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The Shadow of Silicon Valley: The Dispersion of the Information Technology Industry Throughout The San Francisco Bay Area, 1990-2010

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The Shadow of Silicon Valley:
The Dispersion of the Information Technology Industry
Throughout The San Francisco Bay Area, 1990-2010

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By
Taner Osman
2015

ABSTRACT OF THE DISSERTATION

The Shadow of Silicon Valley:
The Dispersion of the Information Technology Industry
Throughout The San Francisco Bay Area, 1990-2010

By

Taner Osman
Doctor of Philosophy in Urban Planning
University of California, Los Angeles, 2015
Michael C. Storper, Chair

Regional economic development is shaped by the growth dynamics of certain industries. The forces that shape industrial location across regions reflect the demand by industries for a particular region, which is determined by the economic geography of an industry, and the comparative advantage of the region for that industry. Large metropolitan regions are not uniformly attractive to key industries, but instead offer a wide range of different locational attributes. Within metropolitan regions, decision-making is fragmented across myriad local governments. These governments (cities and their planning and economic development activities) act in a disjointed manner to shape where industries locate. Thus, local authorities may have effects on industrial location and efficiency that go beyond their borders, as they shape the geography of the industry in the region as a whole. The changing geography of the information technology (IT) industry in the San Francisco Bay Area, the home of Silicon Valley, is a key example of the intersection of the economic geography of an industry with local economic

development policies. The IT industry has dispersed from its original home in Santa Clara County, around the broader 10-county metropolitan region. In 1990, cities in Santa Clara County were home to 71% of the region's IT jobs; in 2010, they were home to 57% of these jobs. This dissertation finds that land use regulation has shaped the geography of the industry within the regional economy and considers the effects of this evolution. The principal contribution of this dissertation is to bring together two bodies of theory and evidence that are typically considered in isolation from one another: local land use and economic development actions and economic geography. By doing this, it allows consideration of how uncoordinated local actions pertaining to land use and economic development might affect the performance of an industry that functions at a metropolitan scale, and hence reevaluate the actions of local planners in terms of wider regional economic development effects.

The dissertation of Taner Osman is approved.

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Chris Tilly

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2015

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Introduction

Over the past five years, the emergence of a new generation of Information Technology (IT) companies has signaled the start of another IT boom within the San Francisco Bay Area. Airbnb, LinkedIn, Lyft, Twitter, Uber and WhatsApp are now as synonymous with Silicon Valley – which is located within the Bay Area – and the IT industry generally, as Ebay, Facebook, Google and Yahoo were at the turn of the century. An era of depressed economic growth and job creation appears to be coming to a close (in the US context, at least), and the performance of Silicon Valley has emerged as one of the pillars of the economic recovery. Such has been the extent of Silicon Valley's wealth creation and innovation in the IT industry for a number of decades that, as each new wave of the IT industry develops, it seems natural for Silicon Valley to be leading the way.

Within the San Francisco Bay Area, however, the geography of the IT industry has experienced a pronounced evolution. This change is most clearly in evidence in the distribution of IT employment across the regional economy. Over the period 1990-2010, IT job losses have occurred in the cities that have been home to the historical core of the IT industry within the region (Silicon Valley), while IT employment has grown in cities that have been relatively peripheral to the location of the industry within the region. This dissertation will explore the reasons underlying the dispersion of the IT industry within the San Francisco Bay Area economy over this period and examine the significance of this change from the perspective of the performance of the industry within the region.

Silicon Valley

The San Francisco Bay Area is, today, formally comprised of 12 counties. The Federal Government's Office of Management and Budget defines the metropolitan region, officially referred to as a Combined Statistical Area (CSA), as comprising: Alameda, Contra Costa, Marin, Napa, San Francisco, San Benito, San Joaquin, San Mateo, Santa Clara, Santa Cruz, Solano and Sonoma Counties. These counties are considered to be an integrated region because there exists a high degree of social and economic interaction between the people and firms that reside in and are located across them. The counties of San Benito and San Joaquin were added to the definition of the region in 2012 (as the region has expanded in size), and since this occurred after the period of observation in this study (1990-2010), they will not be included in this dissertation. This study will, therefore, focus on the 10-county region illustrated below.

Figure 1: The Counties of the San Francisco Bay Area

The term Silicon Valley originally referred to a group of cities in the northwest of Santa Clara County, and Menlo Park, in the neighboring San Mateo County[1]. Today, most observers consider Silicon Valley to include all of Santa Clara and San Mateo

[1] Silicon Valley is not an admisitrative region and its boundaries have expanded as the IT industry has grown over time.

Counties and parts of western Alameda County[2]. However, according to a number of key measures, the development of the IT industry within the San Francisco Bay Area has been, until quite recently, led by the performance of the part of the industry that is located in Santa Clara County. In 1989, Santa Clara County was home to over 70% of the region's IT employment. At this time, 7 cities (out of 103 across the metropolitan region) in Santa Clara County (the cities of Cupertino, Milpitas, Mountain View, Palo Alto, Santa Clara, San Jose and Sunnyvale) were home to 68% of all IT jobs in the Bay Area. Furthermore, the industry in Santa Clara County has been home to the most recognizable companies in the region, such as Apple, Facebook, Google, Hewlett Packard, Intel and Yahoo!. The industry in the county has also been home to the majority of patent activity and venture capital funding within the region (Kenney, 2000). Santa Clara County is not completely synonymous with Silicon Valley, but for decades the part of the IT industry within it has been the principal contributor to the IT industry within the region.

The Dispersion of the IT Industry Around the Bay Area, 1990-2010

The period from 1990 to 2010 was a period of pronounced growth followed by a sharp decline for the IT industry in the region. Over the period 1990-2000, during the dot.com bubble, over a quarter of a million net IT jobs were added to the Bay Area economy, representing roughly 28% of all of the net jobs added to the region over this period. Over the period 2001-2010, the IT industry in the region shed 220,254 net jobs, which accounted for around 83% of the net jobs lost in the region over this period.

During the 1990s, the San Francisco Bay Area was the epicenter of the tech bubble. The remarkable growth of the IT industry throughout the 1990s and the aftermath

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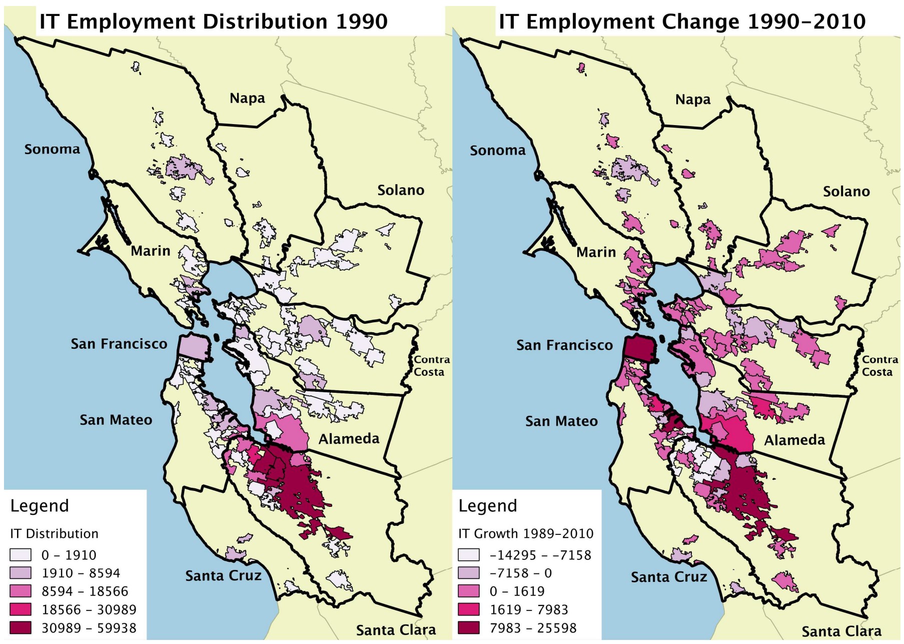
[2] Joint Venture Silicon Valley, a Silicon Valley leadership organization, today defines the region as the cities of San Mateo and Santa Clara Counties, the cities of Fremont, Newark and Union City in Alameda County, and Scotts Valley in Santa Cruz County (Massaro, 2015)

of the subsequent bust have had geographical consequences within the region. In the face of such change, the IT industry in some counties, and the cities within them, has fared better in terms of IT job creation than in others. Despite the IT industry's historical strength in Santa Clara County, the performance of the industry in the county, as measured by net job creation, has been declining. In 1990, IT establishments in the county employed roughly 71% of the region's IT workers. By 2010, however, this share had fallen to 57.5%. In 2010, there were 25,864 fewer IT jobs in Santa Clara County than there were in 1990 – at a time when the IT industry within the regional economy added jobs. In fact, Santa Clara County was only one of three counties within the region where IT industry employment did not grow over the period. Of the 10 cities in which the highest number of net IT jobs were lost after the tech bubble burst, 6 of these cities are found in Santa Clara County. The IT job losses across these cities are significant. The industry in Cupertino, Mountain View and Sunnyvale, which is where the IT industry pioneered within the region, lost over 10,000 jobs in each of these cities over this period.

In figure 2 below, the distribution of IT employment across the cities within the San Francisco Bay Area in 1990 is displayed in the left panel. The map shows the extent to which IT activity was clustered in the northwest of Santa Clara County at this time. In the right panel, by contrast, growth of IT employment by city over the period 1990-2010 is displayed. Here the loss of jobs in the cities in the northwest of Santa Clara County can be seen, while employment growth has occurred in many other cities throughout the region. While this dissertation examines the dispersion of the IT industry from Silicon Valley, the boundaries of Silicon Valley have changed over time. From an analytical standpoint, the dispersion of the IT Industry has occurred from the cities in Santa Clara

County around the broader region. From a geographical standpoint, city governments are the unit of analysis in this study, since, as will be described below, they have powers, in principle, to affect the location of the IT industry within the regional economy. In total, there are 103 city (or municipal) governments in the Bay Area and this dissertation seeks to determine why the IT industry has performed differently across these cities.

Figure 2: IT Employment Distribution in 1990 and Subsequent Change



In recent years, the IT industry within the Bay Area has started another period of pronounced innovation and expansion, led by firms in the social media and "shared economy" functions of the sector. Over this period, the City of San Francisco has emerged as a major IT center. Over the period 2008-2012, for example, the IT industry in the City of San Francisco[3] accounted for 13,000 of the 10,000 net IT jobs added to the region. Since 2008, by contrast, the IT industry in Santa Clara County has shed around 7,000 jobs. Seen in this light, it is the City of San Francisco, not Santa Clara County, that

[3] From an adminsitrative standpoint, San Francisco is both a city and a county

is at the center of regional growth in IT employment. The growth of the IT industry in San Francisco is somewhat surprising since the city has historically been a finance, insurance and business services center, with relatively little activity in the IT industry.

Chapter 2 will present data that shows that while the IT industry in Santa Clara County has lost jobs over the period 1990-2010, the IT industry in other parts of the region has gained in employment. As mentioned above, over this period, IT industry employment in Santa Clara County declined by 25,864 jobs. At the same time, IT employment grew in the cities of Alameda (by 19,169), San Francisco (by 16,405) and San Mateo (by 25,039) Counties.

The IT industry in the cities of these four counties (Alameda, San Francisco, San Mateo and Santa Clara) made up 93% of the region's total in 2010. Yet historically, the firms located across these counties have performed different functions within the regional economy[4]. San Francisco has been the region's de facto downtown or central business district. It is densely developed in office buildings that have been home to finance, insurance, and business and legal services. Alameda County, by contrast, has been less densely developed, characterized by low-rise facilities. Historically, it has been relatively specialized in manufacturing and relatively lower value added economic functions within the region. Santa Clara County, and to an extent San Mateo County, were relatively less well developed until after the Second World War but then became relatively specialized in defense and electronics related research and development functions and sophisticated manufacturing functions (and are also characterized by relatively low density land use).

[4] County boundaries, to an extent, can be relatively arbitrary with respect to the scale at which regional economies operate. In reality, the division of functions within the regional economy is more fine-grained than these boundaries would suggest. However, county boundaries are a useful, if crude, way to dissect the regional economy.

As should be expected, given the differences in the nature of economic activity across these counties, the composition of the IT industry differs across them. Today, the industry found in San Francisco and San Mateo Counties is relatively specialized in software components. At the same time, the industry in Santa Clara County is relatively more specialized in the sophisticated, while in Alameda County, it is specialized in relatively less sophisticated, hardware and manufacturing components of the industry. This discussion is important since, to truly understand the nature of the dispersion of the IT industry from Santa Clara County around the broader region, it is critical to understand the nature of the growth of the industry in the other parts of the region.

For example, can the growth of the industry within Alameda County be understood as the deagglomeration of the lower value added functions from Santa Clara County to this relatively cheaper part of the regional economy? Can the growth in San Mateo County be understood as direct spillover from the original core of the industry in Santa Clara County to its neighbor to the west? If this is the case, the IT core within the region has expanded outwards and as a whole, the core of the original region has simply pivoted geographically. Furthermore, how is it possible to make sense of the growth of the industry in the City of San Francisco? Has the City of San Francisco developed a new niche (or agglomeration) within the regional industry parallel in its degree of sophistication to the industry in Santa Clara County? To reiterate, understanding the qualitative nature of the evolution of the industry across the region is critical to interpreting the IT job losses that have occurred in Santa Clara County.

Theoretical Framework

Why has the IT industry dispersed, from its historical home, around the broader San Francisco Bay Area? Furthermore, could this change in the industry's geography affect the performance of the industry within the region? These questions provide the rationale for this dissertation. To answer these questions, this dissertation will explore the interaction between theories of economic geography, on the one hand, and the actions of local governments, on the other. One of the key features of economic geography is the extent to which economic activity is highly concentrated in space. This phenomenon is most clearly observed in the existence of cities, or to be more precise, metropolitan regions. Within the United States, for example, a variety of studies reveal that people and firms are concentrated on a small fraction of the nation's land (Brookings Institution, 2007; Glaeser and Gottlieb, 2009). For example, according to some estimates, 75% of the nation's population is found on just 2% of the country's territory (Rosenthal and Strange, 2004).

Beyond the broad concentration of economic activity, individual industries are highly localized geographically. This can be seen anecdotally in the concentration of entertainment industry firms in Hollywood, auto manufacturers in Detroit and finance firms on Wall Street. Take the IT industry, for example. Employment in this industry is not spread evenly across the nation's metropolitan regions. Some regions, like the San Francisco Bay Area, are home to a much larger share of IT employment than is found in other locations. For example, in 2012 the San Francisco Bay Area was home to 3% of the nation's total employment, but 9% of its IT jobs. Another major tenet of economic geography is the extent to which different metropolitan regions specialize in the production of different goods and services. Theories of economic geography, such as agglomeration theory, which is explored in detail in chapter 1 of this dissertation, describe why it is that economic activity generally, and individual industries specifically, show a tendency to cluster together in space (Krugman, 1991; Storper, 1997; Moretti, 2012). These theories outline that there are significant productivity advantages that arise from the geographic concentration of economic activity.

These theories have been enriched by relatively recent empirical work that has demonstrated that the advantages that firms of localized industries gain from locating close to one another attenuate over relatively short distances. For example, for the advertising industry in Manhattan, it has been found that the benefits that firms gain from colocation attenuate at a distance of half a mile (Arzaghi and Henderson, 2008). These findings have been confirmed for a larger range of industries over a larger number of locations (Rosenthal and Strange, 2003 and 2010). These studies suggest that, for an IT firm to benefit from clustering close to other IT firms, locating anywhere within the San Francisco Bay Area may not be sufficient, it would be necessary for the firm to locate within specific parts of the region.

Just as the concentration of economic activity is a key feature of economic geography, so is the dispersion of economic activity to new, once peripheral locations, over time. This is in evidence in the growth of regions that were once somewhat peripheral to national economies (such as the rise of the sunbelt in the US), or the emergence of international trade emanating from nations that were once peripheral to the global economy, such as the economic growth of China (Glaeser, 2011; Kemeny, 2011). More precisely, this is in evidence in the dispersion of particular industries over time. An obvious example in this regard is found in manufacturing industries, which, for much of the past century have shown a tendency to disperse, first within developed economies, and then around the world (Bluestone and Harrison, 1982; Dicken, 2003; Glaeser and Gotlieb, 2004). Industries can disperse over time for a number of reasons. For example, a decline in transportation costs can decrease the cost of interaction between once geographically remote places, facilitating economic activity between these places (Glaeser and Gotlieb, 2004). Another reason for dispersion can be found in industrial maturation. As industries evolve over time, the inputs upon which they rely can change, meaning that these industries will have different geographical preferences with the passage of time (as different locations within regions, nations and the globe provide a different range of inputs at a different range of prices to firms) (Norton and Rees, 1979). In some instances, the dispersion of economic activity can be found in technological breakthroughs that give rise to new industries, which may emerge away from existing concentrations of economic activity (Scott and Storper, 1987). As chapter 1 will describe, each of these theories help to understand the potential reasons for the dispersion of IT activity within the Bay Area.

These theories provide lenses through which the concentration and dispersion of the IT industry within the Bay Area can be understood. However, the location of economic activity does not occur on a blank canvas. Within a metropolitan region, city governments have the potential to influence the location of economic activity through the major policy lever that they control, namely, how land is used (in addition to other actions, such as direct economic development policies). Quite simply, IT establishments must interact with local governments in order to conduct business within a given community. In the most basic form, a company requires a business license from a local government in order to operate within any jurisdiction (Fulton, 2005). Likewise, if an establishment intends to purchase or construct business premises, they require permission from a local jurisdiction – either through the zoning code, which authorizes different uses of land, or through the issue of building permits (Fulton and Shigley, 2012). IT firms do not locate their premises in a vacuum but on land that is administered by local governments. Therefore, these administrations have great powers, in principle, to determine the location of the IT industry within the region.

Empirical Challenge

At its core, this dissertation attempts to explore the interaction between these different theories. Why has the IT industry within the region dispersed and how can this dispersion be understood? Has the industry dispersed due to reasons outlined by theories of economic geography? For example, as the different subsectors of IT industry have matured, do IT firms in these subsectors require different inputs – such as land prices, labor market access, or building types – found in different locations within the regional economy? Those forces that bind firms tightly together in space at one point in time may change for certain parts of the industry at another point in time. From this "natural evolution" perspective, the variety of administrative units in the region (city governments) provide a range of locational characteristics (for example, some are abundant in office space, while others have a greater stock of manufacturing facilities, and there is a range of land prices across the cities in the region) from which an industry (or firm) can choose to locate its functions depending on its needs at different points of its evolution. According to these views, the dispersion of the IT industry within the Bay

Area represents an efficient spatial reconfiguration to the extent that parts of the industry are simply responding to different geographical preferences over time.

On the other hand, it is possible that the diffusion of the industry within the region is “premature” on the part of the industry. From this perspective, actions by local governments could either push the industry away from its natural core through restrictions on land use, or they could attract the industry to other parts of the region through various sorts of incentives or other qualities of the local environment. Under the second scenario, the actions of local governments can have important welfare impacts if these policies are capable of reshaping the geography of an industry so that it becomes significantly different from the pattern of agglomeration and dispersion that would exist without such policies.

Whether the industry has evolved geographically in the region due to some sort of natural evolution or a premature departure is crucial to how this dispersion is understood. There is a nascent but burgeoning empirical literature that examines the impact of local decisions about how land is used on the economic performance of industries (Cheshire et al, 2014). This literature is largely descendant from the study of how land use decisions impact residential patterns within regional economies. It is considered that land use decisions can impose two “indirect” costs on business location decisions within a regional economy. First, if the supply of land is constrained to the point where it is unable to meet demand, it can impose a cost on businesses in the form of higher land rents. Second, land use constraints can influence where businesses are able to locate (by, effectively, restricting the supply of land) and have the capacity to divert business activity to less productive parts of the regional economy (Cheshire et al, 2014). This second point dovetails with the earlier discussion about the attenuation of localization economies within metropolitan regions. Recall that, there is evidence that agglomeration economies are stronger in some parts of regional economies than others. If planning decisions have the ability to restrict entry to those parts of a regional economy where agglomeration economies are the strongest (for a particular industry), there is a significant possibility that planning has the ability to affect the productivity of companies and, by extension, industries. To be more concrete, if there are parts of the Bay Area economy, such as Santa Clara County, where IT firms are more productive, due to the nature of agglomeration economies, land use constraints in these communities can push firms to parts of the region where firms are, on average, less productive.

Within the U.S., as is the case in so many other countries, the scale at which economic geography operates is inconsistent with the scale at which local governments function. To reiterate, over the period of this study, the San Francisco Bay Area was comprised of 10 counties, which are further divided into 103 municipal governments. While the metropolitan region is considered to be an integrated economy, local governance of the region in a large number of policy areas – including land use and economic development – resides in the hands of myriad, municipal governments. This provides a conceptual challenge since the interests of localities are not always aligned with the interests of the regional economy. This is in evidence when it comes to land use restrictions and how they affect residential patterns. It is widely held that land use restrictions (growth controls) in central or dense parts of regional economies induce sprawl, which can have negative impacts on the environment as well as engender other social costs that are associated with increased commute times (Glaeser and Kahn, 2010;

Glaeser 2011). In this instance, the objectives of local residents, who perceive that capping development enhances their quality of life and protects their property values (Fischel, 2002), may be at odds with regional objectives, such as reducing carbon emissions. This same conundrum (the conflict between local and regional interests) can also be true for the regional economy. If development within certain cities is restricted, this can potentially redirect firms to less productive parts of the regional economy, and therefore induce costs for the regional economy.

There is a well-established literature in which the welfare effects of economic development actions by local governments are evaluated across different spatial scales. This literature typically examines whether local policy actions that may benefit a given jurisdiction are zero-sum, growth enhancing or pure waste from the perspective of the state or national government (Bartik, 1991; Cheshire and Gordon, 1998). This dissertation takes a different perspective in that it examines how the actions of local governments within a metropolitan regional economy affect the welfare of a particular industry within this economy.

The impact of land use decisions on the economic performance of firms and industries is understudied and, therefore, not well understood. This dissertation aims to contribute to this literature by examining how the actions of municipal governments within a metropolitan region interact with the decisions of entrepreneurs about where to locate IT establishments within this region. The goal of this dissertation is to answer two primary questions. First, why has the IT industry dispersed, from its original home in Santa Clara County, around the broader San Francisco Bay Area? Second, are local governments undertaking actions that prevent IT firms from locating in their preferred locations within the regional economy?

The principal contribution of this dissertation is to bring together two bodies of theory and evidence that are typically considered in isolation from one another. The literature on local land use and economic development actions are largely silent with respect to their impact on the performance of the key industries that comprise regional economies. The primary interest here is to see how such local decisions have affected the economic geography, and therefore, the welfare of the key wealth generating industry within the Bay Area economy. The purpose of this dissertation, therefore, is to examine how uncoordinated local actions pertaining to land use and economic development might affect the performance of an industry that functions at a metropolitan scale, and hence reevaluate the actions of local governments in terms of wider regional economic development effects.

The rest of this dissertation proceeds as follows. Chapter 1 examines theories and evidence relating to forces of economic concentration and dispersion. Chapter 2 provides a brief historical background of Silicon Valley before providing descriptive statistics about the region and the dispersion of the IT industry within it. Chapter 3 considers the views of public officials in the Bay Area about the dispersion of the IT industry from Silicon Valley. Chapter 4 provides statistical analysis that evaluates the impact of different factors on the dispersion of the industry within the region.

Chapter 1

Theory and Evidence

The first challenge of this chapter is to understand why it is that the IT industry is so heavily located in the San Francisco Bay Area generally, and Silicon Valley specifically. The first part of this chapter, therefore, will focus on economic geography theories of agglomeration and location that outline the benefits that economic activity generally, and firms of tradable industries specifically, gain from locating in close proximity to one another. The chapter will then explore evidence that reveals that the benefits that firms gain from clustering together attenuate within metropolitan regional economies. These findings are crucial to this dissertation because they raise the possibility that the dispersion of the IT industry within the Bay Area may not be an optimal spatial outcome for the industry (if new IT establishments are unable to access "core" areas of localization within the regional economy). Following this discussion, this chapter will explore theories that outline the possible reasons why the IT industry may have dispersed within the Bay Area. These theories are firmly grounded in the disciplines of economic geography and regional science. Likewise, theories of urban spatial structure provide a useful basis for understanding the location of economic activities within regional economies and these theories will be explored, also. Finally, this chapter will summarize what theory has to contribute to understanding the role that local governments can play in influencing the location of economic activity within regional economies.

Part 1: Understanding Urbanization: Why Economic Activity Clusters In Space

In 2014, it was estimated that six metropolitan regions accounted for around one quarter of the United States' economic output – New York, Los Angeles, Chicago, Washington DC, Dallas and Houston (Desilver, 2014). This finding adds to research in 2009 that found that, in the year 2000, 68% of the US population lived on 1.8% of its land (Glaeser and Gottlieb, 2009) and research in 2004 that estimated that 75% of Americans live in cities that comprised just 2% of the country's land (Rosenthal and Strange, 2004). In 2007 it was estimated that the one hundred largest metropolitan areas in the U.S. encompassed just 12 percent of the nation's land but were home to 65% of the nation's population, 68% of its jobs and generated 75% of the nation's gross domestic product (Brookings Institute, 2007). Differences in these estimates exist due to the different methodologies and data that have been employed to generate these figures, but the overarching point is clear: people and economic activity are tightly bound together in space and are concentrated in relatively few locations. This is true not only in the US, but throughout the globe. Not only do we see economic activity and population patterns concentrated at such high levels, but also, surprisingly few locations account for the economic growth that occurs at any given time. Research by Galbraith and Hale (2004) estimates that the bulk of U.S. national income growth between 1994 and 2000 was driven by gains in just five of the country's more than 3000 counties: Santa Clara, California; San Mateo, California, San Francisco, California; King, Washington; and Manhattan, New York.

Economic activity has become increasingly concentrated in space since the dawn of the industrial revolution and this trend has accelerated since World War II (Storper, 2013; Glaeser and Gottlieb, 2009). In 1950, it is estimated that 30% of the world's population lived in cities. In 2010, by contrast, it was estimated that, for the first time in history, more than half of the world's population lived in cities (United Nations' Population Division 2010). According to further estimates by the UN, the share of the world's population living in cities will grow from 54% today to 66% in 2050 ("World

Urbanization", 2014). However, these numbers mask the fact that there have been periods of crisis for urban areas, when central cities, in particular, lost population and economic activity to their suburbs and less urbanized areas, and some predicted that cities would become less relevant entities of economic organization (Bluestone and Harrison, 1982; Moss, 1998; Euchner and McGovern, 2003; Wilson, 2011).

Predictions about the "death of cities" can be traced to the urban crisis of the 1960s. During the early decades after the Second World War, a mass relocation of the population occurred in the U.S., from central cities to their suburbs, and to previously less developed parts of the country, such as the South. The reasons for this relocation are many, and include: the desire of affluent city residents to avoid the congestion and crime of central cities; aging infrastructure in central cities; the mass adoption of cars coupled with the construction of a highway system that enabled the flow of people to the suburbs of central cities; the dispersion of manufacturing activities from the central cities of the Frostbelt to less dense Sunbelt cities, in addition to race and policy factors that are usually labeled as "white flight" (Jacobs, 1961: Bluestone and Harrison, 1982; Euchner and McGovern, 2003; Wilson 2011). At the same time that people were leaving central cities for flourishing suburbs, technological revolutions in transportation, but particularly information and communication technologies, led many to question the logic of people and firms clustering together in expensive cities (Moss, 1998; Kolko, 2000). Alfred Marshall (1890) made the case for how improved communication technologies could shape the location of economic activity. He wrote that,

> "Every cheapening of the means of communication, every new facility for the free interchange of ideas between distant places alters the action of the forces which tend to localize industries" (page 354).

As will be discussed below, according to theory, one of the reasons that firms of the same industry locate together in space is due to what is referred to as "information spillovers" or "learning" – the idea that there is friction to the dispersion of information over space. As information technologies improved, some believed that ideas would spread more freely over space, obviating one of the major reasons why people and firms need to congregate together (Moss, 1998; Friedman, 2003).

The trend towards urbanization also masks the reality that the prosperity of different cities is not uniform. In the US, for example, just as there has been growth in cities of the Sunbelt since the mid-twentieth century – both in terms of population and economic output – there has also been a decline in population and economic output for a number of cities in the Frostbelt (Glaeser, 2011; Kemeny and Storper, 2012; Storper, 2013). This is also true in the European context and across the globe, generally. For example, Cheshire et al (2014) document the uneven development across cities in the UK. Views differ about why some cities prosper and others flounder. This debate typically seeks to answer whether "production" or "consumption" drives the fortunes of regions (Storper and Scott, 2009; Partridge, 2010; Storper, 2013). At the core of this debate is whether regional development is driven by the location preferences of industries at different stages of their development or the lifestyle preferences of people in determining where they would like to live. According to the first view, we can ascribe the gradual loss of economic activity in the Midwest after World War II to the maturation and routinization of industries in this region, which lead these industries to seek out lower cost locations throughout the globe. According to the second view, we can assign the change that occurred in the Midwest over this period to the preferences of people, who left the region due to – among other things – the relatively high cost of the region and the cold weather (Glaeser, 2011; See Storper, 2013; Cheshire et al, 2014).

Agglomeration Economies: Why Cities Exist

Ultimately, across most developed economies, we see a great unevenness in the distribution of people and economic activity. Furthermore, we see great inequality in the distribution of certain industries. It has been demonstrated that these distributions are non-random in nature (Ellison and Glaeser, 1994); namely, there is a reason that firms locate close to one another that cannot be reduced to chance. We cannot understand the uneven development of land by referring to natural geography, either – in the simplest terms, this is the idea that some places are naturally more hospitable to development than others. It is true that throughout the nineteenth and early twentieth centuries many cities arose due to some form of natural advantage, as firms and people clustered together to take advantage of natural resources such as access to a waterway or a resource that could be extracted, such as coal. However, today it is widely held that people and firms do not cluster together in space due to reasons relating to natural geography (Starrett, 1978; Rosenthal and Strange, 2004; Puga and Duranton, 2004; Glaeser and Gottlieb, 2009; Puga, 2010; Cheshire et al, 2014). In order to comprehend the emergence and the continued existence of cities, an understanding of agglomeration economies is necessary. Agglomeration economies, which can also be referred to as external economies of scale, can refer to both the advantages that occur when economic activity clusters in space generally (urbanization economies), but also, and more narrowly, those benefits that occur when firms of the same tradable industry concentrate together geographically (localization economies) (Puga and Duranton, 2004; Rosenthal and Strange, 2004).

Increasing Returns

Cities are expensive places in which firms and people can locate. As they cluster together in a particular place, land in this place becomes relatively scarce, which increases the price of this resource (Starrett, 1978; Fujita, 1990; Puga, 2010; Glaeser, 2011; Cheshire et al, 2014). The crowding in cities also gives rise to negative externalities, such as traffic congestion and pollution. Such externalities add to the cost of production and the cost of living in a given place. In order to endure such negative factors, people and firms must receive some offsetting benefit from locating in cities. For economic activity to cluster together in space, increasing returns must be present (Krugman, 1991; Puga and Duranton, 2004; Puga, 2010). Increasing returns to production is a technical term that refers to the relationship between the level of economic inputs (such as labor and capital) and the level of output (goods and services) they generate. Specifically, when increasing returns are present, the level of output generated from one unit of input increases with the scale of production, and production becomes cheaper with scale (this is known as economies of scale). Such economies of scale can be achieved internal to a given firm (internal economies of scale) – the idea that a single firm can achieve efficiency by producing a good or service in high volume – or through a collection of different firms that cluster together in space and combine to generate output (external economies of scale) (Scott and Storper, 1987; Storper, 1997; Chatman and Noland 2012). Without such increasing returns, in the presence of transport costs, there is no incentive for people and firms to cluster in space and goods and services would be produced locally in small scales (Krugman, 1991; Puga, 2010).

One way to understand the benefit that firms and people share from colocation is the indivisibility in the provision of certain public goods and facilities (Puga and Duranton, 2004). By locating close to one another, firms and people can support the construction of shared facilities, such as parks, museums, schools, sewer systems and airports, that are indivisible in nature. One hundred thousand people can share an airport, but it is implausible for these people to each have their own airport. Not only do cities support the provision of indivisible goods, but also they enable residents of these cities to share the cost of such goods. The fixed cost for a given good or facility is often shared across the residents of a city in the form of local taxes. In theory the cost per user of a large facility becomes cheaper the more people it serves (Puga and Duranton, 2004).

Ultimately, cities are not the outcome of indivisibilities in the provision of a single good or facility. Cities enable residents to share a number of goods and facilities. Furthermore, there are capacity constraints to the use of a given good or public facility, and, as the number of people who use a facility grows, crowding occurs. In the most basic form, such crowding occurs as the number of people trying to access a facility increases (congestion costs, are one example). In this light, cities can be considered to be the trade-off between the benefits from sharing large indivisibilities and the costs of crowding. To put this another way, Cities are the outcome of the trade off between economies of agglomeration, on the hand, and diseconomies of agglomeration on the other (Puga and Duranton, 2004; Rosenthal and Strange, 2010; Puga, 2010).

Cities, therefore, are the most efficient way to provide certain infrastructure to a large number of people. Such benefits are often referred to as economies of urbanization. Urbanization economies are distinguished from localization economies, which refer to industry specific advantages that emerge from the congregation of firms in space. Localization economies are discussed below. Urbanization economies are external to a particular firm or industry and are the advantages that arise from cities generally. This can be seen in infrastructure, but an extension of this idea is found in the work of Jane Jacobs, who believed that the diversity of cities generates great pools of knowledge (an indivisible good) that cross-fertilize to create new economic activities (Jacobs, 1970).

Specialization and Localization

Urbanization economies are the advantages that arise from the clustering of people and firms generally, but a key feature of cities remains unexplored. A consistent feature of scholarship about the economies of countries and cities is the extent to which different places specialize in industries that produce different goods and services. In the context of US cities, the most notorious examples of this include the entertainment industry in Los Angeles, the IT industry in the San Francisco Bay Area, the finance Industry in New York and automobile manufacturing in Detroit. In each of these locations, the local share of employment and output devoted to each of the respective industries far exceeds the national share of employment and output devoted to these sectors. Certain industries are not distributed evenly across the nation's cities. For example, the Bay Area is home to 3% of all jobs in the US, but is home to 9% of all IT jobs in the country.

In certain cases, specialization may occur, not in a particular industry, but in a particular function or activity. For example, some regions specialize in the *manufacture* of a variety of goods, from automobiles to computers, while other cities are home to *management* functions across a variety of industries (Puga and Duranton, 2005; Storper, 2013). Industrial specialization across different places is an important area of enquiry since the goods and services that a region produces have profound effects on the level of income within a given region (North, 1957; Krugman, 1991; Krugman and Obstfeld, 2000; Moretti, 2012).

This feature of local economies, the extent to which they produce a different range of goods and services, helps to understand why countries and regions engage in trade with one another. The idea that regions specialize in the production of certain goods and services is greatly influential, and has formed the basis for subsequent models of regional growth, such as the new economic geography (NEG). Increasing returns and transportation costs are crucial to NEG. Assume a world in which transportation costs are high. Under this scenario, the concentration of economic activity in a few places would be unlikely (unless the savings from increasing returns outweigh high transportation costs) and there would be little inter-regional trade. But when transportation costs fall and increasing returns are present, inter-regional trade will emerge. Due to increasing returns, it is cheaper and more efficient to produce the goods and services of some (tradable) industries in one, or very few places, and transport them to markets around the world, than it is for each place around the world to produce a full range of goods and services locally.

Sources of Localization: Sharing, Matching, Learning

Despite various useful and insightful modifications to his work, theories that describe why firms of the same industry (tradable industries) tend to locate in close proximity to one another are still traced back to the work of Alfred Marshall in 1890. Marshall identified three advantages that such firms gain from clustering close to one another. First, their combined location generates a market for, and gives rise to, specialized input suppliers, upon which the industry comes to rely. Second, the firms create a specialized local labor market, which enhances the efficiency of labor market interactions. Third, firms in such clusters benefit from industry specific knowledge spillovers, the flow of which is constrained geographically. These concepts explain how increasing returns provide productivity advantages to firms that are clustered together in space.

