Congested Development

A Study of Traffic Delays, Access, and Economic Activity in Metropolitan Los Angeles

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UCLA ITS
INSTITUTE OF TRANSPORTATION STUDIES

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A Report to the
John Randolph and Dora Haynes Foundation

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Executive Summary

For years Los Angeles has been ranked among the most traffic congested metropolitan areas in the U.S., often the most congested. This past year the Texas Transportation Institute (TTI) ranked LA second only to Washington D.C. in the time drivers spend stuck in traffic. Such rankings are lists of shame, tagging places as unpleasant, economically inefficient, even dystopian. Indeed, the economic costs of chronic traffic congestion are widely accepted; the TTI estimated that traffic congestion cost the LA economy a staggering $13.3 billion in 2014 (Lomax et al., 2015).

Such estimates are widely accepted by public officials and the media and are frequently used to justify major new transportation infrastructure investments. They are based on the premise that moving more slowly than free-flow speeds wastes time and fuel, and that these time and fuel costs multiplied over many travelers in large urban areas add up to billions of dollars in congestion costs. For example, a ten mile, ten minute suburb-to-suburb freeway commute to work at 60 miles per hour might occasion no congestion costs, while a two mile, ten minute drive to work on congested central city streets – a commute of the same time but shorter distance – would be estimated to cost a commuter more than 13 minutes (round trip) in congested time and fuel costs each day.

But while few among us like driving in heavy traffic, do such measures really capture how congestion and the conditions that give rise to it affect regional economies? This study explores this question for metropolitan Los Angeles by examining how traffic congestion is (i) related to a broader and more conceptually powerful concept of access and (ii) how it affects key industries, which are critical to the performance of the region's economy.

In a nutshell, we find that road network delay is at best an indirect measure of the ease and quality of social interactions and economic transactions that are the bedrock of metropolitan areas and their economies. For example, a long distance trip to a grocery store in uncongested conditions on the outskirts of the region is not inherently superior to short distance grocery trip to the store in congestion, if both trips take about the same amount of time. Yet conventional measures of congestion delay would suggest otherwise. In central city areas, building densities are higher, which both pushes trip origins and destinations closer together and gives rise to traffic delays. So while high land use density is associated with increased traffic congestion, by allowing people and firms to locate in close proximity to a greater range of economic opportunities, such density helps to mitigate the effects of traffic congestion. Our analysis shows that more often than not in Los Angeles, the time lost to commuter traffic delays is more than off-set by the greater opportunities to reach destinations over shorter distances to which high development densities gives rise.

Emphasize Access not Mobility

Many residents are understandably wary of new development. The increased density caused by new construction generates new trips locally which are often associated with increased traffic delays. The solution to most local residents is obvious: limit new development in congested areas and encourage growth elsewhere. But will pushing new development to outlying areas where travel distances tend to be much longer, or to other metropolitan areas all together, really make things better? Where one stands on this question depends very much on where one lives.

Contrary to popular wisdom, we find that the ability to travel quickly along roads is not associated with the ability to access economic opportunities in Los Angeles. For example, living in parts of the region with relatively low levels of congestion does not increase accessibility to jobs. This is because the key to accessibility is the time and cost associated with reaching a desired destination, and travel time, in turn, is a function of both speed and proximity. By emphasizing *accessibility* (which is a function of both proximity and speed) within regional economies rather than *mobility* alone, our analysis produces more meaningful measures of the economic effects of traffic congestion. It's possible to reach great speeds on a "road to nowhere," but travelling at high speeds in and of itself does not meaningfully affect one's ability to reach work, friends, stores, or recreational activities.

What Does Congestion Mean for Commuters?

We find that, on average, more jobs can be reached in a given amount of time via the congested streets of Santa Monica, Westwood, Beverly Hills, Hollywood, Koreatown, and Downtown, than on the fast moving freeways and boulevards in the fringes of the region. Put in general terms: As speeds on the road network increase for commuters in more remote parts of the regional economy, such mobility is more than canceled out by an associated lack of nearby destinations. However, we do find that *within* a given community – be it densely developed and chronically congested, or sprawling with few traffic delays – access to destinations is higher where traffic is lighter.

Figures 1 and 2 below display the contrasting effects of proximity and speed in determining accessibility to jobs within the region. In the left panel, we see that, as the number of jobs within 10 kilometers of where an individual lives increases, an individuals' accessibility to jobs also increases. By contrast, as the speed that an individual is able to drive over a distance of 10 kilometers from where they live increases (namely, those areas where traffic delay is relatively low), job accessibility actually declines. The message from these charts is clear: high-density areas in the region provide better access to jobs than those areas where traffic conditions are relatively less congested.

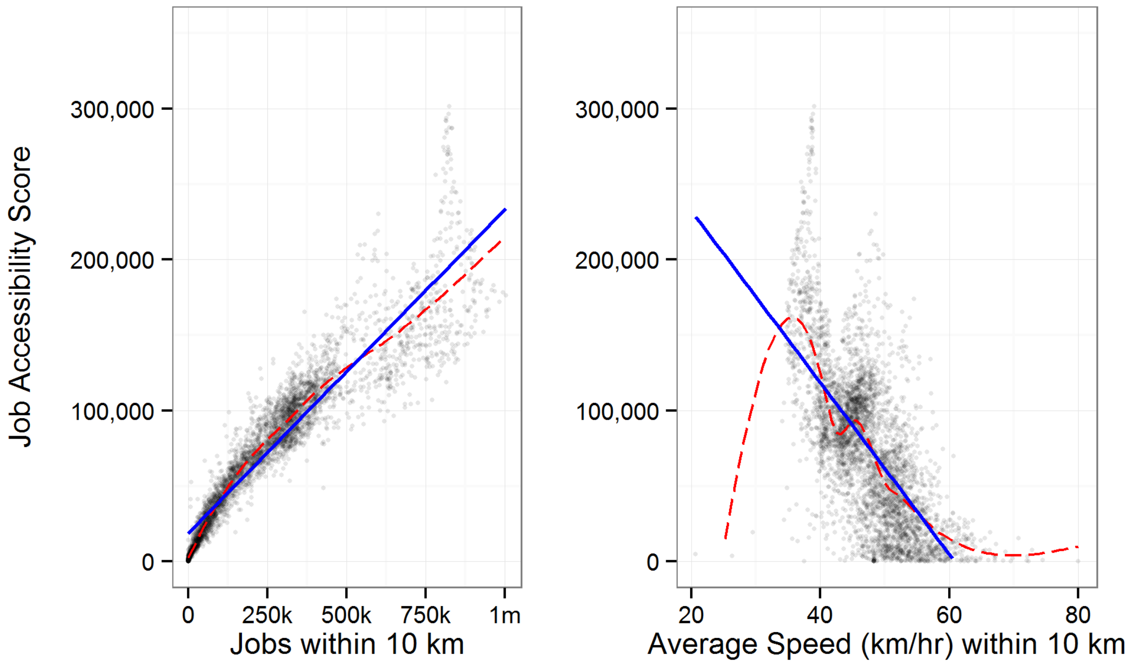

Figure 1 The Relationship Between Proximity To Jobs And Job Accessibility (left) and Local Area Traffic Speeds And Job Accessibility (right)

While the above comparisons show that increased job density is associated with increased job access, and *increased* average travel speeds are (perhaps counter-intuitively) associated with *decreased* employment access, they don't reveal how proximity and speed combine to produce accessibility. More specifically, they don't tell us the effect of traffic speeds in areas with similar levels of employment proximity. To examine these combined effects, we incorporated both speed and proximity as predictors in a multi-factor statistical model to simultaneously account for within and between communities effects. The results of this statistical model are shown in Figure 2, which shows that the effects of proximity (i.e. nearby jobs) on overall job accessibility are far greater than the effects of faster travel speeds due to lower levels of congestion – whether looking within or between communities in metropolitan Los Angeles.

