Chapter 10

Regional Innovation Transitions

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The Problem: Innovation and Turbulent Regional Economic Performance

Since the Industrial Revolution, the world economy has enjoyed ongoing productivity increases that have steadily raised global living standards in the context of a growing world population. This represents a change from the reality prior to roughly 1820, which was marked by long-term stagnation in both living standards and population levels, a condition referred to as the Malthusian Trap (Maddison, 1982). The vast historical literature on the Industrial Revolution, complemented by recent advances in growth theory, demonstrates that capitalism has been able to break this historical trap for more than two centuries through a powerful systemic capacity to generate productivity-increasing innovations.

Within this two-century period, however, innovation has not occurred evenly over time nor over geographical territory. The time dynamic is that major innovations occur in waves, and are centered on sets of technologies and their principal industries, such as the textile technology revolution of the late eighteenth and early nineteenth centuries, with its harnessing of water power sources and its mechanical innovations for weaving. In the nineteenth century, technologies around steel, coal, and railroads generated another major wave of productivity increases. In the very late nineteenth century and early twentieth century, the internal combustion engine, electricity, and more mechanical engineering technologies generated another astonishing wave of productivity gains (Gordon, 2016).

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The uneven geography of that greatest wave of innovation, the Industrial Revolution of the late eighteenth century, generated a *great divergence* in world incomes between Europe and some of its overseas outgrowths and the rest of the world (Pomeranz, 2000). This outcome is perhaps only now being reshaped with the possible rise of East Asia as a center of world innovation, but it is too early to tell. Studies of the geography of innovation, stemming largely from the pioneering work of Feldman (1994) and Jaffe (1989), have also established that innovation is geographically concentrated and uneven at the finer geographical scale of subnational regions. The invention of the internal combustion engine in the late nineteenth century sustained the rise of distinct regional centers of the mechanical engineering industries in Europe and the Americas (Storper & Walker, 1989). More recently, the information technology (IT) revolution of the 1970s generated the IT industries and in combination with open capital market policies stimulated the growth of the modern finance sector. Both have contributed to the concentration of skills, capital, entrepreneurship, and leading firms in certain metropolitan regions of the developed economies.

Within the United States, for example, in 2001, the 50 largest regions had per capita incomes 27% greater than the U.S. economy as a whole, with this advantage growing to 34% by 2015. Per capita income in the Brownsville, Texas, metropolitan region is \$23,000 per year compared to about \$75,000 in the San Francisco Bay Area and Washington, DC, or about one third as much as in the higher-income metropolitan regions. From the 1960s until as recently as the 1980s, population, employment, and incomes grew faster in suburbs and nonmetropolitan areas than in central cities in general and large metropolitan areas in particular, as the dominant industries of the mid-twentieth century matured and de-agglomerated. The income levels of U.S. states converged from 1880 to 1980, during which time the richest state (Connecticut) went from being 4.5 times richer than the poorest (Arkansas) to just 1.76 times. In the new millennium, the coefficients of variation of both gross domestic product (GDP) per capita and total GDP between U.S. states have increased steeply. (Drennan & Lobo, 1999; Ganong & Shoag, 2012; Moretti, 2012; Yamamoto, 2008). Researchers now speak of a new *great inversion* and a *new geography of jobs* within countries, as shown in Figure 10.1 (Moretti, 2012). What will be the geography of this next wave of innovation and its effects on population and incomes? At the present time, the genetics and molecular biology revolutions are generating biotechnology industries, artificial intelligence industries, robotics industries, and many other sectors whose contours are yet to be fully defined, but which surely will create powerful winner regions.

Most urban and regional development theory concentrates on the broad structural determinants of the pattern of economic development, and to some extent, the dynamics of resilience or failure. It identifies the characteristics of broad categories of places, such as *high skill cities*, *manufacturing cities*, *high income regions*, and *low income regions*, as well as the overall geographical pattern defined by each major wave of innovation and economic growth, something like the structural clubs of different kinds of places in each phase.

Fig. 10.1 Population and per capita income, compound annual growth rates, 1970–2012, 30 largest Combined Statistical Areas in 2012. Solid horizontal and vertical rules represent average growth rates for population and income among all Combined Statistical Areas. Points are scaled according to population in 2012. From Storper, Kemeny, Makarem, & Osman (2015, p. 11). Reprinted with permission. © 2015 by the Board of Trustees of the Ireland Stanford J University. All rights reserved. By permission of the publisher, sup.org. No reproduction or distribution is permitted without prior publisher's permission

But theory and research say little about why specific places join certain clubs or fall out of them. The overall divergence in development that occurs with major waves of innovation is complemented by individual turbulence in regional performance. In the United States, Detroit was the sixth richest metropolitan region in 1970; it is now 52nd on the list of all U.S. metro regions with more than two million population, and joins Cleveland as a case of declining income rank with population loss, as shown in Table 10.1. Seattle, Minneapolis, Washington, DC, San Francisco, and Houston have combined population growth and improvement in their income rank. Orlando, Miami, and Phoenix have had great population growth without moving up the ranks of per capita incomes. Among older metropolitan regions, Boston is now one of the top five American metropolitan regions in income, but it was not even in the top 10 in 1970. New York is a case of income resurgence with moderate population growth.

The city-regions that have been successful in some combination of maintaining high relative per capita incomes and retaining or growing population have done so through transitions in their economic base. A successful transition is a dynamic of the local economic base that involves keeping, creating, or attracting activities that

Table 10.1 U.S. combined statistical areas with population above two million, ranked according to per capita personal income levels

Combined Statistical Area	Income rank			Population change (%) 1970–2010
	1970	1990	2010	
San Jose–San Francisco–Oakland, CA	1	2	1	56.5
New York–Newark–Bridgeport, NY–NJ–CT–PA	2	1	2	12.4
Chicago–Naperville–Michigan City, IL–IN–WI	3	6	11	19.7
Los Angeles–Long Beach–Riverside, CA	4	10	25	79.1
Washington–Baltimore–N. Virginia, DC–MD–VA–WV	5	3	3	60.3
Detroit–Warren–Flint, MI	6	12	52	–0.5
Minneapolis–St. Paul–St. Cloud, MN–WI	7	7	9	60.8
Seattle–Tacoma–Olympia, WA	8	9	6	99.1
Cleveland–Akron–Elyria, OH	9	13	36	–7.0
Philadelphia–Camden–Vineland, PA–NJ–DE–MD	10	8	10	13.8

Note. Calculations by Thomas Kemeny from U.S. Bureau of Economic Analysis Regional Economic Accounts data

are innovative and entrepreneurial and have high profit margins, skills, and wages (Feldman, 2014; Feldman & Lowe, 2011). By contrast, the city-regions that fall down the ladder of incomes, sometimes in combination with population stagnation or loss, are those whose economic base has not been successful in capturing the innovative industries of the period.

Turbulence opens up a major puzzle for the geography of innovation. The factors that distinguish the pathways of supposedly structurally similar regions are usually relegated to the sidelines of research, as *effects of history*, *shocks*, or *accidents*. In this paper, I shall address this question by comparing the economic transitions of two regions in detail. In 1970, the Greater Los Angeles and San Francisco Bay Area metropolitan regions—defined here as their respective Combined Statistical Areas (CSA)—had very similar levels of per capita income, ranking fourth and first respectively among large U.S. metropolitan regions. By 2010, they had almost a one-third difference in per capita income and Los Angeles had slipped to 25th place. This contrast in fates is perplexing, because Los Angeles and San Francisco belonged to the same high-income, high-tech club in 1970; they faced the new economy from similar structural starting points. Via a detailed comparative analysis of how these two regions faced the new economy, I advance an explanation of why some regions succeed in major innovation transitions—by which I mean major transformations of the economic base of a region that occur through the shaping or uptake of major waves of innovations—and others largely fail at such transitions.

