are $130,197 in the Bay Area and $112,152 in Los Angeles. Though housing costs may be somewhat higher in the Bay Area, firms selling tradable goods and services would be unable to remain in high cost locations if those locations also did not provide offsetting productivity benefits (Acemoglu and Angrist, 1999). This is another way of saying that, for a given activity, higher pay in the Bay Area cannot only reflect pass-through of higher local housing costs. It must instead indicate either (1) that Bay Area computer programmers are more productive than their Angeleno equivalents at the same tasks, or (2) that Bay Area computer programmers are engaged in different (and more productive) tasks than their Angeleno equivalents. Both could be happening at the same time.

The divergence in the sophistication of the industrial bases of each region can also be observed in the task content of employment. Following Autor et al (2003), based on occupational structure and the Dictionary of Occupational Titles, we estimate the extent to which tasks in each region require nonroutine cognition. We take nonroutine cognitive work to be a proxy for sophistication, in that occupations that intensively require such tasks tend to require higher levels of human capital, and ought to generate a higher frequency of innovations. Table 3 presents indices that estimate each region's nonroutine cognitive intensity over nearly 40 years. In 1970, although the two economies were somewhat differently specialized, the overall task content of the work performed in each region was similar. Subsequently, the relative importance of nonroutine cognitive work grew steadily in the Bay Area. Meanwhile, the Los Angeles economy went from performing tasks that were more sophisticated than those in the national economy as a whole, to performing tasks less sophisticated than both the Bay Area and the overall national economy.

Table 3

Aggregate regional nonroutine cognitive task indices

Region	*1970*	*1980*	*1990*	*2000*	*2006–08*
Los Angeles	2.58	2.54	2.78	2.88	2.82
San Francisco	2.61	2.68	3.11	3.57	3.47
United States	2.40	2.41	2.75	2.99	2.95

Note: Authors' calculations based on IPUMS 1 percent 1970 metro sample; 5 percent 1980, 1990, and 2000 samples; and the 3 percent *American Community Survey* sample for 2006–2008. In each case, person-level sample weights are used to estimate task means. Higher values of non-routineness indicate that the occupational mix in a region is tilted toward jobs that require greater non-routine interaction and analytics, here taken as a proxy for sophistication. Each outcome reported here had an acceptably small linearized standard error.

4. Explaining Specialization and Economic Transition: The Information Technology and Biotechnology Industries:

We return now to the central question at the heart of this paper: what makes two similarly endowed regional economies evolve so differently when faced with major waves of technological change? We can shed light on this issue by examinig the evolution of the information technology and biotechnology sectors in each region in the period following their major technological breakthroughs. This comparison is all the more powerful because both the Bay Area and Los Angeles have been home to pioneering firms and innovations in the biotechnology and information technology industries. Yet today, biotech and IT firms in the Bay Area are global market leaders, while the equivalents in Los Angeles are largely “second-movers”. The Bay Area is home to six of the ten largest companies listed on the NASDAQ, the marketplace for technology companies. Despite having had twice as many workers in IT in 1970, the Los Angeles region is home to only one of the largest 25 NASDAQ-listed companies. Today, information technology in the Bay Area employs roughly twice as many workers as in Los Angeles, and in comparable sectors Angelenos are less well paid. A similar story of divergence emerges from examining the evolution of biotechnology since 1970.

4a. The Information Technology Industry

The history of the IT industry in the Bay Area is long and distinguished (Sturgeon 2000; Saxenain 1996; Lecuyer 2006). The electronics industry in Silicon Valley emerged from experiments with arc transistors by radio enthusiasts at the turn of the 20th century, and expanded with the subsequent development and production of vacuum tubes.[vi] The electronics industry in Silicon Valley became singular during the 1970s. In 1971, Intel created the first microprocessor and by 19XX Silicon Valley accounted for X percent of the semiconductor market in the US. Since this time, the Bay Area has become a global leader of subsequent iterations of the IT industry, including the computer manufacture, software development, Internet, application development, cloud computing and social media subsectors of the industry, and is home to market leading firms such as Apple, Alphabet (Google), Facebook and Intel.