Puga and Duranton (2004) refine Marshall's sources of agglomeration, re-categorizing them by the labels of "sharing", "matching" and "learning." In so doing, the authors reconfigure Marshall's three principles to discern between the different *mechanisms* of agglomeration. Since suppliers (or intermediaries), labor and knowledge are all inputs to production, what is the unique mechanism contributed by each of these factors that bind firms together in space? For example, for intermediaries and labor, proximity is hypothesized to provide a better match between each of these inputs and firms. To treat these sources separately is to suggest that some different mechanism relates them to the spatial concentration of firms, when in fact the same mechanism (better matching) may account for each.

The sharing mechanism can refer to the idea of sharing large indivisible facilities, as discussed above. From the localization perspective, it refers to the idea that the spatial concentration of firms of the same industry generates a large market for input suppliers and labor, which the firms "share". The size of the market that the colocation of firms creates enables the specialization of input services (Smith, 1776). The venture capitalist industry and intellectual property lawyers that service the IT industry in the Bay Area are an example. In this case, the high concentration of IT firms has given rise to specialized services, which in turn gain productivity advantages from the scale at which they serve the local industry (Rosenthal and Strange, 2004). If there were no scale economies in input production, a downstream firm would be able to source inputs at the same price in isolation as it would if the inputs were clustered together (Rosenthal and Strange, 2004). The large demand for industry specific workers also creates a specialized labor market.

Spatial concentration also enables employers to share risk in their recruitment strategies. The risk to a firm from laying off a sub-optimal worker will be lower in those places where the firm has access to a large pool of industry specific workers (replacements). Likewise, the consequences to a worker from leaving a job to seek another will be lower in those places where there are many employers in the industry in which they work. This means that firms are able to be flexible in their recruitment practices, and means workers are more likely to enjoy sustained employment in a given region. Overall, through their colocation, risk is minimized (or shared) for both employers and workers in this industry (Puga and Duranton, 2004).

While scholars have attempted to measure the impact of input sharing, it is difficult to know its precise impact controlling for the other sources of agglomeration. Rosenthal and Strange (2001) and Overman and Puga (2010) find weak evidence in support of sharing as the true source of agglomeration when controlling for the other mechanisms of agglomeration. Ellison et al (2007), by contrast, find that that input sharing is a significant source of agglomeration. However, in this study, the authors were unable to control for the other effects of agglomeration, namely, matching and learning.

Spatial concentration of industries also enables the better matching of workers to employers and buyers to suppliers (Puga and Duranton, 2004; Puga, 2010). Workers and employers should be better matched in large cities or where an industry is highly concentrated in one place. The IT firms in Silicon Valley have created a skilled labor force in the region. A new tech firm will maximize its chances of finding skilled IT labor in Silicon Valley and IT workers will maximize their chances of finding a job there, too. The same logic applies to buyers and suppliers, especially if the nature of the transaction between the two parties is costly (Storper, 1997).

Operationalizing labor market "matching" in a given place is not an easy task. Measuring termination rates across places, after controlling for other factors that might affect termination such as industry or economy effects, might be one approach (Rosenthal and Strange, 2004). If termination rates were higher in one place than another, it might be evidence that firms believe the risk of recruiting further staff as needed is relatively low. However, this approach is complicated since it is difficult to discern whether a termination rate is lower in one place compared to another because firms have been able to find good matches in their recruitment, or because employers have access to fewer qualified replacements. As is the case with sharing, there is not overwhelming empirical evidence in support of the mechanism of matching. The work of Costa and Kahn (2000) is often cited in support of matching (Rosenthal and Strange, 2004; Puga, 2010). In their work, they show how married couples with college degrees have shown a greater tendency to live in cities over time. An explanation for this is that such couples are more likely to find a match for their skills in large cities. Although in this regard, urbanization, rather than localization economies, are likely to be at play. However, in reality, there is very little empirical support of the idea that workers are better matched to employers in big cities. A large reason for this is the lack of good data.

Learning refers to the idea that information and knowledge spread most effectively from face-to-face contact. To put this another way, learning refers to the idea that there is a friction to the flow of ideas over space. Alfred Marshall (1890) was one of the first to theorize about the local nature of learning writing that “The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously” (page 271). In short, the spatial concentration of firms enables them to learn from one another. There is evidence of localized knowledge spillovers, as evidenced by patent citations, whereby inventors are more likely to cite patents from other inventors in the same city (Jaffe and Trajtenberg, 2002; Feldman, 1994).

Ultimately, despite Marshall’s theoretical structure, developed over a century ago, the empirical support for the core tenets of agglomeration theory generally, and the new economic geography specifically, has been slow to emerge (Puga and Duranton, 2004; Arzaghi and Henderson, 2008; Ellison et al, 2007; Puga, 2010; Storper, 2013). A big part of the problem in these efforts is that each source of agglomeration predicts the same effect. Each source of agglomeration predicts that the clustering of activity in space enhances productivity for a given industry (Puga, 2010).

The Geographic Scope of Agglomeration

Of particular importance to this dissertation is the following question: at what scale do agglomeration economies attenuate? Until quite recently it was widely assumed that agglomeration economies were region-wide in their scope (Rosenthal and Strange, 2003 and 2010). In other words, so long as two firms of the same industry were in the same metropolitan region, it was assumed that the benefits from this colocation were the same regardless of whether they were located on the same block or 20 miles apart. These assumptions were based, in part, on the fact that fine-grained data were not easily available at sub-metropolitan scales.

However, interesting research has revealed that agglomeration economies attenuate over much shorter distances. In 2003, Rosenthal and Strange studied the location of new establishments for six industries (software, food products, apparel, printing and publishing, fabricated metal and machinery). They studied the location of new establishments across all zip codes in the United States and inferred agglomeration economies from where new establishments decide to locate. For a given site at which a new establishment locates, Rosenthal and Strange analyze the local economic environment and ask at what spatial scale the level of same industry employment is a significant predictor of a new establishment's location decision. In other words, what best predicts why new establishments in a given industry locate where they do: the level of same industry employment within 1 mile, 5 miles or 10 miles?

For a collection of metropolitan regions, the authors establish concentric rings around each zip code at distances of 1 mile, 1 to 5 miles, 5 to 10 miles and a distance of 10 miles and greater. Within each ring, they measure total employment for each of their industries of interest. Rosenthal and Strange find that the level of same industry employment within one mile of a given zip code had the most significant and largest impact on the location of new establishments for 5 of the 6 industries, when compared to same industry employment at their other scales of enquiry (agglomeration effects were not found for the printing and publishing industry). For the software industry, for example, they find that adding 100 employees within 1 mile of a given zip code creates 10 times more new establishments than the same level of employment within 1-5 miles. At the 5-10 mile scale, the number of start-ups is similar to the 1-5 ring, 0.004. In other words, agglomeration economies attenuate quickly over quite short distances and then attenuate much more slowly after that. The authors confirm these findings for a similar set of industries in Manhattan (Rosenthal and Strange, 2005)

In 2010, Rosenthal and Strange take their findings one step further. In this study, they sought not only to understand at what scale the level of same industry employment impacts the location decisions of entrepreneurs (new establishments), but also the impact of the nature of the local industrial organization environment on the decisions of entrepreneurs. Specifically, they set out to test the ideas and research advanced and conducted by Vernon (1962), Chinitz (1961), Jacobs (1970), Piore and Sabel (1984) and Saxenian (1996). To these authors a variety of other studies can be added, including Storper and Christopherson (1987). In each of these studies, scholars identified that production systems characterized by a large collection of small firms which are able to combine and recombine into flexible production systems of inter-linked firms are a key feature of the success of what are often termed "industrial districts", namely localized geographic concentrations of firms of the same industry.

To test this assumption, Rosenthal and Strange look not only at the impact of same industry employment on the location of new establishments, but whether this same industry employment is concentrated in small (fewer than 10 employees), medium (10-49 employees) or large establishments (50 or more). They first looked at the significance of same industry employment within one mile of a given census tract. Across a range of metropolitan areas, they found that same industry employment is a significant predictor of new establishments (which confirmed their earlier findings). However, they also found that the way in which local industry is organized has a bearing on new establishment activity. Compared to other sized establishments, for manufacturing, wholesale trade, FIRE (finance, insurance and real estate) and services industries, the level of employment in small establishments was the only constant positive and significant predictor of the level of new establishments (i.e. the effects of medium and large establishments were not consistently positive or significant). In this study, they also consider the small establishment effect at two levels: within a 1-mile radius of a given zip code and a 1-5 mile radius, this time, for two industry categories: manufacturing industries and all industries combined. They find that the small establishment effect attenuates with distance. Namely, the level of employment within small establishments is a bigger source of new establishments within 1-mile of a zip code than it is the 1-5 mile range.

In a similar vein, Arzaghi and Henderson (2008) study the characteristics of census tracts in which new advertising establishments in Manhattan have located. They infer agglomeration economies, also, from the decisions new establishments make about where to locate. Again, they use concentric rings, this time around each census tract, to calculate at what scale same industry employment influences the location of new establishments in this industry. However, they consider the impact of same industry employment over much shorter distances. They employ 5 concentric rings at increments of 250 meters from a given census tract. The first ring covers a distance of 0-250 meters, the second 250-500 and so on. Interestingly, they find that within the first two rings (a distance of up to 500 meters) the effects of same industry employment are quite similar and are a positive and significant predictor of the number of new advertising establishments which emerge in a given census tract. In the third ring (500-750), they find a positive effect of own industry employment, but to a much lesser degree; the impact of same industry employment is 5 times lower at this scale. After 750 meters, the level of same industry employment has a small and insignificant bearing on the location of new establishments. In other words, after 750 meters (a distance of roughly half a mile), the number of advertising employees has no bearing on the creation of new establishments in a given census tract. Further to this, they not only find that new establishments want to locate close to existing stocks of advertising employees, but that they are willing to pay a rent premium for this proximity. In the first ring (0-250 meters), for example, a new establishment is willing to pay a 0.77% rent increase to have one more neighbor in this ring.

These findings add considerable depth to the understanding of the mechanics of agglomeration economies. They relate to a broad range of industries and metropolitan regions, and they find that the benefits to a given firm from proximity to other firms of the same industry may attenuate over short distances. How is it possible to make sense of such attenuation? There are three major mechanisms of agglomeration (sharing, matching and learning), does the effect of each attenuate at the same scale, or can attenuation be understood as the outcome of the declining effect of just one of these mechanisms over short distances? In this area, Rosenthal and Strange and Arzaghi and Henderson posit a number of explanations, mainly based on the sharing, matching and learning framework. However, as is the case with agglomeration economies generally, it has proven difficult to provide definitive answers about the magnitude of the effect of each source of agglomeration on attenuation.

Arzaghi and Henderson (2008) believe that labor market pooling cannot be the root of such attenuation since labor markets are region wide in their scope. In their view, the geographic extent to which workers commute cannot explain the attenuation of agglomeration effects over distances of 500 meters. The authors, therefore, focus on information spillovers as the likely source of attenuation based on the idea that dense information networks in certain parts of Manhattan facilitate information exchange, and that these networks become weaker over space. The authors believe that input sharing can play a role in attenuation, evoking the idea that transactions costs to doing business with intermediaries increase over distance. They believe that, as the distance between establishments' increases, the cost of maintaining such information and buyer-seller networks becomes costly to firms.

In their 2003 and 2010 works, Rosenthal and Strange, also, believe that information spillovers are a natural explanation for why proximity effects attenuate sharply, since contact between workers within a given region become less frequent with distance. They, too, dismiss matching (or labor market effects) as a source for attenuation, again relying on the regional nature of commuting patterns. Rosenthal and Strange also rely on input sharing as an explanation for attenuation. They believe that new establishments, which are typically small in size, will be drawn to those parts of cities which provide a variety of downstream services, such as lawyers, accountants, graphic designers and other inputs to their businesses. Small firms are reliant upon such inputs since they do not have the scale to maintain them internally.

All in all, rather like the case with agglomeration economies generally, it has been identified that agglomeration economies attenuate over short distances, but it is not possible to detail the precise source of this attenuation. While both sets of authors are in agreement that information spillovers can best explain why agglomeration economies appear to attenuate over relatively short distances, they both seem to be in agreement that the different components of agglomeration (sharing, matching and learning) might attenuate over different scales. However, when the scholars rely on information spillovers as a cause for attenuation, they have used quite a narrow definition of information spillovers. For example, is it inconceivable that the "information exchange and networking" to which Arzaghi and Henderson refer might also facilitate matching and sharing processes? Perhaps the intense nature of networks in Southern Manhattan greatly facilitate the labor matching process by enhancing the possibility that an employee learns about job openings much quicker than people 1 mile away. The same might be true of buyer-seller matching processes. Perhaps there are highly localized mechanisms for learning about niche suppliers.

It has been theorized that face-to-face contact is an essential element in all three mechanisms of agglomeration - sharing, matching and learning (Storper and Venables, 2004). For example, in the case of sharing, complex interactions between a given firm and its supplier, perhaps due to uncertainties in the production process, are made less costly through face-to-face contact (Storper and Venables, 2004; Rosenthal and Strange 2010). Likewise, for the case of matching, face-to-face contact can enhance a match between employer and employee by augmenting processes of screening and signaling. For learning, flows of information are greatly enhanced through face-to-face contact. Rosenthal and Strange and Arzaghi and Henderson have identified that agglomeration economies attenuate over short distances; however, they seem too dismissive of the idea that such proximity (which fuels face-to-face interaction) could enhance all three mechanisms of agglomeration. Storper and Venables, by contrast, add to the work of these studies in that they identify that face-to-face contact is critical to all three mechanisms, however, these authors are do not consider how the need for face-to-face contact plays out over different spatial scales.

These theories raise important questions for the purpose of this dissertation. Concerning scale, agglomeration economies seem to have two dimensions. At a macro level, firms in certain tradable industries gravitate towards certain metropolitan regions. Within regions, however, agglomeration economies are more intense in some parts of regions than in others. In the case of the advertising industry, if each location within Manhattan is equally as appealing, why would firms pay rent premiums to be in certain locations within the region? This same logic surely applies to the finance industry centered on Wall Street. This being the case, there are clearly advertising firms that are locating in parts of Manhattan where agglomeration economies are less strong. Since Manhattan is an expensive place to do business generally, these firms must yield some benefit that offset the high costs of production there. This suggests that there are different scales to agglomeration economies within regional economies. Some firms will pay a premium to locate in certain locations given the nature of the functions they perform. For other firms, the nature of their activities might dictate that they locate close to the buyers or sellers of their products, but given the nature of their functions or the nature of their relationship with buyers and sellers (due to relatively lower transaction costs), they may have the ability to locate slightly further away from regional "centers of action". In the context of this dissertation, if some parts of a regional economy display stronger agglomeration economies than others, what does this mean for the dispersion of the IT industry within the Bay Area? The following sections highlight theories to help answer this question.

Part 2: Theories of Dispersion

The primary concern of this dissertation is to understand why the IT industry has been dispersing throughout the Bay Area and to understand the consequences of this dispersion. To this point, this chapter has examined why firms of the same industry locate in close proximity to one another, but what does theory have to say about why economic activity disperses over space over time? Dispersion of economic activity clearly occurs at a global scale, as countries that were once considered peripheral to the global economy become prominent actors (Kemeny, 2011). The rise of South East Asian economies since World War II is a classic example in this regard (Dicken, 2003). Dispersion can also occur within nations, such as the rise of the economies of the South in the US over the same time period (Glaeser, 2011; Kemeny and Storper, 2012). Dispersion also occurs within metropolitan regions, such as the increase in economic activity in suburban areas of the US over the second half of the twentieth century (Euchner and McGovern, 2003; Hill and Brennan, 2005). The best guide to understanding why firms disperse within regions comes from those theories that explain the movement of industries at broader scales, such as from one region or country to another. When discussing intraregional dispersion, Weber (1929) wrote ". . . exactly the same rules of orientation will be operative in detail which determine the orientation at large for the whole country, with its extensive transportation system. Everything will simply be repeated in miniature" (page

87).

Recall that while firms of the same industry congregate together within regional economies, there is a micro geographical component to this agglomeration: within a regional economy, there is growing evidence that agglomeration economies are stronger in some parts of regions than in others. The dispersion of an industry within a regional economy, therefore, is an important area of enquiry. This dispersion could, on the one hand, be an intentional act by firms that comprise an industry. Locational characteristics that are important to a firm at one point in time, whether this is access to a particular labor market or a supplier, may cease to be important at some other point in time. On the other hand, it could be the case that a firm's access to a particular place may become obstructed by costs or a lack of available space. This section will outline those theories that relate to how technological and industrial evolution can influence firm and industrial location over time.

Trade Costs

What causes an industry that was once heavily located in one region to disperse to others? One reason for the dispersion of parts of industries is found in transportation costs. To reiterate a point made earlier in this chapter, transportation costs are integral to the new economic geography. According to the NEG, goods producers seek to locate close to their primary markets to reduce their costs of transportation. As transportation costs have become cheaper over time, this has enabled industries to locate further from their markets. However, the market for a given good is not just comprised of end consumers. The majority of transactions in the global economy are between businesses, what is referred to as B2B transactions (Storper, 1997; Dicken, 2003). Transportation costs, therefore, don't just relate to transporting goods to consumer markets but the potential for firms to transact with one another over space.

Adam Smith (1776) posited that the production of a particular good or service could be enhanced through fragmenting the process of production for this good or service into a series of discrete tasks. Such fragmentation enables the specialization of individual tasks to occur. This process can occur either within a particular firm, or between firms (when firms specialize in different parts of the production process, what is known as the social division of labor). According to this view, a collection of different firms, each specializing in a particular function, which are later combined together into one product, will be more effective than if one firm attempts to specialize in each and every part of the production process. Such disintegration enables economies of scale to occur for the disparate functions that comprise a given industry (Scott and Storper, 1987 and Storper, 1997).

This disintegration of the production process across firms, what is commonly known as flexible specialization, has been a feature widely observed by scholars since the 1980s (Piore and Sabel, 1985; Storper and Christopherson, 1987; Saxenian, 1996). While the disintegration of the production process described above is believed to yield greater efficiency to industries, the transactions between firms to which this process gives rise generates certain costs. For example, there is a cost involved in the specification, negotiation and monitoring of contracts between firms, which can be either high or low, depending on the complexity of the production process (Scott and Storper, 1987). If the transaction costs for these firms to do business with one another are high, due to the complex nature of a transaction between two parties, this will induce firms (party to these transactions) to locate in close proximity to one another, since face-to-face contact can greatly assist specification and monitoring (Storper and Venables, 2004). When the nature of the relationship between firms is stable or easily standardized in some way, there is scope for these parties to locate further apart from one another.

Reductions in transportation costs and improved communication technologies have enabled industries to seek out those points around the globe that are best suited to the particular functions that comprise their production chains (comparative advantage) – a certain function may be best performed by workers in a particular region who possess certain skills, for example – and efficiently link these separate functions (and places) together as part of the production process (Storper, 1997; Scott, 1998). The dispersion of manufacturing from the Rustbelt, which first happened within the US and then occurred overseas was made possible by a pronounced drop in the cost of shipping goods throughout the twentieth century (Glaeser and Kohlhase, 2004), but it was also made possible by standardization in the manufacture of certain goods. In the first instance, then, dispersion is made possible by lower costs of transportation and communication. The decline in the cost of trade has enabled the production process to be splintered and for separate components to be efficiently located in different places.

Product Cycle Theory

Kuznets (1930) and Burns (1934) are credited to have been the first scholars to observe that industries pass through a development cycle (Markusen, 1985; Norton and Rees, 1979). Vernon formally applied this theory to the context of trade between nations (Vernon, 1966), and the theory has since been applied to development patterns within nations (Norton and Rees, 1979). In essence, the theory describes how, at the different stages of development of a particular industry, the required inputs to the production process evolve and vary and that such variation has consequences as to where the different functions of industries locate over time. Ultimately, the theory details how functions of given industries show a tendency to disperse from their places of inception with the passage of time (Norton and Rees, 1979).

An industry is theorized to pass through four stages of development. First, an industry experiences a period of experimentation, then a period of rapid growth, followed by a period of diminished growth, and then a period of stability or decline. From its inception to its maturity, the production process evolves from a phase of innovation and experimentation to a period of stability and mechanization. In the early phases of development, a new product is created, and its production is often exploratory and characterized by uncertainty. Often times, such innovation is contained within small firms that are reliant on the rich ecosystems of wealthier cities, such as skilled labor forces, reliable infrastructure and business services. Industries are more or less contained within the minds of their creators early in the cycle, making them relatively labor intensive and tied to very specific places at this stage of their development.

As industries develop and grow, production becomes less and less experimental and more and more routine. As competition emerges through technological diffusion and imitation, industries move into a phase of cost cutting, as successful production is increasingly tied less to the minds of skilled workers and becomes more reliant on machines. This evolution frees certain business functions (production) from expensive cities enabling them to be moved to low cost locations, where industries are able to substitute labor for capital.

In summary, in the early phases of a new industry, firms are small and their products are yet to be standardized. At this point in the industry's development, firms will achieve a sort of safety in numbers. By locating in close proximity to one another, they can achieve external economies of scale and employ flexible production strategies. As an industry becomes more mature, production processes become more certain and stable, and as firms grow, they are freed from spatial constraints, to an extent. Diseconomies of agglomeration in cities, such as the high cost of land, labor costs, land scarcity and congestion induce firms to move to outlying locations of regions and beyond.

Vernon and Hoover also applied this theory to the location of economic activity within metropolitan regions (Vernon and Hoover, 1962). Vernon and Hoover provide an account of why some firms locate in the center of metropolitan areas, while other firms locate in the periphery of these regions. Scholars had observed that small firms showed a tendency to cluster together at the center of cities, while larger firms were found in suburban areas. For Vernon and Hoover, the explanation for this phenomenon finds its root in an understanding of scale economies and the production process (and the uncertainties it may entail).

Small establishments, by their very nature, are unable to achieve economies of scale. This plays out in both the production process and production related costs, such as access to infrastructure. Clustering in close proximity to one another enables small firms the opportunity to overcome their insufficient scale through subcontracting with other small firms. They can effectively subcontract parts of the production process that they cannot afford to maintain in-house. In this manner, a web of subcontract arrangements is observed in the center of cities between a number of small firms who, collectively, are able to achieve scale economies. Central cities seem to be natural locations for small firms since these locations have historically tended to have the most developed infrastructure in metropolitan regions. In central locations, local infrastructure, such as power, water, sewage and police protection, are effectively paid for by a divisible service fee (property taxes), where as, in more remote, less populated locations, an indivisible fee may accompany such services. By contrast, when an industry and the firms within them grow, the space required for production often becomes too great for central cities and scale economies can be achieved within individual establishments. According to Vernon and Hoover, such evolution helps to explain why larger establishments are found in the suburbs of regions.

Technological Rupture

Another set of theories helps us to understand dispersion through the lens of technological breakthroughs. Scott and Storper (1987) outline a theory in which the dispersion of economic activity within a national or global context can emerge from technological change. According to the authors, as new discoveries are made and new industries emerge, “old centres” of economic activity can lose out to new locations as the new home to these industries. One reason for this may be diseconomies of scale, such as land prices, congestion costs and pollution. Another reason lies in the desire of new industries to escape existing industrial relations in a given place (such as a high degree of unionization), and build these relations anew in some other location. According to these authors, as a new industry emerges there exists a “window of locational opportunity”. A new industry may have different geographical needs from existing industries, and just as importantly, its geographic needs might be so broad that any number of locations might reasonably be home to them (since the nature of production in the new industry may not rely upon a specialized labor force found in only a few locations). This provides the possibility that new industries might take root away from the so-called “old centres” of economic activity. The authors cite the emergence of the hi-tech complex in Silicon Valley and Southern California after World War II, away from the existing advanced research powerhouses of the East Coast, as an example of how new industries can emerge in what are relatively less established centers of economic activity.

How, then, do these theories help to explain the dispersion of the IT industry within the San Francisco Bay Area? These theories seem to provide two possible explanations. It seems possible that as the IT industry within the region has become more mature, parts of the industry have moved to cheaper parts of the regional economy. Diseconomies of agglomeration in the core of Silicon Valley, especially the high price of land in these locations, may mean that functions of the industry that do not need to pay a premium to be in a core location have moved to other parts of the regional economy. Another explanation might be that, as the industry has evolved and technological innovation has occurred, new segments of the industry have found home in other parts of the region, perhaps because they are less reliant on existing network structures or because they require different types of building (office compared to industrial space, for example). Overarching this discussion is the question of the scale at which agglomeration economies operate. As the studies by Arzaghi and Henderson (2008) and Rosenthal and Strange (2003, 2004 and 2010) highlight, within a regional economy, agglomeration economies might exist at multiple scales. Just as the IT industry is dispersing within the Bay Area, it is also dispersing at a global scale. The “Designed in California Assembled in China” labels attest to this. There must be a reason why some dispersion occurs “locally” while other dispersion occurs overseas, and theory suggests that this is the case because agglomeration economies are multi-scalar in nature.

Part 3: Urban Spatial Structure

Beyond theories of concentration and dispersion, there are theories that specifically predict where different activities locate within regional economies. The seminal work in this field dates back to von Thünen in 1826. In “The Isolated State”, von Thünen developed a model of land use and land rents relating to the agricultural land (hinterlands) surrounding a town. In transporting their goods to the market (in this case the central town) each farmer is faced with a trade off between land rents, which are more expensive on the land close to the town, and transportation costs, which become more expensive with distance from the town. In equilibrium, costly agricultural production will bid up the rent of land close to the town, since these producers’ seek to reduce their transportation costs to the market. Less expensive agricultural production, by contrast, can locate further from the town, since such producers’ are able to absorb the higher transportation costs. Thünen’s theory is grounded in the concept of arbitrage, the idea that the utility of farmers is equalized everywhere. Around the town in Thünen’s model, there are concentric rings, known as bid rent curves, where rents, and accordingly, land use, vary depending on market access (transportation costs) (Fujita, 2010). Other important contributions to the field include the work of Weber (1929), Losch (1954), Cristaller (1966) and Isard (1956). In the 1960s, economists began to formalize these theories into models. These models of land use form the basis of the field of urban economics.

Theories pertaining to monocentric cities are perhaps the most influential guide to understanding the structure of metropolitan areas. The often-cited Alonso-Mills-Muth model (developed in the 1960s) creates a general equilibrium framework based on von Thünen's isolated state. Alonso was the first scholar to formally adapt von Thünen's work to an urban or industrial context, replacing the central town in Thünen's model with a central business district and the hinterlands with residential land. In its simplest form the model specifies that, within a city, all firms, and therefore all employment, will be located in a central business district (CBD), surrounded by a circular residential area, divided into concentric rings layered by different rents (White, 1976; Giuliano and Small, 1991; Crane, 1996; Anas et al, 1998; Mills, 2000; Redfearn, 2007; Leslie, 2010; Duranton and Puga, 2014). The model asserts that firms locate in those places where they can minimize their costs of doing business. Early models consider transportation costs to weigh the most heavily on the location decisions of firms. Accordingly, firms will locate in central areas of cities, since this is where it is assumed that the best transportation hub exists. Proximity to this transportation hub allows firms to reduce their costs of shipping goods to other locations (White, 1976; Anas et al, 1998). Essentially, firms outbid residents for land in these central locations and dominate land use in this area of a city. The central location of firms also holds intellectual appeal since, in theory, it minimizes the commuting costs of city residents as they travel to and from work (Bogart, 2006; Mills, 2000).

Another main focus of the model is the decisions households make to maximize their utility. In the model, housing, unspecified other goods and costs of transportation determine an individual's utility. When the model is in equilibrium, each household receives the same level of utility no matter where they are located within the city. The standard approach outlined by the model is that each household will trade off the value of access to their job, which is located in the center of the city, against the cost and size of housing when choosing where to live (Crane, 1996; Anas et al, 1998). Cheaper, larger housing in the perimeter of a city is offset by the costs associated with commuting to central locations. More expensive, smaller housing closer to the CBD is offset by cheaper travel to work. This concept is known as the bid rent function (Anas et al, 1998).

According to these models, the desire to minimize transportation costs were the original justification for cities and their form. Over time, as models have become more elaborate, other justifications for urban form have been offered. In more recent iterations of the model, firms locate in the center of cities to benefit from external economies of scale; namely, the production advantages firms yield from locating in close proximity to one another (Fujita, 1989; Giulliano et al, 2007). Yet while this extension of the model provided a different explanation for the formation of firms at the center of cities, the relationship that households have with the CBD remained the same in these models.

There have been efforts to rework the model to allow for polycentricism in metropolitan areas. Amongst these attempts include Solow's efforts to create a bid rent function for firms. In this model, firms yield the same profit across any location within a city. If a firm moves away from the CBD, for example, the lower rents it can find are offset by higher transportation costs to the city's center, where the major transportation hub for the city lies (White, 1976). Other attempts simply generalize the assumptions of monocentric spatial structures, to a polycentric world (Crane, 1996). In these models, multiple centers in cities each have their own bid rent functions, so that there are different hubs each with firms at the center, surrounded by a residential zone. According to these models, firms locate away from the central city because there is a transportation node in an outlying area, making it cost effective for firms to move there (Bogart, 2006; White, 1976).

Descendent from the New Economic Geography (NEG), models have emerged that try to accommodate industrial organization into the spatial form of cities. One of the first efforts to account for industrial organization was made by Ota and Fujita (1993). Rather than assuming that firms were single-unit enterprises (as had been the case in previous models), Ota and Fujita present a general equilibrium location model based on multi-unit firms. Each firm in this case is comprised of a front-unit (business office) and a back-unit (a production plant or a back office). They assume that each front-unit communicates with other front units (what they refer to as business communication) in addition to communicating with their own back-units, while each back-unit exchanges information only with the front unit of the same firm. Key to this model is the assumption that each organization chooses the location of its front and back office units optimally, according to land prices. According to this model, as the cost of intra-firm communication decreases, there is a desegregation of front and back-units. When communication costs are low enough, front offices locate in the central business districts of regions (where they can enjoy agglomeration economies derived from their location with other front office units), while back office functions are located in the outskirts of cities, where rents are cheaper. Therefore, a duel labor market emerges within cities with a primary labor market surrounding and commuting into the central business district, with a secondary labor market in the suburbs working in back office locations.

In a similar vein, Duranton and Puga (2005) provide another model of spatial disintegration within organizations, applied to systems of cities rather than the internal dynamics of individual cities. In their model, functions are divided between management and production. According to Duranton and Puga, cities no longer specialize in particular industries but in particular functions. They divide business functions between production and management operations and believe that management functions, regardless of industry, will show a tendency to collocate, as will be the case for production functions. Again, lower costs in transportation and telecommunications will make this separation possible. Since agglomeration benefits exist to a greater degree for headquarters and business services, these functions will tend to locate in larger cities. Production centers, on the other hand, will locate in smaller, more remote cities.

While Duranton and Puga have created a model rooted in ideas of systems of cities, they rely on standard economic accounts of the internal structure of cities. Within individual cities, therefore, they believe that businesses will locate in central business districts surrounded by residential zones, across which residential utility is in arbitrage, as workers trade off commuting time for residential space.

The above account of firm location within metropolitan areas relies on cost minimization. Consequently, when urban economists' theorize why firms would relocate away from central business districts, these explanations, too, are rooted in efforts at cost minimization. The possibility of decentralization is viewed as a tension between economies of agglomeration on the one hand, and the diseconomies of agglomeration, on the other. At that point when the benefit to firms from being located in close proximity to one another fall below the costs of being located in close proximity to one another, firms will locate away from central locations.

Part 4: The Role of Local Governments

The companies that comprise the IT industry must interact with local governments in order to conduct their operations within a given community. In the most basic form, a company requires a business license from a local government in order to operate within any jurisdiction. Likewise, if an establishment intends to purchase or construct business premises, they require permission from a local jurisdiction – either through the zoning code, which authorizes different uses of land, or through the issue of building permits (Fulton and Shigley, 2012). IT firms do not locate their premises on a blank canvas but on land which is administered by local governments and, therefore, these administrations have great powers, in principle, to determine the location of economic activity within a metropolitan region.

Yet, how do the actions of local governments interact with the dynamics of economic geography? On the one hand, it is possible that local governments provide a range of different locations within a regional economy, each providing different attributes between which companies can choose when deciding to locate or expand their premises (for example, some are abundant in office space, while others have a greater stock of manufacturing facilities, and there is a range of land prices across the cities in the region). From this perspective, companies will locate in those communities that provide the range of services they desire at a price (in the form of rent) that they are willing to pay. On the other hand, it is conceivable that a particular company may wish to locate in a given community but is unable to do so because there is a lack of available space (readily available sites or premises), which in turn affects the rent payable in the community.

According to one possibility, the dispersion of the IT industry around the Bay Area can be seen as the consequence of industrial dynamics, or natural expansion (fulfilling the location preferences of the industry and firms at given points in time). From another perspective, it is possible that the diffusion of the industry within the region is "premature" on the part of firms within the industry. According to this view, actions by local governments could either push the industry away from certain IT centers within the region, through restrictions on land use, or they could attract the industry to other parts of the region through various incentives or other qualities of the local environment. Under the second scenario, the actions of local governments can have important welfare impacts if these policies are capable of reshaping the geography of the industry such that firms are forced out of sub-regional agglomerations where they would be naturally inclined to locate, representing a potential productivity or innovation loss to the industry. In this case, a firm may be prevented from accessing (or drawn away from) localized sharing, matching and learning effects.

In 1991, Timothy Bartik wrote that "growth and structural change in the economy of a state or local area are arguably affected by every government action, from the quality of public schools to the regulation of optometrists" (page 3). The task here is to examine those actions, both explicit and otherwise, that can shape economic activity within a metropolitan region (those forces that both push and pull industries from and to different locations within a regional economy). The focus of this discussion on the location of economic activity within a region, consequently, is distinct from the literature that seeks to understand what policies influence economic growth across regional economies (For excellent reviews of this literature see Bartik, 2012 and Cheshire et al, 2014).

In reality, there are four tiers of government that could influence the location of economic activity within a regional economy. Federal and state governments can affect activity in two ways. First, these levels of government typically finance grand infrastructure projects, which often relate to transportation ventures. Second, through programs which might be funded by these levels of government but administered locally (Fulton and Shigley, 2012). In California over the period of this study, two major types of program have been funded by the federal and state governments and enacted locally: redevelopment and enterprise zones (Fulton, 2005). Below, this section will briefly cover how each of these three policies – infrastructure, redevelopment and enterprise zones – might affect the location of economic activity within regional economies.

Local governments – counties and cities – can also enact policies that influence the location of economic activity. The primary way through which they do this is through the control of land. Ultimately, local governments have the exclusive power to determine what activity locates where on their land. According to Fulton (2005) “the use of land and the planning processes that determine that use lie at the heart of the economic development process for local governments.” Beyond land use, governments play a role in shaping economic activity through influencing the costs and benefits that a firm faces in any given jurisdiction. The typical direct costs that a business might face locally are tax rates and business regulations, such as the cost of a building permit, the length of time it might take for a company to receive permission to build or a business license fee. This section will also cover the ways in which each of these factors can influence economic activity before briefly considering the role that public services, generally, might play in shaping economic activity within regions though the lens of the Tiebout model.

Conceivably, there are different types of infrastructure that higher levels of government can provide or fund for cities, but this section will focus on infrastructure that connects different places to one another, and therefore helps to reduce the transportation costs between different locations. Within a metropolitan region, public investment in transportation can make urban economies more efficient by increasing employer access to the local labor market at a lower cost (Drennan and Brecher, 2012). By extension, such investment can also improve firm-to-firm interaction and information spillovers (Chatman and Noland, 2012). Since agglomeration economies likely attenuate at sub-regional scales, increasing access between different places within regions can have the effect of increasing the scale at which processes of sharing, matching and learning function within a regional economy (fueling dynamics of natural expansion). By contrast, if congestion in some parts of a regional economy generates diseconomies of agglomeration, this might push the IT industry away from core areas to other parts of the region (the "premature" departure scenario).

Enterprise zones, which have been funded by the state of California, are a potential government tool that could affect the distribution of firms within a metropolitan region. Enterprise zones entail incentivizing firms to locate in specific (underperforming) parts of a city or metropolitan region through tax incentives and other enticements, such as reducing or exempting certain business or planning regulations (Euchner and McGovern, 2003: Cheshire et al, 2014). In certain instances, local infrastructure may be improved to encourage firms to locate in such zones (Euchner and McGovern, 2003). If tax breaks and looser regulations are of a sufficient magnitude that they offset the localization benefits of some parts of a regional economy, they might "pull" firms away from core locations within the regional economy. This process might benefit a given locality, however, it could have important welfare impacts if these policies are capable of reshaping the geography of an industry so that it becomes significantly different from the pattern of agglomeration and dispersion that would exist without such policies.