A Brief Introduction to Los Angeles and San Francisco

By any standard, the Los Angeles and San Francisco metropolitan regions are large, wealthy, and dynamic. Los Angeles, in this context, means the Greater Los Angeles CSA, which had 18.679 million residents in 2015, making it the second most populous metropolitan area in the United States, with a 4.48% population increase from 2010 to 2015. Los Angeles is one of the largest economies in the world, with a nominal gross metropolitan product that would rank it as the world's 16th largest economy, after Mexico (112 million inhabitants) and above Indonesia (220 million). Meanwhile, the San Francisco Bay Area CSA had a 2015 population of 8.713 million, growing 6.87% since 2010. It would be the 22nd largest economy, just after Argentina (35 million) and before Sweden. Depending on the method of calculation employed, the overall size (regional gross output) of the economy of Greater Los Angeles is third or fourth among metropolitan regions in the world, while that of the San Francisco Bay Area is about ninth. In terms of per capita income, San Francisco is consistently in the top five metro areas in the world in per capita income. In that latter group, Los Angeles ranks about 20th. However, from a national perspective, Los Angeles is on the verge of falling out of the highest income group of big metropolitan regions, while San Francisco remains among the leaders. As Figure 10.2

Fig. 10.2 The evolution of per capita personal income in large metropolitan areas, 1970–2012. CSA definitions are used, with boundaries laid out by the U.S. Office of Management and Budget (2013). CSAs represented in this chart comprise the list of regions that had populations over five million people in 1970. From Storper et al. (2015 p. 7). Copyright 2015 by Stanford University Press. Reprinted with permission. © 2015 by the Board of Trustees of the Ireland Stanford J University. All rights reserved. By permission of the publisher, sup.org. No reproduction or distribution is permitted without prior publisher's permission

illustrates, in 1970 per capita personal income in Los Angeles was 6% less than that of San Francisco. By 2012, the gap was almost 30%.

The stakes of this turbulence are very big. For example, though by world standards these are still wealthy regions, their divergent income levels have widened the gap in their public spending capacities. In their Californian context, each region's public agencies have tax receipts that are capped at about 7% of regional GDP.¹ At this identical rate, the Bay Area now collects and spends \$25,000 per regional resident, while Greater Los Angeles can only raise \$18,500 per resident. Economic divergence thus can give rise to circular and cumulative gaps in regional public investment capacity, with important potential impacts on quality of life and the capacity to invest in measures that may reinforce differential long-term economic performance. This unfavorable comparison is not only due to the Bay Area's excellent economic performance. A number of major American metropolises successfully navigated the transition to the new economy, as shown in Figure 10.2.

This comparison is particularly interesting because Los Angeles would have seemed to be an ideal candidate to lead the innovation transition to the new economy. From 1910 to 1970, metropolitan Southern California multiplied its population 21-fold, climbing the income ranks of American metro regions to become not only very big, but very prosperous as well. It did so through a several-decades-long leadership in innovative entrepreneurship. Southern California became home to many household names in manufacturing, technology and entrepreneurship, coupled with additional innovations in infrastructure, lifestyles, and consumption. From 1900 to the 1970s, Southern California combined quantitative and qualitative growth successfully in a way perhaps not equaled by any other metropolitan area in the western world.

Changes in Specialization: The Key Determinant of Income Levels

The proximate cause of divergence and turbulence is to be found in changes in specialization, reflecting different levels of creating or absorbing innovative activities. The Bay Area became the world center of the IT industry, generating Silicon Valley (which did not exist as such in 1970) (Table 10.2). The Bay Area then enjoyed the growth of IT-related corporate headquarters and has recently become a significant hub of cutting-edge sectors such as biotechnology, mobile device applications, cloud computing, and artificial intelligence. In contrast, Los Angeles experienced dramatic downsizing of its mass manufacturing and high-tech aerospace and defense sectors and replaced them with lower-wage sectors, such as light manufacturing and international trade and logistics. Los Angeles's concentration of corporate headquarters declined and the region currently seems to be losing out in biotechnology. In other words, San Francisco had a successful regional innovation transition in its

¹ In other words, prior to their residents' tax contributions to state and federal governments.

Table 10.2 Tradable industry groups in 1970 and 2010

Tradable Industry Group	Los Angeles		San Francisco	
	Employees	Employment Share (%)	Employees	Employment Share (%)
	1970		1970	
Information Technology	81,872	2.6	38,621	2.70
Aerospace and Defense	108,083	3.4	455	0.03
Logistics	39,851	1.3	21,313	1.50
Entertainment	22,978	0.7	2,171	0.15
Apparel	56,965	1.8	7,806	0.06
2010		2010		
Information Technology	153,524	2.7	255,334	10.20
Aerospace and Defense	47,960	0.9	735	0.02
Logistics	129,651	2.3	23,505	0.90
Entertainment	141,025	2.5	14,686	0.50
Apparel	50,788	0.9	819	0.03

Note. Calculations are based on collections of four-digit Standard Industrial Classification (SIC) codes (1970) and six-digit North American Industry Classification System (NAICS) codes (2010) using County Business Patterns. Adapted from Storper et al. (2015, p. 36)

specialized, tradable-industry activity base, while Los Angeles was much less successful in building the innovative industries of the post-1970 period.

The reason I focus on tradable industries is that they are the motor force in a region’s economic development. The size of tradable industries in a region is not limited by local population levels or incomes, because a great deal of their output is traded. Moreover, spatial concentration in these industries, made possible by their tradability, can generate productivity gains and also enhance ongoing innovation, hence affirming and prolonging regional advantage. In contrast, nontradables, even though responsible for the majority of any economy’s employment, are largely proportionate to population and local budget constraints and do not serve as a primary motor force in development.

Table 10.3 shows a more detailed breakdown of tradable specializations of the two regions, using subsectoral categories. In San Francisco the IT group of sectors increases its role; whereas in 1970 IT had roughly the same share of employment in the two regions, by 2010 its share is four times greater in the Bay Area than in Greater Los Angeles. The high-wage clusters in Los Angeles account for only 6% of total employment, against nearly 11% for IT in the Bay Area. Notice also that Los Angeles’s specialized core accounts for a decreasing share of total employment, whereas San Francisco’s increases. This gives a picture of the Southern California economy as becoming fuzzier over time (with a lower level of overall tradable specializations) while the Bay Area economy becomes more sharply focused.

Moreover, the Bay Area becomes relatively better specialized than Los Angeles. To see this requires considerable disaggregation. The more aggregated the categories, the more likely is serious unobserved heterogeneity and error in the comparison. For example, a comparison of three-digit sectors that suggests similarity of two

Table 10.3 Specialization: The ten largest tradable industries by employment, 1970 (SIC) and 2010 (NAICS)

Tradable Industry	Employment Share	Tradable Industry	Employment Share
1970 (four-digit SIC)			
Los Angeles		San Francisco	
Aircraft	2.7%	Trucking, except local	1.5%
Trucking, except local	1.2%	Semiconductors	0.9%
Electronic components NEC	0.8%	Business consulting services	0.9%
Communication transmitting equipment	0.8%	Wholesalers NEC	0.7%
Business consulting services	0.8%	Electronic components NEC	0.7%
Aircraft equipment	0.8%	Electronic computing equipment	0.6%
Wholesalers NEC	0.7%	Truck equipment	0.6%
Electronic computing equipment	0.7%	Communication transmitting equipment	0.5%
Truck equipment	0.6%	Commercial machines and equipment	0.5%
Motion picture production, except television	0.5%	Electric measuring instruments	0.5%
Total	9.6%		7.3%
2010 (six-digit NAICS)			
Los Angeles		San Francisco	
Motion picture and video production	1.4%	Software publishers	1.9%
Hotels and motels	1.4%	Custom computer programming services	1.8%
General warehousing and storage	0.6%	Electronic parts & equipment wholesalers	1.7%
Computer systems design services	0.5%	Computer system design services	1.6%
Custom computer programming services	0.4%	Hotels and motels	1.5%
Freight transportation arrangement	0.4%	Research and development in physical, engineering, and life sciences (not biotechnology)	1.5%
Women's clothing wholesalers	0.4%	Computer and peripheral wholesalers	0.9%
Women's, girls', and infants' cut and sew apparel contractors	0.4%	Data processing, hosting, and related services	0.6%
Other aircraft parts and auxiliary equipment	0.3%	Semiconductor and related device manufacturing	0.5%
Electronic parts & equipment wholesalers	0.3%	Wineries	0.4%
Total	6.1%		12.4%