Los Angeles’ early history in the electronics industry is less renowned, but no less distinguished. From its roots in the region's pioneering aircraft industry, after World War II, Los Angeles became home to the largest concentration of aerospace production in the U.S. (Markusen 1991). Semiconductors were crucial components of missiles and guidance systems, and as such, the region's aerospace industry was closely intertwined with the electronics industry. Such was the region's strength in electronics that Hughes Aircraft Company – a Los Angeles-based firm which evolved from aircraft to aerospace production and developed advanced electronics components – was home to the largest concentration of technical college graduates, including the greatest number of Ph.D.s, in any single industrial facility of that period except for the Bell Telephone Laboratories in New Jersey. By the end of the 1950s, Hughes was alone responsible for 20 percent of the electronics business in the state of California (Scott 1993). In the late 1950s, Los Angeles manufactured more semiconductors than the Bay Area (Lecuyer 2006; Klepper 2009).

In addition to electrical components, Los Angeles was an early home to significant elements of other parts of the IT industry. In the late 1960s, a Los Angeles-based corporation, Computer Science Corp., was the largest software company in the US and was the first software company to be listed on the New York Stock Exchange. Leonard Kleinrock, a professor at UCLA, was a co-inventor of the ARPANET, the precursor to the Internet, and Kleinrock's computer at UCLA hosted the first Internet transmission in 1969. Yet despite pioneering activity in key sub-sectors of the IT industry that would become multi-billion dollar industries, the region did not share in the economic gains from these industries in a significant way, especially compared to the Bay Area. Given the similar technological endowments of the Bay Area and Los Angeles prior to 1970 – particularly in the electronics industry – how can we account for the divergent trajectory that the IT industry has taken in each region since?

One of the most striking features of the IT industry is the extent to which it has undergone significant technological transition since the 1960s. Growth and innovation in the IT industry today is found in application development, cloud computing, social media and the so-called "sharing" economy. Silicon Valley is remarkable because its IT industry has successfully navigated across these technological transitions, while the IT industries in other regions, notably Route 128 near Boston and Los Angeles, locked themselves in to particular technologies at early stages in the industry's development (Saxenian 1996).

Certain scholars argue that this difference in fates has to do mostly with the technological antecedents of each region; some regions have technologies that limit their subsequent development while others are predisposed to ongoing growth and innovation along a technologically-defined trajectory (Martin 2016; Scott 2017). Yet this account of regional development is at pains to account for why the IT industry in Los Angeles did not become a leader of the IT industry in subsequent decades. After all, Los Angeles County was the biggest center of semiconductor manufacture in the US in the late 1950s, and in addition was home to early developments in the software and internet sectors,. In our view, this perspective applied to the two major cases at hand is unable to tell us why the Bay Area was able to transition from the manufacture of semiconductors to applications development, cloud computing and social media while Los Angeles was not.

This view of regional development is in stark contrast to Schumpeterian views of capitalism in which "creative destruction" heralds the advent of new industries and systems of production, replacing old and declining industries. In this vein, Scott and Storper (1987) assert that, during moments of technological change (between sectors or within them), there are "windows of locational opportunity," such that the advantages of pre-existing agglomerations – such as the organization of production – no longer determine the subsequent location of emerging sectors, with the result being an openness as to where an emerging sector will be located. The organizational practices of the leading edges of today's IT industry bear only a passing resemblance to those of the semiconductor and hardware sub-sectors, which led growth in the IT industry in the 1960s and 1970s. Seen in this light, regional adaptation relies less on technological lineage and more on the ability of regional actors and institutions to generate, import, modify and diffuse new organization forms and technologies within regional economies (Iammarino, 2005; Lundvall 2007).