In general, enterprise zones are not considered to be a great success. When businesses have moved to specific zones, considerable research shows that this has largely entailed establishments moving from one neighborhood to another, at a very localized level, with little net job creation (Bartik, 2002; Kolko and Neumark, 2009; Einio and Overman, 2013).

In a narrow sense, the aim of redevelopment is quite simple. Redevelopment policies are geared towards revitalizing underperforming neighborhoods, which, historically, have been found in inner-city areas. In California, such efforts at revitalization have taken many forms and have been used variously to "clear slums", build hotels and convention centers, attract businesses from one municipality to another, to construct low income housing, to build luxury housing, schools, golf courses and a variety of other activities (Fulton and Shigley, 2012). Despite this variability of uses, ultimately, redevelopment is a tool to facilitate real estate development in targeted areas within cities.

To the extent that redevelopment increases the price of land in a particular neighborhood, this will change the demographic of the people living in these places. If neighborhood revitalization is able to change these underlying dynamics, namely, it increases the price of housing and improves the quality of collective goods, this allows for the possibility that economic activity might emerge or be redistributed to and from these locations within a metropolitan region. As the nature of a neighborhood changes, a place that was once considered to be an undesirable place for certain businesses can become desirable (For example, if neighborhoods experience less crime over time, this can reduce the cost of doing business in this location). The link between redevelopment and the distribution of economic activity within regions is less obvious because redevelopment is not specifically targeted at economic activity. However, by changing the demographic composition of neighborhoods, it is possible that the nature of the labor supply will change within such neighborhoods (towards more skilled workers), and change the nature of local matching effects. Such change could "pull" firms to particular parts of metropolitan regions.

Within a metropolitan regional economy, businesses do not locate their premises on a blank canvas. Their ability to locate where they would like is directly determined by the actions of local governments who control the supply of land and determine how land can be used – whether for residential, commercial or recreational activities (Fulton, 2005). There are other factors that determine where a business establishment may locate, such as the cost of land (which is determined by the relative supply of and demand for land), however, bid rent functions – the idea that the use of land will be determined by its most productive use – are at odds with the reality of planning. Market forces do not always govern the use of land in local jurisdictions. As a discipline, planning is justified, in part, on the grounds that it corrects for market failures and planners have motives other than to simply yield the most value from land (Cheshire et al, 2014). Since local governments determine how land is used, it stands to reason that they can play a significant role in where economic activity locates within a regional economy. Restrictive land use policies in one part of a regional economy can "push" activity to another part of the local economy.

It is considered that land use decisions can impose two "indirect" costs on business location decisions within a regional economy. First, if the supply of land is constrained to the point where it is unable to meet demand, it can impose a cost on businesses in the form of higher land rents. Second, land use constraints can influence where businesses are able to locate and have the capacity to divert business activity to less productive parts of the regional economy (Cheshire et al, 2014). This second point dovetails with the earlier discussion in this chapter about the attenuation of agglomeration economies. Recall that there is evidence that agglomeration economies are stronger in some parts of regional economies than in others. If planning has the ability to restrict entry to those parts of a regional economy where agglomeration economies are the strongest (for a particular industry), there is a significant possibility that planning has the ability to affect the productivity of companies and, by extension, industries. To be more concrete, if there are parts of the Bay Area economy, such as Silicon Valley, where IT firms are more productive, due to the nature of agglomeration economies, land use constraints in these communities can push firms to parts of the region where firms are, on average, less productive.

It is widely held that land use restrictions (growth controls) induce sprawl, which can have negative impacts on the environment as well as engender other social costs, such as increased commute times (Glaeser and Kahn, 2010; Glaeser, 2011). However, the impact of land use on the economic performance of firms and industries is less well studied and, therefore, understood. The evidence that does exist suggests that zoning constraints increase office rents in vibrant economies and negatively impact productively. For example, Cheshire and Hilber (2008) find that the supply of office space in certain UK markets is constrained by regulation, which confers a great cost on business owners. Taking their cue from Glaeser et al (2005) – who found that households were paying a zoning tax in certain markets – they believe that land use regulations create an office tax on users. In London, they found that these constraints amount to anywhere between a 400-800 percent tax on the marginal cost of construction. As for the effects of growth controls on productivity, Cheshire et al (2012) find that planning restrictions introduced in 1996 in the United Kingdom have effectively capped the size of retail stores. The authors argue that, since store size is related to productivity, such land use constraints have caused a significant decline in store-level productivity in the UK. However, there have been few attempts, if any, to measure how land use restrictions affect the nature of agglomeration economies within a regional economy.

In theory, lower taxes should influence the location of economic activity, ceteris paribus. If everything else is held constant, a place with lower taxes should be a more appealing location for business activity than a place with higher taxes. However, once the different characteristics of places are taken into consideration, the effectiveness of tax differences should become far less pronounced. Lower taxes in one city, for example, may not be enough to offset weaker productivity in this city compared to some other place for a particular industry. Likewise, lower taxes may not be enough to offset high costs of labor and land in one city compared to some other city, for certain industries (Cheshire et al. 2014). From a theoretical perspective, when two places are very similar in terms of the costs and benefits they provide to businesses, tax rates should help to determine the distribution of economic activity between these two places. Therefore, it should be the case that tax differences across jurisdictions within a metropolitan region, where jurisdictions are closer substitutes for one another than is the case across metropolitan regions or states, are more effective (Bartik, 1991; Bartik, 2002).

The Tiebout hypothesis outlines that municipal governments provide a range of public services between which residents, and by extension, firms, choose when deciding where to locate within a metropolitan region (Tiebout, 1956). According to this theory, people and firms are utility maximizers. A differentiated supply of services by cities will correspond to the location and demand preferences of firms. Firms will be drawn to those places that offer the mix of services they require, at the price for those services that a firm is willing to pay. Effectively, the price of access to such services will be capitalized into land values. If a particular firm values a community with low levels of crime, or a lot of open space, they will chose to pay the price to access these services. This theory predicts that city governments, through their role in the supply of services, provide a range of options from which firms choose when locating their premises. Ultimately, the Tiebout hypothesis views different municipal governments as a market between which firms choose when locating or expanding their premises.

The reality of the structure of local governments in the US adds extra emphasis to this discussion. Metropolitan regions are typically fragmented into hundreds of local jurisdictions. In the Bay Area, over the period of this study, there were 10 county governments and 103 municipal governments[5]. This administrative landscape poses a

[5] In addition to this, there are many special authorities that hold jurisdiction over policy areas such as transportation and water.

challenge since the interests of individual communities may be at odds with wider regional interests. This conflict of interest is most clearly in evidence in relation to sprawl. When communities employ growth controls at the core of regional economies, this has the effect of inducing development at the fringes of regions, inducing sprawl (Glaeser and Kahn, 2010; Glaeser, 2011). In this case, local interests in preserving open space, reducing congestion or the perception of preserving property values are at odds within regional or national goals of reducing carbon emissions (Manville and Osman, 2015).

The local versus regional conflict of interests has been widely studied in the context of economic development incentives that are offered by communities to influence the location of economic activity (Bartik, 1991; Donahue, 1997; Cheshire and Gordon, 1998). This literature typically examines whether the incentives offered by local jurisdictions are zero-sum, growth enhancing or pure waste from the perspective of the state or national government of which the locality is a part (Bartik, 1991; Cheshire and Gordon, 1998). However, the impact of land use decisions on the economic performance of firms and industries is understudied and, therefore, less well understood. If agglomeration economies are not uniform across regional economies, then there exists the potential for local governments, through their control of land, and the other policies outlined above, to influence access by firms to those parts of the regional economy where the IT industry would prefer to locate. The concern of local residents to limit development within their community can have a regional cost if firms are prevented from locating in those parts of the regional economy where agglomeration economies are the strongest.

Conclusion

This chapter has outlined theories that form the basis for the central tension identified in this dissertation. Theories of economic geography explain and model the distribution and spatial organization of economic activities (such as production and employment) across space. Trade costs are the cornerstone of industrial location, since they facilitate the ability of industries to expand across space, fueling national and global webs of production. Central to theories of economic geography is the idea that, at different stages of their development, the inputs upon which industries rely evolve and with them, the locational requirements for the firms of such industries.

There are three inputs that the economic geography theories of location and agglomeration identify as binding firms of the same industry closely together in their early phases of development: specialized suppliers (sharing), specialized labor (matching) and knowledge spillovers (learning). Over time, as industries' become less reliant on the mechanisms of sharing, matching and learning (as routinization of the production process occurs), other requirements of firms shape their locational choices. As an industry grows, the scale of its production changes and with that, the land-intensity of its operations changes. Taken together, the reduced requirements for sharing, matching and learning, along with the growing demand for land and the ability to pay for it, come together to define the industry's preferences for location.

The literature reviewed in this chapter revealed that localization economies are not uniform across regional economies. Sharing and learning effects, in particular, were identified as attenuating over relatively short distances (over as little as half a mile in the advertising industry and 1 mile for a broader range of industries).

Adding to (and clouding) this picture are the actions of local governments. The companies that comprise an industry must interact with local governments in order to conduct their operations within a given community. Firms do not locate their premises on a blank canvas but on land that is administered by local governments, and, therefore, these administrations have great powers, in principle, to determine the location of economic activity within a metropolitan region.

The most obvious way that local governments can influence the location of economic activity within regions is through the amount of commercial and industrial development they permit on their land. Generally, actions by local governments can either "push" an industry away from areas within a region where localization economies are relatively strong through restrictions on land use, or they could "pull" the industry to other parts of the region through various sorts of incentives or other qualities of the local environment.

In this light, the evolving geography of the IT industry in the Bay Area should reflect the interaction between the "demand" for locations – emanating principally from the industry's internal dynamic of changing locational preferences over time, as noted above; and, the "supply" of locations, emanating from local land use policies and incentives provided to the industry to locate within a city's border. This intersection has been little considered in the scholarly and policy literatures to date. Typically, the economic geography literature will consider the natural or "market led" geographical evolution of an industry, while the local economic development literature will, for the most part, consider how local policies affect local economies. The reason for combining these theories is to understand whether the actions of local governments facilitate the natural expansion of industries within regional economies, in a way that enhances the industry's performance, or distort the industry's spatial reconfiguration in a way that inhibits its performance.

Chapter 2

The Evolution of the IT Industry in the Bay Area

This chapter provides a brief history of the IT industry within the San Francisco Bay Area, which traces the industrial evolution of the industry within the region. The chapter then presents descriptive statistics that outline, in a detailed manner, the industrial and geographical evolution of the IT industry within the Bay Area economy since 1990. To this point, this dissertation has asked two questions. First, why has the IT industry dispersed, from its historical home, around the broader San Francisco Bay Area? Second, could this change in the industry's geography affect the performance of the industry within the region? Two approaches to understanding the dispersion of the industry have been outlined. According to the "natural evolution" perspective, as tradable industries evolve over time, the inputs upon which they rely change, meaning that these industries will have different geographical preferences with the passage of time (as different locations within regions, nations and the globe provide a different range of economic characteristics from which industries draw) (Norton and Rees, 1979). According to these views, the dispersion of the IT industry within the Bay Area represents an efficient spatial reconfiguration of the industry to the extent that parts of the industry are simply responding to their different geographical preferences over time.

According to the "premature departure" perspective, actions by local governments could either push the industry away from its historical core within the region through restrictions on land use, or they could attract the industry to other parts of the region through various sorts of incentives or other qualities of the local environment. To put this another way, IT firms might like to access certain parts of the region to maximize their access to processes of sharing, matching and learning but may be denied such access due to how land is used. This dissertation seeks to understand whether any such reconfiguration caused by these actions is optimal from the perspective of the industry.

Recall that Santa Clara County is not completely synonymous with Silicon Valley, but this chapter will show that a remarkable dispersion of the IT industry has occurred from this county around the broader region, and that Santa Clara County has been home to considerable job losses in the IT industry since 1990. The majority of the employment in the IT industry within the Bay Area is found in four counties: Alameda, San Francisco, San Mateo and Santa Clara Counties, where IT firms accounted for 93% of the region's IT employment in 2010[6]. Over the entire period (1989-2010), the IT industry in Santa Clara County lost nearly 26,000 jobs, while significant IT employment growth occurred in the firms in Alameda (19,169 jobs), San Francisco (16,405) and San Mateo Counties (25,039). Yet the underlying nature of the economic geography differs across these locations (particularly in terms of the nature of economic activity, land prices, land scarcity and the built environment across the region).

To place the dispersion of the IT industry in Santa Clara County in context, it is necessary to understand how the industry has geographically reconfigured across the regional economy. For example, a collection of cities in Santa Clara County, and Menlo

[6] In reality, county and municipal boundaries can be somewhat irrelevant units with respect to the scale at which the economic geography of industries function. The economies of different cities within the region combine and recombine across county boundaries to form sub-centers of specialization across a variety of industries. While statistics that pertain to counties can provide useful lenses through which to view sub-regional specialization, the nature of economic geography is complex and caution must be exercised when interpreting data across them.

Park, in the neighboring San Mateo County, represent the original core of the IT industry within the region. Can the growth of the IT industry in San Mateo County be understood as direct spillover from the original core of the industry in Santa Clara County to its neighbor to the west? According to this view, the IT core within the region has expanded outwards and as a whole, the core of the original IT center has simply pivoted geographically. Can the growth of the industry within Alameda County be understood as the deagglomeration of lower value added functions from Santa Clara County to this relatively cheaper county within the regional economy? Furthermore, how is it possible to make sense of the growth of the industry in the City of San Francisco? Has the City of San Francisco developed a new niche (or agglomeration) within the regional economy parallel in its degree of sophistication to the industry in Santa Clara County? To reiterate, understanding the qualitative nature of the evolution of the industry across the region is critical to interpreting the IT job losses that have occurred in, and the dispersion that has occurred from, Santa Clara County. This second part of this chapter will examine these issues through the use of descriptive statistics that focus on the evolution of the industry across the region's counties and cities.

Silicon Valley: A Brief History

It is now widely held that the origins of the information technology industry in the Bay Area can be traced to the work of "radio hobbyists" at the turn of the 20^{th} century (Sturgeon, 2000; Lecuyer, 2006; Rao and Scaruffi, 2011). Radio enthusiasts at this time, such as Cyril Elwell, Lee De Frost, Frederick Terman and Charles Litton, established an early presence in the region in transmitters and power vacuums, which at that time were technologies used to transmit radio waves. Elwell's company, the Federal Telegraph

Company (FTC), provided the US Navy with their key ship-to-ship and ship-to-land communication systems during WW1. These contracts enabled FTC to draw a team of skilled engineers to the region (Sturgeon, 2000; Lecuyer, 2006).

During the 1930s, Eitel-McCullough and Litton Industries, which, at that time, were both located in the Bay Area, emerged as major producers of power tubes, and later, microwave tubes. These electrical components had become the basis for radar systems, in addition to their use in radio communications. Litton mastered the design and construction of the specialized vacuum equipment required to make power tubes (Lecuyer, 2006), while Eitel-Mcullough, in particular, became a nationally recognized producer of power tubes during WWII. Together, the two firms firmly established the Bay Area's presence in the manufacture of electrical components (Lecuyer, 2006). While the level of production in the Bay Area at this time lagged behind the output of the electronics giants on the East Coast, the companies helped the Bay Area emerge as a national player in the industry.

From this basis, the electronics agglomeration in the region began to gather momentum. Frederick Terman, who was Dean of the School of Engineering at Stanford University, was close friends with Litton and began to promote and establish courses at Stanford University in fields of science closely related to the region's industrial specialization in power tubes. In the 1930s, he developed a program in vacuum tube engineering. Terman hired Litton to teach courses about vacuum tube making, while Litton supported the program by donating $1,100 to the electrical engineering department. Part of this money was used by Terman to lure one of his former students, David Packard, back to the university. Packard worked with Litton at Stanford and would later form a company with the financial support and backing of Terman, with his friend and fellow graduate student, William Hewlett (Lecuyer, 2006).

Frederick Terman was a native to the San Francisco Bay Area, who graduated from the Massachusetts Institute of Technology. During his time at Stanford, both as a professor, and then the Dean of Engineering, he was an active booster of the electronics industry in the San Francisco Bay Area. He pioneered three institutional changes in academia, which would take universities in other regions decades to replicate. First, the Stanford Research Institute (SRI) was established for "pursuing science for practical purposes (which) might not be fully compatible internally with the traditional roles of the university" (page 23). Second, Stanford opened its classrooms to local companies through the Honors Cooperative Program, facilitating relationships between academia and industry. Third, he was responsible for the Stanford Industrial Park, which was the first university industrial park in the US. The first tenants of the park were Varian Associates, the inventors of the Klystron, which was a precursor to the vacuum tube. Terman was a key player in fostering a technology community in the region, specialized in the transmission of electrical signals (Saxenian, 1996).

In 1948, three scientists at Bell Laboratories in New Jersey, one of whom was William Shockley, a native of the San Francisco Bay Area, invented the first semiconductor (Klepper, 2009; Lecuyer, 2006). These transistors, which submit electrical signals, would come to substitute vacuum tubes in a wide variety of products. In 1955, William Shockley moved to Palo Alto where he created Shockley Transistors. Shockley's decision to move back to the Bay Area, to be close to his mother, was a significant moment in the evolution of the electronics industry in the region. Prior to this time there was little production of semiconductors in the greater San Francisco area (Lecuyer, 2006).

Providing engineers the opportunity to work in the cutting edge field of solid-state diffusion, a key element in the production of transistors, Shockley was able to draw highly talented engineers to his firm. However, disenchanted with Shockley's style of management – the so-called "traitorous eight" left Shockley to create Fairchild Semiconductors in 1957. The eight defectors were keen to find employment together as a group and were eager to remain in the Bay Area. When they could not find an employer for the entire group, they were offered the opportunity to start their own firm by an investor Arthur Rock, a New York based banker, who found them investment in the form of Fairchild Camera (Lecuyer, 2006)[7].

When Fairchild was created, it entered a world in which production of semiconductors was concentrated in three primary locations: Boston, Los Angeles and New York (Klepper, 2009). Fairchild would alter this landscape. The company had a lasting impact on the region in a number of ways. First, it was among the first firms in the country to produce silicon transistors; transistors until this point had been made from germanium (Silicon components were much better at resisting high temperatures than germanium ones). Second, Fairchild pioneered the planar manufacturing process, which would later be adopted by all semiconductor producers. Third, it created the integrated circuit. These breakthroughs marked a technology rupture of sorts, ultimately enabling the region to become a technological leader in transistor production. Fourth, not only

[7] Fairchild Semiconductors received its initial capital from Fairchild Camera, a New York based corporation. The money was provided by Sherman Fairchild, who provided the money on the condition that he would be able to purchase the equity of the 8 founding members for $300,000 per member, should the firm prove successful. Within three years, the founding members were bought out. This led a number of engineers to leave the firm to start their own enterprises (Kenney and Florida 2000).

was Fairchild the first spin off company in Silicon Valley, but it generated an unparalleled number of spin off companies. In total, Fairchild was responsible for 24 spin offs, the biggest of which were Intel, National Semiconductor and AMD.

Silicon Valley stands apart from the rest of the nation in terms of its fertility of spin off companies. In work on the genealogy of semiconductor firms, Klepper (2009) shows that, over the period 1957-1986, there were 91 spin off companies in the semiconductor industry nationwide. Silicon Valley accounted for 79 of them. The cycle of spin offs descendent from Shockley would become a key feature of the Silicon Valley economy. Over the period 1960 to 1990, Silicon Valley's share of the semiconductor market rose from 5 % of the national market to 47% (Klepper, 2009).

Until the 1970s, the primary consumer of semiconductors was the Department of Defense (DoD). Due to instability in DoD demand – such demand was reliant on political considerations 3,000 miles away– and concerns about DoD intrusion into their affairs – defense contracts entailed detailed reporting requirements and outlined with whom companies could buy and sell – in the 1960s Silicon Valley firms actively sought commercial clients for their products. They were greatly assisted in these efforts by the demand for integrated circuits from the burgeoning computer industry. Integrated circuits were general-purpose technologies used in most electronic devices. During the 1970s, venture capital replaced the military as the leading source of finance for Silicon Valley firms. Computers and other industrial markets became the dominant consumers of semiconductors by the late 1970s (Saxenian, 1996). Government contractors accounted for half of all semiconductor purchases throughout the 1960s, this dropped to 12 by 1972 (Saxenian, 1996).

Throughout the 1970s, great advances were made in the evolution of computers. Various forms of computers had existed for decades, even centuries, but prior to the 1970s, computers were large, cumbersome machines primarily used by governments, large corporations and universities, due to the fact that they consumed so much space and energy, and were prohibitively expensive to buy. Until this point, computers were far from the multipurpose and functional machines they would become, their use primarily restricted to problem solving and complex arithmetic applications. Until the 1980s, IBM, a New York based firm, dominated the mainframe computer market, which along with the minicomputer, was one of the major predecessors to the personal computer (PC). The 1980s would see mainframes and mini computers disappear with the rise of the PC. The earliest forms of the PC are traced to the Alto, a product created, but never produced for market, by Xerox's research lab, PARC, in Palo Alto, and IBM's PC. Xerox was an early investor in Apple Computers, and the avant-garde Alto would shape the design of Apple's computers.

The IBM PC revolutionized computing, selling 1 million units within 3 years of its launch in 1981. Production decisions made by IBM had far reaching consequences. First, having experienced anti-trust lawsuits, IBM decided to make its computer from "off the shelf components", making the specifications of its machines available to its competitors. This enabled its competition to reverse engineer and replicate its machines. Second, IBM, requiring an operating system for its machine, bought an operating system, the 86-DOS, from a young Seattle programmer, Tim Patterson. In 1981, Bill Gates bought the rights to 86-DOS and hired Patterson to develop the MS-DOS, which became the operating system for the IBM PC. Descendant from the IBM PC, a PC-clone industry emerged, which could rely on a ready built operating system, the MS-DOS. Throughout the 1980s, PCs were increasingly manufactured by a variety of Silicon Valley based companies, including Hewlett Packard, Sun Microsystems and Apple (which created the Macintosh). There were also major computer manufacturers outside of the region, including Commodore, Compaq, Dell, IBM and Olivetti. By the late 1980s, PC sales numbered in the millions. The advent of the PC would diversify the Silicon Valley economy away from its primary focus on electrical components and semiconductors, which by that time were becoming mature industries and were subject to deagglomerative forces (Rao and Scaruffi, 2011)

Beyond the reductions in cost and size, computers became so pervasive due to their increased utility. This was due, in no small measure, to software (Rao and Scaruffi, 2011). Computers are comprised of two major components, hardware and software. Until the 1980s, hardware constituted the majority of the production cost of a computer. As competition intensified in the 1980s, especially in the production of semiconductors, the price of hardware fell, enabling companies to invest more in software development. Software would become the most expensive component of computers and represented an area of significant profit (Rao and Scaruffi, 2011).

In the 1980s, the semiconductor manufacturers in Silicon Valley faced setbacks in the face of international competition (Saxenian, 1994: Khanna, 1997). In 1970, the US controlled over 90% of the world semi-conductor market (with Silicon Valley the main contributor). By 1986, Japan held over 50% of this market (Khanna, 1997). By 1989, the top four global semiconductor firms were no longer located in Silicon Valley. They were the Japanese firms NEC, Toshiba, Hitachi and Fujitsu (Khanna, 1997).

Saxenian (1996) attributes the relative decline of the semiconductor industry in Silicon Valley in the 1980s to a change in the nature of the industrial system that had served the region so well in the prior decades. Prior to the 1980s, Silicon Valley firms had largely produced customized transistors for individual systems or specialized devices. Such customization of devices was not conducive to large-scale automation of the manufacturing process, because, by their nature, customized transistors serve relatively small markets. Throughout the 1970s, the semiconductor industry matured and many firms entered the market, placing downward pressure on the price of producing the technology. In a bid to cut costs, producers in the region transitioned from custom design and moved towards standardized products, which could be programmed to the specific needs of companies (Saxenian, 1996). As maturation and routinization of production occurred, firms sort profits from cost cutting, rather than innovation (Saxenian, 1996). Semiconductor manufacturing was outsourced to cheaper locations in the world. Silicon Valley found itself competing with lower cost places in Asia, and saw a considerable drop in its market share in the industry, as noted above.

Silicon Valley firms had departed from their strength in technology development, and, realizing this, a new breed of firms emerged in the region, which focused on the production of customized semiconductors. By the early 1990s, Silicon Valley recaptured its market share of transistor production through providing custom devices, primarily to computer manufacturers. The resurgence of semiconductor firms drew computer manufacturers into their orbit. In their bid to differentiate their products, computer companies sought close proximity to the new round of chipmakers in order to collaborate on the design of custom (Saxenian, 1996; Rao and Scaruffi, 2011).

The Software Industry Takes Off

The advances in semiconductors and computer hardware throughout the 1980s created powerful machines that were not fully exploited by the state of software development at that time. Computers were capable of performing tasks more complex than arithmetic functions and had developed a wider application than office use. Graphical environments replaced the text only user interfaces, and computers performed a variety of functions, becoming indispensible home entertainment systems (Rao and Scaruffi, 2011).

Silicon Valley, once so reliant on Department of Defense contracts to support its firms and drive its innovation, had developed an infrastructure in which hi-technology industries could thrive; it had developed a high-technology agglomeration. The region provided unrivaled intermediaries to start-up firms, from venture capitalists, which provided valuable capital and embedded firms within regional networks, from law firms which specialized in intellectual property, to an independent equipment and manufacturing sector, and specialized marketing and advertising firms (Saxenian, 1996). Firms in Silicon Valley did not invent transistors or the computer, nor did they create the Internet. Yet such was the supporting infrastructure for information technology and forces of agglomeration in the region that Silicon Valley was able to consume these technology breakthroughs within its orbit.

In the early 1990s, a British engineer, Tim Berners-Lee who worked at CERN, the European Organization for Nuclear Research, based in Switzerland, created the origins of the World Wide Web. The rise of the Internet led to the creation of industries in web browsing, web searching, web cataloguing, web design, e-business and social media.

Silicon Valley, with its collection of technologically sophisticated venture capitalists, was well positioned to gain a foothold in the industry.

During the 1990s, the number of websites exploded, as ecommerce companies captured the imagination of investors. As the number of websites grew, to navigate millions of websites effectively, search tools were required. In 1993, Yahoo! – a website which divided different web pages into categories – was created by two students at Stanford University. Yahoo! was one of the first major Internet firms of Silicon Valley.

In August 1995, Netscape, which created an Internet browser and was a firm that until that point had not turned a profit, made a hugely successful IPO. Shares that were originally listed for $14 each, rose to $75 during the course of the first day of trading, achieving a market value of $2.9 billion by the day's end. Netscape's billion-dollar IPO started the "dot-com bubble" of the late 1990s. The advent of Internet Explorer in 1996, which was provided for free with the Windows operating system, provided a fatal blow to Netscape's business. However, investors all over the world envisioned the Internet as a vehicle that would revolutionize business. The Internet would reduce the importance of the "brick and mortar" company (for example, of the physical store), it was believed, and would create new ways for companies to market and sell their products.

Such was the enthusiasm for the new technology that investors poured billions of dollars into Internet-based companies, "dot.com" firms, many of which, it later became clear, had flawed business ideas. Faith in the Internet and that web-based firms would turn huge profits led stock prices to rise exponentially. With the realization that many of these firms could not possibly deliver on their investments, the bubble burst in 2000. When the bubble burst, Internet companies lost 75% of their value (Rao and Scaruffi, 2011). Notable failures of this time include Webvan.com, an online grocery store once valued at $1.2 billion, which went out of business within one year of the crash, The Learning Company, which Mattel bought for $3.5 billion in 1999 and sold for $27.3 million in 2000, and Pets.com, which raised $82.5 million in its IPO and went into liquidation 268 days later (Rao and Scaruffi, 2011).

Despite the failures, and the billions lost in stock value at this time, a number of firms were created in the 1990s, which marked the rise of a new generation of Silicon Valley companies. Search engines were one of the main drivers of the Internet revolution. Early search engines such as Excite, Alta Vista and Hotbot all made advances in the ability to search the Web, but they had not worked out a way to make their applications profitable. In 1998, two students at Stanford, Larry Page and Sergey Brin, created Google. The Web was growing so quickly that the main challenge for search engines was to retrieve relevant information for Internet users. Google pioneered a new form of "searching", which sorted webpages by their degree of popularity (Rao and Scaruffi, 2011).

Google came to dominate the search engine market; by 2004 it handled 85% of all web searches. Google had created an innovative way to search the Web and its strength relied upon network effects. The more people who use the search engine, the better the search engine can optimize results, which in turn draws more people to the service in a path dependent process (Rao and Scaruffi, 2011). Such network effects created monopolies in social media and a variety of other domains across firms such as Facebook, eBay, Craigslist, Paypal, Yelp and Twitter (ibid). In present years, the region has begun to lead the way in new spheres of information technology, such as mobile technology applications, cloud computing and social media.

In summary, descendent from the electrical components industry, and the semiconductor industry in particular, Silicon Valley created an unparalleled technological ecosystem found in few other locations. This agglomeration of skilled workers (matching), who contain within them key industrial knowledge (learning), and specialized suppliers and institutions (sharing) has enabled the region to capture new waves of technological advance, as parts of the industry have matured and experienced slower growth over time.

The IT Industry in Numbers

The remainder of this chapter will provide descriptive statistics that illustrate the evolving nature of the IT industry since 1990. It will do this first by considering developments in the IT industry in the US, before focusing on the evolving nature of the industry in the Bay Area. As the brief history of Silicon Valley above has outlined, there are four major subsectors that comprise the IT industry: electrical components, semiconductors, computer hardware and software. Appendix A provides a list of how each of these subsectors is defined using 6-digit NAICS categories.

A Macro View

In 2012, the IT industry employed just over 3 million people in the US economy, representing around 2.5% of the nation's labor force. Nationally, the industry's share of total employment has been quite consistent since 1990, hovering around 2.5%, although this share did peak at just over 3% at the height of the tech bubble at the turn of the century. Over this period, the IT industry has been a constant source of relatively high paying jobs in the economy nationally. In 2012, the industry paid its employees an average salary of $101,683 across the nation, compared to the average wage for all industries of $48,763. Since 1990, the gap between the wages paid by the IT industry and the wages paid by all industries has increased consistently. In 1990, the IT industry paid wages 54% greater than the national average for all industries; in 2012, the industry paid 108% more than the country's average wage[8].

Over the period 1990-2012, 437,014 net IT jobs were added to the US economy, while the national economy added around 24 million jobs across all industries. Over this period, therefore, the IT industry directly accounted for 1.8% of all net jobs created in the US. This figure likely underestimates the impact of the IT industry to the economy, since relatively well paying jobs carry a substantial multiplier effect (Moretti, 2012).

As displayed in table 2.1 below, since 1990 there has been a marked change in the composition of the IT industry within the US. In 1990, electrical component establishments employed the highest share of IT workers in the nation, accounting for close to 39% of all IT employment. In 2012, by contrast, software establishments accounted for close to 60% of all IT workers nationally. Over this period, the software subsector added over 1.2 million jobs nationally, while employment in the electronics sector declined by close to 600,000 jobs. Job losses also occurred in the semiconductor and computer hardware sectors over this period.

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[8] Note that this analysis draws on two primary datasets. In the first section of this analysis, Quarterly Census of Employment and Wages (QCEW) data are employed. This dataset has the advantage that it provides data for the US, as well each state and county within the country and is freely available. QCEW data provide information on wage and employment levels for each year 1990-2012, at detailed levels of industrial classification. In order to compare the IT industry in the Bay Area with national trends, and to provide data on wages within the industry, this dataset is indispensible. QCEW are derived from unemployment insurance programs and are available for 6-digit NAICS codes. Further into this chapter, the National Establishment Time Series data are used. This is a proprietary dataset which has been purchased for the San Francisco Bay Area only. Unlike the QCEW data, these data relate to employment across cities within the Bay Area. However, the data do not provide information on employee wages.

Table 2.1: The Composition of the IT Industry in the US, 1990-2012

	1990 Share of IT Employment	2012 Share of IT Employment	2012-1990 Employment Change
Semiconductors	16.03%	10.80%	-97,051
Computers	21.89%	14.13%	-152,388
Electronics	38.61%	15.18%	-580,370
Software	23.48%	59.89%	1,266,823

The IT Industry in California

In 2012, California accounted for 17% of all IT jobs in the US, which represented a fall in its share of IT employment from a peak of 21% in 1990. To place these figures in context, California accounted for around 12.67% of employment across all sectors in the US in 1990, and around 11.63% in 2012. Therefore, California's share of the IT industry is greater than its share of US employment as a whole (The Bay Area's strength in the industry plays a significant role in this regard, as will be discussed below). This being said, there is evidence that, just as the industry has dispersed within the Bay Area, it has also dispersed from California throughout the nation – a point which will be expanded upon below.

In 2012, 3.6% of the State's employment was found in the IT industry, down from a peak of over 5% at the turn of the century and a share of 4.35% in 1990. In 2012, the IT industry paid an average wage of $145,392 to its workers in California, a number considerably higher than the state average wage of $56,784 for all industries. This ratio (roughly 2.5:1) has increased significantly since 1990, when the industry in the state paid 55% more than the average wage for all industries. The distance between the wages paid by the IT industry in California and the IT industry nationally has increased significantly over time (see table 2.3). In 1990, the average wage for the IT industry nationally was

$36,092, compared to $40,539 in California (it was roughly 12% higher in California). In 2012, the national average wage for the IT industry was $101,683, compared to $145,392 in California (roughly 43% higher in California). Interestingly, over the period 1990-2012, California lost 34,906 net IT jobs, at a time when IT jobs grew nationally (by 437,014) and the state economy added 1.7 million jobs across all sectors.

As is the case nationally, the composition of the IT sector in the state has evolved significantly since 1990. In 1990, close to 45% of all IT employment in the state was found in electrical component manufacturers. In 2012, by contrast, software establishments contributed the majority of IT employment within the state. The industry in the state has contributed considerably to the national net job losses across the different subsectors of the industry. The industry in California has accounted for 44% of the national net job losses in semiconductors, 31% of the net job losses in computer and communications hardware, and 23% of the net job losses in electrical components. In the software industry, by contrast, the industry in the state has contributed only 15% to the net growth nationally.

Table 2.2: The Composition of the IT Industry in California, 1990-2012

	1990 Share of IT Employment	2012 Share of IT Employment	2012-1990 Employment Change
Semiconductors	20.56%	13.90%	-43,404
Computers	18.92%	11.51%	-46,919
Electronics	44.95%	23.00%	-135,080
Software	15.56%	51.60%	190,497

In table 2.3 below, wages paid by each sub-sector within the IT industry for the US, California and the Bay Area are displayed. In 2012, electrical components were the highest paying subsector of the industry. This pattern is especially pronounced in the Bay

Area where firms of this sector paid an average wage of $216,154 per year. The wages paid by the IT industry in 2012 differ considerably across the three regions. The wages paid in California and the Bay Area are around 45% and 65% higher than the national average, respectively.

Table 2.3: Wages paid by the IT Industry in the US, California and the Bay Area

	US		CA		Bay Area	
	1990	**2012**	**1990**	**2012**	**1990**	**2012**
Semiconductors	36,000	102,151	41,616	134,262	45,857	162,355
Computers	27,859	73,219	30,664	86,563	33,441	115,403
Electronics	37,273	107,329	43,065	159,317	49,297	216,154
Software	41,888	106,882	43,825	155,303	63,498	203,197
IT Industry Average	36,092	101,683	40,539	145,392	45,507	165,636

The Bay Area's IT Industry Within a National Context

In 2012, the IT industry in the Bay Area accounted for just under 51% of all IT jobs in California and a little over 8.5% of all jobs nationally. The region's share of IT jobs has remained quite consistent over time, reaching a peak of around 10% of the IT jobs nationally at the height of the tech bubble. The Bay Area's share of IT jobs in California has grown from 41% in 1990 to account for more than half today. Over the period 1990-2012 the industry added 41,229 net IT jobs in the region, representing around 9.5% of the net national growth in the IT industry over this time period (Recall that the IT industry in the whole of California lost jobs over this period).