Note. 1970 and 2010 data are imperfectly comparable due to the switch from four-digit SIC codes to six-digit NAICS codes in 1997. NEC = not elsewhere classified. Adapted from Storper et al. (2015, p. 36)

Table 10.4 Average wages in ten tradable sectors with highest employment, 2010

Tradable Sector	Wages (\$)	Tradable Sector	Wages (\$)
Greater Los Angeles		San Francisco Bay Area	
Motion picture and video production	69,016	Software publishers	169,432
<i>Hotels and motels</i>	26,217	<i>Custom computer programming services</i>	111,648
General warehousing and storage	40,878	<i>Electronic parts and equipment wholesalers</i>	139,661
<i>Computer systems design services</i>	90,874	<i>Computer systems design services</i>	111,312
Women's clothing wholesalers	50,931	<i>Hotels and motels</i>	30,260
<i>Custom computer programming services</i>	89,295	R&D in physical, engineering, and life sciences (not biotechnology)	133,834
Freight transportation arrangement	50,684	Computer and peripheral wholesalers	155,961
Women's, girls', and infants' cut and sew apparel contractors	18,548	Data processing, hosting, and related services	120,464
Other aircraft parts and auxiliary equipment	65,685	Semiconductor and related device manufacturing	131,059
<i>Electronic parts and equipment wholesalers</i>	77,947	Wineries	54,954

Note. Sectors featured in both regions are italicized. Wages are in nominal 2010 dollars. Adapted from Storper et al. (2015, p. 39)

regions—say in information technology—could mask underlying dissimilarity in the four-digit components of those three-digit sectors, with the regions carrying out different kinds of work and, most importantly, with different wage levels, growth prospects, and innovation trajectories. In the above comparisons, I disaggregated as much as possible in order to avoid such unobserved heterogeneity.

Table 10.4 sheds further light on this issue by using wage data, showing that wages differ across the two regions within the same broad industry groups. This suggests that the specializations of the two regions are even more different than implied in Table 10.3. Table 10.5 supports this interpretation by displaying wage heterogeneity within the very detailed six-digit components of the IT sector, thus showing that wage differences are not due to unobserved differences within sectors.

Still another way to examine differences in the quality of economic specializations is to compare the content of work in them, which is a proxy for embodied skill levels. According to Autor, Levy, and Murnane (2003), the higher the level of non-routine and cognitive work carried out by an economy, the higher its skill levels and innovation content. Table 10.6 shows that the average level of nonroutineness of the work carried out in the two regions was nearly identical in 1970. Subsequently a wide gap opened up, with the Bay Area having much more nonroutine and cognitive work in its economy by 2008 than Los Angeles, with the latter city falling behind the national average and the Bay Area surging above it. Moreover, Los Angeles's level of nonroutineness is lower than one would expect if its economy were to have

Table 10.5 Average wages in information technology sectors, 2010

Sector	Average Wages (\$)	
	Greater Los Angeles	San Francisco Bay Area
<u>Overall IT Agglomeration</u>		
Information Technology Agglomeration (43 six-digit sectors)	86,169	128,216
<u>Selected six-Digit Sectors</u>		
Software Publishers (511210)	128,583	169,432
Custom Computer Programming Services (541511)	89,295	111,648
Computer System Design Services (541512)	90,874	111,312
Computer Equipment and Software Merchant Wholesalers (423430)	80,416	155,961

Note. Wages are averages expressed in nominal 2010 dollars. Adapted from Storper et al. (2015, p. 91)

Table 10.6 Aggregate regional nonroutine cognitive task indices

Region	1970	1980	1990	2000	2006–2008
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. 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. The calculations are based on the Integrated Public Use Microdata Series (IPUMS) 1% 1970 metro sample; the 5% 1980, 1990, and 2000 samples; and the 3% American Community Survey sample for 2006–2008. Adapted from Storper et al. (2015, p. 45)

had the average national level of nonroutineness for each of its sectors, while San Francisco's levels are higher than expected. Further corroborating this point, in 1970 Los Angeles had patents per capita equaling about 90% of those in the Bay Area; by 2010, they were only 16% (Storper et al., 2015, p. 183).

All in all, then, a clear picture emerges of sharply divergent specialization in terms of wages, the drivers of income differences, which are underpinned by differences in tasks and skills in a way that strongly suggests divergent innovative content of the regions' economic bases.

The Causes of Divergent Specialization: Standard Explanations from Urban Economics

Mainstream theories offer a number of ways they attempt to account for regional economic transitions: the education and skills of the workforce; the role of immigration in changing the skills base; the effect of housing costs and cost of living on

Table 10.7 Wages by educational attainment for workers active in the labor market

Educational Attainment	Wages (\$)				
	1970	1980	1990	2000	2005–2010
Los Angeles, college graduates	11,705	20,408	40,317	54,115	68,730
San Francisco, college graduates	11,127	19,981	41,397	69,807	90,102
Los Angeles, some college	7,631	14,128	25,690	31,959	37,936
San Francisco, some college	7,432	14,057	26,027	38,354	43,608
Los Angeles, high school graduates	6,789	12,319	20,557	24,601	29,727
San Francisco, high school graduates	7,059	12,886	21,191	28,631	32,830
Los Angeles, some high school	5,762	9,782	14,177	16,050	19,690
San Francisco, some high school	6,041	9,328	14,447	15,402	19,452

Note. Calculations made using IPUMS data. College graduates are defined as workers with at least four years of college. Adapted from Storper et al. (2015, p. 55)

selecting for the skills base (i.e., the composition of the workforce). Most of the emphasis in the mainstream models is hence about labor supply (Glaeser & Maré, 2001). In these models, workers with different skills sort themselves into different regions. Highly skilled workers cluster together because they want to interact with one another. Regions with highly regulated housing markets will exclude low-skill workers and drive them to regions with lower cost housing. Jobs are said to follow people, hence shaping differences in specialization, with selective migration according to skills playing a central role (Glaeser, 2008). Even though innovation per se is backgrounded in this reasoning, there is nonetheless a strong implicit view that it (like all other changes in regional economic specialization) is driven by changes in labor supply.

In this immigration-supply model, average regional wage differences must be accounted for by the proportions of differently skilled groups, not by interregional differences in wages to each group by skill, since the models explicitly assume that migration equalizes the latter (i.e., migration enhances composition differences but equalizes skill-wages). Yet Table 10.7 demonstrates that wage gaps between San Francisco and Los Angeles for people with similar education increased steadily over the period. By 2005–2010, Bay Area workers at every skill level all earned about one-third more than their Los Angeles counterparts. Average regional wage differences are therefore not entirely due to the composition of each labor force in terms of educational endowments, but instead because people at all educational levels appear to have higher quality work on average in San Francisco than in Los Angeles.

The quantity of low-skill immigration to Greater Los Angeles was greater than that going to San Francisco, even though both currently have the same overall proportion of foreign born (38%). For these differences in migrant skills to be considered a cause of gaps in average regional wages (and by extension, to have driven specialization), the wage gaps would have to be—once again—proportional to the roles of different migrant groups rather than due to differences in the rewards each group receives across the two regions. As Table 10.8 shows, every group of immigrants in the Bay Area earns on average more than that group does in Los Angeles. In other words, considerable differences in average regional wages would exist even

Table 10.8 Wages of immigrant workers by education attainment

Educational Attainment	Wages (\$)				
	1970	1980	1990	2000	2005–2010
Los Angeles, college graduates	10,153	17,981	33,503	45,561	61,171
San Francisco, college graduates	9,313	17,773	37,081	64,433	87,026
Los Angeles, some college	7,114	12,441	21,695	28,105	35,477
San Francisco, some college	6,913	12,807	23,107	33,890	41,289
Los Angeles, high school graduates	6,233	10,904	16,396	21,649	27,319
San Francisco, high school graduates	6,393	11,351	17,726	24,853	30,238
Los Angeles, some high school	5,908	87,130	12,853	17,650	22,079
San Francisco, some high school	6,029	95,840	14,343	19,198	23,850

Note. Calculations made using IPUMS data. College graduates are defined as workers with at least four years of college. Adapted from Storper et al. (2015, p. 67)

if the regional labor forces were composed of identical proportions of workers from each national origin and skill group.