In AnnaLee Saxenian's (1996) account of the divergent fortunes of the electronics and computer hardware industries in Silicon Valley and Route 128, near Boston, she describes the Bay Area's *regional* advantage over its eastern counterpart. Specifically, she pinpoints the Bay Area's decentralized, flexible and cooperative industrial system, based around a culture of risk tolerance for spin-offs and innovation as a local source of competitive advantage. By contrast, the electronics industry along Route 128 was characterized by institutional and cultural rigidities, and an industrial system comprised of vertically integrated, hierarchically managed firms, oriented around practices of secrecy and mass production.

4b. The Biotechnology Industry

The development of the biotech industry in each region exemplifies how differences in regional relational infrastructure and the adaptation of organizational practices can shape the development trajectories of industries. Both the Bay Area and Los Angeles were home to researchers who made significant discoveries in the biotech industry. In the 1970s, scientists in Los Angeles were the first to demonstrate that strands of DNA could be created synthetically; meanwhile in the Bay Area, researchers were granted the patent for recombinant DNA. Genentech in the Bay Area was the first Biotech IPO in 1980, while Amgen in L.A. would become the world's largest biotech company around that time.

Both Genentech and Amgen were initially founded by venture capitalists, in concert with research scientists, at the University of California, San Francisco and the University of California, Los Angeles, respectively. Today, San Francisco is recognized as one of the nation's premier biotechnology clusters, while Los Angeles is not (Padgett and Powell, 1993; Powell et al 2012; Casper 2009; Kenney 1986; Powell 2009).

The leading biotechnology firms in the Bay Area, such as Cetus, Genentech, Biogen and Chiron, pioneered a new form of organization practice. Founded in 1976, Genentech combined serious scientific guidance with venture capital funding. The Genentech story revolves centrally around a young venture capitalist and relatively inexperienced entrepreneur, Robert Swanson, and a world-class scientist, Stanley Boyer of UCSF, coming together to develop a new organizational form. Genentech encouraged its scientists to publish their findings in academic journals and it leveraged outside funding – including from the pharmaceuticals industry – for attaining scientific milestones.

> …Boyer's stature and Genentech's rapid ascendance as a premier scientific lab left a lasting legacy for subsequent biotech firms…..Both founders shared values around what motivates people (freedom, ownership) and how companies succeed (fiscal conservatism). Perhaps most crucially, they were unbiased by the conventions of commercial science… They were able to create an entirely new hybrid: a world-class research lab funded by commercial means… (Powell and Sandholtz, 2012:420).

By contrast, Amgen's organizational form borrowed from the standard corporate playbook. From the beginning, the firm adopted organizational practices, based around the scale-dominated managerial models that were prevalent in Los Angeles industry-military complex, shaping the development of the industry in the region. Powell and Sandholtz (2012: 411) call Amgen a "commerce dominated company" in contrast to the science-dominated major companies of the Bay Area. According to the authors, the

> …commerce model builds on an alternate framework, with management in the lead role and science brought on board, though more as a passenger than driver……important science was harnessed but an academic ethos was not adopted. Publishing was not encouraged; the scientific advisory boards provided a seal of approval but did not dictate or set business strategy.

The paradoxical outcome of this is that LA has a world-class biotechnology firm, and one that was a first-mover, but the company did not become the seed for a major biotech cluster. Favorable (and perhaps somewhat random) breakthroughs in this case, did not lead to cumulative expansion of a biotechnology agglomeration in LA.

5. Relational infrastructure potentiates breakthrough entrepreneurship and new organizational practices

In seeking to explain the differences in economic adaptation in San Francisco and Los Angeles, we aim to establish these two regions differed sharply in their networks and, ultimately, their regional systems of innovation. Significant differences in institutions can shape major transitions of regional economic bases. In the 1990s, Lundvall and Johnson developed the concept of the National Innovation System, a complex armature of organizations and rules that shapes the "know how, know who and know what" of an economy (Lundvall, 2007). The notion was subsequently scaled to the region. Iammarino (2005:499) defines a Regional System of Innovation (RSI) as "the localized network of actors and institutions in the public and private sectors whose activities and interactions generate, import, modify and diffuse new technologies within and outside the region."