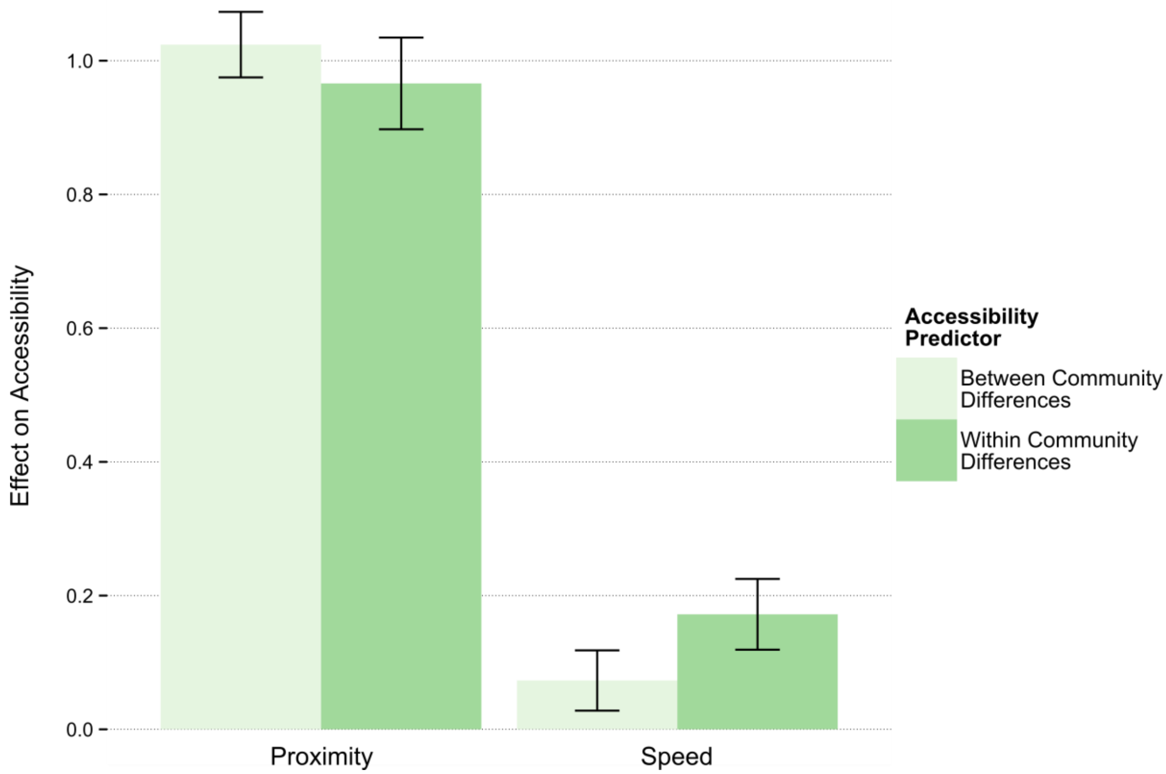

Figure 2 The Relative Effects of Differences in Proximity and Speed on Overall Job Accessibility Metropolitan Los Angeles.

Note: Error bars display 95% confidence interval for proximity and speed effect sizes.

What Does Congestion Mean for Firms?

Just as commuters use the road network to access jobs, firms use road networks to access their suppliers and customers. One key feature of national economies is the extent to which different regions specialize in the production of different goods and services (such as finance in New York and automobiles in Detroit). A key feature of such regional specialization is the extent to which thousands of firms and workers of the same industry cluster in close proximity to one another for productive advantage. The entertainment industry in Los Angeles is a case in point.

Entertainment-oriented firms combine and recombine on a project-by-project basis to generate the industry's key outputs: movies, television shows, and advertisements. From one film to the next, for example, a production company may not contract with the same casting agency, editing company, advertising agency, law firm, caterer, and so on. The dense concentration of entertainment-related firms in Los Angeles is widely held to enable such "flexible" production practices across projects. Yet, the ability of these firms to interact with one another – producers, directors of photography, sound engineers, grips, property masters, caterers, post-production film editors and so on – is directly determined by access, which is in turn jointly determined by proximity and travel speeds. We should thus expect, all things equal, that traffic delays will affect the ability of these firms to interact (access) with one another. Entertainment firms should respond to these effects in one of three ways: (1) cluster closer together to minimize the effects of traffic, (2) move to less congested locations in the region to escape traffic, and (3) move to other regions to escape traffic (as well as other things associated with urban area congestion but not measured here, such as high rents, organized labor, and the like). We evaluate the first two of these responses in this research for the entertainment industry as well as four other basic industries in greater Los Angeles.

Overall we find that congestion levels are not statistically significantly related to the ability of firms to interact with one another in each of five key industries – advertising, apparel manufacturing, entertainment, information technology (IT), and securities and commodities. As with the overall job accessibility analysis described above, physical proximity to other firms, rather than area congestion levels, is the primary component of firms' ability to access other similar firms. In short, we find no evidence in these data that traffic is driving businesses away to less congested parts of the LA region.

To show the effects that same-sector employment proximity and speed have on the likelihood of new firm starts in various LA industries, we estimated a set of statistical models of how proximity to other firms and area traffic speeds affect the likelihood of new firm starts (while statistically controlling for a number of other factors known to influence start-ups). Figures 3a and 3b show the estimated likelihood of new firm start-ups across greater Los Angeles neighborhoods. Each pair of bars in the different graphs represents the number of new firms per neighborhood that we would expect to see for very low and very high values of (1) similar firms within a given distance and (2) sub-regional area traffic speeds, while holding all other variables in the statistical models at their average values.

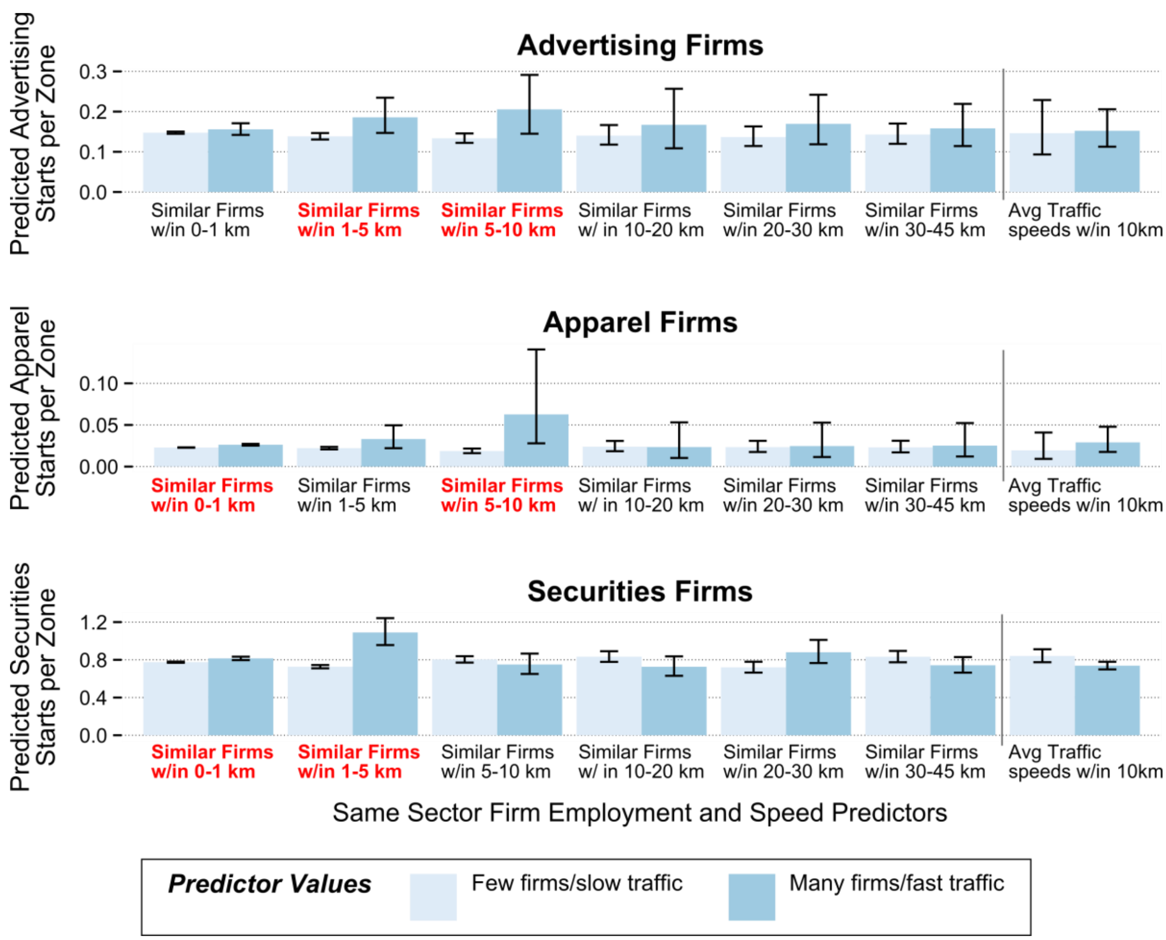

Figure 3a The Effects of Same-Sector Employment Proximity and Average Area Traffic Speeds on the Likelihood of New Firm Starts in the Advertising, Apparel, and Securities Industries

Note: "Few firms/slow traffic" represent the bottom 5th percentile of the respective values, while "Many firms/Fast traffic" represent the top 5th percentile. The error bars represent the 95% confidence interval for predicted firm starts values. Statistically significant predictors are highlighted in red.