Both regions have long-term and extensive Asian and Latin American communities with deep social networks that predate the current period and each experienced major upticks in migration by the two groups during this period, although these migrations differed from earlier waves (Myers, Goldberg, Mawhorter, & Min, 2010). In the new migration, Asians with generally higher skills were drawn to the Bay Area in greater proportion because they were better adapted to the demands of growing industries there. Mexicans were probably disproportionately drawn to Southern California instead of the Bay Area because they largely lacked the skills required by the Bay Area's burgeoning new economy sectors, or perhaps because those who did migrate to the Bay Area acquired these skills in the better jobs they found there. Along these lines, other American metropolitan areas with a great deal of Latin American immigration, such as New York and Houston, likely performed much better in income growth than Los Angeles because the structure of demand in those cities offered higher quality jobs, greater on-the-job learning, or better career ladders to Latin Americans.

Mainstream theories also emphasize aggregate changes in labor supply, with higher-wage regions having more housing regulation (supply restriction) than lower-wage regions. But Los Angeles and San Francisco had roughly the same level of residential housing supply expansion and similar levels of housing and land development regulation, allowing them both to have high levels of population growth.²

In the period under examination, there was obviously a self-reinforcing cycle of changes in labor supply and labor demand. But the evidence shown in this section demonstrates that differences in labor supply did not independently drive the wage and income changes that are the observable economic effects of divergence in spe-

²For a detailed analysis of the role of housing regulation and supply expansion, see Storper et al. (2015, pp. 59–65).

cialization. The different labor supply changes observed, in other words, can be considered more as outcomes of Bay Area success in high-end, new economy industries and Los Angeles's weakness, than as causes thereof.

Innovation as a Lottery: Accidents, Size, and Background

The *new economic geography* (NEG) stresses the importance of agglomeration in innovative industries, but it has no single model of why—during major innovative transitions—such agglomerations will locate in specific places. Three such explanations have emerged from the interface between NEG and innovation studies: accidents; size and lock-in; and technological relatedness.

Development as a Lottery: Accidents and Shocks

One possibility is that the geography of breakthrough agglomerations is due to random shocks. In this account, the Bay Area was simply lucky to get Silicon Valley, just as Los Angeles was lucky to get aerospace and Hollywood in the early 20th century. Key versions of the accident or lottery theory center on either unusual individuals or anchor firms. Thus, in some accounts, Silicon Valley is where it is because William Shockley—the inventor of the silicon-based semiconductor—decided in 1956 to relocate from New Jersey to be near his aging mother in Menlo Park, California. Another anecdote concerning Shockley is that after he attracted the best associates to his first-mover firm, his difficult management style and abrasive personality caused them all to quit on the same day (known as *Shockley's massacre*), thus launching the Silicon Valley process of development through spinoff. There are also more hagiographic versions of “great person” stories. One such trope refers to Steve Jobs's unique marriage of functionality and aesthetics when he invented the Macintosh operating system graphic interface. Many other such great person stories can be found in the annals of innovation. But so many prominent names are associated with Silicon Valley—from Shockley and Terman to Hewlett and Packard and Jobs and Gates and Brin and Page and Thiel—that it seems unlikely that all could be there due to coincidence. Moreover, Saxenian (1994) powerfully argued that mere presence of early innovators is not enough. Plenty were located in Boston, but they did not survive. Zuckerberg left Boston for Silicon Valley because Boston was not the right place to transform a breakthrough invention into a full-fledged innovation, just as happened in New Jersey decades earlier, when Shockley left for the Bay Area.

Another idiosyncratic influence on agglomeration might be decisions by key firms at key moments. Motorola located the largest early semiconductor facility in the world in Phoenix in the 1950s, for example, but this did not establish Phoenix as a subsequent center of the IT industry (Scott & Storper, 1987). Motorola made the

mistake of believing that it could be a geographically isolated first-mover in a technologically innovative industry. It turned out that only those firms—such as Fairchild and Hewlett-Packard—that were first-movers but did not isolate themselves from the emerging open source networks of Silicon Valley were able to keep up with the rapidly rising technology curve.

Negative random shocks also figure prominently in explanations of sharp turning points in regional fortunes. At the end of the Cold War, the Department of Defense reduced investments in the aerospace sector, which was highly concentrated in Southern California, and congressional pressure led much remaining procurement to be awarded to other regions (Markusen, Hall, Campbell, & Deitrick, 1991). But the direct and indirect employment losses attributable to the “build-down” of aerospace in the 1990s in Southern California account for less than 3% of the approximate 30% difference in regional per capita incomes (Storper et al., 2015). The Bay Area suffered a substantial negative employment and investment shock in 2000 with the crash of the *dot.com* boom but then fully recovered and went on to further expansion. Many other regions have overcome negative shocks by creating and capturing new waves of innovation. Boston had very bad luck from the 1950s onward in its mill-based industries and was as a result not even among the top ten metro regions ranked by income in 1970 (Table 10.1). However, the city bounced back by building up new economy sectors. New York deindustrialized from the 1960s through the 1970s, but recovered by reinvigorating its finance sector, and went on to a strong presence in the design of applications, life-sciences, and new media. Seattle transitioned from an old mechanical engineering and resource-based economy to a center of high technology. Negative shocks are indeed important to regional economies, but research needs to identify more precisely what distinguishes those regions that transition effectively from those that do not.

The theories about the ability to respond to negative shocks or to transition from one positive response to opportunity to another take up the roles of size, diversification of the economy in question, and the preexisting technology base of regions. I now consider them.

The Size of Agglomerations

The NEG models a snowball process of how regions progressively draw in supplier firms, human talent, and knowledge. Formally, regional agglomerations have economies of scale, driving a wedge between the leading region’s productivity and innovation levels and those of the other regions that host the industry. Once this happens, the leading industry’s position is said to be locked in (Krugman, 1991; Rosenthal & Strange, 2001; Thisse, 2010). If the comparable size of agglomeration in a closely related technology sector were sufficient to lock in positions from one period of development to the next, then Los Angeles was surely in a better position to capture the semiconductor-driven IT industry than the Bay Area (Tables 10.2 and 10.3). Indeed, Los Angeles County firms constituted the biggest cluster of semiconductor

producers as late as 1970, and at that time their semiconductors were the most technologically advanced. Greater size alone failed to help the Los Angeles IT sector transition from its high-quality, expensive chips to mass produced, cheaper ones and their commercial applications.

Moreover, advantages from size are always partial and are ultimately challenged by product standardization and declining trade costs (allowing de-agglomeration). Silicon Valley's cluster has had this kind of ongoing job loss since the 1970s (Saxenian, 1994). In the face of this, as each previous innovation wave has matured, the Bay Area has created the next wave—from chips to personal computers, to servers and network-ware, to the Internet, to mobile broadband hardware and applications—so that reference is now made to *Silicon Valley 7.0* (Lécuyer, 2006). Scale in one area does not lead straightforwardly to mastering the next wave of innovation.

Technological Relatedness and Subsequent Specialization

Another common extension of NEG models to regional economic dynamics is the notion that previous technological endowments have a strong role in shaping subsequent capture or creation of innovation. In the comparison at hand, both regions were home to close technological antecedents of the IT industry. Most detailed historical analyses of the rise of Silicon Valley demonstrate that it grew from the pre-existing communications equipment sector in the Bay Area (Lécuyer, 2006). As Table 10.3 shows, that sector was just as big in proportional terms in Los Angeles in 1970 as its Bay Area counterpart and thus much bigger in absolute terms. The overall IT sector in the two regions accounted for identical shares of their core employment in 1970. And if aerospace and IT are considered together—two key technology sectors united through the demand for communications technology for guiding missiles and satellites—then a priori, the technological antecedents for the IT revolution were much bigger in Southern than in Northern California.