In what follows, we provide evidence on the four contrasting dimensions of the RSIs of the two regions. First, greater cross-network connections in the Bay area allowed that region's entrepreneurs to invent new organizational practices (Powell and Sandholtz, 2012). Second, organizational sites existed to facilitate this mixing of networks. Third, the Bay Area developed many ‘invisible colleges’ of technologists, researchers and entrepreneurs, and these informal networks made it easier to bring the right people together around new projects. Fourth, elite leadership networks were stronger in the Bay Area and more informed by new economy ideas than in LA.

The joint effects of these four differences—what can be referred to as the ‘relational infrastructure’ of the regions – have determined why the Bay Area has been able to transition across an era of technological change why Los Angeles has floundered in this regard.   Relational infrastructure is crucial to regional economic transition because they potentiate successful entrepreneurship and the emergence of new organizational practices (Saxenian 1996; Storper et al. 2015). During times of economic transition, regional networks enable experimentation, learning, innovation and the diffusion of market information around regional economies.

5a. Cross-network connections

The information technology industry in the Bay Area represents the cross-fertilization of a number of communities, which lashed-up to create the region’s fabled and unique ecosystem. By the 1960s, traditional engineering networks were present in the region, organized around the defense-aerospace-communications sector and marquee names such as Hewlett, Packard and Litton. There was also an alternative technology network within the region, that emerged from the region’s hippie culture, which saw what it called “appropriate” technology in a utopian light, as a means for freedom and creativity. The region’s environmental and business elite networks also influenced the shape of the region's IT network. Straight-laced engineers were ultimately influenced by the counterculture's desire for decentralization and small-scale production (Turner, 2006). Jaron Lanier, a pioneer in the industry and later technology writer argues explicitly for the outsized influence of countercultural spirituality on tech culture in the early days of Silicon Valley (2013, p.205). Key counter-culture figures in the region, such as Stewart Brand and Buckminister Fuller spanned the region's diverse communities, and acted as go-betweens that enabled the mixing of sensibilities and knowledge (Turner, 2006).

5b. Organized sites of cross-network contact

In the Bay Area, a key site of contact between these different networks was established in 1969, when Xerox founded the Palo Alto Research Center (PARC). Three networks came together there: the engineering-based corporate world, with much of it military-procurement based; conventional academic engineering researchers; and the Bay Area alternative technology world. PARC's first employees were academics with no experience of corporate culture and little interest in it. In 1972, *Rolling Stone* (then headquartered in San Francisco) published an article about PARC, authored by Stewart Brand. In it, Brand described the employees of PARC as knowledge-fueled hippies, with computing as a utopian project to create more freedom and creativity. In 2013, in an article in *The New Yorker*, Nathan Heller described the current wave of applications developers locating in San Francisco in analogous terms, as technology-fueled youth seeking freedom, creativity and a non-conformist lifestyle, and cited other articles from the late 1960s that described San Francisco's cultural lash-up of that time in much the same terms (Heller, 2013). Paul Duguid, an early presence at PARC, confirms its key role as a bridge between networks and different ideas of how to push the commercial application of the new technologies, which decisively transformed the vision of the defense-engineering crowd (Duguid, 2009). Such cross-pollination did not occur In Southern California, where the much larger defense-engineering milieu had no such boundary-spanning networks to pull it out of its comfort zone and provide it with a new technological-commercial imaginary. Unlike Stanford and Berkeley, the University of California Los Angeles and Cal Tech never developed the networks that would put research scientists in close contact with engineers, much less the intermediate hippie-environmentalist network tissue that often brought them together in the Bay Area. Los Angeles-based leadership networks became increasingly isolated from emerging technology networks localized in Orange-County, and both of these groups were cut off from both burgeoning alternative technology communities and the entrepreneurially super-charged world of Hollywood.