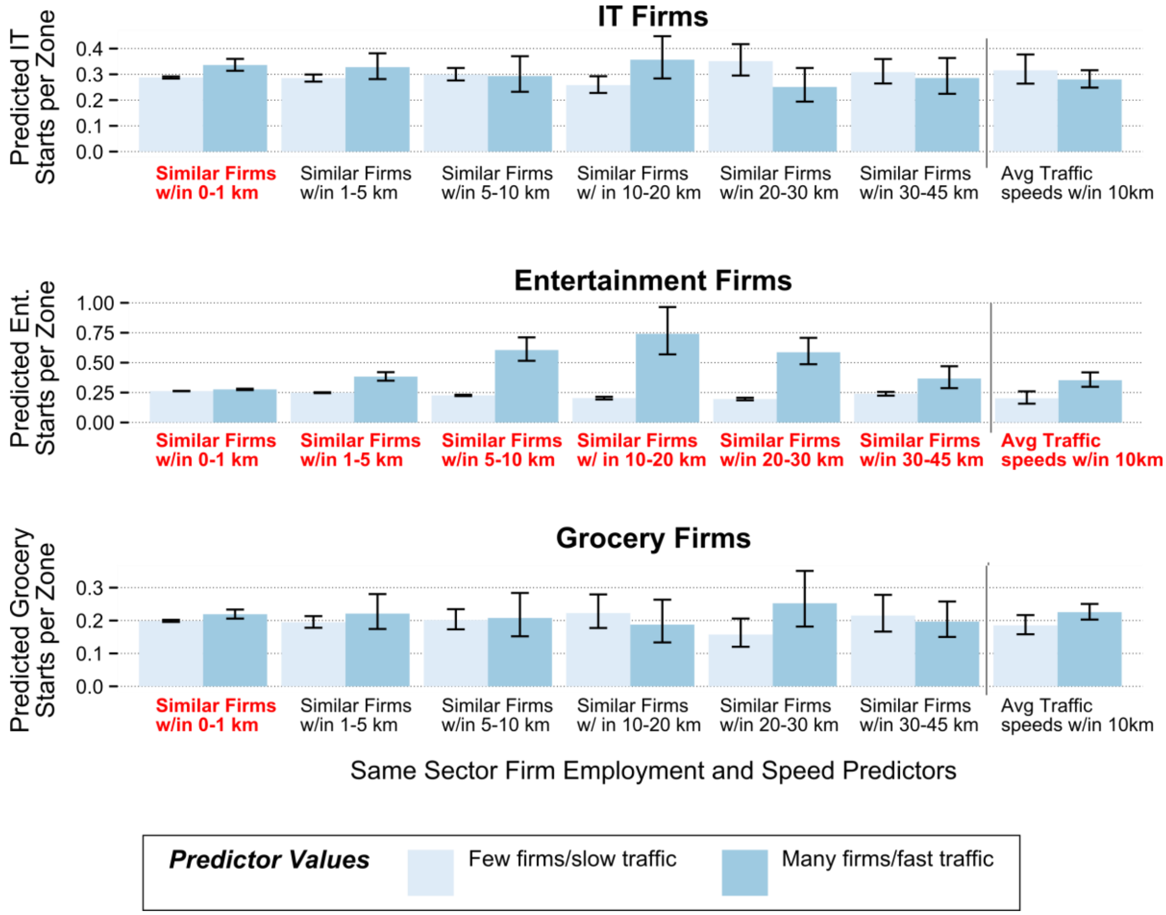

Figure 3b The Effects of Same-Sector Employment Proximity and Average Area Traffic Speeds on the Likelihood of New Firm Starts in the IT, Entertainment, and Grocery Industries *Note: "Few firms/slow traffic" represent the bottom 5th percentile of the respective values, while "Many firms/fast traffic" represent the top 5th percentile. The error bars represent the 95% confidence interval for predicted firm starts values. Statistically significant predictors are highlighted in red.*

These graphs show that increases in vehicular travel speed (the right pair of bars on each graph) have very little or no effect on the occurrence of new firm start-ups in most sectors. Of the six sectors examined, only Entertainment and Apparel Manufacturing show substantial gains from increases in speed, while the likelihood of start-ups in the Securities and IT industries show substantial gains in start-up with *decreases* in speed. But regardless of the observed effect of traffic levels on start-ups, the proximity of similar firms, typically within ten kilometers (6.2 miles) exerts a far greater influence on the likelihood of firm start-ups than any effects of traffic speeds.

Policy Implications: The Congestion Conundrum

Our analyses of employment accessibility and firm start-ups in Los Angeles present something of a congestion conundrum: access, both for commuters to jobs, and for firms to other firms within given industries, is often greatest where traffic is heaviest. As a result, the benefits of proximity in densely developed environments generally outweigh the costs of congestion that such dense development typically entails. Such findings suggest that the congestion calculations proffered by the TTI discussed at the outset are incomplete at best, and misguided at worst. Measuring the costs of traffic delays, infuriating though they may be, without netting them against the access benefits of clustered trip origins and destinations common in (though by no means guaranteed by) densely developed settings paints a decidedly incomplete picture of the ways that cities like Los Angeles facilitate social interactions and economic transactions.

The novel research presented in this report adds considerable support to the growing chorus of voices arguing for a shift from a mobility-focused view of what urban transportation systems do to an access-focused view of what urban systems do. Mobility – in cars, on trucks, via public transit, and by bike and foot – is a *means* to access, not an *end* in itself. This shift in perspective is integral to the new urbanist movement touted by many urban designers and planners and exemplified by places such as Playa Vista in west Los Angeles. Beyond their direct implications for planners and policy makers, our findings offer insights for how transportation and land use decision makers might evaluate new development proposals to consider, not just traffic impacts, but on how they affect neighborhood, sub-regional, and regional accessibility.

While our work directly challenges the local traffic impact logic of evaluating development proposals, by no means do we suggest that traffic occasions no costs on regions, firms, and households, or that there is no merit to traffic mitigation. Our analyses also showed that, within a given area (be it a high-access central area, or a relatively low-access outlying area), less traffic delays are better, all things equal. Such findings suggest that efforts to optimize signal timing, variably price parking and road capacity, increase capacity at severe traffic bottlenecks, and improve alternatives to driving in traffic (such as via public transit, biking, and walking) are typically worthy endeavors. What our analysis does suggest, however, is that a myopic focus on the traffic impacts of new developments is misguided and may actually decrease accessibility and economic activity in an effort to protect traffic flows.

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Tables and Figures

Acknowledgements

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Chapter 1: Introduction

Does chronic traffic congestion impede the economic performance of metropolitan areas? The answer to this seemingly obvious question is remarkably complex. How could traffic congestion *not* be a drag on regional economies? It is certainly a drag to be in. Congestion slows the flow of people and goods, making trips take longer and arrival times more uncertain. Time spent in traffic is often time that could otherwise be spent doing something productive for drivers, passengers, and even goods. Vehicle fuel efficiency generally declines in heavy traffic, while vehicle emissions per mile go up. And who hasn't commiserated with friends and colleagues about that miserable drive on an LA freeway, a slow crawl in a Manhattan taxicab, or that nightmarish drive across the desert to Las Vegas one holiday weekend?

Driving in traffic is a mostly negative and decidedly visceral experience, which perhaps clouds our judgment about its effects. Still, the conceptual links between transportation and economic activity are intuitive. Transport is so central to all economic activity – in moving raw materials to factories, labor to worksites, inputs and outputs along supply chains, consumers to services, and products to consumers – that studying the role of transportation in the economy may seem to some an exercise in the obvious. What is less obvious, however, is how delays on road networks induced by traffic congestion affect the performance of local economies. Economic activity and traffic both vary at small scales, so the effects of traffic congestion in Los Angeles, like in many big cities, are in fact likely to vary significantly among communities within the region, and among sectors of the economy as well.