In 2012, the industry in the region paid an average wage of $165,636, compared to a region wide average wage for all industries of $76,857. As is the case at the state and national level, the difference between the wages paid by the IT industry and all industries combined in the region has grown over time. In 1990, the industry paid 58% more than the regional average for all industries compared to 115% more in 2012. The IT industry in the Bay Area pays close to 3.5 times more than the national average wage for all industries and close to three times the average wage for all industries in California.

Table 2.4: Wages paid by the IT Industry and All Industries Combined for the US, California and The Bay Area

	Average wage, All Industries		Average wage, IT Industry	
	1990	2012	1990	2012
US	23,400	48,763	36,092	101,683
CA	26,162	56,784	40,539	145,392
BAY	28,681	76,857	45,507	165,636

In both California, but the Bay Area in particular, the IT industry represents a greater share of total employment than is the case at the national level. Since both regions exhibit greater shares of IT employment than is the case at the national level, the IT industry is clearly relatively specialized in both locations. There are better measures of specialization, however, which illustrate this point. Locations quotients are a widely used tool to measure the extent to which a given region may be specialized in a particular industry. Location quotients compare employment in a particular industry, such as the IT industry, as a share of total employment in a particular place, such as California, to the share of the IT industry of total employment in some other location, such as the national economy. To continue with this example, if a location quotient is equal to 1, this means that the share of IT employment of total employment in California is identical to the same share for the US. If the value is less than one, it is inferred that the industry in California is less specialized than is the case at the national level; if the value is greater than one, the region is considered to be more specialized than is the case at the national level. Clearly, this measure does not account for differences in productivity across two places; however, it does provide a sense of the extent to which some places have a greater concentration of workers than some other place in a given industry.

In table 2.5 below, it can be seen that both the state of California and the Bay Area are specialized in the IT industry, relative to the rest of the nation. However, in the Bay Area, the location quotients are far higher than is the case for California. In California, in fact, the location quotient for the IT industry has declined since 1990, while it has increased in the Bay Area (although it is a little lower than it was in the year 2000).

Table 2.5: Location Quotients for the IT Industry in California and the Bay Area

	California			Bay Area		
	1990	**2000**	**2012**	**1990**	**2000**	**2012**
Semiconductors	2.12	2.34	1.88	5.53	6.07	4.93
Computers	1.43	1.30	1.19	2.06	2.42	2.22
Electronics	1.93	1.91	2.22	2.70	3.14	3.94
Software	1.10	1.50	1.26	2.07	3.33	3.11
IT Industry Total	1.65	1.67	1.46	2.87	3.47	3.31

The IT industry has been a consistent source of well paying jobs for the US, California and Bay Area economies for a sustained period of time. In fact, wages in the IT sector have been growing faster than the average wage paid by all industries since 1990. The industry has been a modest source of jobs at the national level, while it has actually contributed a net loss of jobs in the California economy.

As is the case at the national level, the Bay Area economy has experienced significant sectoral change over the period 1989-2010. In Appendix B, the share of the Bay Area economy found across 2-digit NAICS classifications is presented, for the years 1990, 2000 and 2010. While analysis at the 2-digit level is not optimal for detailed industrial comparisons, it does highlight a number of important trends in this case. For example, in 1990, 14.9% of regional employment was found in manufacturing industries (this represented the largest share of regional employment at this time, across 2-digit categories). By 2010, this number had fallen to 9.3%. Jobs in professional, scientific and technical services, combined with information industries, have grown from 10.7% of the regional economy in 1990 to 15.4% of the economy in 2010; in 2010, firms in this category were the largest employers in the region.

Just as was the case nationally and within the state of California, the composition of the IT sector within the Bay Area has experienced a considerable transformation since the late 1980s. In 1989, just under 40% of all IT jobs were found in the electrical components sector. Semiconductors made up just over a quarter of all employment, while software and computers made up around 18% and 15% of total IT employment, respectively, at that time. By 2010, software had become the largest subsector in the region, making up roughly half of all employment. Electrical components saw the largest relative loss, with its share falling to around 22% of the industry's employment. Table 2.6 reveals that only the software sector gained employment over the period. In figure 2.2 the magnitude of job losses and gains across each sector over the period of study is displayed.

From this macro perspective, two broad processes seem to be occurring. On the one hand, employment in the IT industry seems to be dispersing from California around the nation. However, within California the industry has consolidated in the Bay Area. At the same, the wages paid by the IT industry in California and the Bay Area have grown at a faster rate than wages paid in the industry in the rest of the nation. While it is necessary to exercise caution when interpreting descriptive statistics, these numbers are highly suggestive that a deagglomeration of the industry from California around the nation is occurring in lower value parts of the industry, while higher value parts of the industry are concentrating (or agglomerating) in the San Francisco Bay Area.

Figure 2.1: Sectoral Change in the IT Industry in the Bay Area

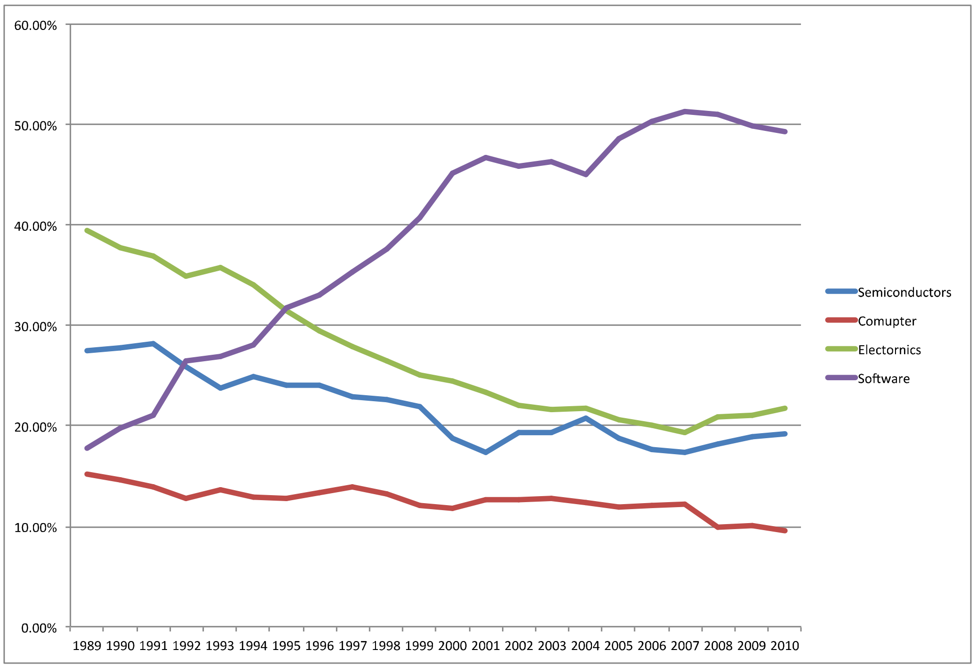
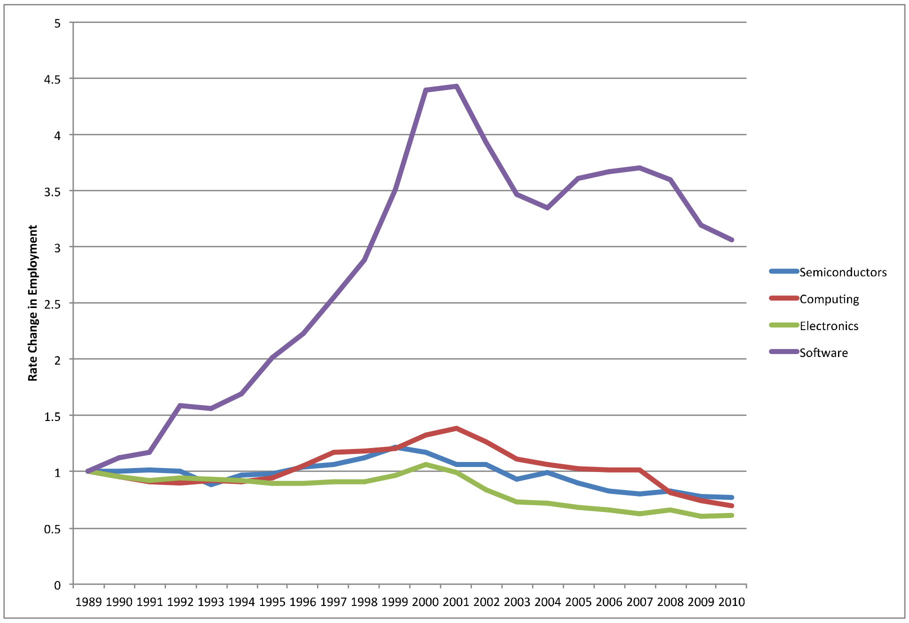


Table 2.6: Employment Change by Subsector in the IT Industry for the Bay Area

	1989-2000 Change	2001-2010 Change	1989-2010 Change
Semiconductors	17,109	-27,976	-22,115
Computers	17,562	-37,367	-16,535
Electronics	9,520	-53,332	-54,416
Software	211,305	-85,164	128,308

Figure 2.2: Rate of Employment Change by IT Subsector in the Bay Area



A Closer Look at the San Francisco Bay Area and the IT Industry

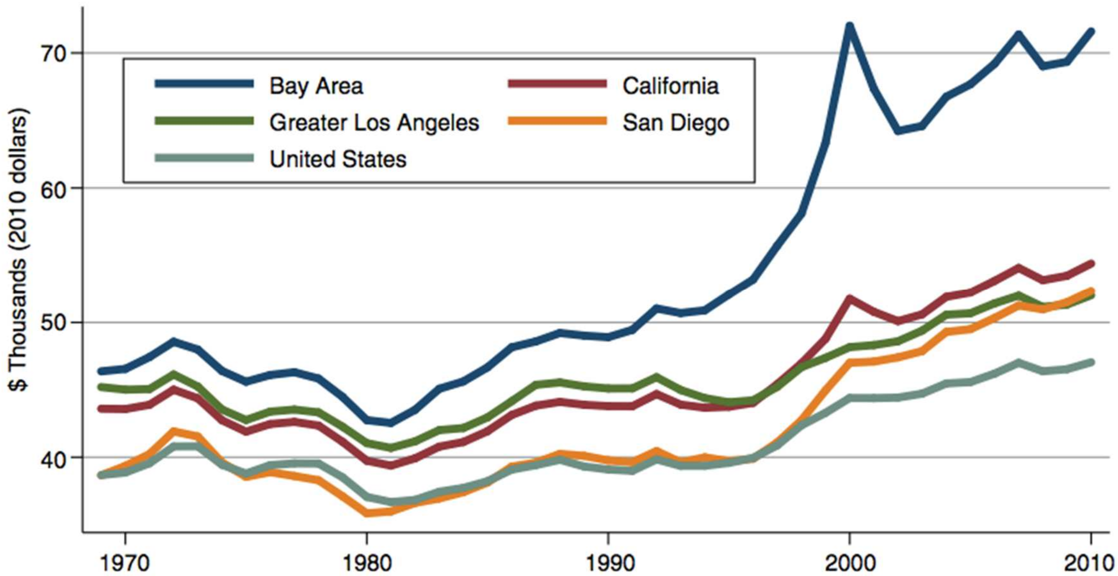
In table 2.7 below, it can be seen that over the period 1989-2010, the economy in the San Francisco Bay Area added 641,190 jobs across all industries, which represents an increase of 17.9% over the period. Across the region's counties, the economy added jobs at different rates. Over this period, the industries in Alameda County added more jobs than the firms in other counties in the region, 145,551 jobs, which represents an increase of 21.6% over the period. The second largest contributor to net job creation was the activity in Contra Costa County, which added 145,219 jobs. Interestingly, firms in the city of San Francisco lost over 20,000 jobs over this period, representing a 3.2% decline in the total number of jobs in the municipality. Firms in eight of the ten counties experienced employment growth greater than the regional average; firms in Santa Clara County join San Francisco in growing slower than the regional average. The industries in Santa Clara County are the largest contributor to jobs in the region. In 2010, they accounted for 25.2% of all jobs in the Bay Area, followed by the firms in Alameda County, which employed 19.36%, and San Francisco that employed 15.25% of the workers in the region.

Table 2.7: Employment Change Across Bay Area Counties, 1989-2010

	Employment Change, 1989-2001		Employment Change, 2001-2010		Employment Change, 1989-2010	
	Employment	Percentage	Employment	Percentage	Employment	Percentage
Alameda	235,524	35.0%	-89,973	-9.9%	145,551	21.6%
Contra Costa	118,160	37.1%	27,059	6.2%	145,219	45.6%
Marin	45,287	35.4%	-11,380	-6.6%	33,907	26.5%
Napa	28,099	59.4%	3,816	5.1%	31,915	67.4%
San Francisco	106,644	16.0%	-128,064	-16.6%	-21,420	-3.2%
San Mateo	88,772	23.7%	6,511	1.4%	95,283	25.5%
Santa Clara	268,299	27.1%	-193,290	-15.3%	75,009	7.6%
Santa Cruz	36,904	37.8%	-749	-0.6%	36,155	37.0%
Solano	31,716	26.8%	3,045	2.0%	34,761	29.4%
Sonoma	62,878	36.3%	1,932	0.8%	64,810	37.4%
Total	1,022,283	28.5%	-381,093	-8.3%	641,190	17.9%

The San Francisco Bay Area is the wealthiest metropolitan region in the US. It has been top or close to the top of the income rankings within the nation consistently for decades, and the distance between the Bay Area and the national average wage has been growing over time, becoming more pronounced since the 1990s (Storper, et al 2015). Figure 2.3 below displays the average wages for the Bay Area compared to other large metropolitan regions in the state, as well as the statewide and national averages. The distance between the lines is somewhat consistent until around the 1990s when significant separation between the Bay Area and the other locations occurred. These differences have been sustained into the 2000s, suggesting a lasting impact of the wealth created by the tech industry during the 1990s.

Figure 2.3: Average Wages in the Bay Area and Other Economic Regions



Source: "The Bay Area, A Regional Economic Assessment" (2012)

The IT industry has been central to the high wages paid in the regional economy and has shaped total employment patterns within the region over the period 1989-2010. An interesting picture emerges when the period 1989-2010 is divided into two segments: the tech boom and its aftermath[9]. From 1989-2000, just over 900,000 net jobs were added to the Bay Area economy (914,501). The IT industry directly accounted for 28.3% of these jobs (254,979). In some years the contribution of the IT industry to the region's net employment generation is especially pronounced. In 1995, the IT industry accounted for 45.5% of the net jobs created in the region, 37% of all jobs in 1998, 46% in 1999 and 30% in 2000. However, just as the IT industry was a significant source of employment prior to the crash of the tech bubble, it has been a source of considerable job losses since. Over the period 2001-2010, 262,200 net jobs were lost in the Bay Area. Over this period,

[9] In reality, the Bay Area experienced more than one recession over this period. The first was in the early 1990s, and then again during the Great Recession. The first recession was quite minor – the region lost around five thousand jobs from the year 1992 to 1993. As for the Great Recession, around 16,000 net jobs were lost over the period 2007-2010. The tech boom had much more profound consequences for the region.

the IT industry lost 220,254 net jobs. Remarkably, the job losses in the IT industry represent fully 84% of the net jobs lost in the region over this period.

Intra-Regional Specialization: The IT Sector Within the Bay Area

The nature of the IT industry across the counties and cities of the Bay Area differs considerably. This can be seen in the level of total employment across each county, and the respective change in these levels over time. Differences also exist across the sub-sectors within which the IT industry across these counties specializes, and consequently, the level of wages paid by the industry across these locations. As the IT industry has grown over time, the industry has developed sub-regional specializations that reflect differences in the underlying nature of the economic geography across the region (particularly in terms of land prices and nature of the built environment across the region).

To place the dispersion of the IT industry in Santa Clara County in context, it is necessary to understand how the industry has geographically reconfigured across the regional economy. For example, Santa Clara County is a rough proxy for the original core of the IT industry within the regional economy. Can the growth of the IT industry in San Mateo County be understood as direct spillover from the original core of the industry in Santa Clara County to its neighbor to the west? According to this view, the IT core within the region has expanded outwards and as a whole, the center of activity has simply pivoted geographically. Can the growth of the industry within Alameda County be understood as the deagglomeration of lower value added functions from Santa Clara County to this relatively cheaper county within the regional economy? Furthermore, how is it possible to make sense of the growth of the industry in the City of San Francisco?

Has the City of San Francisco developed a new niche (or agglomeration) within the regional economy parallel in its degree of sophistication to the industry in Santa Clara County? To reiterate, understanding the qualitative nature of the evolution of the industry across the region is critical in interpreting the IT job losses that have occurred in, and the dispersion that has occurred from, Santa Clara County.

In reality, county and municipal boundaries can be somewhat arbitrary units with respect to the scale at which the economic geography of industries function. For example, the economy of some parts of Alameda County gravitates towards economic activity found in Santa Clara County, while the economy in other parts of the county gravitate towards the City of San Francisco. In reality, the economies of different cities within the region combine and recombine across county boundaries to form sub-centers of specialization across a variety of industries. While statistics that pertain to counties can provide useful lenses through which to view sub-regional specialization, the nature of economic geography is complex and caution must be exercised when interpreting data across them.

Santa Clara County and the Dispersion of the IT Industry

The strong growth of the IT industry throughout the 1990s, and the aftermath of the subsequent bust have reshaped the geography of the IT industry within the region. Over this time, the industry has grown and developed at different rates across the regional economy. In 1989, industries in Santa Clara County accounted for 27.6% of all jobs in the region, compared to 25.2% of all jobs in 2010. This represents a decrease by 2.4 percentage points in the county's regional share of total employment. In 1989, the county was home to a little short of 1 million jobs (991,078) compared to more than a million jobs in 2010 (1,066,087). While its share of regional jobs has declined, the economy within the county has experienced employment growth of roughly 7.6% over the period. However, as demonstrated in table 2.7 above, this rate of growth was much slower than the regional growth in employment of 17.9%. If the economy in the county had maintained its 1989 share of regional employment, in 2010 there would have been roughly 102,000 more jobs in the county than was actually the case (which would add around 10% to the level of jobs in the community).

As is the case with employment across all industries, the firms in Santa Clara County are the major employers in the IT industry within the region. However, whereas firms in the county contribute around a quarter of all jobs in the region, they account for the majority of jobs in the IT sector. In 1989, the IT industry in the county employed roughly 71% of the region's IT workers (compared to 27.6% of all employment at this time). By 2010, however, the share of the region's IT activity found in the county had fallen to 57.5% (see figure 2.4 below). Whereas total employment in the county increased over the period 1989-2010, IT employment in the county actually fell over this time. In 2010, there were 25,864 fewer IT jobs in Santa Clara County than there were in 1989. In fact, Santa Clara County was only one of three counties in which IT employment fell over this period. The other two are the smaller counties of Santa Cruz and Sonoma. This occurred at a time when the region added 35,242 net IT jobs. If the county had maintained its 1989 share of regional IT jobs in 2010, there would have been 50,778 more IT jobs in Santa Clara County than there actually were (in other words, 23% more IT jobs than was the case). To further place these numbers in context, regional IT employment grew by 10% over this period, yet employment in Santa Clara County's IT firms decreased by 10%.

Figure 2.4: Santa Clara County's Share of IT Employment in the Bay Area and IT Employment Change in the Region, 1989-2010

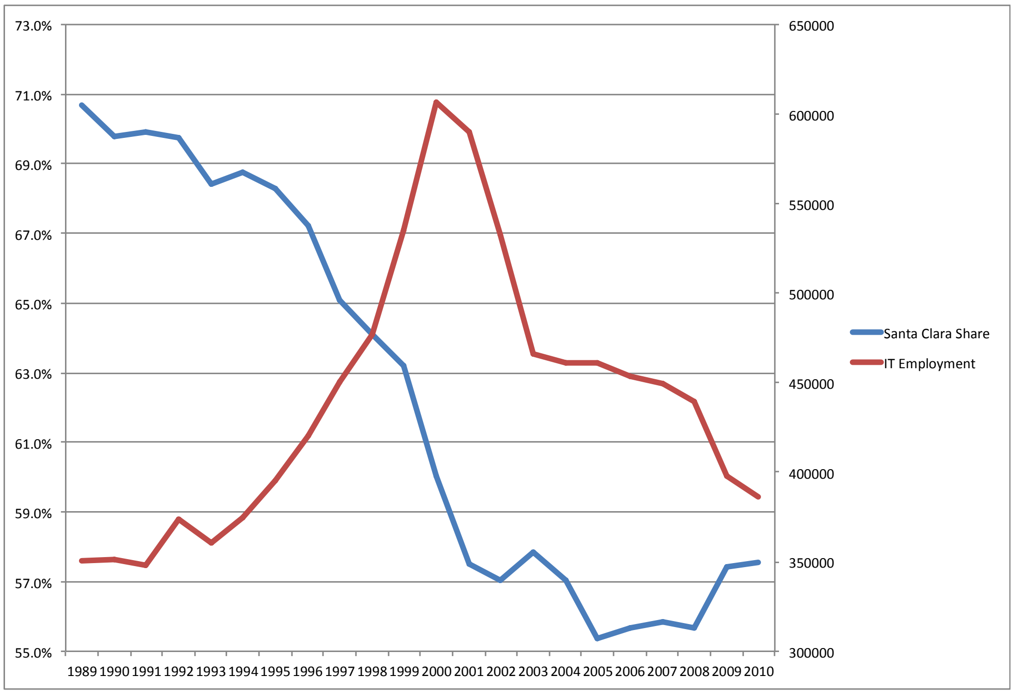


Table 2.8: IT Employment Change by Bay Area County, 1989-2010

	IT Employment Change, 1989-2000		IT Employment Change, 2000-2010		IT Employment Change, 1989-2010	
	Employment	Percentage	Employment	Percentage	Employment	Percentage
Alameda	48,541	150.28%	-29,372	-36.33%	19,169	59.35%
Contra Costa	7,763	68.58%	-7,212	-37.79%	551	4.87%
Marin	11,982	210.06%	-11,460	-64.80%	522	9.15%
Napa	1,125	468.75%	-147	-10.77%	978	407.50%
San Francisco	34,212	384.92%	-17,807	-41.32%	16,405	184.57%
San Mateo	22,668	77.04%	2,371	4.55%	25,039	85.09%
Santa Clara	115,872	46.72%	-141,736	-38.95%	-25,864	-10.43%
Santa Cruz	9,313	128.42%	-10,076	-60.83%	-763	-10.52%
Solano	817	142.09%	-320	-22.99%	497	86.43%
Sonoma	3,203	45.05%	-4,495	-43.59%	-1,292	-18.17%
Total	255,496	72.83%	-220,254	-36.33%	35,242	10.05%

Taken together, over the entire period (1989-2010), the IT industry in Santa Clara County shed nearly 26,000 IT jobs, while significant IT employment growth occurred in parts of the industry found in Alameda (19,169 jobs), San Francisco (16,405) and San Mateo Counties (25,039) (together, industry in the 4 counties account for 93% of the region's total). The analysis now turns to understanding the nature of the change that has occurred across these counties. Of primary interest is to understand the qualitative nature of the reconfiguration of the industry across the region.

Sub-Regional Differences in the IT Industry

Chapter 1 provided a number of theories that provided lenses through which the dispersion of the IT industry from Santa Clara County around the broader region can be understood. The growth of the industry in Alameda, San Francisco and San Mateo Counties might be understood in three different ways. The growth in Alameda County, which has relatively cheaper land than the other counties, might be understood as the growth of lower value added functions that have deagglomerated from Santa Clara County (and other more expensive parts of the regional economy). The growth of San Mateo County might be understood as direct spillover of sophisticated functions that can no longer fit in Santa Clara County, because the land in the county is either too scare, too expensive or some combination of the two. The growth of the IT industry in San Francisco could represent a technological rupture, as a new subsector in the region has emerged away from the existing center of Silicon Valley.

The figures below demonstrate the different degrees of relative specialization in the industry across each of the four counties for the years 1989 and 2010. In 1989, San Francisco, as might be expected given its relatively abundant supply of office space within the regional economy, does not have a great degree of specialization in the manufacturing and the research and development oriented subsectors (computers, electrical components and semiconductors). Santa Clara County has a much larger degree of specialization in semiconductors than is found else where in the region, while Alameda and San Mateo counties display a high level of specialization in electrical components. To be clear, these charts reveal different degrees of specialization across the four counties and are no indication of the absolute size of each sector within and across the counties.

Figure 2.5: Composition of the IT Industry in Alameda County, 1989 and 2010

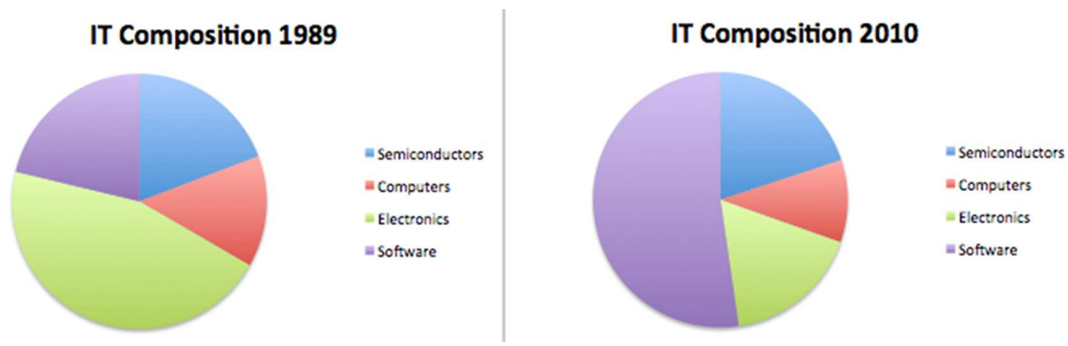


Figure 2.6: Composition of the IT Industry in San Francisco County, 1989 and 2010

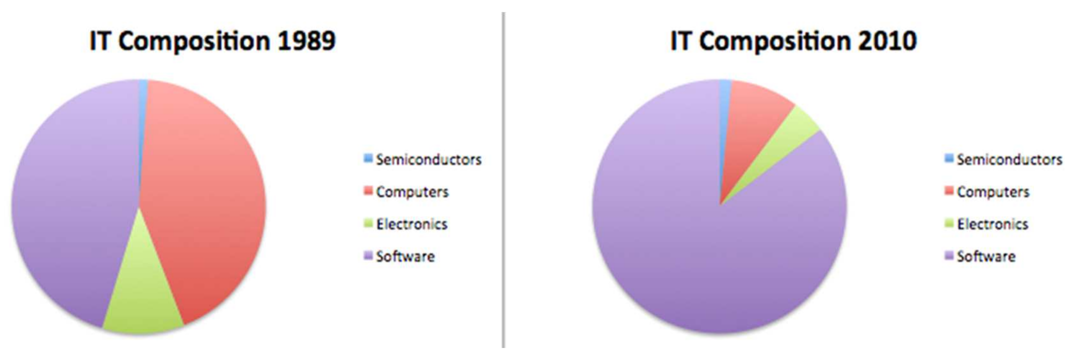


Figure 2.7: Composition of the IT Industry in San Mateo County, 1989 and 2010

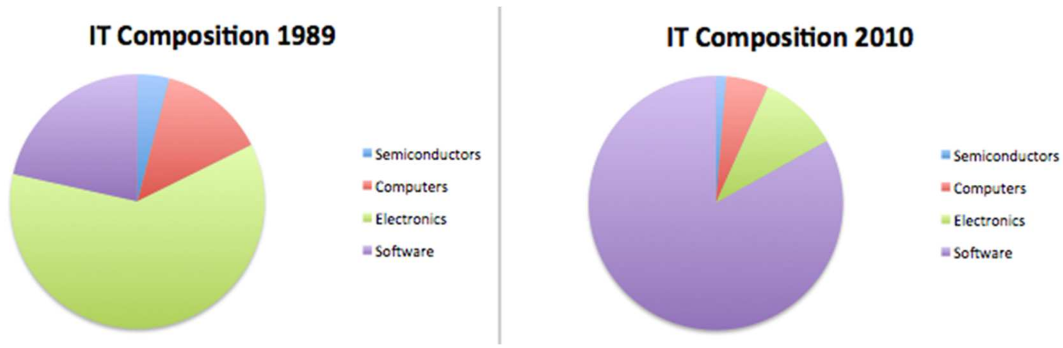
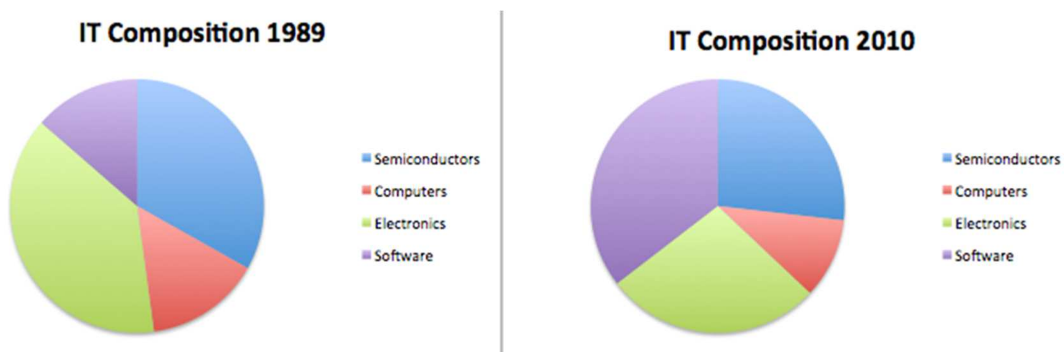


Figure 2.8: Composition of the IT Industry in Santa County, 1989 and 2010



By 2010, the software subsector had grown in each county, relative to the other sectors. In Alameda County, however, software employers represented a little more than half of the IT employment in the county, and the industry in the county retains a relatively strong degree of specialization in the other, manufacturing oriented sectors. The composition of the IT industry in San Francisco and San Mateo Counties look very similar, whereby the IT industry in each county is heavily centered in the software subsector. Santa Clara County looks closer to Alameda than it does these two counties since the industry found there retains a significant share of employment in each of the sectors. However, note that the software sector is larger in Santa Clara County, in terms of total employment, than in the other three counties combined.

For each subsector, table 2.9 below reveals employment change across the four counties over the period 1989-2010. Except for the software industry, which grew across each county, the only other sector in which significant employment growth occurred was the semiconductor sector in Alameda County over this period.

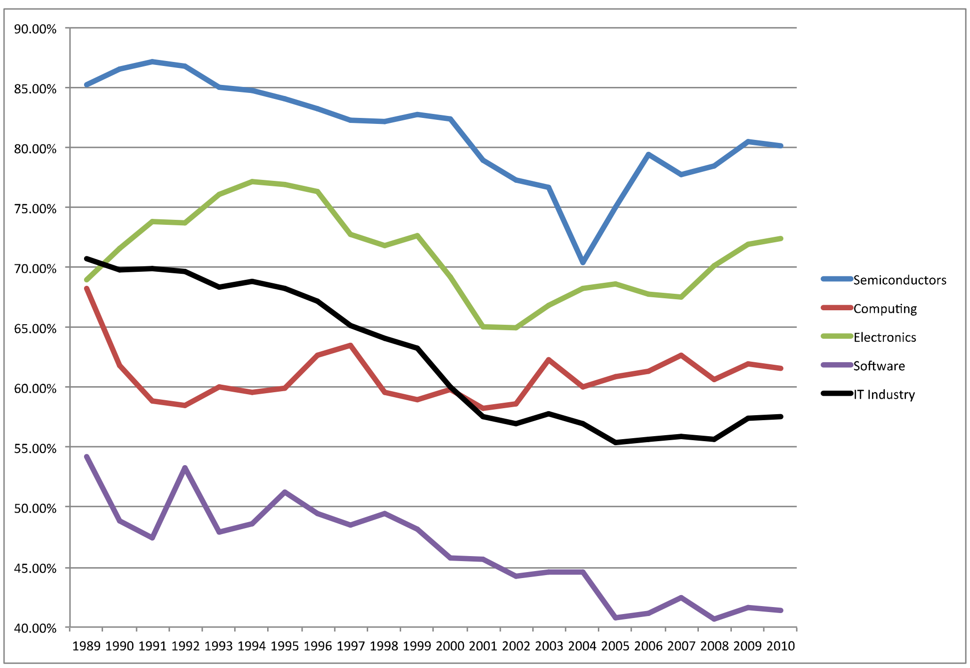
Table 2.9: Change in Employment by Subsector, 1989-2010 for Four Counties

	Alameda	San Francisco	San Mateo	Santa Clara
Semiconductors	4,059	284	-444	-22,667
Computers	817	-1,616	-961	-13,721
Electronics	-5,764	182	-12,141	-34,560
Software	20,057	17,555	40,590	45,084

Figure 2.9 demonstrates the extent to which the industry in Santa Clara County has been specialized in each subsector over time. Dispersion from Santa Clara County has occurred across each subsector to the other counties (in the region) in all except for the electronics industry. This being the case, it is difficult to ascribe the dispersion of the industry from Santa Clara to Santa Clara County's relative demise in a particular subsector.

Taken together, these tables reveal that job losses in Santa Clara County have occurred because the industry within this county was relatively highly specialized in subsectors that have matured and consequently lost employment. However, the industry in Santa Clara County has not just experienced absolute job losses compared to the rest of the region, but relative job losses, also. For example, whereas the software industry in the county accounted for roughly 55% of the region's software jobs in 1990, the subsector in the county has added only one third of the net job growth in this sector since. In Alameda County, employment growth can be attributed to growth in the software industry and growth in the semiconductors subsector. In this latter case, it seems clear that parts of the semiconductor industry have deagglomerated from Santa Clara to the East Bay county. IT employment growth in San Francisco and San Mateo Counties can be directly attributed to the industry's relative specialization in the software industry, which has been the only sector that has added employment in the region over time. While these differences in specialization patterns reveal difference in the nature of the industry across the region, there are further ways to understand the qualitative difference of the industry across the regional economy.

Figure 2.9: Change in Santa Clara County's Share of Regional Employment by Subsector



Further Evidence on Sub-Regional Differences in the Nature of the IT Industry

Above, it is demonstrated that there are within region differences in the composition of the IT industry. However, these figures do not reveal the true extent of the differences in the nature of the industry across the region. For example, to what extent are their qualitative differences in the software industry located in Santa Clara and Alameda Counties? Wages are another way in which sub-regional differences in the nature of an industry can be measured. Higher wages within a given industry or subsector may be a guide that firms in a given sub-region are engaged in more sophisticated, non-routine functions than firms in the same industry in another location (Storper et al, 2015). Recall that the IT industry has added software employment in each of the four counties investigated above. However, the software industry is heterogeneous in nature; not all software activity is equal: some activity is found in higher value added activities than others.

In table 2.10 below, the differences in wages paid by IT establishments across the different counties of the Bay Area for three time periods are displayed. In 2010, IT firms in Santa Clara County paid the highest wages in the region, paying an average of $168,077. IT firms in Napa County, by contrast, paid $72,132 on average. As the analysis earlier in the chapter reveal, the IT industry differs in composition across the counties in the region, which provides a plausible explanation for why wages might differ across counties – one county may specialize in a subsector that pays higher wages than are found in the subsector in which another county specializes, for example. If the majority of the IT firms in Napa County are specialized in a lower paying part of the industry, like computer and communications hardware, while Santa Clara County firms tend to be specialized in electronics, which pays higher wages on average, this would account for wage differences across the region.

Table 2.10: IT Wages (in dollars) Across the IT Industry in the Bay Area

	1990	2000	2010
Alameda	37,736	90,184	115,450
Contra Costa	40,935	84,803	98,929
Marin	44,182	88,071	116,574
Napa	N/A	45,154	72,132
San Francisco	41,264	101,340	138,512
San Mateo	50,350	143,107	137,540
Santa Clara	46,413	156,518	168,077
Santa Cruz	40,840	93,947	93,128
Solano	24,261	55,744	94,794
Sonoma	40,053	83,131	114,303
Bay Area Average	45,507	140,089	152,985

In table 2.11, below, it can be seen that software firms in Napa County pay much lower wages than software firms in Santa Clara County. This provides evidence that the software industry in Santa Clara is either more productive, or develops more sophisticated products, than is the case in other counties within the region (i.e. the wages are evidence of within sector heterogeneity). In either case, the nature of the industry in Santa Clara County would appear to be qualitatively different from the functions of the industry found in Napa County, and the other counties in the region, for that matter.