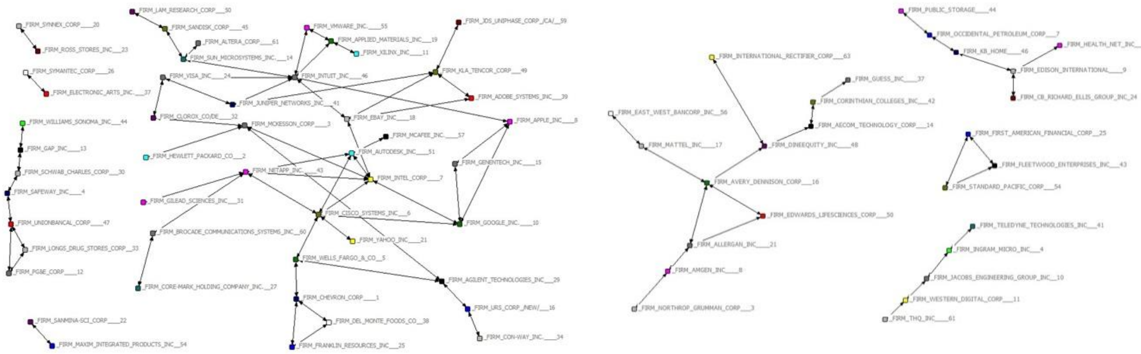
5c. Informal networks: invisible colleges

In the Bay Area, a process of serial entrepreneurship and serial researcher-entrepreneur interactions generated invisible college networks of technologists. These are interpersonal networks of people who have worked together in one way or another. They are many times bigger and denser in the Bay Area than in LA. To take just one recent example, 55% of Bay Area life science researchers have worked together in a firm or research organization, compared to only 2% in Greater LA (Casper, 2009). In the Bay Area, from the early 1970s to 2005, there were three times the patents of university researchers with a commercial assignee as in Los Angeles, or six times the density per capita (Casper, 2009; Kenney and Mowery, 2014). The percentage of patents issued to Bay Area firms or researchers that cite other Bay Area patenters is almost four times as high as in LA (Sonn and Storper, 2008). The more people who established these networks, the more there were to draw on as new projects and ventures took places. With each round of this incipient system, there were exponential increases in the size of the informal networks and bigger and bigger pools of networked people to draw into new ventures. Borrowing the language of Feldman and Zoller (2012), the density of new economy "dealmakers" in the Bay Area – another network – is today many times that of Southern California, and highly disproportional to the differences in size of the two economies or their high-technology employment.

5d. Structure, strength and content of leadership networks

Over the period under examination, Bay Area leadership groups became broader and more inclusive while those in Greater LA weakened and became more fragmented. Storper et al (2015) measured the connections among members of boards of directors of the principal corporations in the two regions, and the contrast is striking, as can be seen in Figure 3.

Figure 3. Board Interlocks in the SF Bay Area and Greater LA, 2010



San Francisco Los Angeles

Source: Storper et al (2015), authors' analysis using UCINET/NetDraw.

In the Bay Area, even when we control for the higher level of industrial specialization of the economy (which would generate more natural overlaps of boards of directors) there is a much greater density of board interlocks both between and within sectors, signifying a generally more connected business elite.