Metropolitan areas exist largely because they facilitate economic transactions and social interactions among firms, households, and individuals, and the transportation network directly affects the quality and cost of these interactions. Thus, delays on road networks reduce regional economic efficiency. Transportation network delay is, by definition, a suboptimal outcome since households and individuals travel to destinations at speeds slower than they would be able to in relatively free-flowing conditions, though free-flowing conditions are often hypothetical rather than attainable, absent mechanisms to ration scarce road space. In the context of the economy, traffic delay is a cost to people and firms. These costs include higher fuel consumption and emissions per mile of travel, higher job access costs for workers, and increased firm costs for (a) distributing products and services to consumers, (b) accessing networks of suppliers and consultants, and (c) receiving production inputs, which is particularly significant in time-sensitive supply networks. While the possible effects of congestion on economic productivity are many, analysts have struggled to measure the cost of congestion on economic performance (Glaeser & Kohlhase, 2004; Hymel, 2009; Sweet, 2011; 2014a). Their efforts are considered in detail in the second chapter of this report.

Given these many costs of congestion, reducing these delays should, in theory, improve regional economic performance. Such theory is the basis for many public officials' efforts to invest public dollars to reduce traffic delays. This theory assumes, however, that there are no benefits to congestion; or more accurately, that there are no benefits to the places and activity in those places that give rise to congestion. This is a very big, albeit common, assumption to which we devote considerable time and effort to excavate in this report. We examine in the pages that follow whether the relationship between traffic congestion and economic performance, both conceptually and empirically, is considerably more subtle and complex than the standard "faster-is-better" refrain would suggest.

Transportation network delay is at best an indirect measure of the ease and quality of transactions and interactions in a regional economy. A more accurate measure of the effects of congestion on the interaction among firms and individuals is *access*, which refers to the ability of people and firms to avail themselves of economic and social opportunities in space.

Accordingly, this study examines how traffic congestion affects economic performance in metropolitan Los Angeles using 2008 data on traffic and vehicular flows from the Southern California Association of Governments, the most recent year for which modeled data were available. Ultimately, we aim to identify where and under what circumstances congestion appears to depress, have no effect, or is associated with increased economic productivity in the Los Angeles region.

The role of congestion in economic development is not simply an academic enquiry. Claims that traffic congestion is a significant drag on metropolitan economies are rarely supported with evidence, yet they are used to justify enormous public expenditures on urban freeways, rail transit systems, and many other forms of transportation infrastructure. For example, in 2008, voters in Los Angeles County approved a half-cent sales tax increase for a variety of transportation projects – the third sales tax increase of its kind. Proponents of the Measure R "Traffic Relief and Rail Expansion" ballot initiative proclaimed that the $40 billion in tax revenues generated by the initiative would be "The Roadmap to Traffic Relief;" the initiative passed by a super-majority (Hymon, 2008; Broverman, 2008). Given both the enormous scale and substantial opportunity costs of such initiatives and investments, public officials and transportation planners need a clear understanding of the links between transportation network performance and economic growth. Yet pubic investments in transportation made in the name of relieving congestion, like Measure R in Los Angeles, are promulgated more on the basis of intuition and conventional wisdom, rather than on careful analysis or convincing evidence. We aim to narrow that intuition/evidence gap in this report.

The Congestion Conundrum

Traffic often moves slowest in the most centrally located and densely developed districts, and fastest in peripheral areas where origins and destinations are widely spaced. This presents a conundrum that can be illustrated by a simple example. Two workers, one a city dweller and the other a suburbanite, can experience very different levels of *mobility*, yet have very similar levels of *access* to their respective workplaces. The city dweller averages just 12 miles per hour driving in heavy traffic each morning to her job four miles away, while the suburbanite averages a speedy 60 miles per hour on his mostly freeway trip to work in an adjacent suburb 20 miles away. While the effects of traffic congestion on their commutes are unambiguously different, the relative proximity of work for the city dweller offsets the much slower travel time; each spends an average of 20 minutes commuting to work, and each enjoys similar levels of transportation access, albeit very different levels of transportation mobility.

As this example suggests, the speed of vehicular travel is not an end in itself, but is instead a means to an end – in this case, of getting to work. As we will see in the chapters that follow, the parts of Los Angeles that enjoy the highest average travel speeds are typically located in the lowest density areas with the fewest nearby destinations, while dense hubs of activity that regularly host clogged roadways and slow travel have the most nearby destinations. Whether one has better job access in outlying areas with fast-moving traffic or in central areas with chronic congestion is an empirical question that we examine in this report.

Conventional wisdom, particularly among urban and transportation planners in the 2000s, is turning away from the long-established focus on travel speeds as the primary means of facilitating interaction, emphasizing instead "access" to destinations, which frames transport as a means to social interactions and economic transactions, rather than an end in itself (Grengs, 2010; Kawabata & Shen, 2006; Shen, 2001). The capacity to access destinations is a function of speed, but also land use patterns and the built environment, such as the array and proximity of destinations from a given place. As noted above, while higher travel speeds and a greater density of nearby destinations each contribute to higher accessibility levels, the two factors often times work at cross purposes. This nuanced framework for understanding the consequences of travel delay will provide the basis for understanding the impact of traffic congestion on the performance of industries in the Los Angeles economy. We hypothesize that access, rather than measures of network delay (congestion), better explains the extent to which the transportation network affects economic performance.

Congested Development?

To examine and better understand the links between traffic speeds, proximity, and economic development, we begin by reviewing the two, largely distinct research literatures on these topics. We then conduct two distinct, albeit complementary analyses using data on metropolitan Los Angeles. The first examines the relationship between travel speeds and proximity across neighborhoods in the Los Angeles region, and the second examines the relationship between travel delays and new business starts in the advertising, apparel manufacturing, entertainment, grocery, information technology and securities, and commodities industries.

We hypothesize that the performance of industries, and by extension, regions, is highly dependent on the particular configuration of land uses and corresponding transportation systems, and not simply on levels of network delay. Put another way, the economies of clustering and agglomeration may outweigh the negative effects of local congestion within the regional economy; we test this proposition empirically.

This study adds to a nascent body of research on the impact of traffic congestion on economic performance since it tests whether the effects of traffic congestion are uniform across regional economies and examines under what circumstances the effects of road delay might be mitigated. Our goal with this work is to help public officials and government analysts to move past simple notions of the transportation/economic competitiveness link to understand where and under what circumstances traffic congestion impedes economic performance, and where it may actually coincide with improved economic performance.

Los Angeles as a Research Venue

LA is outsized in every sense of the word. As the global center of the entertainment industry, billions who have never set foot in Los Angeles know of the place through myriad films and television shows. But it is not all just show. With a population of 18,550,288, the Los Angeles region ranked 16th among the world's megacities in 2015, with a population similar to Cairo, Egypt, but larger than Bangkok, Buenos Aires, Calcutta, Guangzhou, London, Moscow, Paris, and Rio de Janeiro (United Nations Population Division 2015). Owing in no small part to member counties that stretch across the Mojave Desert to the Arizona border, the Los Angeles planning region is physically vast as well. Even without traffic, the drive from Ventucopa in the mountains near the northwestern corner of Ventura County to the Colorado River desert town of Blythe in southeastern Riverside County is, according to Google Maps, a five and a half hour drive of over 350 miles.