As table 2.10 (above) reveals, in 1990, save for Solano County, there is not much variation across the wages paid by the IT industry across the region's counties. At this time, firms in San Mateo County paid higher wages than those in Santa Clara County. However, by the year 2000, a greater range in IT wages across the counties emerges, and IT firms in Santa Clara clearly are paying wages considerably higher than is found in the other counties. In 2010, IT firms in Santa Clara County are still paying higher wages than are found across the region. These numbers are suggestive of the idea that IT firms in Santa Clara County are engaged in higher value added functions than firms in the rest of the region.

Table 2.11: Wages (in dollars) Across Subsectors of the IT Industry in the Bay Area, 2010

	Semiconductors	Computers	Electronics	Software
Alameda	115,026	65,018	142,903	123,111
Contra Costa	72,047	103,965	66,762	102,252
Marin	N/A	76,039	N/A	119,230
Napa	N/A	N/A	N/A	72,132
San Francisco	124,759	98,673	254,711	137,819
San Mateo	103,473	150,342	99,524	137,928
Santa Clara	165,076	124,152	194,048	163,490
Santa Cruz	85,183	44,236	N/A	102,374
Solano	N/A	N/A	N/A	94,794
Sonoma	94,780	41,256	137,696	112,789

An interesting picture develops when the ratio between the wages paid by IT firms in Santa Clara County and the other counties in which the IT industry is primarily located are considered. In the year 2000, IT firms in Santa Clara County paid wages 9% higher than equivalent firms in San Mateo County and 73% and 54% higher than the IT firms in Alameda and San Francisco Counties, respectively. By the year 2010, a time when employment losses occurred within Santa Clara County but employment gains occurred in Alameda, San Francisco and San Mateo Counties, the wage differentials had changed considerably. In 2010, IT wages in Santa Clara County were 45% higher than those in Alameda (the difference was 73% in 2000) and 21% greater than in San Francisco (from 54% in 2000). The distance between the wages paid in San Mateo

County and Santa Clara County increased from 9% to 22%, as the IT firms in San Francisco overtook San Mateo County as those that pay the second highest wages in the industry in the region.

These data confirm four features of the nature of dispersion within the regional economy. First, the IT industry in Santa Clara County, a rough proxy for the original core of the IT industry in the regional economy, is still centered in IT functions that produce higher value added products than is the case in the rest of the regional economy. Second, while the IT industry in San Mateo County is grounded in functions that are relatively more sophisticated than the functions found in the rest of the regional economy (except for Santa Clara County and San Francisco), the functions there are not equivalent to those found in Santa Clara County. While higher value added functions have spilled over from Santa Clara County to San Mateo County, the highest value added functions have remained in Santa Clara County. The IT industry in San Francisco, relative to Santa Clara County, is engaged in more sophisticated functions than was the case at the turn of the century. In fact, the industry in San Francisco paid the second highest wages in the region in 2010. This confirms that there has been a qualitative, not just quantitative, dimension to the growth in the County. Alameda County is engaged in relatively lower value added functions than is the case in the other three counties, but again, the industry is engaged in more sophisticated functions than was the case at the turn of the century, relative to Santa Clara County. Suggesting that the industry in Alameda County is becoming technologically more sophisticated.

The Dispersion of the IT industry Among the Region's Cities

As noted above, counties are a rough proxy for within region variation in economic geography. Each county is comprised of city governments and these cities combine and recombine across county boundaries to form sub-centers of specialization across a variety of industries. Since cities control how land is used within their borders, they can directly influence the growth of the industry across the region's counties. This section will briefly outline how the performance of the industry in individual cities has shaped the more aggregate county trends across the region.

Over the period 1989-2010, the IT industry in Redwood City, in San Mateo County, experienced the highest net job growth across the region. Of the cities in which the industry added the highest number of net IT jobs, the industry in only one city from Santa Clara County, San Jose, is amongst the fastest growing in the region. Six out of the 10 cities in which the industry lost the most net jobs are found in Santa Clara County. Sunnyvale, Cupertino and Mountain View, which are effectively ground zero for Silicon Valley, each shed more than 10,000 jobs over this period. While the industry in other cities at the heart of Silicon Valley (the original core), such as Palo Alto, Menlo Park (in San Mateo County) and Santa Clara together lost close to 20,000 jobs. Remember, these job losses occurred in the context of regional employment growth in the industry.

Table 2.13 provides a more complete picture of the sub-county change in the industry that has occurred across the regional economy. In 1989, the four counties that were the focus of the analysis above (Alameda, San Francisco, San Mateo and Santa Clara) accounted for 92% of all IT employment within the region, in 2010, they accounted for 93%. However, examining the performance of the IT industry across the cities of these counties provides a more complete picture of the reconfiguration of the industry across the region. Within Alameda County, the majority of the growth came from a region known as the Tri-Valley, in the eastern part of the county.

Table 2.12: The Highest and Lowest Performing Cities in Job Creation in the IT Sector, 1989-2010

County	City	1989-2010 Employment Change	County	City	1989-2010 Employment Change
San Mateo	REDWOOD CITY	25,598	Sonoma	SANTA ROSA	-1,627
Santa Clara	SAN JOSE	23,953	Santa Clara	CAMPBELL	-2,018
San Francisco	SAN FRANCISCO	16,405	Contra Costa	CONCORD	-2,093
Alameda	PLEASANTON	7,983	San Mateo	SAN CARLOS	-2,345
Alameda	FREMONT	6,793	Santa Clara	SANTA CLARA	-3,663
San Mateo	SAN MATEO	6,350	San Mateo	MENLO PARK	-7,158
Alameda	OAKLAND	1,619	Santa Clara	PALO ALTO	-7,605
Sonoma	PETALUMA	1,493	Santa Clara	SUNNYVALE	-11,159
San Mateo	FOSTER CITY	1,459	Santa Clara	CUPERTINO	-13,628
Alameda	LIVERMORE	1,262	Santa Clara	MOUNTAIN VIEW	-14,295

Over the period of study, the growth of the IT industry in San Mateo County can almost entirely be attributed to the performance of the industry in one city: Redwood City. From 1989-2010, Redwood City’s share of the region’s IT employment increased from 2 to 8%. Outside of Redwood City, the industry in San Mateo County’s other cities fell in employment.

While the IT industry in Santa Clara lost around 26,000 IT jobs over the period, this figure is masked by the performance of the industry in the City of San Jose. The IT industry in Santa Clara County cities other than San Jose accounted for 55% of the region’s IT jobs in 1989, but only 37% in 2010. The industry in Santa Clara County cities other than San Jose lost close to 50,000 IT jobs over the period, while in San Jose it added roughly 23,000 jobs. Note the cities of Santa Clara County outside of San Jose, in

Table 2.13: IT Employment Change Across Bay Area Sub-Regions

	1989	2010	Change, 1989-2010
ALAMEDA COUNTY			
Total Employment	34,880	55,060	20,180
Percent of Regional Total	10%	14%	
Tri-Valley	6,024	16,986	10,962
Percent of Regional Total	2%	4%	
Alameda County Without Tri-Valley	28,856	38,074	9,218
Percent of Regional Total	8%	10%	
SAN MATEO COUNTY			
Total Employment	29,285	54,254	24,969
Percent of Regional Total	8%	14%	
Redwood City	6,914	32,512	25,598
Percent of Regional Total	2%	8%	
San Mateo County Without Redwood City	22,371	21,742	-629
Percent of Regional Total	6%	6%	
SAN FRANCISCO COUNTY	8,888	25,293	16,405
Percent of Regional Total	3%	7%	
SANTA CLARA COUNTY			
Total Employment	247,997	222,088	-25,909
Percent of Regional Total	71%	58%	
City of San Jose	55,347	79,300	23,953
Percent of Regional Total	16%	21%	
Santa Clara County Without San Jose	192,650	142,788	-49,862
Percent of Regional Total	55%	37%	
FOUR COUNTY TOTAL	321,050	356,695	35,645
Percent of Regional Total	92%	93%	

addition to Menlo Park, represent the core group of cities that were originally labeled Silicon Valley. To refine this analysis further, consider the following. In 1989, the industry in just seven cities (Menlo Park, Cupertino, Milpitas, Mountain View, Palo Alto, Santa Clara and Sunnyvale) accounted for 55% of the IT employment in the region. By 2010, these same cities accounted for 35% of the IT employment in the region. Over this time, the industry in these cities together lost close to 58,000 IT jobs.

Concluding Thoughts

To place the dispersion of the IT industry from Santa Clara County around the broader regional economy in context, this chapter has examined the nature of the qualitative, in addition to the quantitative, change in the industry across the region. The chapter has demonstrated that the nature of the IT industry has evolved over time. At the turn of the 1990s, the IT industry in the region, and nationally, was centered in research and development intensive and manufacturing oriented subsectors of the industry, such as semiconductor production, electrical components manufacturing and computer hardware functions. Over time, these subsectors have matured and routinized, and as a consequence, jobs in these subsectors have been lost in the region. At the same time, the software subsector has emerged as the largest employer in the industry within the region and nationally.

These compositional effects help to explain the heavy job losses that have occurred in the IT industry in Santa Clara County. The industry in the county was heavily specialized in semiconductor production, electrical components manufacturing and computer hardware functions in 1990, meaning that the job losses that have occurred in these sectors across the region have disproportionately occurred within the county.

However, they do not explain why the software industry in Santa Clara County accounted for roughly 55% of the region's software employment in 1990, but accounted for only a third of the region's employment gains in the subsector since.

The wage data analysis found that while employment spillover from Santa Clara County has occurred in San Mateo County, the nature of the industry in San Mateo County is still centered in slightly lower value added functions than is the case in Santa Clara County. The industry in Santa Clara County, therefore, is still the core of the higher value added functions of the IT industry within the region. San Francisco has experienced growth in relatively higher value added functions, while the industry in Alameda County has grown in relatively lower value added functions. These findings provide some evidence in support of the "natural evolution" hypothesis. This is the idea that the dispersion of the IT industry within the Bay Area represents an efficient spatial reconfiguration of the industry to the extent that parts of the industry are simply responding to their different geographical preferences over time. However, the research presented in this chapter cannot answer why the software industry in Santa Clara County has added jobs at a slower rate than its share of this subsector within the region in 1990 would have suggested. The following chapters will explore this question in greater detail.

Chapter 3

Perspectives From Bay Area Local Officials

This chapter draws on the views of local officials from around the San Francisco Bay Area. Throughout 2013 and 2014, personal telephone interviews were conducted with 22 officials representing local city governments, chambers of commerce, leadership and advocacy organizations, property development corporations and coalitions of governments from the region. The sample includes representation from geographically distinct parts of the region, including the South Bay (Santa Clara and San Mateo Counties), the East Bay (Alameda and Contra Costa Counties) and San Francisco (which, together, are the major population and employment centers in the region).

To this point, this dissertation has established the dispersion of the IT industry from Santa Clara County throughout the Bay Area over the period 1990-2010 and has asked two primary questions: first, why has the IT industry dispersed, from its original home within the region, around the broader San Francisco Bay Area? Second, are local governments undertaking actions that prevent IT firms from locating in their preferred locations within the regional economy? Two approaches to understanding the dispersion of the industry have been outlined. According to the "natural evolution" perspective, as tradable industries evolve over time, the inputs upon which they rely change, meaning that these industries will have different geographical preferences with the passage of time (as different locations within regions, nations and the globe provide a different range of economic characteristics from which industries draw) (Norton and Rees, 1979). According to these views, the dispersion of the IT industry within the Bay Area represents an efficient spatial reconfiguration of the industry to the extent that parts of the industry are simply responding to their different geographical preferences over time.

According to the "premature departure" perspective, actions by local governments could either push the industry away from its historical core within the region, through restrictions on land use, or they could attract the industry to other parts of the region through various sorts of incentives or other qualities of the local environment. To put this another way, IT firms might like to access certain parts of the region to maximize their access to processes of sharing, matching and learning but may be denied such access due to how land is used. This dissertation seeks to understand whether any such reconfiguration caused by these actions is optimal from the perspective of the industry.

Recall that Santa Clara County is not completely synonymous with Silicon Valley, but a remarkable dispersion of the IT industry has occurred from this county around the broader region, and the IT industry in Santa Clara County has been home to significant job losses in since 1990. It was made clear to interviewees that the dispersion of the IT industry from Santa Clara County was the primary concern of this analysis. For the most part, the discussions related to the IT industry specifically. Interviews ranged from 20-45 minutes in duration and questions were oriented around two major themes. First, why has the industry dispersed around the region? Second, have local governments played a role in the dispersion of the industry? This chapter will be divided into two parts. In the first part of the chapter, evidence in support of the "natural expansion" view of the dispersion will be explored. To this end, the views of local officials about the evolution in the nature of the IT industry around the region will be presented. In the second part of the chapter, evidence relating to the "premature departure" point of view will be presented, especially the role that local governments can play in the dispersion of economic activity within the region.

Regional Differences in the Nature of the Industry

In the introduction, four "centers" of the IT industry were identified within the Bay Area economy. The IT industry located in Alameda, San Francisco, San Mateo and Santa Clara Counties accounted for 93% of total IT employment in the regional economy in 2010. Chapter 2 outlined that the IT firms across these counties were relatively specialized in different functions. Chapter 2 also identified that growth in IT employment has differed markedly across these counties since 1990. As outlined above, the work in this chapter intends to move beyond the raw numbers and detail the changing nature of the IT industry within the region from the perspective of local officials and other key civic figures who live and work in the local community.

Santa Clara County and the Original Core of Silicon Valley

Recall that the IT industry in the "original core" cities of Silicon Valley has experienced significant job losses since 1989. In 1989, the IT industry in just seven cities (Cupertino, Menlo Park, Milpitas, Mountain View, Palo Alto, Santa Clara and Sunnyvale) accounted for 55% of total IT employment in the region. By 2010, the industry in these same cities accounted for 35% of the IT employment in the region. Over this time, the IT industry within these cities lost close to 58,000 jobs. However, while job losses have occurred in the industry in this part of the region, the industry in Santa Clara County generally continues to pay higher wages than is found in other parts of the regional economy, suggesting that the industry within the county is engaged in higher value added activities than are found in the rest of the regional economy. This combination of high job losses in the IT sector within the county coupled with high wages for the jobs that have remained there suggest a reconfiguration of the industry within the county has emerged. The maturation and routinization of some parts of the industry in the county have led them to disperse to other parts of the regional economy (and beyond), while higher value added functions have remained in the county. This view was supported by views from around the region. According to Thomas Fehrenbach, a local official in the City of Palo Alto,

> “Palo Alto and Stanford is the center and new driver of innovation. All the people who are emanating from this place, all that capital that’s here, all the resources that are here have created this launch pad of these ideas that have turned into these amazing businesses.”

Oscar Garcia, an official from the Mountain View Chamber of Commerce, describing the city’s role within the regional economy, said,

> “We see ourselves as a community that fosters and helps with innovation”

This was not just the view from the original core of Silicon Valley. Edith Ramirez, an economic development official in the City of Morgan Hill, in Alameda County, by highlighting demand for office markets within the regional economy, also sees the original core as the fulcrum of the IT industry within the Bay Area,

> “There is a perception that what is hot right now is Menlo park, Palo Alto, with Facebook leading the way, Santa Clara, Cupertino, Sunnyvale. That is where vacancy rates are really low.“

Note that, while many people around the region consider San Mateo to be part of Silicon Valley, a distinction is still drawn between the functions in the original core and the rest of Santa Clara and San Mateo Counties. As a whole, the original core is still perceived as “ground zero” for the leading IT firms since it provides the greatest access to key industry inputs. Alex Andrade, a city official in the City of Mountain View, said,

> “If you were to take a look at the study of the most expensive streets in the United States, Sand Hill Road, which is in Menlo park would come up as the most expensive place, at about $110 per square foot average, per square foot! It’s the most expensive office park in the US. Why is that? It’s the venture capital community”

However, despite the original core's propensity for innovation, there has been significant IT employment loss in this location. In chapter 2 it was revealed that the IT industry in Santa Clara County has been relatively heavily specialized in functions that have experienced heavy job losses due to either routinization or maturation. Sean Randolph, Senior Director of the Bay Area Council, supported this view,

> "… there was a huge, huge hit on the tech industry in the dot.com bust. That was really more of a Bay Area recession. That's where the bust started and that's where the biggest impact occurred… there were a lot of jobs here at that time that were classified as manufacturing that just disappeared. Many or most of them have never come back. That activity (manufacturing) in terms of employment was really concentrated in Silicon Valley."

These perspectives support the idea that a natural evolution and reconfiguration of the geography of the IT industry within the Bay Area has occurred. Innovative functions of the IT industry have remained within the core areas of Santa Clara County, while more routine functions have left this part of the region.

San Francisco

The IT industry in Santa Clara County has been the pivotal cog for the industry within the region for some time. According to many, the most marked change in the regional economy in recent years has been the emergence of the City of San Francisco as an IT center. Historically, San Francisco has not had a strong presence in the IT industry. Yet this has changed significantly, as outlined by Sean Randolph,

> "So we are in this amazing tech expansion right now… we are seeing it growing pretty much everywhere. The change that has really happened over the last couple of years is the growth of San Francisco as a tech center. It never really was except for a brief period for some companies during the boom."

Terrance Grindall, an Assistant City Manager in the city of Newark, in Alameda County, echoed this sentiment,

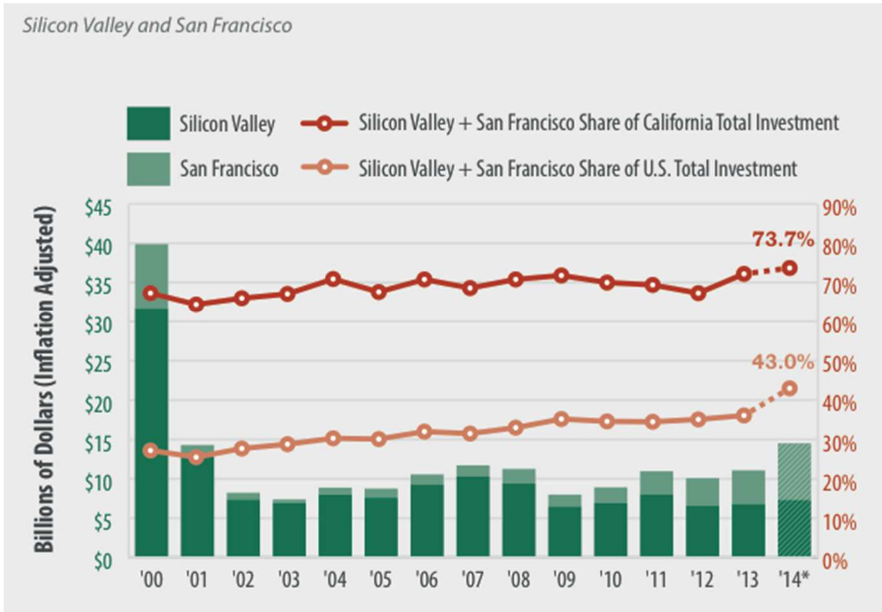
> “The big thing that has changed over the last few years is that San Francisco is a key player in the tech world where as it used to be perceived as more the insurance and banking sector.”

As the data in the previous chapter revealed, not only has San Francisco experienced strong job growth in the industry (it has accounted for 13,000 of the 10,000 net IT jobs added to the region over the period 2008-2012), but the IT industry in San Francisco is engaged in relatively high value added activities, as evidenced by the wages paid by the industry in the city. There isn’t just a quantitative, but also a qualitative dimension to the growth of the industry in San Francisco. Alex Andrade of the City of Mountain View expressed this view,

> “There’s money, quite a bit of venture capital, that community that originated in Silicon Valley is going to San Francisco, which is allowing a lot of these companies… Uber and others that just are obtaining vast amounts that allow them to expand and bring in more employees”

The view of San Francisco as a venture capital magnet is supported by a recent report by a Silicon Valley leadership organization, Joint Venture Silicon Valley. In table 3.1 below, figures from the Silicon Valley Index (2015) are displayed. It shows that the ratio of venture capital investment in San Francisco compared to Silicon Valley (defined as San Mateo and Santa Clara Counties) has increased over time to the point where, in 2014, total venture capital investment in San Francisco is at parity with investment in Silicon Valley.

Figure 3.1: Venture Capital Investment in San Francisco and Silicon Valley



A strong IT center (agglomeration) has emerged in the City of San Francisco over a relatively short period of time. Such has been the rise in processes of sharing, matching and learning in San Francisco, that there has been a proliferation of marquee IT companies locating parts of their operations in San Francisco from Silicon Valley. There is a burgeoning IT community in the city of which these companies are displaying a desire to be a part. Sean Randolph of the Bay Area Council described this process,

> "So what we're seeing is that most of the of the large tech companies have taken major blocks of space now in the city. Google is now the second largest tech company in terms of employment in the city after Salesforce. If you go around South of Market whether it's Adobe, you name them all, they are all here in large numbers and they are leasing several hundred thousand square feet of office space. Companies like LinkedIn… LinkedIn just leased an entire office tower, they just leased the whole damn building!"

San Francisco is among the top 5 most expensive office markets in the US (Carlock, 2015). To reiterate, the growth in the IT industry that is occurring in San Francisco cannot be ascribed to lower value added functions that were located in Silicon

Valley, which have sought out a low cost location in the city. High value added components of the industry are emerging in San Francisco.

The figures in the last chapter revealed that while Santa Clara County is specialized in a boarder range of IT functions (and has a stronger presence in hardware and manufacturing functions than is found in other parts of the region), the City of San Francisco is primarily specialized in the software industry – particularly within social media and "shared economy" functions, which are collectively referred to as "web 2.0". The concentration of hardware functions in Santa Clara County and the emergence of Web 2.0 functions in San Francisco support ideas that a technological rupture has occurred within the industry in the region, as relatively new functions have emerged away from the established center of Santa Clara County in San Francisco. Officials in the region detailed the processes underlying the leapfrog of these functions from one part of the regional economy to another. First of all, the web 2.0 functions require different industrial and commercial premises, referred to as "space", than do the more mature (hardware and manufacturing) elements of the industry. Kim Walesh, Director of Economic Development in the City of San Jose, said,

> "as the tech sector evolved it could fit into different kinds of places. The most extreme example of that is part of the tech sector just needs office space, it doesn't need R & D space and it doesn't need manufacturing space. So that part of the tech sector fits well into San Francisco high rises… whereas the tech industry of 1970s, which was based more on semiconductors and computers and needed R & D space, it wouldn't have fit into San Francisco then... The space that is needed has changed and evolved over time"

In the minds of many, there is a clear dichotomy of functions emerging in the regional economy. Sean Randolph of the Bay Area Council described the dichotomy of functions as follows,

> "I would say hardware stuff still tends to happen on the peninsula. A lot of the software and social media stuff tends to happen in the city."

That being said, the numbers in the previous chapter revealed that Santa Clara County is home to more software employment than the city of San Francisco, and software companies in Santa Clara County pay higher wages than their counterparts in San Francisco. Many of the leading IT firms of the web 2.0 era, such as Facebook, LinkedIn and Pinterest, were created in Silicon Valley. The IT industry in San Francisco is on an upward trend, and this has clearly captured the attention of, not only local officials, but also the popular media. San Francisco has not surpassed Santa Clara County as the center of the software industry in the region yet, but given the density of sharing, matching and learning processes that are occurring in the local economy, it seems reasonable to conclude that San Francisco could exceed Santa Clara County as the major cog of the software industry in the region in the near future (especially in web 2.0 functions).

Below, this chapter will further explore the role that land use has played in the dispersion of the industry within the region. However, beyond space and the availability of land, many officials in the Bay Area ascribe the growth of the IT industry in San Francisco to local labor market matching effects. The popular media has well documented the number of employees who commute from San Francisco to Silicon Valley on privately operated buses (such as the Google buses), and many officials believe the availability of these workers in San Francisco has helped to facilitate the growth of the industry there. Egon Terplan, Regional Planning Director for SPUR, a non-profit organization in the City of San Francisco, said,

> "We have seen the spread due to the evolution of the IT sector itself. There's been a shift from hardware and more manufacturing based to more software based activities, particularly with social media. Different labor forces have concentrated

> in different parts of the region. More engineers that deal with hardware in Santa Clara County. More people dealing with the marketing consumer end and then the social media phenomena that took place in San Francisco. As the industry has shifted and evolved, the talent was attracted to a certain extent and stayed in different parts of the region. And the companies have grown and located to a certain extent near where the workers are"

Sean Randolph of the Bay Area Council supported this view,

> "Part of it is just the growth of the tech sector, part of it is the demographic of the workforce and the appeal of living in a city like San Francisco, and the companies desire to shift their business activity to where their employees want to live."

Oscar Garcia of the Mountain View Chamber of Commerce also observed the attractiveness of San Francisco to younger professionals,

> "Aside from the tax breaks and the financial incentives that the city offers, if you look at the demographics of who is working in these start-ups they are younger folks and the city (San Francisco) is very attractive to the younger population both for the extra curricular activities and that you can get around the entire city on public transportation. So you can work live and play in the city. And that is very attractive to the young professionals."

To reiterate, San Francisco has emerged as a distinct IT center within the region, engaged in high value added functions, and with a focus on social media and "sharing" economy functions. The industry's rise in the city is attributed to four factors. First, the lack of room for expansion in Silicon Valley, which will be explored further below. Second, a technological rupture as new industry functions have emerged away from the historical IT industry core within the region because, three, San Francisco is home to a different type of commercial and industrial space, which is better suited to the industry's new activities than the space found in Santa Clara County. Fourth, a local labor market matching effect, as companies have moved to San Francisco to be closer to the city's labor force, which had previously been commuting to Silicon Valley.

The East Bay

The data presented in chapter 2 indicated that the IT industry in the East Bay[10] is specialized in functions that are more routine in nature than is the case in other parts of the region. These data were buttressed by wage data that revealed that the East Bay has been engaged in relatively lower value added functions than is found in the other major centers of IT employment in the region. These findings were borne out by the interviewees contacted in this study. As Terrance Grindall of the City of Newark describes,

> "Places like Newark and Fremont, which had and still have the bulk of the tech jobs in Alameda County, we were the manufacturing sector. We were sort of the back office of those areas (Silicon Valley) and we still have a little bit of that perception. For example, Fremont was the place where the first Apple computers were manufactured. That was where you offshored. You offshored to Alameda County because it was a little cheaper and the labor was there and so on and so forth."

This view was also expressed by Darien Louie, Executive Director of the East Bay Economic Development Alliance,

> "Historically if you looked at the East Bay, we used to be the manufacturing center for the entire Bay Area. We had shipbuilding, five automobile manufacturing plants, glass, metal plating, food production."

Alex Andrade of the City of Mountain View expressed the dichotomy of functions between the East Bay and Silicon Valley, as follows:

> "we seem to be more R & D related here in Silicon Valley and I guess a comparison would be Tesla. Tesla is headquartered in Palo Alto, but in Fremont, it has its assembly and manufacturing plant, so there is a relationship between our region and the East Bay and San Francisco."

These views are consistent with the idea that the lower value added functions of the IT industry are located in the East Bay. It is important to be clear, however, that the

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[10] The East Bay refers to Alameda and Contra Costa Counties, but the majority of the IT employment across the East Bay is found in Alameda County.

activities in the East Bay are only considered to be relatively lower value added functions when compared to the activities in Silicon Valley and San Francisco. As chapter 2 revealed, the wages paid in the East Bay are roughly 15% higher than the national average for the industry, suggesting that, from a national perspective, the East Bay is specialized in relatively advanced IT functions. This sentiment was expressed by Kim Walesh of the City of San Jose,

> "There're tech jobs all over the world now. There're high value tech jobs, and there are lower value tech jobs. One tech job is not equal. The whole Bay Area is a very expensive place to live and work, so it's going to be home to the highest value segments of the technology industry."

There is a broad sentiment around the region that the East Bay is beginning to outgrow the perception of it as a manufacturing/back office location. Many see a vibrant start-up community emerging in the region, for example. Terrance Grindall of the City of Newark said,

> "I think the narrative could change. The reality is that the East Bay is a magnet for venture capital. The southern Alameda County, Fremont/Newark area is very much a hotbed of innovation and start-ups. There's a lot of venture money going into this area… eventually that reality will catch up with perception."

The East Bay has a number of assets, from the University of California, Berkeley, to nationally funded research laboratories that are poles of knowledge creation in this part of the region. A special case in this regard is the Tri-Valley Area of the East Bay. As the quotes above allude to, the East Bay is a diverse community. Historically, Oakland, and the towns surrounding the Bay, contained heavy industry, largely based around Oakland's port. Further to the east of these communities, however, the landscape is entirely different. The Tri-Valley region is an affluent community located roughly 20 miles south east of Oakland. The major towns in this region are Danville, Dublin, Livermore, Pleasanton and San Ramon. Officials in the East Bay made it clear that the nature of the economy in this part of the region is distinct from the inner East Bay communities. Whereas the inner East Bay communities gravitate towards UC Berkeley, San Francisco and Silicon Valley, the Tri-Valley region has an alternative pole in the form of the federally funded research laboratories, Lawrence Livermore National Laboratory and the Sandia National Laboratory.

About the Tri-Valley, Sean Randolph of the Bay Area Council said,

> "Tri-Valley is an interesting place. That's interesting because you've got the two national labs out there and they've been working, the communities there, to do a more focused job of commercializing technologies that are developed at the labs. So they have a big incubator there, a large economic development program. You have a fair number of companies there that are connected to the lab. I know they are young, but they are growing up out there. You've got a good software community out there, especially going back to when People Soft were there before it was acquired by Google…. there's a substantial and growing software community in the Tri-Valley area. They've always had a concentration of companies in medical devices, and you've got companies connected to the lab. You see a very highly educated workforce. You've got a very good school system, one of the best in the region, for the families who want to have kids in school. It's suburban, it's not San Francisco, but you've got pretty good public transit, a good base for tech companies… even during the big recession Tri-Valley was doing better than the rest of the region."

There is a general consensus that a lot of entrepreneurial activity is emerging in the East Bay based around its research assets. Dairen Louie of the East Bay Economic Alliance also talked about the efforts of the national labs, for example,

> "… we are the only region that has three national labs. We have Lawrence Berkeley which is expanding into Contra Costa County. So there's a lot of R & D activity. Lawrence Livermore is an open campus now and they are really focusing on tech transfer and the build up of companies with work that may have been generated in the lab so there's a lot of opportunity for companies as a result of the lab community and the labs themselves and the work they do and they are large employers in the region."

Just as was the case in San Francisco, growth of the IT sector in the East Bay is ascribed to the availability of space, which will be further expanded upon below, and labor market matching effects. As the population in the region has grown and has sprawled around the Bay Area, this has shifted the center of gravity of the IT workforce. Kim Walesh of the City of San Jose said,

> "The shift to the East Bay was because it was a lower cost area and… because the workforce was dispersing as the Bay Area sprawled away from the inner Bay Area. As the population diffuses companies want to be close to where their workforce is and the desire to be close to where their perceived workforce was living were the two major factors."

Pamlea Ott, Director of Economic Development in the City of Pleasanton in Alameda County, believes the demographics of the residents in the region has fueled the IT expansion there,

> "And the East Bay has traditionally been where a large percentage of the workforce lives. Whether it is I-80/880 corridor or in Contra Costa County or Pleasanton. One of the reasons why more IT companies are working in the East Bay is because here is where the workforce is."

The IT industry in the East Bay is specialized in lower value added functions than the other IT centers in the region, although the perception is that there is a burgeoning start-up community in the region and that the functions performed in the East Bay are becoming more sophisticated over time. Issues of space and land use will be discussed below, but interviewees in the East Bay, as with San Francisco, pressed home the importance, in their minds, of local labor market matching effects to the distribution of IT activity within the region. The importance of local labor market matching effects does stand up to the evidence of what is known about commuting patterns within metropolitan regions. Labor markets are not frictionless within regional economies. For example, according to the University of California, Berkeley's Global Metropolitan Observatory, in 1990, across 9 Bay Area counties (Santa Cruz is excluded in this case) 77% of workers in the region commuted to work within their county of residence. In 2010, 72% of the workers across the Bay commuted to work in their county of residence[11]. Such localized commuting patterns support the idea of local labor market matching effects.

In summary, the perception across the region is that the old core of Silicon Valley has lost employment in maturing parts of the industry, but remains a hotbed for innovation. In this regard, a restructuring of the economy in the old core is emerging, as job losses in mature components of the industry are being replaced by newly emerging, innovative parts of the industry. San Francisco has developed as a bona fide IT center within the region, while the East Bay is home to relatively less sophisticated elements of the industry. These findings provide evidence that the evolving geography of the industry within the region can be attributed to "natural evolution" rather than "premature departure." However, these findings and the data presented in the previous chapter provide an incomplete picture of the geographical evolution of the IT industry within the Bay Area. Many of the IT companies that are now based in San Francisco were created in the old core of Silicon Valley. The next section describes possible reasons as to why these companies did not remain in Santa Clara County.

Land Use and Cost

A recent article by the Wall Street Journal highlighted land use constraint issues in Silicon Valley:

> "Room to grow is evaporating in Silicon Valley as technology giants' appetites for expansion are running up against residents weary of clogged streets and cramped classrooms brought about by the boom of recent years. Some communities are already saying they have reached their limits of development,

[11] http://www.ced.berkeley.edu/research/metropolitanlandscapes/?page_id=52

> while others signal that day is near, raising questions about the ability of the tech sector to keep expanding in what has long been its home base."

As one of many examples, the article cites plans for expansion by Google and LinkedIn in the city of Mountain View:

> "The city in late February received proposals from tech companies Google and LinkedIn Corp., as well as private developers, to add 5.7 million square feet of office space—more than the size of two Empire State Buildings—for an area where the city has planned to allow just 2.2 million square feet of additional growth in the next two decades."

As the article reveals, the capacity of cities (in which the IT industry emerged) in Silicon Valley to absorb growth is running into land use constraints. This view was repeated over and again by the officials interviewed for this chapter. The original core cities are still producing marquee start-up companies; recent success stories include companies such as WhatsApp, Pinterest, LinkedIn and PureStorage. While the cities can accommodate the growth of some of these companies, they simply lack the space to accommodate growth to the extent that they would like. Alex Andrade of the City of Mountain View captured this sentiment succinctly,

> "We are totally built out. There isn't much dirt out here that doesn't have a structure."

He continued,

> "We at this point do not have enough office space to accommodate the demand in the tech world. I mentioned a company called WhatsApp earlier. Facebook bought it for 19 billion dollars. They are going to occupy two new buildings that are being constructed in our downtown…., but we have companies that are coming out of business incubators… like Pinterest, which came out of Hacker Dojo in Mountain View, we don't have enough space to… retain them. So they went to San Francisco. There are companies right now, in our downtown, like Pure Storage, Quick Think and other tech companies that want to expand and go from 100 employees to 200 employees by the end of next year. We simply do not have the office space."

Paul Kermayon, an official in the City of Campbell, in Santa Clara County, observed a similar trend,

> "Hi tech is changing in terms of its growth. So its not surprising to me that it is not locating in Santa Clara. There's not enough land to contain companies that have all these types of uses."

Start-ups typically begin very small and will initially find their homes in some form of accelerator, business incubator or office in a business park. As they grow, and if they become successful, they consume more and more space within a business park or a city until they reach the point where they seek to find an entire building in which to house their operations. Thomas Fehrenbach of the City of Palo Alto told the story of Facebook's expansion,

> "Facebook is a good example of a company that started in Palo Alto. We worked very closely with them as they went though this enormous growth cycle. They started in our downtown, before you know it they had 14 buildings cobbled together in our downtown, and they were starting to face some very challenging real estate prices if they wanted to keep growing at the same level. So we were able to place them into our research park, and eventually into two buildings and then eventually it got to the point where we were not able to support their additional growth, they were just growing too fast. And the only real estate that was available was really, really expensive and they didn't want to tie up their cash in real estate"

According to Alex Andrade of the City of Mountain View, zoning constraints in the community are hurting the capacity of the city to absorb as much growth as it would like,

> "The challenge we have now is that we have companies like Intuit that is going to expand their campus by another 350 thousand square feet. We have LinkedIn that has approached the city and they want to expand at their headquarters, and add… close to a million square feet of offices. These are companies that enjoy being in Mountain View and want to stay for various reasons, but there is a challenge in going to 3, 4, 5, 6 stories like in San Francisco. We just don't have that environment."

These accounts provide a different perceptive of the dispersion of the industry in the region. Local officials frequently outline how companies want to be and remain in these "core" communities, but cannot do so due to land use constraints or cost. This evidence suggests that some companies and parts of the industry are leaving Santa Clara before they would like to.