In addition to this denser structure of connections, the content of the visions the two region's respective leadership networks articulated was different (Storper et al., 2015). A content analysis of 30 years of reports of major business leadership groups and public agencies charged with economic development reveals that the Bay Area, through its Bay Area Council Economic Institute, had a consistent focus on the Bay Area as a knowledge economy, whose comparative advantage in the world had shifted to high-skill, knowledge based activity, evident from the late 19800s onward. In contrast, very little mention of Southern California as a knowledge economy can be found in the reports of its economic development council or chamber of commerce, prior to 2010 (Storper et al, 2015). Indeed, Southern California's reports focus on going back to the past by driving costs and taxes lower with the goal of restoring mass manufacturing to the region. In other words, in the Bay Area, a forward-looking vision reigned, while in Greater LA an atavistic analysis dominated the discussions. And this latter vision corresponded to active support for light manufacturing and logistics in Southern California, both low-wage industries with virtually no technological learning. Thus, the Bay Area and LA were pushed in different directions by the attitudes and beliefs popularized by their leadership groups, backed up by the different shape and overall strength of leadership networks in the two regions.

The entertainment industry in Hollywood was the exception to Southern California's generally conservative and backward looking economic performance. Beginning in the 1950s, Hollywood responded to the twin challenges of competing technology (television) and a US Department of Justice anti-trust action that broke its monopolistic hold on distribution networks. Hollywood responded by transforming its business model towards project-based work, and by the 1970s it was already pioneering flexible combinations of firms and knowledge and inputs from in external networks (Storper and Christopherson, 1987). The giant firms (the studios) switched from being mass production movie factories into investors, product developers and marketers of films and their branded offshoots. They now closely resemble technology-oriented venture capital organizations that populate the Bay Area and beyond.

Yet Hollywood's transformed organizational ecology did not stimulate a wider transformation of the Los Angeles economy. There are many reasons for this. One plausible explanation is that the language of art, dominant in Hollywood, has few natural connections to the language of engineering. This situation contrasts to Silicon Valley, which is based on engineering, and thus has been able to draw from and contribute to engineering communities in that region. Another is that the high-tech and Hollywood leadership groups had few civic forums, neighborhood cross-overs, or cultural gathering points to bring them together to share insights. This then was reflected in a series of missed opportunities in Southern California, such as when New Economy opportunities like Amgen came LA's way, imitation of an earlier era of integrated firms rather than emulation of Hollywood's and Silicon Valley's open networks occurred.

6. Regional economic transitions: networks, practices ideas and visions

Paul Duguid, one of the participants in Xerox Corporation's PARC in the 1970s, uses the term *zeitgeist* to describe the Bay Area's "open source culture." He stresses that the zeitgeist is not "technology-specific," by which he means that it is general to the region (Duguid, 2009). The juxtaposed examples of IT and biotech demonstrate that there is a broader regional context at work and not just technology- or industry-specific factors that govern regional industrial evolution. Zeitgeist consists of the shared ideas and practices and ways of organizing things that take hold in economic environments. These shared ideas, practices and ways of doing are often not fully evident to the people who do them. These notions correspond to what the analytical philosopher David Lewis (1969) defined as "conventions," which are something like rules-of-thumb. Conventions shape economies by helping large and decentralized communities of actors to stay on the same page, underpinning the functioning of an organizational ecology.

Periods of major economic change define opportunities and challenges for city-regions. Existing factor endowments, existing firms, or existing technological capacities do not determine the responses to these forces, although they are influenced by them. At the dawn of any major wave of technological change, many regions – such as in the example of San Francisco and Los Angeles –have factor endowments, types of firms, and experience with technologies that make them plausible candidates for succeeding in one or more of emerging area of technology. Only some of them succeed, however. We hve argued that a critical difference between those that succeed and those that do not is their relational infrastructure, a complex congeries of various kinds of networks – combinations of technological knowledge, business knowledge, attitudes towards markets, the emergence of new deal-making intermediaries – that enable or stymie the fashioning of new opportunities into new economic systems. Once certain regions get ahead in doing this, then normal economic processes of circular and cumulative causation take hold, driving a wedge of size and efficiency between successful and less successful regional economies. This is why different relational infrastructures set off divergent regional development trajectories.

References

Acemoglu, D., & Angrist, J. (1999). *How large are the social returns to education? Evidence from compulsory schooling laws* (No. w7444). National bureau of economic research.