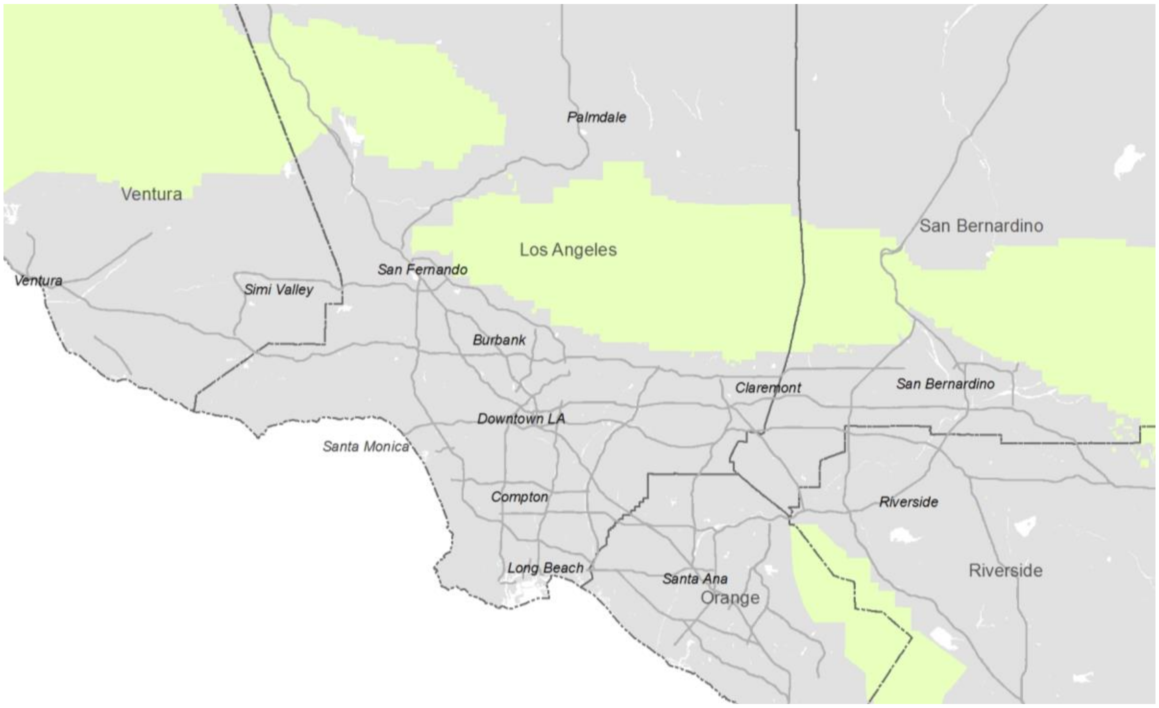

Figure 1.1 Five-County Southern California Study Area

The region's legendary traffic is outsized as well. After many years of being ranked as the nation's most congested metropolitan area, according to the most recent Urban Mobility Report published by the Texas Transportation Institute (Lomax et al., 2015), Los Angeles is the second most gridlocked city in the nation, behind only Washington D.C. On average, commuters in Los Angeles "lose" 80 hours per year to traffic congestion, compared to 82 hours for their counterparts in the nation's capital. Of the top 10 worst "performing" roads in the nation, six of them are found in Los Angeles. To compound matters, freeways in Los Angeles yield the most unreliable travel times in the nation. These facts, coupled with the region's enormous size and (largely undeserved) reputation as the poster child for auto-dependent development, make it the ideal case study for an exploration of the links between traffic delay and economic performance.

Metropolitan Los Angeles is comprised of five (Los Angeles, Orange, Riverside, San Bernardino and Ventura) counties, as defined by the federal government's Office of

Management and Budget, which officially refers to the region as the Los Angeles-Long Beach Combined Statistical Area (CSA). In 2011, the gross metropolitan product of Los Angeles was $897 billion, which, if it were a country, would make it the world's 16th largest economy, one place behind Mexico and one place ahead of Indonesia (Storper et al., 2015).

Los Angeles County is the most populous county in the region (and the nation). In 2009, the period of observation in this study, the county's population stood at 9.8 million people, while the region's second largest county, Orange, had a population of roughly three million people. In 2009, Riverside and San Bernardino Counties each had a population of roughly two million people while Ventura County was home to roughly 800,000 people (retrieved from the U.S. Census Bureau). In 2009, approximately nine million people were employed in the region, according to National Establishment Time Series (NETS) data – one of the primary datasets used in this study. Roughly 58 percent of these jobs were located in Los Angeles County, 20 percent in Orange County, 18 percent in the Inland Empire counties, and 4 percent in Ventura County. In 2008, the average per capita salary in the region was $49,052. In both LA and Orange County, workers received paid wages of roughly $51,500 per year; wages were lower ($46,000) in Ventura County, and lower still in San Bernardino ($39,000) and Riverside ($38,000) Counties.[1]

This study will focus on the performance of six industries within the regional economy. These industries were chosen to represent key sectors within the regional economy for which the nature of production is significantly different, and which cover the spectrum of wages paid within the region. Table 1.1, below, describes total employment and the average annual salary in Los Angeles for each industry of investigation in this report. The size and diversity of the Los

1 Authors calculations from Quarterly Census of Employment and Wages Data

Angeles economy makes the region an ideal venue for the study of the effects of mobility, access, and traffic delays on economic development.

Table 1.1 Descriptive Statistics for Key Industries

	Advertising	Apparel Manufact.	Enter-tainment	Inf. Tech.	Securities and Commodities	Grocery Stores	Region Total
Total 2008 Employment	60,598	54,185	125,055	318,680	108,277	115,497	9,024,457
(% of Reg. Total)	*(0.7%)*	*(0.6%)*	*(1.4%)*	*(3.5%)*	*(1.2%)*	*(1.3%)*	*(100.0%)*
Average Annual Salary	$75,356	$32,783	$90,223	$84,972	$193,062	$27,200	$49,052
(% of Reg. Total)	*(153.6%)*	*(66.8%)*	*(183.9%)*	*(173.2%)*	*(393.6%)*	*(55.5%)*	*(100.0%)*

Roadmap

This report proceeds as follows. Chapter 2 reviews the primary theories and past empirical studies of regional economic performance, traffic congestion, and the links between the two. Chapter 3 examines the relationships between speed and proximity in determining employment access across cities and neighborhoods in metropolitan Los Angeles. Chapter 4 then examines how traffic congestion affects the location of new business establishments in the regional economy for a cross-section of industries, and Chapter 5 summarizes and considers the significance of the findings of this report.

Chapter 2. The Relationship between Traffic Congestion and Economic Development

What do we know about the *relationship* between traffic congestion and economic development? Not much, as it turns out. While there are robust bodies of knowledge on each of these topics, they are largely distinct from one another. Accordingly, this report draws from two bodies of research and theory that have largely been considered in isolation from one another: research on congestion is largely the handiwork of transportation economists, engineers, and planners, whilst economic development has largely been the domain of economic geographers and urban economists.[2] By considering these two bodies of research in concert, we seek to develop a more complete understanding of how traffic congestion affects economic prosperity – which, as noted in the opening chapter, is an important matter of public policy. In the pages that follow, we review in turn the literature on economic geography, agglomeration economies, traffic congestion, and accessibility – concepts that are central to this inquiry and the empirical analysis that follows.

Economic Geography: The Spatial Foundations of Economic Prosperity

There are two ideas central to the study of economic geography: concentration and specialization. With respect to concentration, it is estimated that six U.S. metropolitan statistical areas (MSA) in 2014 accounted for about one quarter of the United States' economic output – New York, Los Angeles, Chicago, Washington DC, Dallas, and Houston (Desilver,

2 As with most general statements, there are exceptions. For example, Kenneth Small, Professor Emeritus at UC Irvine, is both a distinguished transportation economist and urban economist. However, in the realm of congestion research, the benefits of concentrated activity considered by urban economists and the costs of traffic considered by transportation planners remain under-examined, as this review of the literature demonstrates.

2014)[3]. Similarly, a 2009 study found that 68 percent of the U.S. population in 2000 lived on 1.8 percent of its land (Glaeser & Gottlieb, 2009). Further, a 2004 study estimated that 75 percent of Americans live in cities that comprised just 2 percent of the country's land area (Rosenthal & Strange, 2004). The overarching point of these studies is both clear and unambiguous: people and economic activity are tightly bound together in space and are concentrated in relatively few locations.

In addition, regions specialize in the production and export of different goods and services. No city in the United States specializes in supermarkets or gas stations, but metropolitan areas specialize in "basic" (also referred to as "tradable") industries like information technologies (the San Francisco Bay Area), entertainment (Los Angeles), finance (New York City), and automobiles (Detroit). Critically, the goods and services in which a region specializes, to a large extent, determine regional prosperity (North, 1955; Krugman, 1991; Krugman & Obstfeld, 2003; Moretti, 2012).

The transportation network, along with the concept of "increasing returns," are central to formal economic models of "agglomeration economies," which is the study of why economic activity shows a high degree of geographic concentration (Krugman, 1991, 1998). Cities are expensive places to live and do business; so why do people and firms crowd into them? Land is scarce and expensive (Cheshire, Nathan, & Overman, 2014), and so-called "negative externalities" like traffic congestion and air pollution are commonplace. To endure such diseconomies of agglomeration (the costs of crowding), people and firms must receive some offsetting benefit from locating in cities, which are known to increase the economic "returns to production" (Krugman, 1991; Duranton & Puga, 2004).

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3 Such estimates can vary depending on how one defines a metropolitan region. Because this estimate relates to metropolitan statistical areas (MSA) rather combined statistical areas (CSA), large regional economies like in the San Francisco Bay Area are comprised of multiple MSAs.

Increasing returns to production, and the related idea of "economies of scale," describe how the production of a particular good or service becomes more efficient and cheaper as the scale of production increases. Toyota must spend hundreds of millions of dollars up front to design and build the first Corolla, but when those up-front costs are spread over hundreds of thousands of Corollas, the economies of scale make the Corolla an affordable car. Scale economies can be realized in many ways, including from spatial clustering. By clustering together in space, firms in certain industries are able to reduce the cost of, and increase the efficiency in, accessing industry specific workers and input suppliers, which are positive externalities of such clusters (Krugman, 1991). Furthermore, such spatial clustering enhances "information spillovers" (sometimes referred to as the "the secrets of the trade"), which are often associated with frequent face-to-face interaction, as the flow of information has been shown to display more friction with increased distance (Marshall, 1961; Jaffe, Trajtenberg, & Henderson, 1992; Feldman, 1994).