There are many other examples of regions that capture major new sectors with little *technological* relatedness to their preexisting activities. Los Angeles was not a major mechanical engineering region in the 1920s and 1930s, when it became the aircraft engineering center of the United States and, by the 1940s, the world's biggest aerospace cluster. Los Angeles had no previous background in the entertainment industry when the movie studios were established there around 1915. Detroit had fewer antecedents in mechanical equipment than Illinois in the 1890s, but rapidly became the center of U.S. car technology and manufacture. In these, and many other examples, there were technological *windows of locational opportunity*. These ruptures in technological relatedness largely obviate the advantages of preexisting agglomeration economies and create a relatively flat playing field for a short time in the early days of a technology's existence (Scott & Storper, 1987).

Additional arguments about antecedents can now be considered. One such argument is that more diversified economies have a greater probability of successful transitions than narrowly specialized ones. This idea, often attributed to Jane Jacobs

(1969), holds that evolution is a probabilistic process, so having more irons in the fire will likely enable more recombination into future success. Theoretical models of *nursery cities* draw on that notion (Duranton & Puga, 2001). However, in spite of the existence of this notion for many decades, no significant empirical backing for it has been generated. In the case of Los Angeles and San Francisco, the former city was the bigger and more diversified economy in 1970, yet its innovation transition was less successful. I show that diversity per se is not an inherent advantage in the innovation transition but rather—when it does exist—requires connection through relational infrastructure to make it advantageous.

The literature also abounds with stories of narrowly specialized economies that are locked into their technologies and do not transition after negative demand shocks or technology shifts. Thus, Detroit is held up as a case of overspecialization. And yet there are highly specialized centers of mechanical engineering and automotive technology that have mastered subsequent waves of technology, such as Stuttgart. Boston was once narrowly specialized in mill-based industries, as was Seattle in forest products and mechanical engineering, but both are high-tech centers today.

Benjamin Chinitz (1961) made a more subtle argument about the qualities of antecedents. He reasoned that dominant industries tend to monopolize talent, factor supplies, and attention, potentially crowding out other activities, and are hence able to channel the evolution of regional economies down distinctive pathways. New York's antecedents were said by him to be more favorable than those of Pittsburgh. Evolutionary economic geographers give this notion a specific contour, holding that antecedent technologies matter, such that the capacity for regional economic evolution is governed by possibilities for moving into cognate technologies, which they dub *related variety* (Frenken, van Oort & Verburg, 2007). Based on the evidence at hand, such relatedness would clearly have favored Los Angeles and yet San Francisco got ahead.

A somewhat different version of the evolution argument combines technological and organizational antecedents. Saxenian's (1994) seminal comparison of Route 128 and Silicon Valley can be interpreted as showing that the types of entrepreneurship, production organization, and system coordination that existing firms and actors know in a region will shape what it becomes and what kinds of new activities it can generate and capture. Allen Scott, echoing Markusen et al. (1991) has recently argued that the failure of Los Angeles to move into the new economy occurred because the aerospace model of organization—the *genetic codes* of aerospace—weighed it down too much (Aoyama, Powell, Saxenian, & Scott, 2017). But the Bay Area's principal high-tech firms, such as Hewlett-Packard, had an organization almost identical to the aerospace firms in Los Angeles in the 1950s and 1960s; they were *systems houses* using Pentagon guidelines for concurrent engineering. In a parallel example, Seattle was dominated by the assembly lines of Boeing and by large-scale natural resource companies, but now is considered home to some of the most innovative companies in the new economy, who are revolutionizing many organizational practices.

This discussion leaves us with an unsolved mystery. Standard explanations for major regional innovation transitions, whether they are derived from mainstream

urban and regional economics or the extensions of agglomeration economics into innovation studies, cannot account for the great variety of outcomes.

Relational Infrastructure Potentiates Breakthrough Entrepreneurship and New Organizational Practices

If none of the standard accounts fully explains the divergent economic trajectories of the two regions, then a remaining candidate is that there is significant difference in the institutions that shape major transitions of the regional economic base. Institutions are defined here in an expansive way as collective rules, routines, beliefs, or conventions that give regularity to individual behavior in a way that may take precedence over strict individual calculation or self-interest, or that may shape such behavior by generating expectations of payoffs or sanctions from coordination with others. Such institutions can be formal or informal, and can be encapsulated within organizations or in a wider societal environment.

An institutional framework for explaining innovation emerged in the 1990s, when 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) defines a Regional System of Innovation (RSI) as “the *localised* 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*” (p. 499, emphasis in original). Because institutions are means of providing regularity to behavior, they are always underpinned by networks of persons. Networks can range from small-scale and interpersonal to large-scale and anonymous. Networks are a key observable dimension of institutions, though institutions are not reducible to their networks.

In the comparison at hand, sharp differences in networks and, ultimately, the entire RSI, are indeed in evidence. I examine four such differences, all of which are institutional dimensions of the RSIs of Los Angeles and San Francisco. First, greater cross-network connections in the Bay Area allowed that region’s entrepreneurs to invent new organizational practices (Powell & Sandholtz, 2012). Second, early on there were organizational sites for this mixing of networks and for sustaining the mix. Third, the Bay Area developed many informal networks (*invisible colleges*) of technologists, researchers, and entrepreneurs, making it easier to bring them together for new projects. Fourth, elite leadership networks were stronger in the Bay Area and more informed by new economy ideas than in Los Angeles. The joint effects of these four differences—what I call the overall *relational infrastructure* of the regions—is that the RSIs differed in structure, overall strength, and direction.³

³Lazega (2017) also uses the term *relational infrastructure*, with some overlap to my usage, but generally with a narrower meaning having to do with the membership of individuals in organizations or in interorganizational contexts.

Stated another way, there are four observable and measurable dimensions of the differences in the institutionalized RSIs of the two regions, and I use this term to summarize their joint and cumulative effects.

Cross-Network Connections

In the early days of Bay Area IT, there was more than one community that was strongly interested in new information technologies, and there were people who spanned different networks, whose roles as go-betweens enabled the mixing of sensibilities and knowledge (Turner, 2006). From the 1960s onward in the Bay Area there was an *appropriate technology* network of people whose origins lay outside of the Stanford engineering community or the defense-related one. Buckminster Fuller was the utopian alternative technology guru who invented the geodesic dome and proposed alternative technology futures for cities and modern life in general. He embodied the futuristic practicality that would later infuse the developers of personal computers (Foege, 2013). Though he came from the East Coast, his principal breakthroughs occurred while in residence at San Jose State University.

On the other hand, there were traditional engineering networks, organized around the defense-aerospace-communications sector and marquee names such as Hewlett, Packard, and Litton. These networks centered on both Berkeley and Stanford, but Stanford was critical because it contained the Stanford Research Institute, founded by Frederick Terman to link researchers to entrepreneurship (Lécuyer, 2006). Stanford also had the Stanford Artificial Intelligence Laboratory and the Augmented Human Intellect Research Center in the 1960s, both of whose founders—John McCarthy and Douglas Engelbart—and the students working in their labs, were deeply involved in the Bay Area counterculture and political activism (Markoff, 2005).

Critically, Fuller and others did not reject contact with the traditional engineering networks. In the 1960s, they were already creating a bridge between the Bay Area hippies and the tech enthusiasts, as shown by Theodore Roszak in his 1969 book, *The Making of a Counter Culture*. The key published forum for this meeting of counterculture and innovation culture was *The Whole Earth Catalog*. The *Catalog* was published by Stewart Brand, a Stanford-educated biologist, Buckminster Fuller acolyte, and leading Bay Area environmentalist, who also coined the term *personal computer* and the phrase “information wants to be free.” As Foege (2013) noted: “Besides its listings touting primitive tools and sustainable farming methods, the compendium included entries on stereo systems, welding equipment, cameras and computers” (para. 6). Brand was a key figure in building the three-way relationship between tech, wealthy Bay Area elites, and the environmental movement, a third powerful network. He was close to David Brower, who had been the executive director of the Sierra Club and founder of Friends of the Earth and the Earth Island Institute. Brand and Ken Kesey (of *Magic Bus* fame) were the co-producers of the Trips Festival, a rock music gathering held in San Francisco with the world’s first light show, involving the Bay Area artistic networks in the early technology move-

ment. The proof of this network-spanning is that Steve Jobs cites the *Catalog* in his 2005 commencement address at Stanford as one of the major sources of inspiration for the Apple personal computer and its operating system, and for the overall aesthetic of the company (Jobs, 2005).