Autor, D; Levy, F; Murnane, R. 2003. "The skill content of recent technological change: an empirical exploration." *Quarterly Journal of Economics* 118,4: 1279-1334.

Binelli, M. (2013) *The Last Days of Detroit: Motor Cars, Motown and the Collapse of an Industrial Giant*, London: The Bodley Head.

Blinder, 2009;

Blinder

Casper, 2009. *The marketplace for ideas: Can Los Angeles build a successful biotechnology cluster?* Los Angeles, CA: The John Randolph Haynes and Dora Haynes Foundation.

Chinitz, B. 1961. "Contrasts in agglomeration: New York and Pittsburgh." *American Economic Review* 51,2: 279-289.

Cowell, M. (2014) *Deindustrialization: Adaptive Resilience in American Midwestern Regions,* London: Routledge.

Drennan, M.P., Lobo, J., 1999. « A Simple Test for Convergence of Metropolitan Income in the United States." *Journal of Urban Economics,* 46: 350–359.

Duguid, P. 2009. Personal Interview, January 23, University of California at Berkeley, School of Information.

Duranton, G. and Puga, D. 2001. "Nursery cities: urban diversity, process innovation, and the life cycle of products." *American Economic Review* 91,5: 1454-77.

Feldman, M.P. and Zoller, T. D. 2012. "Dealmakers in place: social capital connections in regional entrepreneurial economies." *Regional Studies* 46,1: 23-37.

Feldman, M.P. 1994. *The geography of innovation.* Boston: Kluwer.

Frenken, K ; Van Oort, F ; Verburg, T. 2007. "Related variety, unrelated variety and regional economic growth." *Regional Studies* 41,5: 685-697.

Ganong, P ;, Shoag, D. 2012. « Why has regional income convergence in the US stopped?" Cambridge, MA: Harvard University Kennedy School, working paper RWP12-028. (http://papers.ssrn.com/sol3/papers.cfm?abstract-id=2081216)

Glaeser. E. (2005) Reinventing Boston: 1640-2003, *Journal of Economic Geography, 5,* pp. 119-153.

Grossman, G. M., & Rossi-Hansberg, E. (2008). Trading tasks: A simple theory of offshoring. *The American Economic Review*, *98*(5), 1978-1997.;

Heller, N., 2013. "Bay Watched: How San Francisco's New Entrepreneurial Culture is changing the country." *The New Yorker*, October 14: 67-79.

Iammarino, S. 2005. "An evolutionary integrated view of Regional Systems of Innovation: concepts, measures, and historical perspectives." *European Planning Studies* 13,4: 497-519.

Jacobs, J. (1970). *The economies of cities*. Jonathan Cape.

Jaffe, A. 1989. "Real effects of academic research." *American Economic Review* 79,5: 957-970.

Kenney, M. (1986). *Biotechnology: The university-industry complex*.

Kenney, M. and Mowery, D. 2014. *Public Universities and regional growth: insights from the University of California.* Stanford: Stanford University Press.

Klepper, S. 2009. "Silicon Valley, a Chip off the Old Detroit Bloc." In: Acs, Z., Audretsch, DB; and Strom, R, eds, *Entrepreneurship, Growth and Public Policy.* Cambridge: Cambridge University Press, pp. 79-117.

Kemeny, T., & Rigby, D. (2012). Trading away what kind of jobs? Globalization, trade and tasks in the US economy. *Review of World Economics*, *148*(1), 1-16.

David Lewis (1969)

Jaron Lanier, 2013

Lecuyer, C. 2006. *Making Silicon Valley: Innovation and the growth of high tech, 1930-1970.* Cambridge, MA: MIT Press.

Lewis, D.K., 1969. *Convention: a philosophical study*. Cambridge, MA: Harvard University Press.