Many of the companies that now call San Francisco home were created in the original core of Silicon Valley, yet San Francisco and not Silicon Valley had the space to accommodate the new expansion of the industry. Alex Andrade of the City of Mountain View added,

> "With San Francisco, with the ability to be a lot more dense, there's just more opportunities for these larger companies… to build up. When you look at Silicon Valley, we're just nothing but buildings that are two stories. We have the Bay on one side and the Santa Cruz mountains on the other side. We're really just a slither of land. San Francisco from the Bay to the ocean is only 7.5 miles wide but it is such a dense place and it creates a particular environment where start-ups can thrive."

However, San Francisco is not the only place in which the industry has grown due to a lack of space in the original core. Sean Brooks, an economic development official in Redwood City, San Mateo County, attributes growth in the county to the outgrowth of core Silicon Valley cities,

> "As people out grow Mountain View, Palo Alto, Cupertino, the natural progression is to head north and you see spillover in Menlo Park and Redwood city, I think location, location is a huge seller. We have available office space and office land. With that in mind we have two large office developments such as Redwood Shores and Pacific Shores and each of those complexes has well over 1.5 million square feet of office space."

The same is true of the East Bay. The East Bay not only has the availability of land for development, but it also provides a cheaper alternative for IT firms than is found in the other IT centers of the region. Darien Louie of the East Bay Economic Development Alliance said,

> "Two factors that are really relevant right now are affordability and space. The cost of doing business in terms of facilities and rentals and just the space that you work in has really got expensive in San Francisco and other parts of the Bay Area. And so the East Bay is really being looked at as affordable space. So we have more areas of affordable space. Not just office space, but industry space. People are beginning to look at us as an alternative."

The City of Oakland, for example, is seeing spillover from San Francisco. Sean Randolph of the Bay Area Council described this process,

> "The other thing that has happening of course. Is that as the cost is inevitably going up, it is pushing things out as people are looking for more and more space. Oakland has always been an opportunity waiting to happen, you are starting to see now over the last 4 or 5 years, they have developed a pretty good restaurant scene a more cultural life going on than there was before. Even though rents are going up very fast there, too, it's more affordable than San Francisco. So you are starting to see more movement of not big tech companies but smaller tech companies across the Bay to Oakland. Some place you can hop on Bart for 15 minutes and be in the city which at least now is a lot more affordable.

Robert Sakai of the East Bay Economic Development Alliance also supported this view,

> "One large company that has moved in recently is GE's global software center. Which is focused on the Internet of things and they have ramped up quite considerably over the last couple of years. Starting from 0 and coming up to 600 employees. One of the reasons they moved there is because there is still in the East Bay open space for campus type facilities."

This focus on land use and land costs reaffirms a point made repeatedly throughout this chapter. There are two primary types of space available for expansion from Santa Clara County. There is relatively more expensive space, which is available in San Francisco and parts of San Mateo County, which have become home to relatively higher value added functions. Alternatively, there is relatively cheaper land for development in the East Bay, which has become home to relatively lower value added functions.

As the passage from the Wall Street Journal Article above revealed, local resistance to further growth is a key factor for the relative lack of available of space in Santa Clara County. The interviewees also expressed this opinion. In addition to high demand for space in the county, there is local resistance to further expansion. Egon Terplan of SPUR said,

> "The other part is the ease of expansion. That's the main issue. This is where land use politics and zoning come into play. Especially in IT, the companies grow really fast. If you don't have the ability to expand where you are, or find another building that suits or fits your needs, you're going to go to another community."

A lot of the pressure against creating denser environments in Santa Clara County comes from local residents in these cities. This is the view of Alex Andrade of the City of Mountain View,

> "There's construction happening around town and some community folks are going to construction proceedings and even our council are going to the point where they are deciding that they want to see fewer square feet and more housing units being built. So we have a political component aside from the zoning ordinances, which are creating tension there… an evolution of the way tech companies keep their space is also taking place (towards locating less in research parks, and more within buildings). But clearly in northern San Jose, they are willing to go out and build 6, 7, 8 stories, and for us, we may get there, in terms of building on parcels which are near freeway frontage, but that's kind of few and far between. We have a real challenge in terms of retaining our tech base"

While Oscar Garcia of the Mountain View Chamber of Commerce has observed this tension between growth and pro-growth factions within the community, also,

> "One of the things that is critical to our city, and I think it is common to many of the cities around the Bay Area, is this year is an election year for us. A city council race. Essentially we have a community where there are some people who are for growth or smart growth and then there's others that are for no more growth. And that stems from the growth coming form the hi tech industry."

As has been alluded to throughout this chapter, the combination of high demand for sites in Santa Clara County coupled with relatively constrained supply of land for development has created an environment of high land prices. Local governments exercise a large degree of control over the levels of density within their communities, and the land use that occurs within these communities, and therefore the amount of space available for development. Within a regional economy, the combination of high demand for and restricted supply of space within a given community can have the effect of increasing land prices (Cheshire et al, 2014). The price of land within Santa Clara County is at the forefront of local officials minds and is considered to be a major contributing cause of dispersion.

Paul Kermayon, an official in the City of Campbell, said about parts of Silicon Valley,

> "And that's another thing. People are moving out because it's expensive here. It's expensive to live; the property values are expensive. If you can move your company else where, where it is lower rent. That's the enticement."

While Kara Gross of the Silicon Valley Economic Development Alliance said,

> "Basic locational issues don't change. Any business location criteria will tell you that there's cheaper places to be than Palo Alto, Mountain View and Sunnyvale."

Again, for those companies that are engaged in higher value added functions, the cost in the old core will be less prohibitive. For firms engaged in lower value added functions, however, the cost of land in Santa Clara County is a critical cause of dispersion.

The cost of land also has a bearing on local matching effects. Oscar Garcia of the Mountain View Chamber of Commerce said,

> "Other parts of the region are cheaper. Less expensive commercial and residential. Square footage is less in other cities. From an employees standpoint your housing is cheaper in other areas. As a business, lowering or minimizing your cost is very important… being able to attract employees is another thing that is important. If you have a city where you have a business

> and your cost of living to your potential employees is less, then you have an advantage of in attracting employment."

Thomas Fehrenbach of the City of Palo Alto also saw the cost of housing as an issue,

> "Certainly the cheaper parts of Alameda County might explain some of the growth there. It's a major deciding factor. For people who are nearly married and starting families, priorities change a little bit. It's one of the major factors that people consider when they decide where to take employment (the cost of living)."

Employees who perform higher value added functions will be able to afford to live in San Francisco and Santa Clara County, where housing is relatively expensive. Employees performing relatively lower value added functions will be more apt to live in the cheaper parts of the regional economy. As workers disperse, there is a consensus that the industry has dispersed, not only to access cheaper land, but to facilitate local labor matching effects.

Other Government Action and the IT Industry

Land use is a key way in which governments can influence the location of economic activity, however, chapter 1 outlined other ways in which local governments can prematurely affect the distribution of IT activity within a regional economy. Recall that the task here is to understand whether there have been actions that local governments may have undertaken that have caused the IT industry to disperse from Santa Clara County. Interviewees were asked to provide other examples of ways in which governments can influence the location of the IT industry within the region. The overriding consensus was, that, in reality, beyond land use decisions, local governments are quite restricted in their capacity to provide incentives to firms to induce them into their communities.

Three specific examples were cited of cities that have made concerted efforts to lure the IT industry within their borders. The city of San Leandro, located in Alameda County, around 20 miles from San Francisco, is not known for being an IT center, but it provides an interesting example of a local action oriented towards attracting the IT industry to a city. San Leandro undertook a partnership with a private company, OSIsoft to create a fiber optic loop in the city. As part of this partnership, the city provided 11 miles of underground conduits, while OSIsoft installed the fiber optic loop. The city claims to provide a loop that generates Internet speeds 2000 faster than the average connection. The city hopes the loop will draw firms into its borders and that it can sell access to the loop around the region. According to Robert Sakai of the East Bay Economic Development Alliance,

> "The city donated conduits and so all of a sudden you have companies moving in to take advantage of this fiber optic loop and there are a lot of cities interested, including the Port of Oakland, in hooking up to this fiber optic loop."

According to the website for the loop, known as LIT,

> "Broadband has become basic infrastructure for economic development. Businesses in almost every industry are dependent on the Internet for communications and data management. Cities with exemplary connections speeds have a competitive advantage in attracting and supporting data intensive and high-tech businesses. San Leandro is poised to capitalize on its manufacturing legacy by become a hub for advanced manufacturing, medical research, graphic arts, and software development. World-class connection speeds will also make San Leandro a hotbed of innovation, cultivating and growing the industries of the future."

The city of San Francisco is another city that is considered to have made a concerted effort to attract IT firms within its boundaries. San Francisco is unique to the region, and the state, in that it levies a payroll tax on employees. The city has waved this tax for IT firms who locate in the city's Mid-Market neighborhood. Twitter famously, and somewhat controversially, was awarded a payroll and stock option tax waiver amounting to $70 million to locate in the neighborhood.

The city of Santa Clara is also held up as an example of a city that has taken a specific action to attract elements of the IT industry. Kara Gross of the Silicon Valley Economic Development Alliance described the city's actions,

> "The city of Santa Clara has a municipal utility, Silicon Valley Power. Silicon Valley Power's rates are extremely attractive. So Santa Clara has attracted and retained more hardware-ish and more data centers, intensive operations. Santa Clara has not traditionally been known as a marquee headquarters town, with the exception of Intel. However, Santa Clara has done extremely well in applied materials and other companies that have heavy energy needs because they are their own utility and they run an economic development program … to help companies find space to move into and expand in their cities."

These endeavors aside, there are few examples of specific economic development actions undertaken in the region specifically oriented towards attracting the IT industry to cities.

The Role of Incentives

To reiterate, very few officials within the region attribute the dispersion of the IT industry to specific economic development actions undertaken by local governments. Kara Gross of the Silicon Valley Economic Development Alliance, when asked whether city governments have played a role in the dispersion of the industry, said,

> "I'd like to say yes. But honestly, at the end of the day businesses make their business decisions based on other factors, so I think that there has certainly been particular cases where, in heavier parts of the tech industry, hardware type things, that businesses have taken advantage of certain kinds of incentives, that could have been offered through redevelopment or enterprise zones or there are a very modest number of economic development incentives that we do have in this state. As you're well aware they are extremely modest, and now the redevelopment part is gone."

There is a common sentiment around the region that local governments have very little power at their disposal to directly affect the location decisions of firms. About this issue, Rosanne Foust of the San Mateo Economic Development Association said,

> "If you were to compare California economic development efforts to a lot of places in the US, it's very much not as proactive as other places. I did international economic development for 20 years. I watched how European countries would compete against each other with incentives, tax credits, with corporate income tax reductions. California has never been about incentives. It's interesting with all this talk going around now about Tesla's giga factory and what the state of California is willing to do or not do. Local communities really don't have any grants to give, they don't have the financial wherewithal to give grants. So what do they have to do, they have to build the right product to attract the companies. They have to be open for business."

This view was reaffirmed by Kim Walesh of the City of San Jose,

> "There was one case with Netflix a couple of years ago where they very visibly were saying we're going to talk to Santa Clara and we're going to talk to San Jose see what you can do for us. But that's very rare. But generally cities don't have money to give away like that in California. Especially with redevelopment gone. So you're really competing on whether your community has the kind of buildings the company is looking for... what they are willing to pay and the kinds of amenities (they want). You want to have the reputation of your city as being easy to work with. In terms of timely approvals of permits and doing any sort of trouble shooting the company needs in terms of relocation or expansion."

A lot of the powers that local governments had to provide incentives to firms were found in local redevelopment agencies, and there is a wide feeling that as redevelopment in California has ended, so have a lot of the tools at the disposal of local communities[12]. Redevelopment efforts, however, are not viewed as a program that has affected the location of the IT industry within the region. In part, this is because redevelopment was geared towards redeveloping certain neighborhoods by inducing real estate development in residential and consumption-based industries, such as restaurants. On occasion, redevelopment has been targeted at manufacturing establishments, which were willing to

[12] Funding for redevelopment agencies ended in 2011

redevelopment buildings. The redevelopment of property, however, is not seen as an attractive proposition to IT firms. The City of San Jose had one of the largest redevelopment agencies in the state, but in the words of Kim Walesh of this city,

> "These measures didn't affect the dispersion of the industry overall. I think the tech industry generally is very sensitive to costs, they don't want to have to invest in real estate."

Apart from redevelopment, as the quote from the San Mateo official above suggested, there's very little that local governments can do in terms of providing financial packages to firms. Terrence Grindall of the City of Newark describes what the city might have been able to do for Facebook, which considered locating at a site in Newark, before moving from Palo Alto to Menlo Park,

> "We could have provided them waivers on fees, we could have focused some infrastructure money we have, to the extent that they have sales tax generated, we could have returned that to them, there are ways we could have provided some incentive but the amount of incentives we can provide are really not going to change the game. There's not that much we can do. What we can do is provide good services, provide a community that's perceived as safe, and hope that businesses can flourish."

When companies sell goods, they generate sales taxes. Within the Bay Area, sales tax rates ranged from 8.5 - 9.75% in 2010, of which cities retain 1% of this amount. In certain instances, cities can reimburse companies part of the city's share of the sales tax. Cupertino does this for Apple, for example ("Economic and Fiscal Impacts", 2013). However, most companies do not generate sales taxes.

Again, across local governments there is a certain sense of helplessness when it comes to attracting companies. Edith Ramirez, an economic development official in the City of Morgan Hill said,

> "So now that we don't have redevelopment, it's putting a lot of pressure on cities to be creative and find ways to be supportive and provide incentives to attract

> companies…but quite honestly no one can really compete with states like Texas and places that are throwing a lot of money to companies to move there. What we do in Morgan Hill? We have sewer tax credits, other impact fee credits available, we have a loan program at reasonable rates for companies expanding in Morgan Hill through our grow America fund."

The overriding sense amongst local officials is that, for the most part, cities are able to offer very modest assistance to firms. The widely held belief is that the type of assistance cities are able to provide plays almost no role in the decisions made by companies about where to locate. In the example of Facebook above – where it outgrew its premises in Palo Alto – there were far cheaper locations not only in the Bay Area, but also around the state, than Menlo Park, to which the company could have relocated but it was keen to stay in the core of Silicon Valley. Implicitly, the decision to remain in Silicon Valley is not a decision that is made with cutting costs in mind. It is a decision that is made to access the processes of sharing, matching and learning that are present in the region.

Benefits of the IT Industry and Local Competition

Beyond the lack of tools available to cities, there are other reasons for the absence of competition between them to lure IT firms within the borders. The first relates to the nature of public finances in California, where Proposition 13 restricts the ability of cities to raise income through property taxes. As Kim Walesh of the City of San Jose described,

> "Most communities that want to have employment want to have tech jobs. They are great jobs, but the irony is they don't really help a city financially. Cities are extraordinarily constrained in California and the two major revenue sources are sales tax and property tax, the growth of that is constrained... The irony is that most cities do not benefit financially but yet we want them in our midst for the employment that they bring and the other benefits. They don't generate sales tax."

Edith Ramirez of the City of Morgan Hill said,

> "It's an interesting question. You know, everybody wants a Google; everybody wants a Facebook. Everybody wants the big company that has the big name recognition. And often has big jobs, but in reality… for cities, we always seek a

> job housing balance, and we want to have industry in our community and we want to have jobs and we don't just want to have housing because that's really expensive for cities to maintain. But the truth is that many companies, especially IT companies, don't generate a lot of revenue for cities. So while they bring in the jobs and there is money with the jobs because some of the employees end up shopping in your community, depending on the company you may get very little financial revenue or benefit from a company. And while something that is not as sexy as an IT company, but it is perhaps, more manufacturing related, you might have the benefit of business-to-business tax (sales) so that our city can get a financial benefit from. "

A second reason relates to the sense of community that exists amongst cities in the region. There is a very clear spirit of regionalism across the cities in the Bay Area. For example, the members of the Silicon Valley Economic Development Alliance, a 22-city membership group and the East Bay Economic Development Alliance, an equivalent group of 20 cities in the East Bay, each have a memorandum of understanding (MOU) outlining that companies will not "poach" companies from one another. Kara Gross of the Silicon Valley Economic Development Alliance described the agreement,

> "It basically lays out some parameters, that were originally proposed by the retired Palo Alto city manager. He was the champion of our initiative. Palo Alto has been the single most successful city. He has a strong voice for regionalism and really put his stamp on our organization early on. It says… we all succeed when businesses are happy. If a business shows up in your city and is from a neighboring city. You speak to that city and see if they've done all they can to accommodate them. If so, then you can help them"

While Thomas Fehrenbach of the City of Palo Alto explains how the agreement works in practice,

> "If we get approached, the first thing we would do is ask them (the company) if they have spoken to their local economic development (official), and we would want to give them a heads up, as a professional courtesy. We understand that companies are going to move between our cities and there are different reasons that people make those decisions, but they should have had access to all of us in terms of helping them to understand what's available."

There is an MOU in the East Bay, too, as Darien Louie, Executive Director of the East Bay Economic Development Alliance, explains,

> "Our organization is a membership organization of 20 cities in the East Bay region. And they have a non compete agreement, in that they don't poach."

The sense of community amongst economic development officials in the region is pervasive. Kara Gross of the Silicon Valley Economic Development Alliance describes the spirit of collaboration in the region,

> "We have our alliance, it's more like professionals coming together, to partner to learn from each other and share information.... In Silicon Valley we have a very collaborative partnership, in fact, I am the chair this year of the Silicon Valley Economic Development Alliance. It's a partnership of professionals of three counties and all of us who do economic development and we work in partnership and we understand that companies make decisions to grow and expand and they don't really look at city boundaries and they don't make decisions based on that. They often make decisions based on real estate and accessibility to workforce. Our job is to help companies grow and expand here in Silicon Valley. We want to be a resource to the companies and be sure that when they make their decision, they are being hand held from city to city and supported through that exercise. At the end of the day it really impacts and benefits all of the cities around us. The company might be in one city, but for example, in Morgan Hill, the majority of our employees come from San Jose. So there's a much bigger ecosystem."

As this quote suggests, the overarching theme throughout the region is one of regional cooperation. It was consistently expressed that cities would much rather a company left their community and stayed in the region than head out of state. Alex Andrade of the City of Mountain View expressed this sentiment,

> "That might be because I see economic development through a regional lens, versus competition. I would rather have a company move away from Mountain View, I'd rather it goes to San Francisco, than going to Texas. If they stay, it is still a win for the region."

About Facebook's move from Palo Alto to Menlo Park, Thomas Fehrenbach said,

> "And I see the story a very successful story for Palo Alto, because again, we are that launch pad, and of course the press tries to spin it as Menlo Park stole Facebook from Palo Alto, and I'm sure a lot of people feel that way, but it's actually a success to keep them in the region, they found a location that suited their needs and we were happy to have exhausted all of the options in Palo Alto, and just happy that they ended up staying in the region."

Conclusion

This chapter has discussed a variety of factors that have contributed to the dispersion of the IT industry throughout the Bay Area, from the perspective of representatives from the region. For the most part, these factors speak to the central tension that has been outlined in this dissertation. The nature of the IT industry has evolved. The evidence presented suggests that processes of natural expansion and premature departure have both played a role in the dispersion of the industry within the region – it is probable that some interaction of the two processes has occurred. The interviews revealed that there are many IT firms that are created in the old core of the IT industry in the region that would like to stay there, but are unable to do so. This has created a window of locational opportunity, for a new sub-agglomeration to emerge within the regional economy (Scott and Storper, 1987).

From these accounts, the original area known as Silicon Valley is assuming a specific role within the regional economy. It has reached a point where the development of major tech campuses and buildings has become a major challenge, due to relative land scarcity. In this regard, Silicon Valley is assuming the role of creator and innovator of cutting edge ideas within the region, but once companies start to experience rapid growth, their expansion must occur in other parts of the region. Oscar Garcia of the Mountain View Chamber of Commerce described this process,

> "Of course we want to see them (IT firms) in Mountain View. But the reality is, Mountain View is a small city. We are 12 squared miles. We can only accommodate so much here… We understand what our role is and we feel like we play it very well. It would be like in baseball. Asking a closer if he was disappointed that he didn't pitch all 9 innings. And only got three outs. No. That's their role to be the closer. And that's the way we see our role in Mountain View. We understand that because we are 12 square miles that there's only so much growth that we can accommodate… We see ourselves as a community that fosters and helps with innovation with the companies that are start-ups and then once they reach a certain size, if there's space for them great, we'll keep them, but if not they end up leaving. For example, Evernote started here in Mountain View and they couldn't find space here, so now they are located in Redwood City. And I think it's like a 6 or 7 story building they are located in. And there's no way, there's no way a building that size would accommodate them here…"

Thomas Fehrenbach of the City of Palo Alto believes that the lack of room for expansion in Santa Clara County could come at a cost to the regional economy,

> "And so yeah, I think it is a critical component, if we continue to live in a way where we see ourselves as the suburban areas to San Francisco then we will limit the creativity and innovation that can happen in Silicon Valley in the future."

From this perspective, the rise of San Francisco within the regional economy may have been critical to the region's ability to capture the growth of the most recent IT wave in social media and the "sharing" economy. Generally, the fact that many localities in the Bay Area offer a variety of combinations of land prices and availabilities, together with a relatively good regional transportation network, suggests that a multi-locational IT industry has emerged at regional scale and will perpetuate the ability of the industry to develop in the wider Bay Area.

However, whether the overall outcome is optimal with respect to the emerging geography of the IT industry in the Bay Area depends, however, on the interaction between strong localization effects on the one hand, and zoning constraints on the other. The restrictions on commercial land availability and development in the original core of the region have probably pushed IT firms away from the core of Silicon Valley faster and to a greater extent than would have otherwise occurred. The following chapter examines this issue in greater detail.

Chapter 4

The Determinants of Dispersion: A Statistical Investigation

To this point, this dissertation has detailed the dispersion of the IT industry from Santa Clara County around the broader San Francisco Bay Area since 1990. It has also explored theories that identify the potential causes and consequences of this dispersion. In chapter 3, the reasons for this dispersion were explored through the eyes of local officials within the Bay Area. This chapter will build on these foundations and statistically examine the relative impact of the potential causes for dispersion that have been identified throughout this dissertation.

The primary motivation of this dissertation is to answer the following questions: why has the IT industry within the region dispersed and how can this dispersion be understood? The introduction identified potential reasons and implications for this dispersion. From an economic geography perspective, as the IT industry has matured, do IT firms require different inputs, found in different locations within the regional economy? From this perspective, those forces that bind firms together at one point in time may change for certain parts of the industry at another point in time. According to this view, dispersion of the industry can be understood as "natural expansion" – an efficient spatial reconfiguration of the industry to the extent that parts of the industry are simply responding their different geographical preferences over time. On the other hand, it is possible that the diffusion of the industry within the region is "premature" on the part of the industry. If local planning has the ability to restrict the entry of IT firms to those parts of a regional economy where localization economies are the strongest, there is a significant possibility that planning has the ability to affect the productivity of firms and, by extension, the industries to which they belong. By the same token, if planning or local economic development measures can be so attractive as to weaken naturally occurring agglomeration economies, then they can have an effect on industry-wide productivity. The welfare impacts of both restrictive and expansive local economic development policies, if those policies are capable of reshaping the geography of an industry so that it becomes significantly different from the pattern of agglomeration and dispersion that would exist without such policies, might therefore be important to the industry and the regional economy in question, in ways that differ from their strictly local (i.e. sub-regional) impacts. It is this difference that is rarely considered in evaluations of local economic development and planning policies, and it is why this dissertation works to bring together these two disparate fields, namely, local economic development policies and economic geography.

The Model

For the most part, business location modeling relies on a profit maximization framework. The profit of a firm is equal to the difference between a firm's revenue and its costs (Cowen and Tabarrok, 2010). The variables identified in this chapter attempt to identify how forces of economic geography on the one hand, and the actions of local governments on the other, influence the potential profitability of firms and shape their location within the regional economy. The economic geography variables that have been identified relate primarily to agglomeration economies (the localization effects of sharing, matching and learning). A second set of variables relate to the actions of local governments. This group of measures includes government actions that directly influence the price of land through zoning, in addition to other factors that governments control, such as taxes and economic development. In addition to these variables, it will be necessary to provide a number of controls in this analysis, such as size differences across given jurisdictions (such as population levels or land areas).

Today, modeling business location decisions, for the most part, relies on count models, such as a Poisson or negative binomial (NB)[13] model (Guimarães et al, 2003 and 2004; Kim et al, 2008; Arzaghi and Henderson, 2008). Poisson models are used to model events that occur infrequently, which are typically non-linear in nature. Modeling business location relies on a discrete choice framework (namely, scholars attempt to understand why new firms or establishments choose to locate in one of many different possible locations). Historically, multinomial or conditional logistic regressions were used for discrete choice modeling, descendant from the work of McFadden (1974). However, the multinomial model has limitations when a discrete choice set is large. Another problem posed by the multinomial logit is the assumption of the independence of irrelevant alternatives (IIA)[14]. Poisson models, from which the negative binomial model is descendant, have been found to approximate the findings of multinomial models and

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[13] The classical form of the Poisson regression is found in the following log linear format:

$$\mu_i = E[y_i|x_i] = \exp(x_i, \beta)$$

In this specification, y_i is the number of occurrences of the event of interest, the dependent variable, and x_i represents the independent variables that are thought to determine the occurrence of the event. β represents the parameters of the model, namely, the coefficients of the independent variables. The model is specified in log-linear form to ensure that the outcome is a positive number. The Poisson regression is estimated via the maximum likelihood function:

$$L(\beta|\ y, X) = \prod_{i=1}^{N} \Pr(y_i|u_i)$$

The model assumes that the conditional mean of the outcome is equal to the conditional variance. This is known as equidispersion. However, a negative binomial regression is usually preferred for business location modelling. It is a generalized version of a Poisson regression. Since there is a large number of cities in this analysis with zero new IT firms for given years, the variance of the distribution is likely to be greater than the mean. The negative binomial is a better fit for this analysis since it has the same mean structure as the Poisson but has an extra parameter to control for over-dispersion.

[14] This assumption posits that any unobserved differences relating to the alternative choices cannot be correlated across a given choice set. Most scholars believe this to be an unrealistic assumption when applied to business location, especially when the choice set, in this case the territories, are relatively small units in close proximity to one another.

are not restricted by large choice sets, making them the preferred models in the field (Guimarães et al, 2003 and 2004).

The Poisson and negative binomial models relate the number of firms that open in a particular location in a given year to the attributes of that site (Guimarães et al, 2003 and 2004). Within the context of this dissertation, the model estimates why an entrepreneur would choose to start an IT establishment in one location, or city, rather than some other city. The dependent variable, therefore, is the number of new IT establishment that locate in a given city for a given year. The independent variables are the attributes of these cities for each year. As described in the introduction, cities within the Bay Area are the geographical unit of analysis since these entities control how land is used within the regional economy.

Business location modeling (using these models) relies on a random utility maximization framework. Within this framework, business location is framed as a discrete choice problem in which profit (utility) maximizing firms select sites from a distinct set of localities (Guimarães et al, 2004). Entrepreneurs are assumed to choose to start their business in a location in which they expect to yield the greatest profit (or maximize their utility). Different locations provide a range of characteristics, which ultimately affect the potential profitability of firms. According to Guimarães et al. (2004) “the probability of a new plant being opened at a particular site depends on the relative level of profits that can be derived at this site compared with those of all other alternatives”. In short, the model estimates the extent to which different factors affect the decision of a firm to locate in one jurisdiction over another.

Variables and Data

Dependent Variable

As mentioned above, the dependent variable in this analysis will be the number of IT start-up establishments that emerge in each city for each year. Recall that there are 103 cities in this analysis, which represents the choice set faced by an entrepreneur when choosing to locate their establishment within the region. This analysis relies on panel data relating to the period 1992-2009[15]. San Francisco had the highest number of IT establishments emerge in a given year (1998), when 495 IT establishments were created. Across the time span of this analysis, an average of 20 IT establishments were created for each city in each year. There are many cities in which no IT start-up establishments occurred in given years, including Watsonville, Woodside and Yountville which are primarily residential, suburban communities. As noted above, a negative binomial model accounts for over dispersion caused by a high incidence of "zeros.[16]"

Data for IT establishments will be drawn from the National Establishment Time Series (NETS), which is a proprietary dataset. The NETS database is complied and released by Walls and Associates in partnership with Dun and Bradstreet (D&B). The dataset is comprised of Duns Market Information data (DMI), which is a dataset that seeks to catalogue every single establishment in the U.S. and provide detailed information about each establishment.

[15] While data relating to the dependent variable cover the period 1989-2010, certain key variables, such as house prices, are only available since 1992, curtailing the period of study for this statistical analysis.

[16] Often times, when there is a high number of "zeros," a zero-inflated negative binomial model might be a better fit for such analysis. Such models account for the fact that a "zero" incidence might be caused because entrepreneurs do not want to start an IT establishment in a given community, or because it is unable to. Both versions of the model provided similar results in this analysis, but the standard model provided the better fit

NETS is a micro dataset, where each observation is an establishment. The data are in the form of a longitudinal file, which tracks every establishment from its birth to its death. Over the life of an establishment, the dataset records the employment level of the establishment for each year, how its sales change by year, and any physical relocations it makes. The street address of each establishment is provided, both where the establishment was created and the address of any site to which an establishment may move. The industry to which a firm belongs is classified according to the North American Industry Classification System (Neumark and Zhang, 2005). The dataset covers the period 1989 - 2010 for the state of California.

Independent Variables

At the outset, it is important to be clear that important decisions about which variables to include in this analysis must be made and justified. Over 50 independent variables were compiled during the course of this research, and it is necessary to make choices between them for inclusion in this work. These decisions are led by theory and modeling considerations. For example, the variables the "total number of employees" and the "total number of firms" across all industries have both been used in studies to measure urbanization economies. The total level of population across cities is used in some studies to proxy for the potential pool of entrepreneurs in a given location, or local market demand, or to control for scale differences from one place to another. The scale of IT employment from one city to the next could be used as a localization economy effect. The land area of given cities can also be used to control for scale differences from one city to another. A problem arises since each of these variables are co-linear with one another so that the inclusion of each of them in the same model would bias the effects of the respective coefficients. As this chapter proceeds, the case will be made as to why particular variables have been chosen over others.

Agglomeration Economies

Economies of agglomeration refer to those advantages that occur when economic activity clusters together in space. Recall that there are two forms of economies of agglomeration. Localization economies are the benefits that firms of the same industry gain from locating in close proximity to one another, while urbanization economies refer to the advantages that are available to all firms from co-location, regardless of their industry. Most studies of business location activity include measures for both types of agglomeration in their analysis.

Localization economies refer specifically to processes of sharing, matching and learning. Recall that it has proved challenging for scholars to measure the individual effect of each of these mechanisms, therefore scholars infer their presence from the geographical patterns of firm location – namely, their spatial concentration (Arzaghi and Henderson, 2008).

Agglomeration economies have been widely found to have a positive impact on firm location within metropolitan regions. That being said, a variety of indicators have been used to measure agglomeration economies, across a variety of spatial scales. These approaches can be referred to as the scale approach, the share approach and the density approach. In the scale approach, scholars measure either the total number of firms or employees of the same industry within a given geographical unit. In relation to this dissertation, this would entail measuring the total number of IT workers or firms across cities in the Bay Area as a measure of the degree of localization for the IT industry

(Kohlhase and Ju, 2007; Waddell and Ulfarsson, 2004; Jofre-Monseny, 2011; Hilber et Voicu, 2010; Arauzo-Carod et al, 2009). Under the share approach, scholars calculate the level of employment or firms in a particular industry as a share of the total number of employees or firms for given jurisdictions (Wasylenko, 1980; Ellison and Glaeser, 1994; Guimaràes et al, 2000; Holl, 2004; Brulhart et al, 2012; Devereaux et al, 2007). Using this approach, it would be necessary to determine what percentage of the employees who work in each city of the Bay Area work in the IT industry, for example. There are slight variations to this approach, where scholars might use share indexes such as location quotients. The third method for measuring agglomeration is the density approach. Under such an approach, scholars typically calculate the number of firms or employees of a given industry per square mile for a given geographical unit (Guimaràes et al, 2004; Baptista and Mendoca, 2010).

As the variety of methods that have been employed across these studies reveal, there isn't a universally accepted way to measure agglomeration economies in such analyses. This analysis will measure localization economies using the share approach. For some geographical scales, it is preferable to measure specialization employing absolute employment levels for particular industries (Kemeny and Storper, 2014). However, this approach is problematic when examining geographical units within regional economies. Total IT employment across each city-year within the Bay Area is highly correlated with other key variables, particularly total employment across all industries for each city-year, where the correlation coefficient is 0.84. Both variables are highly correlated with population levels and land area for each city-year. To include total IT employment as a measure of specialization, it would not be clear whether a specialization or a scale effect is being detected (namely, larger cities will naturally have more IT employment). The cities of San Francisco and San Jose are by far the largest cities within the region, in terms of population, and will have more IT firms and employees than the other municipalities through their sheer scale. To include these variables together (total employment, total IT employment, population levels and land area) to parse out the individual effects of each would give rise to collinearity, biasing the effects of the individual coefficients.

The share of each city-year's total employment found in the IT industry overcomes the scale problem since the variable is highly correlated with total IT employment for each city-year (the correlation coefficient is 0.69) but *IT share* is uncorrelated with the other scale variables (its correlation coefficients with total employment, land area and population are 0.39, 0.16 and 0.10), respectively. IT employment share of total employees, therefore, detects the specialization component that is required for this analysis without including undesirable, confounding effects.

On the face of it, city boundaries are arbitrary units with respect to economic geography. In some respects, localization economies function and combine across different cities. In other cases, localization effects might be confined within individual cities. One of the major themes of this dissertation is the mismatch between the scale at which economic geography functions and the landscape of administrative units (i.e. cities) within metropolitan regions. Given this disparity, are localization economies measured within individual cities defensible from a theoretical perspective? The introduction to this work, in addition to chapter 1, discussed that there are potentially multiple dimensions to localization effects within a regional economy. The decision about where to locate a new IT establishment within the Bay Area has at least two dimensions to it. First, a new IT establishment must decide in which metropolitan region to locate (for example, The San Francisco Bay Area or some other metropolitan region in the US or the world). Since every establishment in this analysis has chosen the Bay Area over some other metropolitan region, a regional agglomeration effect can be inferred from the decision to locate in the Bay Area. If this were not the case, an IT establishment would locate in a cheaper region. Within regions, evidence reveals that there is a micro geographical localization effect (Arzaghi and Henderson, 2008; Rosenthal and Strange, 2003, 2005, 2010). These studies find that localization economies attenuate at distances of at least half a mile (0.8 squared miles). The mean land area of each city in the Bay Area is 13.7 square miles. This distance more than covers the scale at which agglomeration economies have been measured to attenuate. This means there is a strong case to be made that the localization effects of sharing, matching and learning exist within individual municipalities.

There will be sub-regional localization effects within the economy also (an East Bay effect, for example). The San Francisco consolidated statistical region (the metropolitan area) is further divided into 8 metropolitan statistical areas (MSA). MSAs are subdivisions of regional economies in which the degree of economic and social interaction is the most pronounced, as defined by the US Census Bureau. In the Bay Area, the counties of San Francisco and San Mateo are combined together as one MSA, as are Alameda and Contra Costa Counties. The other counties count as stand alone sub-regions. To measure a localization effect beyond the borders of municipalities, the sub-region localization effect will also be included in this analysis, namely, the share of IT employment of total employment for each of these sub-regions. In sum, while city boundaries are arbitrary with respect to the scale at which economic geography functions, they are not incongruent with the possible scales at which agglomeration economies attenuate. The use of sub-regions helps to control for the broader scales at which localization economies function.

Across the cities in the Bay Area, Scotts Valley, in Santa Cruz County, recorded the highest share of IT employment for a given year over the study period. In 2000, a remarkable 63% of the city's 15,506 jobs were found in the IT sector. Other cities with high shares of IT employment include Milpitas, which had a share of 52% in 1999 (there were 70,164 jobs in Milpitas in this year), and Cupertino, where 50% of the 47,764 jobs in the community in 1998 were found in the IT sector. There are some cities in which there is no IT employment at all for a number of years. It should be expected that, as the share of IT employment within a community increases, so does the number of new IT establishments starting in this place.