A new vision of technology was generated by this cross-network pollination. Bay Area environmentalist movements not only had a traditional elite focus on land conservation, but also had a utopian notion of using capitalism to make a better world through a rationalist and technological approach to better modern living. The difference between alternative technologists and mainstream engineers was not about the virtues of technological solutions to social problems, but more that the former had an innate preference for decentralization and small scale, and the latter for centralization and scale (Turner, 2006). The phenomenon is explicitly emphasized by such early industry leaders as Jaron Lanier, who wrote in 2013 that “it’s hard to overstate how influential” (p. 205) the crossover between countercultural spirituality and tech culture was in the early days of Silicon Valley. This crossover took the specific organized form of the Global Business Network, a durable meeting place for environmentalists and technologists founded by, among others, Stewart Brand.

Important members of the San Francisco downtown finance and corporate elite were on the boards of directors of the major environmental organizations—drawn in especially through the leadership of David Brower. The result was a fourth important Bay Area node in the networks that interacted with the technology community. This mixture of straight-laced elite and bohemian experimentalism had boundary-spanners such as Brand and others moving between them.

The cross-network mixing had a geographical dimension. Hewlett and Packard started out in the 1930s, far outside the orbit of downtown San Francisco. In the 1960s, Bay Area elites were still based in San Francisco and focused on the traditional industrial base of the region. Silicon Valley was a *greenfield*, a fringe of the region, with little geographical or network integration with San Francisco. But that city’s elites subsequently incorporated the growing Silicon Valley interests and generated strong and multi-layered exchanges between the old and the new industries, but especially between the likes of Hewlett, Packard, Jobs, the environmentalists, the downtown San Francisco corporate leadership, researchers, and the alternative technology movement (Lazarus, personal communication, 2009). This never happened in Southern California, where Los Angeles-based leadership networks actually became more cut off from Orange County’s emerging tech networks, as I discuss below, and neither of them mixed with alternative technology communities nor with the super-charged entrepreneurial world of Hollywood.

Organized Sites of Cross-Network Contact

A key organized 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 its focus on

military procurement; the conventional, academic engineering research community; and the Bay Area alternative technology circle. 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. PARC seems to have picked up on the atmosphere in the other aforementioned labs from earlier in the 1960s. 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 the makeshift nature of San Francisco culture at that time in much the same terms. Paul Duguid, an early presence at PARC, confirmed the Center's key role as a bridge between networks and different ideas about how to push the commercial application of the new technologies. These commercial applications decisively transformed the vision of the defense-engineering crowd (Duguid, personal communication, 2009). It was crucial that the contacts between these networks, initially informal and casual, had a site where their contact would become sustained when it was fragile and given the imprimatur of legitimacy. PARC deepened relationships among key early actors that came from very different worlds.

None of this occurred 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. The University of Southern California, UCLA, and the California Institute of Technology (Caltech) never developed the networks that would put research scientists closely in contact with engineers, much less the intermediate hippie-environmentalist network tissue that often brought them in contact in the Bay Area.

Informal Networks: Invisible Colleges

Invisible college networks of technologists who have worked together in one way or another are many times bigger and denser in the Bay Area than in Los Angeles. 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 Los Angeles (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 & Mowery, 2014). The percentage of patents issued to Bay Area firms or researchers that cite other Bay Area patent holders is almost four times as high as the percentage of patent holders in Los Angeles that cite patent holders in Los Angeles (Sonn & Storper, 2008).

These numbers are the result of a process in the Bay Area consisting of serial entrepreneurship and serial science-entrepreneurship interactions. The more people

who established these networks, the more there were to draw on as new projects and ventures took place. Each round of this incipient system brought exponential increases in the size of the informal networks and ever larger 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. As the former director of the Southern California Association of Governments put it:

the Bay Area got ahead of the curve with respect to the notion of networking systems that allowed for further dissemination of ideas, inventions to innovations . . . the Bay Area began to see the need for networks and networks operating within networks sooner than we did here. (Pisano, personal communication, 2009)

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 Los Angeles weakened and became more fragmented. Moreover, elite leadership groups in the Bay Area early on endorsed a new economy view of the world and the Bay Area's role in it, while the standpoint favored in Los Angeles looked backward, viewing a previous era of mass production in their region as a desirable future to be relaunched.

Storper et al. (2015) measured the connections among members of boards of directors of the principal corporations in the two regions, and the contrast was striking, as can be seen in Figure 10.3. In the Bay Area, even when a control is carried out for the higher level of industrial specialization of the economy, there are more board interlocks, signifying a more networked elite.

But in addition, the elite in San Francisco gave itself a strong formal organization for sustaining networking, the Bay Area Council. Mark Pisano, longtime director of the Southern California Association of Governments, contrasted the leading business network in Southern California, the Los Angeles Chamber of Commerce, to the leading San Francisco network, the Bay Area Council:

When I first came here I went to the Los Angeles Chamber, which at that point in time was a five county chamber and said let's have a public and private coordination and the Los Angeles chamber said, "We don't need the public sector and we really don't want to venture with you." You had a different attitude between the Bay Area Council, which existed at that time and their regional organizations . . . And I think to this date we still don't have the [equivalent of the] Bay Area Council down here. (Pisano, personal communication, 2009)

Max Neiman, the Associate Director and Senior Fellow at the Public Policy Institute of California, echoed this view:

So, there is a cohesiveness up here politically and institutionally that doesn't exist in Southern California. Southern California is much more decentralized politically. You don't have anything really like the Bay Area Council in Southern California. (Neiman, personal communication, 2009).

San Francisco

Los Angeles

Fig. 10.3 Board Interlocks in the San Francisco Bay Area and Greater Los Angeles, 2010. From Storper et al. (2015, pp. 173–174). Copyright 2015 by Stanford University Press. Adapted with permission. © 2015 by the Board of Trustees of the Ireland Stanford J University. All rights reserved. By permission of the publisher, sup.org. No reproduction or distribution is permitted without prior publisher's permission

Jim Lazarus of the Bay Area Council saw it this way:

The Bay Area Council calls us all together, so that we can say, okay, we want these projects in the Bay Area or in Northern California, and now we are going to lobby as one . . .
(Lazarus, personal communication, 2009)

To investigate these impressions more systematically, Storper et al. (2015) measured what is known technically as the *nBetweenness centrality* of the Bay Area Council and the Los Angeles Chamber of Commerce in the networks of their respective regions. This statistic represents the degree to which an organization in a network lies on the shortest path between all pairs of firms in that network. If the *nBetweenness* score of a particular organization in a network is 15%, then this organization lies on 15% of the shortest paths between all pairs of organizations in that network. To make this more concrete, consider two Bay Area firms: Del Monte Foods and Genentech. If David West, the chief executive officer (in 2013) of Del Monte, wants to find a mutual acquaintance at Genentech, the shortest path through the network of board interlocks is as follows: Del Monte Foods → Bay Area Council → San Francisco Chamber of Commerce → The Christensen Fund → Genentech. Hence, the Bay Area Council represents a link on the shortest chain that connects these two firms, suggesting that its members are likely to be involved in connecting these two firms.

The Bay Area Council lies on 18% of all the shortest paths of overlapping board memberships between pairs of firms in the Bay Area network (Table 10.9). Meanwhile, the Los Angeles Chamber of Commerce lies on just 6% of the shortest paths. The Bay Area Council is the most central organization in either region. In addition, both the Silicon Valley Manufacturing Leadership Group and the San Francisco Chamber of Commerce are more central than any business leadership organization in Greater Los Angeles.