Lundvall, B-A. 2007. "National innovation systems – analytical concept and development tool." *Industry and Innovation* 14,1: 95-119.

Markusen, A.R., Hall, P. Campbell, S., Deitrick, S. 1991. *The rise of the gunbelt: the military remapping of industrial America.* New York: Oxford University Press.

Martin, R. (2016). Divergent urban economic development: reflections on a tale of two cities. *Regional Studies*, *50*(9), 1623-1627.

Michaels et al, 2013;

Moretti, E., 2012. *The New Geography of Jobs*. Boston: Houghton Mifflin Harcourt.

North, D. 1990. *Institutions, institutional change, and economic performance.* Cambridge: Cambridge University Press.

Padgett and Powell, 1993;

Pomerantz, K. 2000. *The Great Divergence.* Princeton: Princeton University Press.

Powell 2009

Powell, W.W., Sandholtz,W., 2012. "Chance, nécessité, et naïveté: Ingredients to create a new organizational form." Ch 13 in Padgett, J.F. and Powell, W.W., *The Emergence of Organizations and Markets.* Princeton: Princeton University Press, 379-433.

Saxenian, A., 1994. *Regional advantage: culture and competition in Silicon Valley and Route 128.* Cambridge, MA: Harvard University Press.

Scott 1993

Soctt 2017;

Scott, A.J., Storper, M., 1987. "High technology industry and regional development: a theoretical critique and reconstruction." *International Social Science Journal* 112 (May): 215-232.

Sonn, J.W. and Storper, M. 2008. "The increasing importance of geographical proximity in knowledge production: an analysis of US patent citations, 1975-1997." *Environment and Planning A* 40,5: 1020-1039.

Storper, M. and Christopherson, C. 1987. "Flexible specialization and regional industrial agglomerations: the case of the US motion picture industry." *Annals of the Association of American Geographers* 77,1: 104-117.

Storper, M; Kemeny, T; Makarem, NP; and Osman, T. 2015. *The Rise and Decline of Urban Economies: Lessons from Los Angeles and San Francisco.* Stanford, CA: Stanford University Press.

Sturgeon 2000;

Turner, F., 2006. *From counterculture to cyber-culture: Stewart Brand, the Whole Earth Network, and the rise of digital utopianism*. Chicago: University of Chicago Press.

Yamamoto, D., 2007. “Scales of regional income disparities in the USA, 1955-2003.” *Journal of Economic Geography* 8: 79–103.

Zoller (2012)

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[i] These rankings are authors’ calculations among regions with over 500,000 residents in 1970, based on population and per capita personal income data from the Bureau of Economic Affairs.

[ii] Per capita personal income includes income from wages as well as from other sources, such as rental property, investments, and so on. It is used here largely because it is one of only a few choices for detailed, long-running annual measures of economic well-being at the metropolitan scale. The Bureau of Economic Affairs also estimates average wage per job, as well as gross domestic product per capita. The latter ties most closely to equivalent metrics at the national scale, however the BEA tracks this figure only since 2000. Measures of the average wage per job do not account for workers who hold multiple jobs. Nonetheless, results using average wages per job do not markedly differ from those estimated using PCPI (although the gap between the group of metros and Los Angeles is smaller). Later in the chapter we use wage data from the Decennial Census and the American Community Survey. These paint a highly consistent picture to the evolution of PCPI, however the Census wage data are not available as an annual series from 1970.

[iii] This threshold is arbitrary, and is chosen chiefly for clarity of presentation. However, the story does not materially change with a more inclusive cutoff.

[iv] (footnote about SIC NAICS here)

[v] “Software publishers,” “Custom computer programming services,” “Electronic parts and equipment wholesalers,” “Computer systems design services,” “Computer and peripheral wholesalers,” “Data processing,” and “Semiconductor and related device manufacturing.”

[vi] For industrial histories of the region see: Sturgeon 2000; Saxenian 1996; Lecuyer 2006; Scaruffi and Rao 2011