Transportation costs, particularly between cities and regions, are as important as increasing returns to understanding why economic activities cluster in space. If transportation costs are high, they offset the economic benefits of clustering. As transportation costs fall, however, inter-regional trade emerges (Krugman, 1991). Due to increasing returns and transportation costs that have steadily fallen over time, it is cheaper and more efficient to produce the goods and services of some (tradable) industries in one, or very few places, and then 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 (Glaeser & Kohlhase, 2004).

Until quite recently it was widely assumed that agglomeration economies were region-wide in scope (Rosenthal & Strange, 2003, 2010). In other words, as long as two firms of the same industry were in the same region, their agglomeration benefits were thought to manifest regardless of whether they were on the same block or located 20 miles apart. These assumptions were not tested for many years because fine-grained data were not easily available at sub-metropolitan scales. However, recent research using better data finds that agglomeration economies attenuate over much shorter distances than previously thought – as little as a half-mile (Arzaghi & Henderson, 2008; Rosenthal & Strange, 2010).

Conceptually, it stands to reason that agglomeration economies attenuate *both* regionally and locally. With respect to specialized labor market access, the scale of so-called commute sheds (which roughly cover the area accessible within an hour of peak direction travel) argue for metropolitan scale agglomeration economies. By contrast, firm-to-firm interactions and knowledge spillovers appear to attenuate much more locally. In both cases, transportation networks (both regional and local) are critical to regional prosperity, both by moving workers, goods, and consumers, and by facilitating inter-firm agglomeration economies. Thus, transportation networks are critical to the scale and efficiency with which firms and employees in basic/tradable industries are able to interact and transact with one another.

But despite the conceptually central role that transportation networks play in facilitating agglomeration economies at multiple scales, urban economists and economic geographers have largely been silent on the empirical effects of transportation networks in general, and traffic congestion in particular, on the performance of regional economies, either among regions or within regions, where both transportation systems and traffic delays vary greatly over space.

Transportation and Economic Development

Transportation networks have long played, and continue to play, a vital role in the economic development of cities and nations. Transport is central to all economic activity – in moving raw materials to factories, labor to worksites, inputs and outputs along supply chains, consumers to services, and products to consumers. Within regional economies, the emergence of streetcars and various forms of rail infrastructure (in addition to modern elevators) were a major contributing factor to the rise of central business districts and the growth of cities in the late nineteenth century (Cervero & Landis, 1997; Chatman & Noland, 2014). Such infrastructure enabled the development of residential neighborhoods further from central business districts than had previously been possible. To this extent, transportation systems determine the extent of labor markets (since they enable more people traveling at greater speeds to access employment over greater distances) and enable cities to expand in size (Giuliano, Agarwal, & Redfearn, 2008; Drennan & Brecher, 2012). Since scope and scale economies broadly mean that the size of cities is strongly correlated with productivity and economic growth (Duranton & Puga, 2004; Cheshire et al., 2014), transportation networks play a crucial role in shaping regional, and by extension, national prosperity.

To this end, the provision of transportation infrastructure has been a widely used economic development policy tool to foster growth in underperforming regions, both within the U.S. and globally (Pike, Rodríguez-Pose, & Tomaney, 2006; Cheshire et al., 2014). In one of America's grand experiments in regional development, 70 percent of all Appalachian Regional Commission funds spent to develop the region went to the construction of new highways to better connect the then relatively isolated region to other parts of the country (Isserman & Rephann, 1995; Singerman, 2008). Increasing access from the region to other, more prosperous places, it was believed, would enable Appalachian producers to benefit from increased market access and generate economies of scale in local production. But, of course, this increased access also opened up Appalachian consumer markets for cheaper goods produced elsewhere. This so-called "two-way roads problem" highlights that, while roads do indeed enhance access from poorer regions to other places, they also increase competition for previously shielded local industries, which can be disruptive to uncompetitive local producers (Cheshire et al., 2014).

While transportation is necessary for economic development, it is of course not alone sufficient. Indeed, transportation infrastructure investment has long been a popular economic development tool in declining, once-prominent urban economies, such as Buffalo, Detroit, and myriad other cities (Euchner & McGovern, 2003). On balance, however, investment in transportation infrastructure in such economies has proven to be an ineffective urban development tool (Cheshire et al., 2014). In such places, inadequate transportation was not the only barrier to economic growth, or even a principal one. With respect to traffic congestion, places underperforming economically are, almost by definition, places with relatively low levels of traffic congestion. In economies losing population, like Cleveland, Detroit, and Saint Louis, there remains substantial transportation infrastructure relative to local population and employment levels. In such cases, economic theory suggests that adding further transportation infrastructure will do little to increase local levels of productivity. Put simply, when transportation is not the problem, transportation investment will not be the solution.

By contrast, added or improved transportation infrastructure in congested or fast growing places can meaningfully affect local economic performance since it can increase access to economic opportunities for people and firms (Glaeser & Kohlhase, 2004: Cheshire et al., 2014). While perhaps self-evident, when inadequate transportation inhibits economic activity, transportation investments can meaningfully affect regional economic productivity.

Traffic Congestion and Economic Performance

As noted at the outset, because it slows travel speeds and decreases travel time reliability, traffic congestion is widely assumed to exact a toll on the performance of regional economies. According to a recent study, traffic congestion imposed a $160 billion drag on the U.S. economy in 2014, or around 0.9 percent of total gross domestic product (GDP) (Lomax et al., 2015).[4] Previously, some have estimated traffic congestion to generate a cost as high as 2 to 3 percent of GDP per annum (Cervero, 1988). Furthermore, the cost to the economy from traffic congestion is believed to have increased over time. According to Schrank, Lomax, and Turner (2010) the cost of time delay to the U.S. economy increased from $24 billion in 1982 to $115 billion in 2009 (in 2009$).

These estimates typically measure what Sweet (2011) refers to as the *first-order* impact of traffic congestion. First-order effects refer to the immediate costs imposed to road users by time delay generated on transportation networks. There are typically two types of first-order costs: (a) nonproductive travel delay and (b) unreliable travel times. Beyond challenges in defining the value of time, the true cost of congestion, as seen through such a lens, is difficult to determine since it is not clear whether time spent in traffic is "unproductive," and therefore represents some form of opportunity cost (Sweet, 2011).

Sweet (2011) also identifies *second-order* congestion effects, which are the primary concern of the analysis reported here. Second-order effects refer to longer-term costs to economic productivity and growth that are induced by traffic congestion. If the diseconomies of scale (the costs of crowding) to which congestion gives rise increase to the extent that they outweigh the economies of scale from agglomeration (the benefits of crowding) – productivity

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4 The same report estimates that traffic congestion exacted an economic toll of $133 million to the Los Angeles area in 2015.

declines and economic activity will tend to relocate to other parts of a region, or perhaps to other regions. Indeed, limited evidence does suggest that traffic congestion may be a drag on employment and productivity growth across metropolitan regions (Hymel, 2009; Sweet, 2014).

In general, studies of the economic effects of traffic congestion are both few in number and vary widely in relation to the scale of investigation, the measures of congestion and economic performance used, and the methodological approaches taken. This variation renders it difficult to compare results across studies in order to draw definitive conclusions about the effect of traffic congestion on economic performance.

The effect of congestion on economic outcomes has mostly been examined at two geographic scales. Some studies focus on the net effect of traffic congestion on economic performance *across* a range of cities and metropolitan economies (Hymel, 2009; Boarnet, 1997; Fields, Hartgen, Moore, & Poole Jr, 2009; Sweet, 2014), while others examine the impact of traffic congestion on economic outcomes *within* regional economies (Graham, 2007; Sweet, 2014).

Measuring roadway congestion has been an important part of transportation planning and engineering since the early years of the profession, and as federal, state, and regional oversight of transportation systems has evolved, accurate measures of road performance have become a critical part of evaluation, planning, and finance (Boarnet, Kim, & Parkany, 1998; Lomax et al., 1997). While measures of congestion across studies converge on the idea that traffic congestion increases travel time for road users compared to free-flowing driving conditions, individual indicators differ from study to study. Historically, such variation existed because different transportation agencies used different measures and methodologies to record local network data, while others maintained no information pertaining to local road networks at all (Boarnet et al., 1998). The absence of standard indices made it difficult to compare individual studies and to test the net effect of congestion across a range of regions and times, without relying on crude proxies for congestion (Boarnet et al., 1998; Bartik, 1991). Encouragingly, new data sources, such as the Texas Transportation Institute's Urban Mobility Report, have made it possible to compare congestion across regions and to employ consistent measures across studies (see for example Hymel, 2009; Sweet, 2014).