Not only were Bay Area networks stronger, broader, and more inclusive, but the content of the visions they articulated was different. Douglass North, in accepting the Nobel Prize in economics, affirmed that beliefs and attitudes matter in economic development, because they serve as a decentralized coordinating force under uncertainty (North, 1993). A content analysis of 30 years of reports of major business leadership groups and public agencies charged with economic development revealed that in the Bay Area, through its Bay Area Council Economic Institute, there had been a perceptible and consistent focus since the late 1970s on the Bay Area as a knowledge economy, whose comparative advantage in the world had shifted to high-skill, knowledge-based activity. 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 Los Angeles 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,

Table 10.9 nBetweenness of regional business leadership organizations and business leaders

Region	Business Leadership Organization	nBetweenness (%)
Greater Los Angeles	Los Angeles Chamber of Commerce	5.9
	Los Angeles Economic Development Corporation	1.7
	Valley Industry & Commerce Association	0.6
	Orange County Business Council	0.0
	CALSTART	0.0
San Francisco Bay Area	Bay Area Council	18.0
	Silicon Valley Manufacturing Leadership Group	6.0
	San Francisco Chamber of Commerce	5.8
	Semiconductor Industry Association	5.0
	Joint Venture Silicon Valley (JVSV)	0.0

Adapted from Storper et al. (2015, p. 180)

the Bay Area and Los Angeles 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 Biotechnology Case: History Repeats Itself

Nothing exemplifies the difference in how the relational infrastructures of Greater Los Angeles and San Francisco documented previously shaped different responses to challenges and opportunities better than the pathways traveled by the two regions in the emerging biotechnology sector. The science of gene splicing emerged contemporaneously in the two regions. In 1976, Arthur Riggs and Keiichi Itakura were the first to demonstrate that strands of DNA could be synthesized; they achieved this at City of Hope medical research center in Southern California. At the same time, Stanley Cohen, at the University of California, San Francisco (UCSF), and Herbert Boyer, at Stanford, were carrying out the research that would lead to the Cohen-Boyer patents for recombinant DNA in 1980, 1984, and 1988. Moreover, each region developed a pioneering flagship firm: Amgen in Los Angeles, Genentech in San Francisco.

Both Genentech and Amgen were initially founded by venture capitalists, in concert with research scientists, respectively at UCSF and the University of California, Los Angeles. Genentech was founded in 1976 by UCSF biochemist Boyer, working with Robert Swanson, a young venture capitalist. The key feature of Genentech was that it encouraged its scientists to publish their findings in academic journals and kept these research scientists in strategic managerial positions and on the board of directors.

Amgen was the brainchild of a Silicon Valley venture capitalist, William Bowes, who wanted to create a biotech firm with an all-star scientific advisory board. Bowes

asked a Stanford geneticist to assemble the board, but he declined, turning the task over to Winston Salser, a molecular biologist based at UCLA. The first break with Bay Area tradition occurred: Amgen was located in Thousand Oaks in order to be equidistant from UCLA, the University of California, Santa Barbara, and Caltech, effectively isolating it from all of them. Powell and Sandholtz (2012) note that:

This geographical isolation is certainly one cause and consequence of Amgen's development as a sort of scientific island, manifest not only in its singular achievement of FIPCO (fully-integrated pharmaceutical company) status, but also in its aggressive (and on the whole, successful) legal battles to protect its core patents. (p. 411)

Within three years, the scientists were eliminated from management, following a successful initial public offering. Powell and Sandholtz (2012) call Amgen a "commerce dominated company" (p. 411) in contrast to the science-dominated major companies of the Bay Area.

[Amgen's] . . . 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. (Powell & Sandholtz, 2012, p. 420)

Genentech, meanwhile, actively encouraged its scientists to start up other firms and interact with the Bay Area high tech entrepreneurship environment, through revolving doors, feeding into the previously mentioned invisible colleges.

Thus, Amgen's managers took a conception of how to succeed that borrowed from the standard playbook of the old-economy corporate world that dominates in Greater Los Angeles. The paradoxical outcome of this is that although Los Angeles has a world-class biotechnology firm, one that was a first-mover, but that company has not become the seed for a major biotech cluster. The Genentech approach had much more favorable consequences for regional economic development in the Bay Area. From 1976–2005, four times more biotech firms were created in the Bay Area than in Los Angeles, more than twice the patents, more than ten times the venture capital funding, and more than 50 times the revenues from initial public offerings (Casper, 2009).

What is in the Air: Contrasting Regional Zeitgeists

Paul Duguid, one of the participants in Xerox Corporation's PARC in the 1970s, used the term *zeitgeist* to describe the Bay Area's *open source culture*. He stressed that the *zeitgeist* is not *technology specific*, by which he meant that it is general to the region (Duguid, personal communication, 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 is a German term that translates as the *spirit of the age*, here meaning the spirit of the age in a certain region. *Zeitgeist* consists of the shared ideas and practices and ways of organizing things that take hold in economic environments. These shared ideas, beliefs, practices, and ways of doing are often not fully evident

to the people who do them. The *Economist* (2015) magazine recently said, along these lines, that “Cambridge’s genius is off-balance-sheet.” These notions correspond to what the analytical philosopher David Lewis (1969) defined as “conventions,”⁴ which are something like rules of thumb, and are similar to the beliefs as used by North (1990, 1993). Conventions shape economies by helping large and decentralized communities of actors to stay on the same page, underpinning the functioning of an organizational ecology.

The entertainment industry in Hollywood was the exception to Southern California’s conservative zeitgeist. Beginning in the 1950s, Hollywood responded to the twin challenges of competing technology (television) and a U.S. Department of Justice anti-trust action that broke its monopolistic distribution networks (studio-owned movie theaters). In response, it became a project-based industry and by the 1970s was already pioneering flexible combinations of firms and knowledge and inputs from external networks (Storper & Christopherson, 1987). The giant firms (the studios) transformed themselves from mass production movie factories into investors, product developers, and marketers of films and their branded offshoots. They are very much like venture capital organizations today.

Yet Hollywood’s transformation into a new organizational ecology did not transform the wider Los Angeles economy. There are many reasons for this. Part of it 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. But Los Angeles’s problem is not uniquely one of technological unrelatedness between Hollywood and technology. Seattle has transitioned from mechanical engineering and forest products to an Internet-based economy and Boston from mill-based manufacturing to a research-and-development-based economy. Los Angeles’s entertainment agglomeration has actually flourished, but there are virtually no networks to allow it to transfer its organizational skills to the region’s engineering firms. Even when New Economy opportunities like Amgen came Los Angeles’s way, the region’s weak or non-overlapping networks and conservative zeitgeist pulled it back to the business practices of an earlier era.

Conclusion

In this detailed paired comparison of the innovation transitions of two major metropolitan regions, I have proceeded first by considering the standard explanations of divergent pathways of economic change and found them wanting. This turned attention to institutions, and especially regional innovation systems. I decomposed the

⁴Lewis defines these as: “A regularity R, in the behavior of members of a population P, when they act in a recurrent situation, S, is a convention . . . for the members of P, when: Each conforms to R; Each anticipates that others will conform to R; Each prefers to conform to R on the condition that others do so. Since S is a problem of coordination, the general conformity to R results in coordination.” (Lewis, 1969, p. 42)

RSI into four distinctive elements—together comprising the relational infrastructure of a region—and showed that the two regions under examination differ significantly in all four areas. By combining this information with a historical perspective, and by showing the parallels to a more recent example—biotechnology—of their divergent reaction to technological opportunities, I showed that these region-wide institutional structures provide a plausible explanation of their different innovation transitions.

A paired comparison has the advantage of depth and controls for many sources of additional variation, but the disadvantage of small sample size. What remains now is to extend this deep case study approach to a larger sample of cases. To do so, robust but detailed data on the forces documented in this paper are needed, as well as systematic data on a larger number of regional innovation transitions. It seems promising that the type of explanation advanced here could successfully fill in some existing gaps in the current understanding of transitions. At the present time, explanations range from fully historicist and unique (luck), to attempts (not very successful on balance) to reduce such transitions to technological antecedents, factor endowments, size, and diversity. As defined here, the institutional differences documented in this comparison might then emerge as a missing link between these other factors and outcomes, the common element in what is a dizzying set of differences in the starting and ending points of regional transitions.