A measure of local IT specialization will also be added to this analysis. To measure the effect of relative degrees of specialization within the IT industry across the regional economy on the location of new IT activity, a "non software share" variable will be included. This variable measures the share of employment in the IT industry in a given community that is located in electronics, semiconductors and computer hardware (which are manufacturing oriented industries). This variable is included in this analysis to test to what extent established patterns of industrial activity in the region affect the location of new IT activity.

Three primary approaches have been employed to measure urbanization economies across business location studies. In a first approach, again, scale is used to measure the extent of total economic activity within a given geographical unit. In this approach, the total number of firms or employees in a given place, regardless of industry, is used (Gabe, 2004; Hackler, 2007). The second approach, the density approach, measures the number of employees or firms per square mile in a given jurisdiction (Araozo-Carod, 2009; Coughlin and Segev, 2000; Woodward, 1992). Both approaches are oriented towards measuring the extent to which a given location is urbanized or developed. In a third approach for measuring urbanization economies, scholars have used measures of diversity, most commonly, the Herfindahl index (Holl, 2004; Devereaux et al, 2007; Jofre et al, 2007; Hilber and Voicu, 2010). By employing this diversity measure, these scholars are employing a proxy for Jacobsian diversity.

This study will use the log of total employment for each city-year to measure urbanization economies. This variable has the advantage of measuring not only the extent of economic activity from one place to another (urbanization) but it also controls for the scale (size) of different locations. The inclusion of the log of employment means that the log of population will not be included in this analysis (since the two variables are highly correlated and are subject to collinearity)[17]. These data will also be drawn from the NETS data. San Jose, in 2001, had the highest level of total employment within the region, with 773,759 employees, while various communities had zero employment.

[17] In early versions of the model, the Herfindahl index was employed, yet it is negatively correlated with IT employment share, so that the two variables measure similar effects.

Labor Market Matching Effects

As discussed in chapter 1, matching effects could equally refer to matching between input-suppliers and buyers and employers and employees. This section will further explore labor market matching effects. In relation to the labor market, some scholars believe that matching effects do not attenuate within regional economies, since by definition, regional economies are integrated labor markets (Azaghi and Hendrson, 2008; Rosenthal and Strange, 2003). However, as mentioned in chapter 3, labor markets are not frictionless within regional economies. For example, in 2010 72% of the region's population worked within the county in which they lived. Due to a lack of data, it is not possible to measure the supply of IT workers across the regional economy in a detailed way (data relating to the detailed occupation characteristics of city residents do not exist consistently over time). However, there are good theoretical reasons to include a local educational attainment effect in this analysis.

Some scholars use measures of education attainment across jurisdictions as a proxy for the potential pool of entrepreneurs across municipalities (Holl, 2004). Carlton (1979) takes a similar approach in his study of MSAs in the US. The number of residents within a given city who hold a graduate degree could equally measure local differences in labor supply, or a local skill base that provides a potential pool of entrepreneurs. Data for educational attainment by city of residence are available from the Census Bureau, which measures the characteristics of people across cities in California. Since Census data are available only for the years 1990, 2000 and 2010, values for the intervening years have been interpolated over the period. As the proportion of residents in a community who hold a graduate degree increases, the number of IT start-ups should also increase, due to either entrepreneurship or local matching effects. Palo Alto, in 2009, had the highest percentage of residents who held a graduate degree, where a remarkable 48.5% of people held such credentials in the community. Suisun City in 1991, where 0.38% of residents held a graduate degree had the lowest share of residents with a graduate degree across the region over the period of analysis.

The Role of Local Governments

The following variables represent different ways in which local governments might influence the location of economic activity within the regional economy. They are oriented towards determining whether governments may have induced "premature departure," preventing firms from locating in their preferred destinations within the regional economy or whether governments facilitate "natural expansion" of the industry within the region. The most obvious way that a local government can influence economic activity is through land use. Local governments control access to communities through how they zone their land. Quite simply, if land is not zoned for some form of industrial activity, a company cannot locate there, however much a company is willing to pay. Constricting the supply of land in the face of high demand for this land also has the effect of driving up the price of land within a community. There are other ways in which local governments can influence the level of economic activity within their community, and this work will focus on two more of them: the degree of business regulation (commonly referred to as red tape) and economic development policies.

Land

A major cost to a given establishment is the price that it pays to carry out its business in a given location. The direct cost of locating in a city is, typically, the price of rent or the price of purchasing a building. These factors are typically determined by the price of land in a given community. All else being equal, it is expected that firms would prefer to locate in those places with relatively lower land values (Bartik, 1985; Kim et al, 2008; Hilber and Voicu, 2010). Within metro areas, there is great variation in the price of land. Within a metropolitan region, the price of land has a strong association with its relative level of supply. Strong demand to purchase land in a given municipality in the face of constrained supply of this land is expected to increase its price (Glaeser, 2005; Cheshire et al, 2014).

Measuring land prices across a regional economy is a notoriously difficult endeavor. Historically, crude measures have been employed to measure variation in land prices. Bartik (1985 and 1991) identifies population density as a proxy for land price – according to this view, as population density increases, land available for commercial development becomes relatively scare and therefore expensive. House prices have been widely used as a tool to measure the value of land (Kok et al, 2011). House prices are not a perfect measure of the price of land, but there is empirical evidence that variation in the price of housing is driven by changes in the price of land (Davis and Heathcote, 2007). There are concerns about using house prices to measure the price of land faced by businesses. First, the average house price of a community is not the direct cost faced by a business to locate in that community. Second, house prices could proxy for a variety of factors that are only indirectly related to commercially zoned land, such as the quality of local schools (or public services or the quality of life, generally), the nature of housing stocks or the affluence of local residents. However, data on commercial rents are not freely available for the duration of this study at the scale of municipal governments. The evidence that land density proxies for the price of land is weak (Bartik, 1991), while there is evidence that house prices proxy for land values (Davis and Heathcote, 2007). If house prices are high, this is likely a sign that the price of land in a community is high for other use types, also. This is the case since house prices are correlated with zoning constraints (Glaeser, 2005; Cheshire et al, 2014). With these caveats in mind, average house price will proxy for differences in the cost of land across the municipalities in the region. Given the caveats about using house prices to proxy for land values across cities identified above, the coefficient of the variable will be interpreted with caution. Recall from chapter 4 that many local officials believe that the price of housing acts as a deterrent to people who might choose to live in a community. In turn, this could affect the decision made by a firm to locate in a community; namely, firms are concerned about how easily their workers can access their premises.

Data on average house prices for all homes across California cities is complied by the Rand Corporation from data provided by DataQuick News and are available for each year since 1992[18]. The highest average house price over the period is found in the city of Atherton, when in 2008, the average sale price was $3,998,333. The lowest house price was in Emeryville in 1992, where the average sale price was $92,155.

Price is not the only attribute of land. There are two other factors of land that are often included in studies: land area and zoning. Land area is usually included in studies based on what Bartik (1985) refers to as the dartboard theory. According to the dartboard theory, all else being equal, those cities with more land area should receive more new establishments. In his study of states, Bartik hypothesized that if two states are identical in their characteristics but one state is twice as large as another, we should expect the

[18] http://ca.rand.org/stats/statistics.html

state which is twice as large to have double the number of businesses within its borders. Land area has also been used to proxy for the number of available sites within a given location, and therefore the potential for development (Bartik, 1991). However, land area is highly correlated with total employment, which will be used in this study to proxy for urbanization effects. Due to reasons of collinearity, land area will not be included in this analysis.

Zoning

Any study of business location within metropolitan regions will be biased unless zoning differences across communities are taken into account (Bartik, 1991). Across a metropolitan region, there are some cities that are more receptive to development and growth than others (Fischel, 2002). Zoning constraints are critical to this dissertation since how cities use land has been identified as a way in which the geography of the IT industry in the region has been shaped. Measuring the degree of receptiveness to development across communities is a notoriously difficult task. This is the case since supply and demand for land across communities cannot be easily measured, nor can issues of endogeneity be easily resolved. Data are available for the number of residential building permits, and the value of commercial and residential permits issued across cities in California for the duration of the period of this study. The number or value of permits issued across different communities can be used as a measure of zoning stringency (Kahn, 2011). However, this approach is problematic since it is not clear whether the number of permits issued by a given community is driven by supply or demand. If a given city issues few permits on a per capita basis, for example, is this number low because the community in question practices stringent zoning, or because there is little demand for permits to build in this community?

Three separate approaches to measuring land use restrictiveness were considered in this analysis, each with its own advantages and disadvantages. Measuring the ratio of the value of commercial permits to residential permits issued by a community may provide a sense of the extent to which a community favors commercial compared to residential development. However, a low commercial share might mean that housing is relatively expensive in a community or that there is little demand by companies to locate in a particular community. A second approach might be to consider the per capita number of permits issued by a community. This approach has the inherent problems described above. A third approach could measure what share of the residential permits in a given year are issued to single family housing, compared to multifamily housing units. There is a large literature devoted to the use of single family zoning as an exclusionary zoning technique (Hoch, 2000). This measure is problematic since it does not directly measure a community's views towards commercial development. In both the second and the third approach, using residential permits to measure commercial development has obvious problems. That said, it is likely that a community that is resistant to multi-family housing development, is resistant to development generally. The second approach, single-family share of total housing permits issued, will be employed since it does not have the "demand" problem of the other two approaches.

It is expected that the greater the share of a community's permits which are issued for single family housing, the more likely the community would be to resist commercial development. There have been years when some communities, such as the cities of

Atherton, Los Altos Hills and Woodside, have zoned exclusively for single family housing. Other cities, such as San Francisco, Emeryville and Burlingame, zone for very little single family housing as a share of total permits issued. Over the period of study, roughly 77% of all permits issued in the region were for single family. The data for this variable are drawn from the Construction Industry Research Board, complied by the Rand Corporation.

Property Tax

Taxes are the most frequently investigated government instrument that might affect business location. At the local level, the property tax is the most commonly studied tax variable. This is so because, in most communities, the property tax – a tax on land – is the primary means of raising income for local governments. In theory, local taxes should be a cost to businesses. If one location has a higher tax rate than others, then businesses should be less likely to locate in that destination, ceteris paribus. However, while taxes could potentially act to increase the costs to a firm, the services that a firm receives as a result of these taxes could act to lower the costs to firms (Fox and Murray, 1991; Coughlin and Segev, 2000; Gabe, 2003). This poses a problem since it is not clear the extent to which the tax (a cost) is offset by the services it provides (benefit).

Property tax rates will not be included in this study for two of reasons. First, Proposition 13 restricts the extent to which property tax rates can vary within California. Property taxes are fixed at 1% per year, although this rate can vary subject to the approval of two-thirds of the residents in a community. This makes differences in rates across cities negligible. Second, there is no central agency in California that stores property tax rates for cities, so information about them are not readily available.

Other Local Taxes

In 2012, across the cities in California, taxes did not represent the largest source of public income. Current service charges generated 41.52% of all income, compared to the 35.58% that was raised from taxes (Chiang, 2014). Property taxes generated the largest source of all taxes, 23.44%. Sales and use taxes followed, contributing 19.28%, followed by utility user taxes and the business license taxes, which contributed 8.93% and 5.51%, respectively.

Sales Tax

As of January 1 2013, the statewide sales tax rate in California was 7.5%. Of this 7.5%, 1% of the revenue generated from the tax returns to the local government in which the transaction occurred (what is known as the situ method of taxation). The tax rate varies across different localities subject to the approval of two-thirds of a given locality's voters. At first, sales tax rates do not appear to be relevant to the location of business activity. Any purchases of goods and services an establishment makes that are used in the production of the good or service they produce are exempt from sales taxes in the state of California. However, the sales tax rate can be useful to the extent that it represents a local government's and local voters' views on taxation. Since any variation in sales taxes rates across cities lies in the hands of local voters, the sales tax can proxy for both the desire of local governments to increase taxes and the willingness of local voters to approve these increases. Sales tax rates are available for each city from the State Board of Equalization.

Development Fees

As mentioned above, service charges are the largest source of income for local governments. These fees come in a variety of forms, such as a variety of user connection fees, and are collected for services such as garbage collection, water supply and sewage treatment. Fees became a big source of revenue for local governments in the aftermath of the passage of Proposition 13. One example of this is found in development fees. A development fee is charged to a developer to cover the cost of the infrastructure improvement to which their investment gives rise. In the aftermath of Proposition 13, a 1987 survey by the Bay Area Council found that the impact fee for building a new home in the Bay Area had increased by 644% over the 10-year period 1977-1987, as governments sought to make up for the short fall in their property tax balances (Abbott et al, 2012).

It is widely understood that local authorities adjust their development fees to induce development. Immediately following the aftermath of the Great Recession, for example, a number of cities reduced their development fees to induce new investment within their communities. The city of Fremont is a case in point, which reduced its development impact fees by 10% until 2010 and by 25% in its central business district until 2011 (Klipp, 2009).

It seems conceivable that development fees might influence business location in at least two ways. First, cities that might be less than welcome to growth might have inflated development fees to deter development. It might also be possible for cities to lower development fees as a way to stimulate development. Recall, also, from chapter 3 that local economic development officials can waive certain fees to spur development. For each city in California, data exist on the value of the permits that cities have issued. The permit valuation simply refers to the value of proposed developments that a given permit allows. These data exist for the duration of the period of analysis and are, again, compiled by the Rand Corporation based on figures provided by the Construction Industry Research Board. Contained within the city budgets that are submitted to the State Controller is the amount of revenue that each city has raised through various fees. It is therefore possible to compile the total fees paid for engineering, plan checking, sewer connection, water connection and zoning for each city. These are fees that have been identified as being the most applicable to new construction. From these data the amount of fees paid as a share of the total development that occurred can be calculated for each city-year.

Economic Development

Finding consistent measures of local economic development action for any given point in time across a large number of jurisdictions is a notoriously difficult task (Storper et al, 2015). To gather such measures over a 20-year period is nigh on impossible. One of the only consistent ways to proxy for economic development in California is to look at public budget expenditures. Local governments submit detailed budgets to the state controller each year. Budgets are divided into different expenditure categories, such as transportation, community development, parks and recreation, police and fire protection and so on. To measure the degree of local economic development activity across communities, the share of city expenditure on community development will be included in this analysis. Expenditure on community development includes spending on workforce development, community promotion, redevelopment and housing. This is certainly a rough proxy that does not account for the wide range of local economic development activities that governments employ, but it does provide a sense of the relative levels of activity and the importance of economic development to local communities. On average, communities spent 9.8% of their budgets on community development over the period of analysis. Again, the Rand Corporation, based on figures released by the State Controller's Office, compiled budget data.

Crime

Local crime rates will be used to proxy for the desirability of a given community to both residents and business establishments. Crime is considered to be a cost to businesses and therefore should deter new establishments from locating in given communities. Crime data is drawn from the Rand Corporation that publishes the California Crime Index, which is based on data from California's Attorney General Office.

Variable Lags

In such analyses, it is common for certain variables to be lagged by one year (Bartik, 1991). In fact, Hilber and Voicu (2010) outline three reasons why variables should be lagged. First, they believe that the decision to open an establishment is made some time prior to the time when an entrepreneur officially opens for business, therefore, information used in the decision making process relates to information in some prior period. Second, this is compounded by the fact that there are bureaucratic requirements that factor into the time it takes to open an establishment – such as applying for business permits. Finally, lagged variables are one way to deal with problems of endogeneity. This study uses panel data, which means that a couple of additional factors must be considered. For certain variables, there may be little variation from one year to the next. This is certainly the case for variables such as the sales tax rate, which changes quite infrequently. In such cases, whether a variable is lagged or not is likely to make little difference to coefficients. There are no hard and fast rules about which variables to lag.

In this study, the following variables will be lagged by 1 year: the agglomeration variable, the urbanization variable, land prices, development fees and the crime rate. These variables are likely to be the key factors that determine the decision to open a new establishment in some prior period[19].

Fixed effects

Across the different municipalities, there is likely to be unobserved heterogeneity. There may be factors that are specific to given locations that influence the location of economic activity that cannot be observed. Adding a fixed effect to the model controls for unobserved factors relating to a particular territory, which remain constant over time.

Table 4.1: Descriptive Statistics

	Mean	Low	High	Standard Deviation	Expected Impact
Number of IT Start Ups	20.64	0	495	48.31	
City IT Employment Share	0.07	0	0.63	0.11	+
City Non Software share of IT Employment	0.41	0	1.00	0.26	-
All employment	41,384	0	773,759	87,521	+
Community Development Share	0.10	0	0.64	0.07	+
Crime Rate	1,558	0	11,228	1,187	-
Zoned Single Family	0.77	0	1.00	0.31	-
House Price	518,856	92,155	3,998,333	407,101	-
Share Graduate Degree	0.16	0	0.00	0.48	+
Sales Tax	0.08	7.00	9.75	0.50	-
Development Fees	0.01	0	0.03	0.11	-

Model Findings

Table 4.2 reveals the output from a negative binomial regression for the panel data employed in this study. Each independent variable has been standardized, so that the

[19] Note that in different iterations of the model, lagging variables by a year makes little difference to the model results.

effect of each coefficient can be directly compared. Many of the model variables behaved as expected. The city measure of localization is positive and significant at the 99% level of confidence. Recall that there are a number of ways that the localization effect can be measured. This model employed the share of local employment that is found in the IT industry in a given city, since it provides a cleaner measure of the localization effect. It is clear in this case that the variable is picking up a localization effect since there are few plausible explanations for why the share of local employment found in the IT industry would predict the emergence of new IT start-ups within a city with such a high level of confidence. All else being equal, IT establishments seek to locate in those communities where there is a high local share of employment in the IT industry. This finding is evidence of local sharing, matching and learning effects.

Table 4.2: The Predictors of New IT establishments 1990-2010[20]

IT Start Ups	Coefficent	Stdandard Error	Z-Score	P-Value
City IT Employment Share (1 yr lag)	0.216	0.037	5.91	0.00
City Non Software share of IT Employment (1 yr lag)	-0.132	0.033	-4.00	0.00
Log of all employment (1 yr lag)	0.194	0.121	1.60	0.11
Community Development Share	-0.062	0.027	-2.25	0.03
Crime Rate (1 yr lag)	-0.271	0.048	-5.61	0.00
Zoned Single Family	-0.035	0.015	-2.40	0.02
House Price (1 yr lag)	-0.811	0.047	-17.42	0.00
Share Graduate Degree	0.181	0.072	2.51	0.01
Sales Tax	0.018	0.033	0.56	0.58
Development Fees	0.000	0.059	0.00	1.00
_cons	1.807	0.100	18.14	0.00

The model also reveals that the emergence of new IT establishments is significant and negatively related to the nature of IT specialization across cities at a 99% level of confidence. Recall that the "non software share" variable measures the share of employment in the IT industry in a given community that is located in electronics,

[20] For each model, the number of observations is 1197

semiconductors and computer hardware. New IT establishments are locating away from the more mature and routine elements of the industry. This could be the case since the greater the extent to which a community is specialized in non software functions, the greater are the diseconomies of agglomeration, such as land scarcity. It could also be the case that new IT establishments are increasingly found in the software subsector, which is emerging away from the more established elements of the industry within the region.

The log of total employment within cities also positively predicts the emergence of new IT start-ups, and is significant at a 90% level of confidence. This suggests an urbanization effect whereby IT establishments are drawn to existing patterns of economic activity across the region. Recall also that this variable, log of all employment, could proxy for different scale effects across cities, reinforcing the idea that IT establishments are locating in parts of the region that are relatively highly developed. The share of residents in a city who hold a graduate degree is also significant and positively predicts the emergence of new IT establishments with a 95% level of confidence. This variable could proxy for local labor marker supply, which is perhaps a sign of a local labor market matching effect or it could proxy for the supply of skilled workers across cities, who might be more apt to start their own enterprises.

The sales tax rate and the local development fee as a share of total development expenditures display no significant impact on the location of IT activity. However, the share of city budgets devoted to community development expenditures is significant and a negative predictor of the location of IT start-ups with a 95% degree of confidence. This could be because local jurisdictions, given the nature of the environment for local public finance in California, in which cities pursue sales tax over property tax revenue, are not oriented towards attracting the IT industry. The type of activities that are pursued by cities may crowd out the IT industry, such as the use of land for shopping malls or car dealerships. This is a well-documented problem in the state of California, and precludes effective economic development policies at the local level, that might actually be beneficial to the industry (Fultona and Shigley, 2012). The local crime rate and house prices are negatively associated with the emergence of new IT start-ups across given cities at a 99% level of confidence, while the share of zoning devoted to single family compared to multifamily units is negative and significant at a 95% level of confidence.

Of all of the variables, the average house price across cities displays the highest coefficient. As described above, there are a number of ways the house price variable could be interpreted. Since the house price variable is negatively associated with IT starts, it might be interpreted in the following ways. First, it could mean that wealthy communities are less apt to approve commercial development within their communities than is the case in other communities. In this regard, the house price variable could proxy for some measure of anti-growth sentiment locally. Second, high house prices might be evidence of restrictive land use practices in the face of high demand to access a community. Third, high house prices might price certain workers out of communities, such as those workers engaged in relatively lower value added functions. For those parts of the industry engaged in relatively lower added functions, IT establishments might locate away from wealthier communities to enhance local labor market matching effects. Fourth, house prices could be a measure of land prices. High house prices are likely to be a sign of high land prices generally, which could deter IT start-ups from a given community.

Note that the house price effect outweighs the localization effect. All else being equal, the impact of a one standard deviation increase in house prices is over 4 times greater than the impact of a one standard deviation increase in IT employment share on the decision of an IT firm to locate in a given community. It is important for IT starts to be around relatively high concentrations of IT activity, but house prices in such communities act as a deterrent. The outcome for the zoning variable (share of residential permits that are issued to single family uses) suggests that this variable is a fairly good proxy for zoning stringency. It is hard to provide another plausible explanation as to why this variable would be so highly significant. However, the low coefficient of the variable suggests that the measure is likely a weak predictor of zoning stringency across communities. The coefficient might also be relatively weak since the house price variable picks up a degree zoning stringency across communities, also. Finally, the significance of the crime variable suggests that local safety, or the quality of life generally, is important to new IT start-ups.

The findings of this model shed further light on the theoretical and empirical issues identified in the early chapters of the dissertation. There is a tension within the regional economy between the preferences of IT establishments to locate close to existing levels of IT activity and their ability to act upon these preferences due to how land is used, a point that will be expanded upon below.

Table 4.3 below is specifically oriented towards testing the "window of locational opportunity" hypothesis. In this model, new software establishments are the dependent variable, and the localization effect *only* measures the extent to which the IT industry in a given community is specialized in non-software subsectors. As before, this variable measures the share of IT employment in a given community that is located in electronics, semiconductors and computer hardware subsectors. Here, the share of a local community's IT industry that is found in non-software components of the industry is negative and significant at the 99% level of confidence. The negative coefficient of the variable is essentially unchanged by omission of the overall IT share variable. Thus, the more mature and routine elements of the industry have a robust repulsive effect on new software startups. This finding could be explained in two ways. First, it can be viewed as support for the window of locational opportunity explanation, namely that new subsectors are emerging away from the historical concentrations of IT activity within the region. Second, this finding could be understood as the product of diseconomies of agglomeration. Those parts of the region in which the IT activity was most heavily concentrated might also be home to diseconomies of scale, pushing new activity to other parts of the regional economy. The two explanations need not be mutually exclusive. The relationship between new software starts and the other variables in the model is similar to the findings found in model 1 in table 4.2 above. In model 2, log of all employment is a positive and significant predictor at the 99% level (compared to 90% above) and "zoned single family" is negative, but the significance of the variable has dropped from 95% to 90%. In the second case, this could be because new software establishments require different space (i.e. less land) than the manufacturing and research and development functions of the industry.

Table 4.3: The Location of New Software Establishments

Software Starts	Coefficent	Stdandard Error	Z-Score	P-Value
City Non Software share of IT Employment (1 yr lag)	-0.134	0.036	-3.71	0.00
Log of all employment (1 yr lag)	0.469	0.118	3.99	0.00
Community Development Share	-0.065	0.031	-2.11	0.04
Crime Rate (1 yr lag)	-0.322	0.052	-6.22	0.00
Zoned Single Family	-0.027	0.017	-1.60	0.11
House Price (1 yr lag)	-0.839	0.051	-16.53	0.00
Share Graduate Degree	0.286	0.074	3.85	0.00
Sales Tax	-0.020	0.035	-0.56	0.57
Development Fees	-0.036	0.066	-0.56	0.58
_cons	1.598	0.102	15.60	0.00
(Note: all variables are standardized)				

The model output below (table 4.4) enables the comparison of the sub-regional localization effect with the city effect in the first model. This model employs the same variables as the models above (namely all of the none localization variables relate to the city scale), except it replaces the city localization variable with the sub-region localization variable. The output shows that while the strength of the localization variable is stronger when using the sub-region scale, the model provides some curious results. For example, the inclusion of the sub-regional variable renders the effect of the urbanization variable and the share of local employees who hold a graduate degree insignificant, while the sales tax rate variable is significant. The other variables maintain the same signs as in model 1. While the localization variable effect provides evidence that localization effects are more important at the sub-region than the city scale, the curious effect of the inclusion of the sub-region variable on the other variables requires caution to be exercised. A multi-level model may be better suited to testing the effects of sub-regional localization effects (instead of including variables that related to multiple scales, as is the case in this model). However, a multi-level model in this case would reduce the sample size considerably (the number of geographical units would decline from 103 for each year to 10)

Table 4.4: The Sub-Region Agglomeration Effect

ITstartups	Coefficent	Stdandard Error	Z-Score	P-Value
Sub Region IT Employment Share (1 yr lag)	0.581	0.066	8.86	0
Log of all employment (1 yr lag)	0.067	0.114	0.59	0.555
Community Development Share	-0.031	0.023	-1.32	0.186
Crime Rate (1 yr lag)	-0.206	0.047	-4.42	0
Zoned Single Family	-0.030	0.013	-2.28	0.023
House Price (1 yr lag)	-0.652	0.046	-14.29	0
Share Graduate Degree	0.037	0.073	0.5	0.619
Sales Tax	0.111	0.030	3.73	0
Development Fees	0.021	0.058	0.35	0.723
_cons	1.850	0.104	17.74	0

(Note: all variables are standardized)

Table 4.5 below further explores the relationship between the localization effect and house prices, by interacting the localization variable with house prices[21]. The interaction term is significant at a 95% level of confidence and is positive. The positive relationship means that IT establishments seek to locate in those communities that have a combination of both a relatively high share of local employment in the IT industry, and relatively high house prices. Above, a variety of ways that the house price variable could be interpreted were outlined. The interpretation that house prices proxy for land prices is supported by the interaction term[22]. From this perspective, the positive relationship of the variable suggests that IT establishments are willing to pay a land price premium to be located in those communities where the localization effects of sharing, matching and learning are the most pronounced. The variable could also be interpreted to mean that IT

[21] Note, in this model, the localization effect applies to the city scale

[22] To interpret the land price variable as evidence of a land use constraint in this interaction term would mean that IT start-ups are locating in those communities with a combination of high shares of IT activity and a high level of land use constraints

establishments engaged in high value added functions are locating in those communities where high value added workers are located, perhaps due to local labor market matching effects. Since house prices are a negative predictor of the emergence of IT starts generally, the positive interaction term suggests that some IT establishments are willing to pay the land price premium, suggesting, as would be expected, that there are qualitative differences between IT start ups (a type of inter-firm heterogeneity that cannot be directly observed). This finding supports the findings of Arzaghi and Henderson (2008) that localization effects have a steep decline with distance and that firms are willing to pay land rents to access them.

Table 4.5: The Predictors of New IT Establishments with Interaction Between House Price and Localization Term

IT Start Ups	Coefficent	Stdandard Error	Z-Score	P-Value
City IT Employment Share (1 yr lag)	0.160	0.045	3.54	0.00
City Non Software share of IT Employment (1 yr lag)	-0.124	0.033	-3.78	0.00
Log of all employment (1 yr lag)	0.207	0.120	1.72	0.09
Community Development Share	-0.061	0.028	-2.22	0.03
Crime Rate (1 yr lag)	-0.270	0.048	-5.67	0.00
Zoned Single Family	-0.036	0.015	-2.48	0.01
House Price (1 yr lag)	-0.880	0.057	-15.46	0.00
Share Graduate Degree	0.165	0.072	2.28	0.02
Sales Tax	0.011	0.033	0.33	0.74
Development Fees	-0.003	0.059	-0.05	0.96
Interaction City IT Share and House Price	0.077	0.035	2.20	0.03
_cons	1.808	0.099	18.25	0.00

Table 4.6 further explores the relationship between the localization effect and land use controls, by interacting the localization variable with the share or residential permits that are issued for single family housing across communities. The variable is significant at a 95% level of confidence and negative. In the absence of a plausible alternative explanation for the variable's significance, this provides further evidence that the land

use constraint variable does capture some form of growth control sentiment. This interaction term provides the clearest evidence that land use constraints divert IT activity away from those cities where the localization effects are the strongest. As the local share of employment in the IT industry increases more IT establishments should seek to locate in those communities (as evidence by the models above), however, zoning constraints in these communities act to push IT establishments from these locations. This is evidence that zoning constraints are redistributing IT activity from those communities where the localization effects are the most pronounced.

Table 4.6: The Predictors of New IT Establishments with Interaction Between Zoning and Localization Term

IT Start Ups	Coefficent	Stdandard Error	Z-Score	P-Value
City IT Employment Share (1 yr lag)	0.258	0.040	6.52	0.00
City Non Software share of IT Employment (1 yr lag)	-0.130	0.033	-3.98	0.00
Log of all employment (1 yr lag)	0.212	0.121	1.75	0.08
Community Development Share	-0.056	0.028	-2.03	0.04
Crime Rate (1 yr lag)	-0.269	0.048	-5.65	0.00
Zoned Single Family	0.006	0.023	0.27	0.79
House Price (1 yr lag)	-0.807	0.046	-17.41	0.00
Share Graduate Degree	0.189	0.072	2.61	0.01
Sales Tax	0.010	0.033	0.31	0.76
Development Fees	0.004	0.059	0.07	0.94
Interaction City IT Share and Zoned Single Family	-0.054	0.022	-2.40	0.02
_cons	1.816	0.100	18.12	0.00

Conclusion

The findings in this chapter reveal that that there exists a local (i.e sub-regional) localization effect within the IT industry in the Bay Area. Despite the limitations of using city boundaries, which can be arbitrary with respect to economic geography, the findings reveal that, all else being equal, new IT establishments prefer to locate in those cities where the localization effects are the strongest. However, other effects, most notably house prices, can strongly counteract localization effects, suggesting that they may be pushing firms to locate farther away from other firms, and from clusters of firms, than they might do if land or housing prices were smoother across the regional landscape. Since it seems highly probable that such housing price differences are strongly shaped by land use regulation, and that they proxy well for commercial land price and availability, the evidence can be interpreted as showing a strong role for commercial land use regulation in core IT areas as influencing the dispersion of the IT industry. These findings confirm the central tension identified in this dissertation, namely, the desire of IT firms to locate close to one another on the one hand, and the potential for land use decisions to push the IT industry away from existing centers of activity on the other hand.

Taken together, these models reveal that there are probably differences in the nature of new IT establishments across the region; such differences correspond to the maturation of the IT industry and to its internal heterogeneity. The region contains firms at the cutting edge of technology development all the way to those that are engaged in more routinized production of IT products and services, and everything in-between. The locational requirements of these many types of firms will be different, in terms of land needs, labor requirements, and interaction needs. Thus, some IT starts will be willing to locate in places where land prices are high, if the localization effect is large enough. The city of San Francisco is a case in point. This is a city in which land prices are high, as are localization effects. By the same token, certain IT establishments are willing to pay a premium to locate in the "core cities" of Silicon Valley, most probably those on the cutting-edge of hardware or social media development. Clearly, the benefit of sharing, matching and learning effects in both these sub-regional agglomerations outweigh the diseconomies of agglomeration, such as high land values.

However, even those establishments willing to pay to access high localization effects may be limited by local land use zoning or construction rules. In those communities where localization effects are relatively strong, zoning acts to deter the location of IT starts. In this case, no matter how much a given enterprise is willing to pay to locate in the old core of Silicon Valley, zoning constraints have curtailed these efforts.

Returning to the overall impact of these findings, there is undoubtedly a mix of two rather different overall economic effects. On one hand, part of what has occurred is an efficient sorting process within the regional economy whereby those new IT starts that are most reliant on strong localization effects outbid other IT starts for access to such communities. From this perspective, there is a hierarchy of locations with respect to localization economies within the regional economy and market processes efficiently match each company to their optimal location. This idea is supported by the fact that, on average, the price of land is a deterrent to the location of new IT starts in given communities. For firms engaged in lower value added functions, the price of land is a strong deterrent to their location in the Silicon Valley core (suggesting the growth of the IT industry in the East Bay). The fact that many localities in the Bay Area offer a variety of combinations of land prices and availabilities, together with relatively good regional transit access, suggests that a multi-locational IT industry at the regional scale will perpetuate the ability of the industry to develop in the wider Bay Area. At the same time, other policies that could attract different segments of the IT industry to other locations in the region are basically ineffectual, perhaps because local jurisdictions, given the nature of the environment for local public finance in California, are not oriented towards attracting the IT industry. The type of activities that are pursued by cities may crowd out the IT industry, such as the use of land for shopping malls or car dealerships.

Whether the overall outcome is optimal with respect to the emerging geography of the IT industry in the Bay Area depends, however, on the negative association between high localization effects and zoning constraints. The restrictions on commercial land availability and development have probably pushed IT firms away from the first and second cores of Silicon Valley, faster and more than would have otherwise occurred. The overall welfare effects of this counterfactual economic geography for the IT industry in the Bay Area cannot be further modeled in this dissertation, but they are interesting to contemplate in the framework of a *regional* perspective on the sum of fragmented *local* economic development and land use measures.

Conclusion

The basis for this dissertation is the finding that the IT industry within the San Francisco Bay Area, which was, at the turn of the 1990s, highly geographically localized in Santa Clara County, has been steadily dispersing around the broader metropolitan region. In 1990, the IT industry in Santa Clara County, a rough proxy for the original core of the IT industry within the region, accounted for 71% of the region's total IT employment. In 2010, the IT industry in the county accounted for 57% of the region's IT employment. Over this period, industry employment within the county fell by close to 26,000 net jobs, while the industry within the region as a whole added roughly 36,000 net IT jobs. This geographical focus on counties understates the full extent of the dispersion within the region. In 1989, just seven of the region's 103 cities (Cupertino, Menlo Park, Milpitas, Mountain View, Palo Alto, Santa Clara and Sunnyvale – where the industry in the region originally emerged) accounted for 55% of the IT employment in the region. By 2010, the industry in these same cities accounted for 35% of the IT employment in the region. Over this time, the industry in these cities lost close to 58,000 net IT jobs. To reiterate, this was in the context of job growth in the industry in the region over this period.

There are two motivations for the analysis of the IT industry's changing geography in the San Francisco Bay Area, drawing from two theoretical and policy fields that are usually considered in isolation from one another: economic geography and local economic development. Theories of economic geography explain and model the distribution and spatial organization of economic activities (such as production and employment) across space. The laws (or forces) of economic geography provide the framework within which local economic development policies operate. That said, local economic development policies can affect the geography of economic activities. This dissertation, by considering the two together, has attempted to assess how and to what extent local economic development policies have affected the economic geography of the IT industry in the Bay Area, and to begin to consider some of the consequences of these actions on the Bay Area economy.

Central to theories of economic geography, is the idea that, at different stages of their development, the inputs upon which industries rely evolve and with them, the locational requirements for the firms of such industries. There are three types of input that the economic geography theories of location and agglomeration identify as binding firms of the same industry closely together in their early phases of development: specialized suppliers (sharing), specialized labor markets (matching) and knowledge spillovers (learning). For example, at one point in time the manufacture of cars was reliant on skilled craftsman and niche part suppliers. As the nature of production in the industry evolved, its reliance on these inputs changed. The production of cars became less reliant on skilled labor (matching) while the automation and codification of the production process enabled the knowledge (learning) created in one place to be applied in some other location. At these very different points in the evolution of the industry, the industry was able to locate in very different territories based on comparative advantage and cost saving motives (Markusen, 1985).

Over time, as industries' become less reliant on the mechanisms of sharing, matching and learning, other requirements of firms shape their locational choices. As an industry grows, the scale of its operations changes (such as the change from the batch to the mass production of cars) and with that, the land-intensity of its operations changes. Taken together, the reduced requirements for sharing, matching and learning (due to routinization), along with the growing demand for land and the ability to pay for it, come together to define the industry's preferences for location.