Congestion measurement is a core part of transportation engineering and planning practice but has tended to emphasize two distinct types of metrics: region-wide and highly localized individual transportation link delay measures. The widely-cited Travel Time Index developed by the Texas Transportation Institute is an example of the former, and level of service and volume/capacity ratios for individual road segments or intersections are examples of the latter (Schrank, Eisele, & Lomax, 2012; Ye, Hui, & Yang, 2013). While separated in scale, both types of measures have emphasized speed or reductions in speed on the network without taking travel alternatives or effects on travelers' accessibility into account (Mondschein, Taylor, & Brumbaugh, 2011; Ye, Hui, & Yang, 2013). Researchers have increasingly highlighted the importance of considering traffic congestion's effects not only on delay, but on interactions among delay and individual and firm choices, and economic and quality of life outcomes (Mondschein et al., 2011; Kwan & Weber, 2003; Glaeser & Kahn, 2004; Sweet, 2011). In other words, they call for a linkage between direct measures of delay, and indirect measures of congestion's effects on the economic development outcomes described above.

In response, both policymakers and transportation practitioners have begun to shift from an analytical emphasis on network-measured delay alone, especially if those measures are seen as detrimental, to broad objectives such as sustainability and accessibility. Perhaps the most notable example of this is the introduction of legislation in California to end use of roadway level of service impacts in state-mandated environmental impact analyses (DeRobertis et al., 2014).

As noted above, measures of economic performance in traffic congestion studies also differ greatly. In some cases, scholars seek to quantify the value of time delay, while others focus on employment growth, changes in productivity, or the performance and/or location of particular industries or by individual firms (Hymel, 2009; Sweet, 2011, 2014; Boarnet, 1997; Graham, 2007; Fernald, 1999; Stopher, 2004; Weisbrod & Treyz, 2004). In addition to the variation in these measures, statistical modeling challenges are another reason for the lack of consensus in this field. The problem of "endogeneity" is the major statistical modeling constraint faced by scholars. Ultimately, traffic congestion is a product of social and economic activity, where the most congested regions are frequently the most economically vibrant. As a local economy expands, (whether through employment, output, or population growth), new trips are generated, which gives rise to traffic congestion. But just as economic growth causes traffic congestion, traffic congestion can in turn impede economic growth. To this extent, the two factors – economic activity and traffic – are highly correlated with, and determined in part by, one another, such that determining the direction of causation between the two variables has proved challenging (Hymel, 2009; Sweet, 2014). Given this unavoidable analytical conundrum, the different approaches employed to overcoming this challenge have, unfortunately, generated considerable variation in the findings across studies.

Traffic Congestion

Traffic congestion occurs when the demand for road space exceeds its supply in a given direction at a given time in the day. This imbalance between supply and demand creates a scarcity of road capacity; as more individuals use a relatively fixed supply of road space, less space is available for travel by others and queuing for the scarce capacity occurs. Absent some form of variable road pricing or some other rationing schema (to bring the demand for travel in line with supply), road scarcity is signaled by lower and more variable travel speeds than would be the case during free flowing conditions. Traffic congestion, therefore, typically refers to travel delay on road networks caused by vehicles upstream and is measured in numerous ways, such as: average peak-period speeds on links in the transportation network, so-called "level of service" calculations (most typically applied to intersections), and, increasingly, the additional amount of time required to travel during peak periods relative to off-peak, free-flow speeds, or posted speed limits (Bertini, 2006).

The long-term causes of traffic congestion are many and include: population and job growth rates that exceed the rate of growth of road supply, increasing incomes and/or decreasing auto operating costs, concentration of economic activities in locations and at times that concentrate traffic flows, low-density/auto-oriented development that discourage travel by means other than automobile, and limited alternatives to motor vehicle travel (such as public transit service) (Taylor, 2002). Varying combinations of these factors have ensured that traffic congestion has increased over time in most metropolitan areas. In addition, there are short-term causes of congestion, such as crashes, construction projects, inclement weather, and special events (Downs, 2004).

Access

Mobility, whether by motor vehicle, bus, train, bicycle, or foot, enables the social interactions and economic transactions central to urban life. But mobility is not the only means of providing people and firms with *access* to one another. Accessibility is a popular and variously defined term that centers on the ability of travelers to avail themselves of economic and social opportunities in space. It is possible to reach great speeds on a "road to nowhere," but travelling at high speeds in and of itself does not meaningfully affect one's ability to get to work, friends, stores, or recreational activities. In this context, mobility – the speed at which it is possible to travel – is a "means" of travel whereas access is considered an "end" of travel, and refers to the actual opportunities to reach desired destinations within a regional economy.

Not only do traffic delays vary substantially from one place to another in a metropolitan area, it is also likely that traffic delays in some places inhibit social and economic interaction more than in others. Major causes of variable effects of similar levels of delay across space include (i) the density of land use, (ii) the characteristics and capacity of the transportation network, (iii) the particular nature of delays on the network, (iv) the desires and resources of delayed travelers, and (v) how these four elements interact. Mondschein et al. (2011), for example, found that in Los Angeles and Orange County some neighborhoods are better "congestion-adapted" than others, since they host higher levels of individual activity participation in spite of relatively large traffic delays. This is because in some places, less vehicle travel (due to short travel distances, and ease of walking, biking, and transit travel) is required to access an equivalent range of opportunities *ceteris paribus*. Assuming accessibility to be largely a function of speed may lead us to inappropriately prioritize congestion reduction at the expense of spatial (land use) arrangements that may more effectively improve accessibility in some (or perhaps many) places. Within the context of this study, we investigate whether traffic congestion affects economic performance more in some parts of a regional economy than in others and under what conditions such differences arise.

A Focus on Access, Modified by Traffic Congestion

Urban economists and economic geographers examine the location behavior of industries within and across regions, and find that firms in basic/tradable industries tend to exhibit a high degree of inter- and intra-regional clustering, or agglomeration (Rosenthal & Strange, 2003, 2010; Arzaghi & Henderson, 2008). The performance of regional economies is heavily reliant on the ability of firms in key industries to interact. Yet, as noted above, the many business location studies are for the most part silent on the role that the transportation network plays in facilitating such clustering. Since the performance of particular basic/tradeable industries determines, to a great extent, the success of regional economies, and co-location – or "reduced impedance" in the parlance of transportation planners – contributes importantly to within sector productivity, our work necessarily draws on both transportation economics and economic geography to determine how transportation networks and delays on them affect the ability of industries to productively co-locate in regional economies.

This study adds to the relatively few studies of how traffic congestion affects economic performance by testing whether the effects of traffic congestion are uniform or variable within regional economies in how they affect access of firms to both other firms and to workers. In doing so we consider under what circumstances the mitigation of road delay might bring substantial economic benefit, and when and where it might have little or no economic effect.

While Mondschein et al. (2011) have proposed considering effects on accessibility rather than mobility as an alternative approach to understanding the consequences of traffic congestion, research on and methods for quantifying delay's effects on access remain limited (Mondschein et al., 2011; Lomax et al., 1997; Sweet, 2014). The appeal of an accessibility-oriented approach to evaluating traffic congestion is predicated on the idea that the purpose of transportation systems is a means to access places and opportunities, and that the delay-free operation of these systems is not a meaningful end in itself (Wachs & Kumagai, 1973). Accessibility can be measured in terms of places or individuals and households, whether considered in terms of cumulative opportunities from a given place or the time and monetary cost of, for example, a trip to the doctor (Levinson & Krizek, 2005). We expect that traffic congestion will have a measurable effect on impedances, which is the product of the time, money, information, and risk costs of mobility, and in turn, access. But higher levels of access are also in part a product of clustered, agglomerated opportunities. Metrics that account for both delay and proximity are thus central to understanding how delays affect access, but to date remain largely undeveloped in the accessibility literature.