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References

- Aoyama, Y., Powell, W., Saxenian, A., & Scott, A. (2017, April 5). [Review of the book *The rise and fall of urban economies: Lessons from San Francisco and Los Angeles*, by M. Storper, T. Kemeny, N. Makarem, & T. Osman]. *AAG Review of Books*.
- Autor, D. H., Levy, F., & Murnane, R. J. (2003). The skill content of recent technological change: An empirical exploration. *Quarterly Journal of Economics*, 118, 1279–1334. doi:<https://doi.org/10.1162/003355303322552801>
- Casper, S. (2009). *The marketplace for ideas: Can Los Angeles build a successful biotechnology cluster?* Los Angeles: The John Randolph Haynes and Dora Haynes Foundation.
- Chinitz, B. (1961). Contrasts in agglomeration: New York and Pittsburgh. *American Economic Review*, 51, 279–289. Retrieved from <http://www.jstor.org/stable/1914493>
- 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. doi:<https://doi.org/10.1006/juec.1998.2126>
- Duranton, G., & Puga, D. (2001). Nursery cities: Urban diversity, process innovation, and the life cycle of products. *American Economic Review*, 91, 1454–1477. doi:<https://doi.org/10.1257/aer.91.5.1454>
- Feldman, M. P. (1994). *The geography of innovation*. Boston: Kluwer Academic.

- Feldman, M. P. (2014). The character of innovative places: Entrepreneurial strategy, economic development and prosperity. *Small Business Economics*, 43, 9–20. doi:<https://doi.org/10.1007/s11187-014-9574-4>
- Feldman, M. P., & Lowe, N. J. (2011). Restructuring for resilience. *Innovations: Technology, Governance, Globalization*, 6(1), 129–146. doi:https://doi.org/10.1162/INOV_a_00063
- Feldman, M. P., & Zoller, T. D. (2012). Dealmakers in place: Social capital connections in regional entrepreneurial economies. *Regional Studies*, 46, 23–37. doi:<https://doi.org/10.1080/00343404.2011.607808>
- Foege, A. (2013, February 27). California's successful dilettantes. *Zocalo Public Square*. Retrieved from <http://www.zocalopublicsquare.org/2013/02/27/californias-successful-dilettantes/chronicles/who-we-were/>
- Frenken, K., van Oort, F., & Verburg, T. (2007). Related variety, unrelated variety and regional economic growth. *Regional Studies*, 41, 685–697. doi:<https://doi.org/10.1080/00343400601120296>
- Ganong, P., & Shoag, D. (2012). Why has regional income convergence in the U.S. stopped? Harvard Kennedy School Faculty Research Working Paper Series (RWP12-028). Retrieved from http://scholar.harvard.edu/files/shoag/files/why_has_regional_income_convergence_in_the_us_declined_01.pdf
- Getting to Cambridge: The political philosophy of Britain's most successful city. (2015, August 22). *The Economist*, para. 8. Retrieved from <http://www.economist.com/news/britain/21661670-political-philosophy-britains-most-successful-city-getting-cambridge>
- Glaeser, E. L. (2008). *Cities, agglomeration and spatial equilibrium*. Oxford: Oxford University Press.
- Glaeser, E. L., & Maré, D. C. (2001). Cities and skills. *Journal of Labor Economics*, 19, 316–342. doi:<https://doi.org/10.3386/w4728>
- Gordon, R. J. (2016). *The rise and fall of American economic growth*. Princeton: Princeton University Press.
- Heller, N. (2013, October 14). Bay Watched: How San Francisco's new entrepreneurial culture is changing the country. *The New Yorker*. Retrieved from <http://www.newyorker.com/magazine/2013/10/14/bay-watched>
- Iammarino, S. (2005). An evolutionary integrated view of regional systems of innovation: Concepts, measures, and historical perspectives. *European Planning Studies*, 13, 497–519. doi:<https://doi.org/10.1080/09654310500107084>
- Jacobs, J. (1969). *The economy of cities*. New York: Random House.
- Jaffe, A. B. (1989). Real effects of academic research. *American Economic Review*, 79, 957–970. Retrieved from <http://www.jstor.org/stable/1831431>.
- Jobs, S. (2005). Commencement speech, Stanford University. Retrieved from <http://www.networkworld.com/community/blog/apples-steve-jobs-stanford-commencement-speech-transcript>
- Kenney, M., & Mowery, D. C. (2014). *Public universities and regional growth: Insights from the University of California*. Redwood City: Stanford University Press.
- Krugman, P. R. (1991). Increasing returns and economic geography. *Journal of Political Economy*, 99, 483–499. doi:<https://doi.org/10.3386/w3275>
- Lanier, J. (2013). *Who owns the future?* New York: Simon & Schuster.
- Lazega, E. (2017). Organized mobility and relational turnover as context for social mechanisms: A dynamic invariant at the heart of stability from movement. In J. Glückler, E. Lazega, & I. Hammer (Eds.), *Knowledge and networks* (pp. 119–142). *Knowledge and Space: Vol. 11*. Cham: Springer.
- Lécuyer, 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, 95–119. doi:<https://doi.org/10.1080/13662710601130863>
- Maddison, A. (1982). *Phases of capitalist development*. Oxford, UK: Oxford University Press.
- Markoff, J. (2005). *What the dormouse said: How the 60s counterculture shaped the personal computer industry*. London: Penguin.

- Markusen, A., Hall, P., Campbell, S., & Deitrick, S. (1991). *The rise of the gunbelt: The military remapping of industrial America*. New York: Oxford University Press.
- Moretti, E. (2012). *The new geography of jobs*. Boston: Houghton Mifflin Harcourt.
- Myers, D., Goldberg, S., Mawhorter, S., & Min, S. (2010). Immigrants and the new maturity of Los Angeles. In A. Modarres (Ed.), *State of the City* (pp. 12–27). Los Angeles: Pat Brown Institute, California State University. Retrieved from http://popdynamics.usc.edu/pdf/2010_Myers-etal_Immigrants-New-Maturity-LA.pdf
- North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge, UK: Cambridge University Press.
- North, D. C. (1993). *Economic performance through time* [Nobel prize lecture]. Retrieved from http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/1993/north-lecture.html
- Pomeranz, K. (2000). *The great divergence: China, Europe and the making of the modern world economy*. Princeton: Princeton University Press.
- Powell, W. W., & Sandholtz, K. (2012). Chance, nécessité, et naïveté: Ingredients to create a new organizational form. In J. F. Padgett & W. W. Powell (Eds.), *The emergence of organizations and markets* (pp. 379–433). Princeton: Princeton University Press.
- Rosenthal, & Strange. (2001). The determinants of agglomeration. *Journal of Urban Economics*, 50, 191–229. doi:<https://doi.org/10.1006/juec.2001.2230>
- Roszak, T. (1969). *The making of a counter culture: Reflections on the technocratic society and its youthful opposition*. Garden City: Doubleday.
- Saxenian, A. (1994). *Regional advantage: Culture and competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press.
- Scott, A. J., & Storper, M. (1987). High technology industry and regional development: A theoretical critique and reconstruction. *International Social Science Journal*, 39, 215–232.
- Sonn, J. W., & 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, 1020–1039. doi:<https://doi.org/10.1068/a3930>
- Storper, M., & Christopherson, S. (1987). Flexible specialization and regional industrial agglomerations: The case of the U.S. motion picture industry. *Annals of the Association of American Geographers*, 77, 104–117. doi:<https://doi.org/10.1111/j.1467-8306.1987.tb00148.x>
- Storper, M., Kemeny, T., Makarem, N., & Osman, T. (2015). *The rise and fall of urban economies: Lessons from Los Angeles and San Francisco*. Redwood City: Stanford University Press.
- Storper, M., & Walker, R. (1989). *The capitalist imperative: Territory, technology and industrial growth*. New York: Basil Blackwell.
- Thisse, J.-F. (2010). Toward a unified theory of economic geography and urban economics. *Journal of Regional Science*, 50, 281–296. doi:<https://doi.org/10.1111/j.1467-9787.2009.00651.x>
- 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. (2008). Scales of regional income disparities in the USA, 1955–2003. *Journal of Economic Geography*, 8, 79–103. doi:<https://doi.org/10.1093/jeg/lbm044>

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