The Bay Area is divided into 103 municipal governments that are primarily responsible for determining how land is used within their borders, giving rise to a patchwork of different types of land use across the region. Each city offers a different mix of locational characteristics (for example, some are abundant in office space, while others have a greater stock of manufacturing facilities, and there is a range of land prices across the cities in the region). The regulation of land use by municipalities responds to many forces, but the principal ones are the pressures from landowners and residents (local politics) and the use by cities of land use regulation as an economic development tool, namely, as a way to generate income by influencing the nature, level, and mix of economic activities within their borders.

In this light, the evolving geography of the IT industry in the Bay Area should reflect the interaction between the "demand" for locations – emanating principally from the industry's internal dynamic of changing locational preferences over time, as noted above; and, the "supply" of locations, emanating from local land use policies and other government actions. From this perspective, actions by local governments could either push the industry away from its natural core through restrictions on land use, or they could attract the industry to other parts of the region through various sorts of incentives or other qualities of the local environment.

This intersection has been little considered in the scholarly and policy literatures to date. Typically, the economic geography literature will consider the natural or "market led" geographical evolution of an industry, while the local economic development literature will, for the most part, consider how local policies affect local economies. The reason for combining these theories is to understand whether the actions of local governments facilitate the natural expansion of industries within regional economies, in a way that enhances the industry's performance, or distort the industry's spatial reconfiguration in a way that inhibits its performance.

This dissertation, therefore, considers an understudied impact of local economic development policies. Namely, their effects on the geography of a regionally-important industry and hence, on the economic efficiency of the industry as a whole, at the regional scale, not just within the borders of individual cities within the region. This is very thorny interaction that this dissertation has certainly not been able to entirely disentangle and document; but it has opened up this vitally-important industry- and regional-scale perspective on local economic development policies that is relatively unexplored in the various economic development literatures.

This dissertation found that there are four basic sets of cities in the Bay Area, that now constitute the four sub-regions of the IT industry in the region. This is the IT industry's new economic geography within the world's leading IT center: the original core of the industry in the region, a rough proxy for which is Santa Clara County; the extended core, which includes the southeastern half of San Mateo County; the city of San Francisco, which is emerging as a home to the current leading edge of the industry, namely, social media and "sharing economy" functions; and Alameda County, which has been the industry's expansion area for more land-intensive operations and somewhat lower value added production operations.

These sub-regions each play distinctive roles in the industry within the regional economy, corresponding to the different locational requirements of IT firms over time. The IT industry in San Francisco and San Mateo Counties is relatively specialized in the software subsector of the industry and the industry in Alameda County is relatively specialized in manufacturing functions. The industry in Santa Clara County is home to the highest concentration of workers across each subsector of the IT industry. There exists within subsector heterogeneity – the idea that software operations are different in their degree of sophistication across the region. For example, the firms in this subsector in Santa Clara County paid an average wage of $163,490 in 2010 compared to $137,928 in San Mateo, $137,819 in San Francisco and $123,111 in Alameda Counties. This is evidence that the firms in Santa Clara County are engaged in higher value added functions than the software establishments in the remainder of the region. In other words, there are sources of unobserved heterogeneity that would better be revealed by even finer decomposition of the industry than has been possible with the data available to carry out the research reported in this dissertation.

The idea that four sub-regions each play a role in facilitating and accommodating the expansion and development of the IT industry within the region supports the natural or "market led" interpretation of the dispersion that has occurred in the region, as proposed by theories of economic geography. The evidence presented in chapters 3 and 4, however, revealed that land scarcity in Santa Clara County, which is a direct effect of local zoning decisions, has restricted the development of the IT industry in the historical core of the region. As new waves of the software industry have emerged in the region, namely, social media and "sharing" economy functions, many of the pioneering firms originated in Santa Clara County. Land scarcity in the core prevented these firms from developing there, providing a window of locational opportunity as these functions sought a new location to expand and grow. The city of San Francisco, with its stock of office buildings and its proximity to Silicon Valley (which enabled it to benefit from regional localization effects), is emerging as the home to these functions.

In addition to cost and the price of land, the level of crime across cities, which is a proxy for the desirability or the quality of life of different jurisdictions, and the relative level of economic development activity across cities were a negative and significant predictor of new IT establishments across jurisdictions. In this latter case, this could be because local jurisdictions, given the nature of the environment for local public finance in California, in which cities pursue sales tax over property tax revenue, are not oriented towards attracting the IT industry. The type of activities that are pursued by cities may crowd out the IT industry, such as the use of land for shopping malls or car dealerships. This is a well-documented problem in the state of California, and precludes effective economic development policies at the local level, that might actually be beneficial to the industry. Other tools that local governments might use to attract IT companies, such as waving certain fees and local tax rates were found to be insignificant predictors of new IT activity in the region. Again, it is likely the case that such levers are not oriented towards the IT industry.

The discovery that Poisson models replicate the estimates of multinomial logit models has helped to resolve many of the difficulties of business location modeling – namely, the problems of modeling location decisions when a choice set is large and the assumption of the independence of irrelevant alternatives (IIA). That said, across business location models there is an inconsistent use of geographical units of analysis. This poses a problem when interpreting variables that relate to processes of economic geography, in particular. A localization effect means something different when confined to the boundaries of a census tract, a city, a county, or a metropolitan region. In each of these cases, there is an obvious problem: administrative boundaries, often times, are entirely arbitrary with respect to the scale at which economic geography functions. The convenience of using administrative units, which makes it easier for researchers to measure differences in tax rates and a variety of other local public polices, entails sacrifices from an economic geography standpoint.

In reality, different economic activities combine and recombine across administrative units across different industries. This means that administrative units arbitrarily slice though functioning units of economic geography within regional economies. Within a metropolitan region, it would be desirable to construct geographical units of analysis that better account for the different scales at which mechanisms of sharing, matching and learning operate. However, there are two problems in this regard. First, while point data on industry and firm characteristics are increasingly available, they are expensive to purchase and therefore are under used in such analyses. Also, building data from block levels (while logical from an economic geography standpoint) complicates measures of local land use characteristics and social demographic information, such as census data, for which data are difficult to acquire and incomplete at such micro levels of analysis.

Second, the field has been unable to discern between the different mechanisms of agglomeration. It is likely that the processes of sharing, matching and learning attenuate at different scales within regional economies, but it is still not clear to what extent. Therefore, modeling these processes at micro levels of geography is a major challenge. For example, the assumption that is often made that labor markets are metropolitan region-wide in scope is problematic. Average commute times, which in the US is 24 minutes, and inter-regional commute patterns demonstrate a highly localized labor market dynamic within metropolitan regions. These dynamics should be better accounted for in models. Also, there is still a lack of data pertaining to firm-to-firm relationships (input-output) at sub-regional scales. Again, this makes modeling and discerning across these effects, especially at micro levels of geography, a challenging task.

Finally, measuring land use, which is so critical to business location modeling, remains a great challenge for researchers. The number of different proxies used across studies makes it difficult to discern the true effect of land use constraints across localities, with respect to economic development. Clearly, better data pertaining to how land is used a micro levels of geography would greatly assist the field.

Returning to the overall impact of these findings, evidence of two types of dispersion has occurred in the Bay Area. On one hand, part of what has occurred is an efficient sorting process within the regional economy whereby IT functions that are most reliant on strong localization effects outbid other IT companies for access to communities with such effects, as the analysis in chapter 4 revealed. From this perspective, there is a hierarchy of locations with respect to localization economies within the regional economy and market processes efficiently match each company to their optimal location. This idea is supported by the fact that, on average, the price of land is a deterrent to the location of new IT starts in given communities. For firms engaged in lower value added functions, the price of land is a strong deterrent to their location in the Silicon Valley core (suggesting the growth of the IT industry in the East Bay). The fact that many localities in the Bay Area offer a variety of combinations of land prices and availabilities, together with a relatively good regional transportation network, suggests that a multi-locational IT industry at the regional scale will perpetuate the ability of the industry to develop in the wider Bay Area.

Land use decisions have shaped the economic geography of the IT industry in the region. Whether the overall outcome is optimal with respect to the emerging geography of the IT industry in the Bay Area depends, however, on the interaction between strong localization effects on the one hand, and zoning constraints on the other. The restrictions on commercial land availability and development in the original core of the region have probably pushed IT firms away from the core of Silicon Valley faster and to a greater extent than would have otherwise occurred. The overall welfare effects of this counterfactual economic geography for the IT industry in the Bay Area cannot be further modeled in this dissertation, but they are interesting to contemplate in the framework of a *regional* perspective on the sum of fragmented *local* economic development and land use measures. Further research is required to tease out these dynamics.

Industries are the lifeblood of regional economic performance. Yet within the "black box" of a regional economy, far too little is understood about those mechanisms and processes that influence the welfare of wealth generating industries. The role of local governments and planning is a case in point. Land use decisions may influence the performance of different industries, and so might traffic congestion, public transit and other realms of local decision-making. The fields of economic geography and local economic development lack a grasp of how these different actions influence the welfare of industries. This dissertation has shown that local planning decisions do matter to the location of industries within a regional economy. Future research must be oriented towards understanding the consequences of these actions. By understanding these dynamics, more effective local planning decisions can be fostered.

Appendix A

NAICS	Title	Sub-sector
333295	Semiconductor machinery manufacturing	Semiconductors
333314	Optical instrument and lens manufacturing	Semiconductors
334413	Semiconductor and related device manufacturing	Semiconductors
334513	Instruments and related products manufacturing for measuring, displaying, and controlling industrial process variables	Semiconductors
334515	Instrument manufacturing for measuring and testing electricity and electrical signals	Semiconductors
334519	Other measuring and controlling device manufacturing	Semiconductors
334111	Electronic computer manufacturing	Computer and Communications Hardware
334112	Computer storage device manufacturing	Computer and Communications Hardware
334113	Computer terminal manufacturing	Computer and Communications Hardware
334119	Other computer peripheral equipment manufacturing	Computer and Communications Hardware
334210	Telephone apparatus manufacturing	Computer and Communications Hardware
334220	Radio and television broadcasting and wireless communications equipment manufacturing	Computer and Communications Hardware
334290	Other communications equipment manufacturing	Computer and Communications Hardware
334511	Search, detection, navigation, guidance, aeronautical, and nautical system and instrument manufacturing	Computer and Communications Hardware
334613	Magnetic and optical recording media manufacturing	Computer and Communications Hardware
335911	Storage battery manufacturing	Computer and Communications Hardware
335912	Primary battery manufacturing	Computer and Communications Hardware
335921	Fiber optic cable manufacturing	Computer and Communications Hardware
335929	Other communication and energy wire manufacturing	Computer and Communications Hardware
335931	Current-carrying wiring device manufacturing	Computer and Communications Hardware
335932	Noncurrent-carrying wiring device manufacturing	Computer and Communications Hardware
335991	Carbon and graphite product manufacturing	Computer and Communications Hardware
335999	All other miscellaneous electrical equipment and component manufacturing	Computer and Communications Hardware
334411	Electron tube manufacturing	Electronic Components
334412	Bare printed circuit board manufacturing	Electronic Components
334414	Electronic capacitor manufacturing	Electronic Components
334415	Electronic resistor manufacturing	Electronic Components
334416	Electronic coil, transformer, and other inductor manufacturing	Electronic Components
334417	Electronic connector manufacturing	Electronic Components
334418	Printed circuit assembly (electronic assembly) manufacturing	Electronic Components
334419	Other electronic component manufacturing	Electronic Components
334611	Software reproducing	Electronic Components
518210	Data Processing, Hosting, and Related Services	Electronic Components
511210	Software publishers	Software
514210	Information Services and Data Processing Services	Software
518111	Internet Service Providers	Software
518112	Web Search Portals	Software
541511	Custom Computer Programming Services	Software
541512	Computer Systems Design Services	Software
541513	Computer Facilities Management Services	Software
541519	Other Computer Related Services	Software

Appendix B

Table 2: Bay Area Employment by Industry, 1990–2011

	Share of Bay Area Employment (%)				Employment Levels (Thousands)			
Industry	1990	2000	2003	2011	1990	2000	2003	2011
Prof., Sci. & Tech. Srvcs.	7.8	10.3	9.4	11.8	205	332	278	340
Health Care & Soc. Asst.	7.4	7.6	8.9	11	196	244	262	317
Retail Trade	12.9	11	11.4	10.8	342	353	336	311
Accom. & Food Srvcs.	7.8	7.7	8.6	9.8	207	249	252	283
Manufacturing	14.9	13.1	10.9	9.3	395	423	320	269
Educ. Services	5.9	6.2	7.1	6.6	156	200	208	190
Admin., Support & Waste	6.2	7.3	5.9	5.8	165	237	172	167
Other Srvcs.	4.0	4.0	4.7	5.4	107	128	138	154
Construction	5.6	5.8	6.1	4.6	149	188	179	132
Wholesale Trade	5.3	4.3	4.2	3.9	141	137	124	113
Public Admin.	3.9	3.1	3.8	3.8	103	101	111	110
Finance & Insurance	5.8	3.9	4.8	3.7	153	124	141	105
Information	2.9	4.3	3.8	3.6	78	139	110	103
Trans. & Warehousing	4.1	3.8	3.7	3.0	109	123	110	86
Mgmt. of Companies	0.6	3.4	2.3	2.1	15	111	68	60
Arts, Ent., & Rec.	1.6	1.3	1.5	1.9	42	43	45	54
RE, Rental, Leasing	2.4	1.9	2.1	1.8	62	62	61	52
Other	0.9	0.8	0.9	1.3	24	27	27	37
Total	100.0	100.0	100.0	100.0	2,649	3,219	2,943	2,884

Sorted by 2011 Share of Bay Area Employment
Source: BLS; calculations by Bay Area Council Economic Institute

Bibliography

Abbott, W. W., Detwiler, P. M., Jacobsen, M. T., Sohagi, M., & Steiner, H. A. (2001). *Exactions and Impact Fees in California*. Solano Press.

Anas, A., Arnott, R., & Small, K. A. (1998). Urban spatial structure. *Journal of Economic Literature*, *36*(3), 1426–1464.

Andrade, A. (2014, August 21). Telephone Interview.

Arauzo-Carod, J.-M., Liviano-Solis, D., & Manjón-Antolín, M. (2010). Empirical Studies In Industrial Location: An Assessment Of Their Methods And Results. *Journal of Regional Science*, *50*(3), 685–711.

Arauzo-Carod, J.-M., & Viladecans-Marsal, E. (2009). Industrial location at the intra-metropolitan level: the role of agglomeration economies. *Regional Studies*, *43*(4), 545–558.

Arzaghi, M., & Henderson, J. V. (2008). Networking off Madison Avenue. *Review of Economic Studies*, *75*(4), 1011–1038.

Baptista, R., & Mendonça, J. (2010). Proximity to knowledge sources and the location of knowledge-based start-ups. *The Annals of Regional Science*, *45*(1), 5–29.

Bartik, T. J. (1985). Business location decisions in the United States: Estimates of the effects of unionization, taxes, and other characteristics of states. *Journal of Business & Economic Statistics*, *3*(1), 14–22.

Bartik, T. J. (1991). The effects of property taxes and other local public policies on the intrametropolitan pattern of business location. *Industry Location and Public Policy, University of Tennessee Press, Knoxville*, 57–80.

Bartik, T. J. (1992). The effects of state and local taxes on economic development: A review of recent research. *Economic Development Quarterly*, *6*(1), 102–111.

Bartik, T. J. (2012). The future of state and local economic development policy: what research is needed. *Growth and Change*, *43*(4), 545–562.

Bluestone, B., & Harrison, B. (1982). *The deindustrialization of America: plant closings, community abandonment, and the dismantling of basic industry*. Basic Books.

Bogart, W. T. (2006). *Don't call it sprawl: metropolitan structure in the twenty-first century*. Cambridge University Press

Brooks, S. (2014, Mid-August). Telephone Interview.

Brülhart, M., Jametti, M., & Schmidheiny, K. (2012). Do agglomeration economies reduce the sensitivity of firm location to tax differentials?. *The Economic Journal*, *122*(563), 1069–1093.

Buss, T. F. (2001). The effect of state tax incentives on economic growth and firm location decisions: An overview of the literature. *Economic Development Quarterly*, *15*(1), 90.

Carlock, C. (2015, March 5). *This Boston neighborhood is among the country's most expensive office markets.* Retrieved from http://www.bizjournals.com/boston/real_estate/2015/03/this-boston-neighborhood-is-among-the-country-s.html

Carlton, D. W. (1979). *Why new firms locate where they do: an econometric model*. Joint Center for Urban Studies of MIT and Harvard University.

Carlton, D. W. (1983). The location and employment choices of new firms: an econometric model with discrete and continuous endogenous variables. *The Review of Economics and Statistics*, *65*(3), 440–449.

Chatman, D. G., & Noland, R. B. (2011). Do public transport improvements increase agglomeration economies? A review of literature and an agenda for research. *Transport Reviews*, *31*(6), 725–742.

Chatman, D. G., & Noland, R. B. (2014). Transit Service, Physical Agglomeration and Productivity in US Metropolitan Areas. *Urban Studies*, *51*(5), 917–937.

Cheshire, P. C., & Hilber, C. A. (2008). Office Space Supply Restrictions in Britain: The Political Economy of Market Revenge. *The Economic Journal*, *118*(529), F185–F221.

Cheshire, P. C., Hilber, C. A., & Kaplanis, I. (2014). Land use regulation and productivity—land matters: evidence from a UK supermarket chain. *Journal of Economic Geography*, lbu007.

Cheshire, P. C., Nathan, M., & Overman, H. G. (2014). *Urban economics and urban policy: Challenging conventional policy wisdom*. Edward Elgar Publishing.

Cheshire, P., Hilber, C. A., & Kaplanis, I. (2011). Our system of land use planning can often have damaging impacts on retail productivity. *British Politics and Policy at LSE*. Retrieved from http://eprints.lse.ac.uk/38040/

Chiang, J. (2014, April 23). *Cities Annual Report.* Retrieved from http://www.sco.ca.gov/Files-ARD-Local/LocRep/1112cities.pdf

Chinitz, B. (1960). *Freight and the Metropolis*. Harvard University Press.

Christaller, W. (1966). *Central places in southern Germany*. Prentice-Hall.

Costa, D. L., & Kahn, M. E. (1999). Power couples: Changes in the locational choice of the college educated, 1940-1990. National bureau of economic research. Retrieved from http://www.nber.org/papers/w7109

Coughlin, C. C., & Segev, E. (2000). Location determinants of new foreign-owned manufacturing plants. *Journal of Regional Science*, *40*(2), 323–351.

Cowen, T., & Tabarrok, A. (2010). *Modern Principles: Economics*. Worth.

Crane, R. (1996). The influence of uncertain job location on urban form and the journey to work. *Journal of Urban Economics*, *39*(3), 342–356.

Davis, M. A., & Heathcote, J. (2007). The price and quantity of residential land in the United States. *Journal of Monetary Economics*, *54*(8), 2595–2620.

Desliver, D. (2014, February 21). *Chart of the Week: How metro areas drive the U.S. economy.* Retrieved from http://www.pewresearch.org/facttank/2014/02/21/chart-of-the-week-metro-areas-drive-the-u-s-economy/

Devereux, M. P., Griffith, R., & Simpson, H. (2007). Firm location decisions, regional grants and agglomeration externalities. *Journal of Public Economics*, *91*(3), 413–435.

Dicken, P. (2003). *Global shift: Reshaping the global economic map in the 21st century*. Sage Publications Ltd.

Drennan, M., & Brecher, C. (2012). Can Public Transportation Increase Economic Efficiency? *ACCESS Magazine*, *1*(40).

Duranton, G., & Puga, D. (2004). Micro-foundations of urban agglomeration economies. *Handbook of Regional and Urban Economics*, *4*, 2063–2117.

Duranton, G., & Puga, D. (2005). From sectoral to functional urban specialisation. *Journal of Urban Economics*, *57*(2), 343–370.

Economic and Fiscal Impacts Generated by Apple in Cupertino – Current Facilities and Apple Campus 2 (2013). Retrieved from https://www.apple.com/pr/pdf/apple_economic_impact_on_cupertino.pdf

Einiö, E., & Overman, H. (2012). The Effects of Spatially Targeted Enterprise Initiatives: Evidence from UK LEGI. ERSA conference papers, European Regional Science Association

Ellison, G., & Glaeser, E. L. (1994). *Geographic concentration in US manufacturing industries: a dartboard approach*. National Bureau of economic research. Retrieved from http://www.nber.org/papers/w4840

Ellison, G., Glaeser, E. L., & Kerr, W. (2007). *What causes industry agglomeration? Evidence from coagglomeration patterns*. National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w13068

Euchner, C. C., & McGovern, S. J. (2003). *Urban policy reconsidered: dialogues on the problems and prospects of American cities*. Routledge.

Fehrenbach, T. (2014, August 13). Telephone Interview.

Feldman, M. P. (1994). The geography of innovation. Springer Science & Business Media. (Vol. 2).

Fischel, W. A. (2001). The homevoter hypothesis. *How Home Values Influence Local*. Harvard University Press.

Figueiredo, O., Guimaraes, P., & Woodward, D. (2002). Home-field advantage: location decisions of Portuguese entrepreneurs. *Journal of Urban Economics*, *52*(2), 341–361.

Foust, R. (2014, August 19). Telephone Interview.

Fox, W. F., & Murray, M. N. (1991). The effects of local government public policies on the location of business activity. *Industry Location and Public Policy*, 97–119.

Freidman, T. (2005). *The world is flat*. *New York: Farrar, Straus and Giroux*.

Fujita, M. (1989). *Urban economic theory: Land use and city size*. Cambridge University Press.

Fujita, M. (2010). The evolution of spatial economics: from Thünen to the new economic geography. *Japanese Economic Review*, *61*(1), 1–32.

Fujita, M., Krugman, P. R., & Venables, A. J. (2001). *The spatial economy: Cities, regions, and international trade*. MIT press. Retrieved from

Fulton, W. and Shigley P. (2012). Guide to California Planning. 4th Edition. Solano Press Books.

Gabe, T. M. (2004). Tradeoffs between local taxes and government spending as determinants of business location*. *Journal of Regional Science*, *44*(1), 21–41.

Garcia, O. (2014, August 25). Telephone Interview.

Giuliano, G., Agarwal, A., Redfearn, C., & Traveled, V. M. (2008). Metropolitan Spatial Trends in Employment and Housing. *Transportation Research Board*, 29.

Giuliano, G., & A Small, K. (1999). The determinants of growth of employment subcenters. *Journal of Transport Geography*, *7*(3), 189–201.

Giuliano, G., Redfearn, C., Agarwal, A., Li, C., & Zhuang, D. (2007). Employment concentrations in Los Angeles, 1980–2000. *Environment and Planning A*, *39*(12), 2935–2957.

Giuliano, G., & Small, K. A. (1991). Subcenters in the Los Angeles region. *Regional Science and Urban Economics*, *21*(2), 163–182.

Glaeser, E. (2011). *Triumph of the City*. New York: Penguin Press.

Glaeser, E. L. (2009). Green cities, brown suburbs. *City Journal*, *19*(1), 50–55.

Glaeser, E. L., Gyourko, J., & Saks, R. (2005). *Why have housing prices gone up?*. National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w11129

Glaeser, E. L., & Kahn, M. E. (2010). The greenness of cities: carbon dioxide emissions and urban development. *Journal of Urban Economics*, *67*(3), 404–418.

Glaeser, E. L., & Kohlhase, J. E. (2004). Cities, regions and the decline of transport costs*. *Papers in Regional Science*, *83*(1), 197–228.

Grindall, T. (2014, August 13). Telephone Interview.

Gross, K. (2014, August 15). Telephone Interview.

Guimaraes, P., Figueiredo, O., & Woodward, D. (2000). Agglomeration and the location of foreign direct investment in Portugal. *Journal of Urban Economics*, *47*(1), 115–135.

Guimaraes, P., Figueiredo, O., & Woodward, D. (2004). Industrial location modeling: Extending the random utility framework*. *Journal of Regional Science*, *44*(1), 1–20.

Hackler, D. (2007). Local economic development and information-economy growth in Metropolitan Los Angeles. *Journal of Urban Technology*, *14*(1), 51–76.

Hilber, C. A., & Voicu, I. (2010). Agglomeration economies and the location of foreign direct investment: Empirical evidence from Romania. *Regional Studies*, *44*(3), 355–371.

Hill, E. W., & Brennan, J. (2005). America's central cities and the location of work: Can cities compete with their suburbs? *Journal of the American Planning Association*, *71*(4), 411–432.

Hoch, C., Dalton, L. C., So, F. S., & Institute, I. T. (2000). *The practice of local government planning*. Published for the ICMA Training Institute by the International City/County Management Association.

Holl, A. (2004). Transport Infrastructure, Agglomeration Economies, and Firm Birth: Empirical Evidence from Portugal*. *Journal of Regional Science*, *44*(4), 693–712.

Hoover, E. M., & Vernon, R. (1962). *Anatomy of a Metropolis*. Doubleday.

Isard, W. (1956). Location and space-economy. Retrieved from http://trid.trb.org/view.aspx?id=131509

Isserman, A., & Rephann, T. (1995). The economic effects of the Appalachian Regional Commission. *Journal of the American Planning Association*, *61*(3), 345–364.

Jacobs, J. (1961). *The life and death of great American cities*. New York: Random House.

Jacobs, J. (1970). The economy of cities. *The Economy of Cities.*

Jaffe, A. B., Trajtenberg, M., & Henderson, R. (1992). *Geographic localization of knowledge spillovers as evidenced by patent citations*. National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w3993

Jofre-Monseny, J., Marín-López, R., & Viladecans-Marsal, E. (2011). The mechanisms of agglomeration: Evidence from the effect of inter-industry relations on the location of new firms. *Journal of Urban Economics*, *70*(2), 61–74.

Jofre-Monseny, J., & Solé-Ollé, A. (2007). Tax differentials and agglomeration economies in intraregional firm location. *XREAP Working Paper No. 2007-5*.

Kahn, M. E. (2011). Do liberal cities limit new housing development? Evidence from California. *Journal of Urban Economics*, *69*(2), 223–228.

Kemeny, T. (2011). Are international technology gaps growing or shrinking in the age of globalization? *Journal of Economic Geography*, *11*(1), 1–35.

Kemeny, T., & Storper, M. (2012). The Sources of Urban Development: Wages, Housing, and Amenity Gaps Across American Cities*. *Journal of Regional Science*, *52*(1), 85–108.

Kemeny, T., & Storper, M. (2014). Is specialization good for regional economic development? *Regional Studies*, (ahead-of-print), 1–16.

Kenney, M. (2000). *Understanding Silicon Valley: the anatomy of an entrepreneurial region*. Stanford University Press.

Kenney, M., & Florida, R. (2000). Venture capital in Silicon Valley: Fueling new firm formation. *Understanding Silicon Valley: The Anatomy of an Entrepreneurial Region*, 98–123.

Kermayon, P. (2014, August 13). Telephone Interview.

Khanna, D. M. (1997). *The rise, decline, and renewal of Silicon Valley's high technology industry*. Taylor & Francis.

Kim, H., Waddell, P., Shankar, V. N., & Ulfarsson, G. F. (2008). Modeling Micro-Spatial Employment Location Patterns: A Comparison of Count and Choice Approaches. *Geographical Analysis*, *40*(2), 123–151.

Klepper, S. (2009). Silicon valley—a chip off the old Detroit bloc. *Entrepreneurship, Growth, and Public Policy*, 79–115.

Klepper, S. (2010). The origin and growth of industry clusters: The making of Silicon Valley and Detroit. *Journal of Urban Economics*, *67*(1), 15–32.

Klipp, S. (2009, May 21). *Cities Cut, Delay Development Fees.* Retrieved from http://www.cp-dr.com/node/2328

Kolko, J. (2000). The death of cities? The death of distance? Evidence from the geography of commercial Internet usage. *The Internet Upheaval: Raising Questions, Seeking Answers in Communications Policy*, 73–98.

Kohlhase, J., & Ju, X. (2007). Firm location in a polycentric city: the effects of taxes and agglomeration economies on location decisions. *Environment and Planning C: Government & Policy*, *25*(5), 671–691.

Kok, N., Monkkonen, P., & Quigley, J. M. (2013). Land Use Regulations and the Value of Land and Housing: An Intra-Metropolitan Analysis. *AREUEA Meetings Denver*. 2011.

Kolko, J., & Neumark, D. (2009). *Do California's Enterprise Zones Create Jobs*. Public Policy Institute of California.

Krugman, P. (1998). What's new about the new economic geography? *Oxford Review of Economic Policy*, *14*(2), 7–17.

Krugman, P. (2000). Where in the world is the "new economic geography." *The Oxford Handbook of Economic Geography*, 49–60.

Krugman, P. (n.d.). R. and Maurice Obstfeld (2000) International economics: theory and policy. Pearson Education India, 2008.

Krugman, P. R. (1991). *Geography and trade*. MIT press.

Kuznets, S. S. (1930). Secular movements in production and prices. Retrieved from http://agris.fao.org/agris-search/search.do?recordID=US201300602353

Lécuyer, C. (2006). *Making Silicon Valley: Innovation and the growth of high tech, 1930-1970*. The MIT Press.

Leslie, T. F. (2010). Identification and Differentiation of Urban Centers in Phoenix Through a Multi-Criteria Kernel-Density Approach. *International Regional Science Review*, *33*(2), 205.

Losch, A. (1954). Economics of location.

Louie, D. and Sakai, R. (2014, August 14). Telephone Interview.

Manville, M. and Osman, T. Motivations for Growth Revolts: Discretion, Pretext, and Discontent. *Journal of Planning Education Research* (Being Revised for Resubmission)

Markusen, A. R. (1985). *Profit Cycles, Oligopoly, and Regional Development*. Cambridge, Mass: MIT Press.

Marshall, A. (1961). Principles of Economics, 1890. *London: McMillan*.

Massaro, R (2015). *Silicon Valley Index: People, Economy, Society, Place, Governance.* Retrieved fromhttp://www.jointventure.org/images/stories/pdf/index2015.pdf

Mills, E. S., Epple, D., & Oates, W. E. (2000). A Thematic History of Urban Economic Analysis [with Comments]. *Brookings-Wharton Papers on Urban Affairs*, 1–52.

Moretti, E. (2012). *The New Geography of Jobs*. Houghton Mifflin Harcourt (HMH).

Moss, M. L. (1998). Technology and cities. *Cityscape*, *3*(3).

Neumark, D., Zhang, J., & Wall, B. (2005). *Employment dynamics and business relocation: New evidence from the national establishment time series*. National Bureau of Economic Research.

North, D. C. (1955). Location theory and regional economic growth. *The Journal of Political Economy*, *63*(3), 243–258.

Ota, M., & Fujita, M. (1993). Communication technologies and spatial organization of multi-unit firms in metropolitan areas. *Regional Science and Urban Economics*, *23*(6), 695–729.

Ott, P. (2014, August 14). Telephone Interview.

Overman, H. G., & Puga, D. (2010). Labor pooling as a source of agglomeration: An empirical investigation. In *Agglomeration economics* (pp. 133–150). University of Chicago Press.

Partridge, M. D. (2010). The duelling models: NEG vs amenity migration in explaining US engines of growth. *Papers in Regional Science*, *89*(3), 513–536.

Piore, M. J. & Sabel, M. (1984). *The second industrial divide: possibilities for prosperity*. Basic books.

Puga, D. (2010). The Magnitude and Causes of Agglomeration Economies*. *Journal of Regional Science*, *50*(1), 203–219.

Ramirez, E. (2014, Mid-August). Telephone Interview.

Randolph, S. (2014, August 13). Telephone Interview.

Rao, A., & Scaruffi, P. (2011). *A History of Silicon Valley: The Largest Creation of Wealth in the History of the Planet: A Moral Tale*. Omniware Group.

Redfearn, C. L. (2007). The topography of metropolitan employment: Identifying centers of employment in a polycentric urban area. *Journal of Urban Economics*, *61*(3), 519–541.

Rees, J. (1979). Technological Change And Regional Shifts In American Manufacturing. *The Professional Geographer*, *31*(1), 45–54.

Rosenthal, S. S., & Strange, W. C. (2001). The determinants of agglomeration. *Journal of Urban Economics*, *50*(2), 191–229.

Rosenthal, S. S., & Strange, W. C. (2003). Geography, industrial organization, and agglomeration. *Review of Economics and Statistics*, *85*(2), 377–393.

Rosenthal, S. S., & Strange, W. C. (2004). Evidence on the nature and sources of agglomeration economies. *Handbook of Regional and Urban Economics*, *4*, 2119–2171.

Rosenthal, S. S., & Strange, W. C. (2005). The geography of entrepreneurship in the New York metropolitan area. *Federal Reserve Bank of New York Economic Policy Review*, *11*, 29–53.

Rosenthal, S. S., & Strange, W. C. (2010). Small establishments/big effects: Agglomeration, industrial organization and entrepreneurship. In *Agglomeration Economics* (pp. 277–302). University of Chicago Press.

Rosenthal, S., & Strange, W. C. (2011). Agglomeration Economics: Small Establishments/Big Effects: Agglomeration, Industrial Organization and Entrepreneurship.

Saxenian, A. (1983). The urban contradictions of Silicon Valley: regional growth and the restructuring of the semiconductor industry. *International Journal of Urban and Regional Research*, *7*(2), 237–262.

Saxenian, A. L. (1996). *Regional advantage: Culture and competition in Silicon Valley and Route 128*. Harvard University Press.

Scott, A. J. (1998). *Regions and the world economy*. Oxford: Oxford University Press.

Scott, A. J., & Storper, M. (1987). High technology industry and regional development: a theoretical critique and reconstruction. *International Social Science Journal*, *39*, 215–32.

Singerman, P. (2008). Repurposed Federal Economic Development Programs. *Economic*

Development Quarterly, *22*(2), 99 –106.

Storper, M. (1997). *The regional world: territorial development in a global economy*. The Guilford Press.

Storper, M. (2013). *Keys to the City: How Economics, Institutions, Social Interaction, and Politics Shape Development*. Princeton University Press.

Storper, M., & Christopherson, S. (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, M. & Osman, T. Forthcoming book: *The Rise and Decline of Urban Economies: Lessons from Los Angeles and San Francisco,* Stanford University Press, September 2015.

Storper, M., & Scott, A. J. (2009). Rethinking human capital, creativity and urban growth. *Journal of Economic Geography*, lbn052.

Storper, M., & Venables, A. J. (2004). Buzz: face-to-face contact and the urban economy. *Journal of Economic Geography*, *4*(4), 351–370.

Sturgeon, T. J. (2000). How Silicon Valley came to be. *Understanding Silicon Valley: The Anatomy of an Entrepreneurial Region*, 15–47.

Terplan, E. (2013, May 28). Telephone Interview.

The Bay Area: A Regional Economic Assessment. A Bay Area Council Report (2012). Retrieved from http://www.bayareaeconomy.org/media/files/pdf/BAEconAssessment.pdf

Tiebout, C. M. (1956). A pure theory of local expenditures. *The Journal of Political Economy*, *64*(5), 416–424.

Vernon, R. (1957). Production and distribution in the large metropolis. *The Annals of the American Academy of Political and Social Science*, *314*(1), 15–29.

Vernon, R. (1966). International investment and international trade in the product cycle. *The Quarterly Journal of Economics*, *80*(2), 190–207.

Waddell, P., & Ulfarsson, G. F. (2004). Introduction To Urban Simulation: Design And Development Of Operational. Retrieved from http://synthicity.com/introduction_to_urban_simulation.pdf

Walesh, K. (2013, May 13). Telephone Interview

Wasylenko, M. J. (1980). Evidence of fiscal differentials and intrametropolitan firm relocation. *Land Economics*, 339–349.

Weber, A. (1929). *Alfred Weber's theory of the location of industries*. The University of Chicago Press.

White, M. J. (1976). Firm suburbanization and urban subcenters. *Journal of Urban Economics*, *3*(4), 323–343.

Wilson, W. J. (2011). *When work disappears: The world of the new urban poor*. Vintage.

Woodward, D., Figueiredo, O., & Guimaraes, P. (2006). Beyond the Silicon Valley: University R&D and high-technology location. *Journal of Urban Economics*, *60*(1), 15–32.

World Urbanization Prospects: The 2014 Revision (2014). Retrieved from http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf

Zhang, J. (2003). *High-tech start-ups and industry dynamics in Silicon Valley*. Public Policy Institute of California