Sweet (2014) provides one exception to the general absence of accessibility measures in accounting for the effects of congestion delay. As a predictor of firms' decisions to relocate, Sweet specifies a congestion penalty, defined as the accessibility measure for a location given hypothetical free-flow conditions minus the same accessibility measure under conditions of evening peak-hour congestion. While the results presented in this report differ from Sweet's approach in terms of how we operationalize congestion, the general logic is the same: to frame differences in travel speed owing to congestion in terms of their relationship to accessibility. However, rather than emphasize hypothetical differences between free-flow and peak-hour congestion, we examine differences among locations within the region, operationalized at the level of traffic analysis zones (TAZs) under typical peak-period congestion levels. We expect that the tradeoffs between proximity and mobility vary widely among neighborhoods and cities within large regions such as Los Angeles, but the nascent literature on congestion and accessibility has yet to measure the scale of these tradeoffs, or how they are distributed. Our analysis addresses this omission, to which we turn next.

Chapter 3. Congestion in Los Angeles: Speed, Proximity, and Access

As noted in the introduction to this report, Los Angeles usually ranks at or near the top of metropolitan traffic congestion rankings (Lomax et al., 2015). However, these rankings are typically built on measures that estimate peak hour speeds over free-flow speeds on individual links and then aggregated over the entire freeway, or freeway and arterial networks. As discussed in Chapter 2, such measures are of mobility (in this case vehicle volumes and speeds) and not of access (activities and interactions enabled) or even trips completed. The former treats travel as an end in itself, while with the latter travel is a means to an end of place-based interactions that people and firms value (Grengs, 2010; Kawabata & Shen, 2006; Shen, 2001; Wachs & Kumagai, 1973). In an accessibility framework, the utility of a grocery shopping trip lies in the ability to purchase and transport home desired foodstuffs at reasonable time and monetary costs, and is only tangentially related to the speed of vehicular travel between home, the grocery store, and back.

This distinction between mobility and accessibility is important because travel speed is but one contributing component of the latter. The capacity to traverse space is a function of speed, but also of knowledge about destinations, modal options, possible routes, the monetary costs of travel, and risk and uncertainty (Chorus, Molin, & van Wee, 2006; Taylor & Norton, 2009; Carrion & Levinson, 2012). And the capacity to traverse space is, in turn, but one dimension of access, the others being the diversity and proximity of destinations. As noted at the outset of this report, while higher travel speeds and a greater density of nearby destinations can both contribute to higher accessibility levels, the two factors often times work at cross purposes. Areas that enjoy high travel speeds often exhibit low density and few nearby destinations, while dense hubs of activity often feature clogged roadways and slow travel.

These opposing features of accessibility are characteristics of communities and neighborhoods, not entire regions like in the TTI Mobility Index. To understand the relationships among speed, proximity, and access, we must examine them at a local scale.

The potentially complex interplay between density and speed means that gaining a functional understanding of accessibility is necessarily an empirical undertaking. It is simply not possible to say *a priori* how the relative levels of accessibility in, say, a neighborhood with easy highway access and smooth-flowing arterials will compare to those in a dense neighborhood with tightly gridded streets and heavy peak-hour congestion. Despite accessibility's status as an increasingly touted concept, however, its empirical investigation is only just catching up to its current theoretical standing. Valuable empirical efforts have recently included comparisons of inter-regional accessibility, examining the interplay of region-level attributes of density, speed, and access (Grengs, 2010; Levine, Grengs, Shen, & Shen, 2012), as well as detailed assessments of vehicular, transit, and non-motorized accessibility at fine-grained neighborhood levels (Owen & Levinson, 2015; Levinson, 2013). There has been little attention paid, however, to the potentially complex interplay of speed and density at the neighborhood level.

It is at this sub-regional level where an informed understanding of the relative influences of speed and density in helping people access destinations can have the greatest implications for policy and planning, particularly as such an understanding relates to our treatment of traffic congestion. Assuming accessibility to be largely a function of speed will almost certainly lead us to inappropriately prioritize congestion reduction at the expense of land use considerations that may be more effective in improving accessibility in some places. Likewise, though likely a less common occurrence, prioritizing proximity in places where speed most importantly contributes to accessibility could prove problematic as well. Finally, we should expect that these relative contributions of speed and proximity vary not only among metropolitan areas, but even more importantly within them as well.

We report in this chapter on a data-driven assessment of the relationships among speed, proximity, and accessibility in the greater Los Angeles region. Specifically, we analyze the three-way relationships among these variables for the region as a whole, as well as how these relationships vary across LA communities. Our goal with this analysis is to better inform how travel speeds (or lack thereof) are assessed by engineers, planners, and public officials, and how trade-offs between speed and development density may be evaluated in different kinds of communities across the Los Angeles mega-region. To tip our hand, we find broadly that, in Los Angeles, proximity matters more than speed in explaining job access, both overall and for specific industries. However, these relationships vary significantly across the region's communities and neighborhoods, with some neighborhoods more dependent on speed for their accessibility, while more places benefit more from dense concentrations of nearby development and employment, despite chronic heavy traffic.

Data and Methods

Given our hypothesis that the effects of traffic congestion are most meaningfully measured through their effects on access to destinations, we examine these effects in the greater Los Angeles region using destination and mobility data for Los Angeles, Orange, Riverside, San Bernardino, and Ventura County. Our data come from two primary sources: traffic analysis zone-to-zone (TAZ-to-TAZ) distance and travel time data from the Southern California Association of Governments (SCAG), and employment at businesses throughout the region derived from the National Establishment Time-Series (NETS) database. NETS is a proprietary micro dataset released by Walls and Associates and comprised of Duns Market

Information business directory data (DMI). NETS tracks the “birth” and “death” of each establishment in the U.S. since 1990. Over the life of an establishment, the dataset contains records on the employment level and street address of each establishment for each year, so that births, deaths, and relocations can be tracked.

For our focus year of 2008, we derived geographic coordinates for every establishment listed in the targeted Southern California counties. We obtained these geographic coordinates through the use of two different geocoding application programming interfaces (APIs), both accessed from within the R statistical programming language. We first used an API provided by the Data Science Toolkit website (Data Science Toolkit, 2015), which makes use of Open Street Maps and Census data to translate street addresses into coordinates. For firms with complete address data that did not return valid coordinates through the Data Science Toolkit API, we attempted to re-code them using Nokia’s proprietary HERE geocoding API (HERE Platform, 2015). The final set of geocoded business records were then linked to the unique traffic analysis zones in which they fall. With each business associated with a traffic analysis zone, we then calculated the total employment within each zone.

Focus on Peak Speeds

Having a complete set of TAZs for our Southern California region of study, we calculated a number of mobility-related measures that figure centrally into the study of accessibility’s determinants. First, using matrices of 2008 zone-to-zone road network distances and automobile travel times from SCAG, we calculated the average speeds of motorists from each TAZ to all other TAZs within a given road network-derived distance, which gave us a basic set of speed measures for the entire region. The speed measures average both inbound and outbound speeds from a TAZ to its neighbor TAZs during the morning peak period. We emphasize peak speeds because we argue that most – though not all – employees and firms are likely to make their choices about where to live, where to work, and where to set up shop based on peak commute hour travel times.

Bringing in Accessibility

Next, we calculated the total level of employment located within the same range of network distance threshold-based neighborhoods, giving us a basic measure of destination proximity. Figure 3.1 shows the distribution of jobs throughout the region, drawing from the NETS data. Finally, we combined speed and proximity into a single "gravity" weighted accessibility score for all traffic analysis zones. The accessibility models we used were all of the following form, as it appears frequently in the accessibility literature (Handy & Niemeier, 1997; Grengs, Levine, Shen, & Shen, 2010; Geurs & van Wee, 2004)*:*

$$A_i = \sum_j E_j \; e^{-\beta T_{ij}}$$

In this equation, A_i represents the total accessibility for zone i, E_j represents the total amount of employment in each destination zone j, and T_{ij} represents the morning peak-hour travel time in minutes from zone i to zone j. Finally, the parameter β has the effect of determining how much travel impedance matters in weighting a zone's accessibility contribution; larger values of β mean that even relatively short travel times will greatly devalue the accessibility benefit of neighboring destinations, while smaller values of β mean that accessibility scores will give greater weight to a wider swath of destinations. In terms of labor markets, relatively lower skill, spatially dispersed jobs – like fast food worker – would tend to have higher β values (i.e. more friction of distance), while higher skill, scarcer jobs – like cardiologist – would tend to have lower β values (i.e. lower friction of distance); this is because workers are less likely to commute long distances to relatively low paying, spatially ubiquitous jobs, but more likely to be willing to endure long commutes to much rarer and higher paying work. For the purposes of our analysis, which emphasizes access across multiple industrial sectors, we apply a common β value to represent the friction of distance between residents and jobs across the entire labor market.

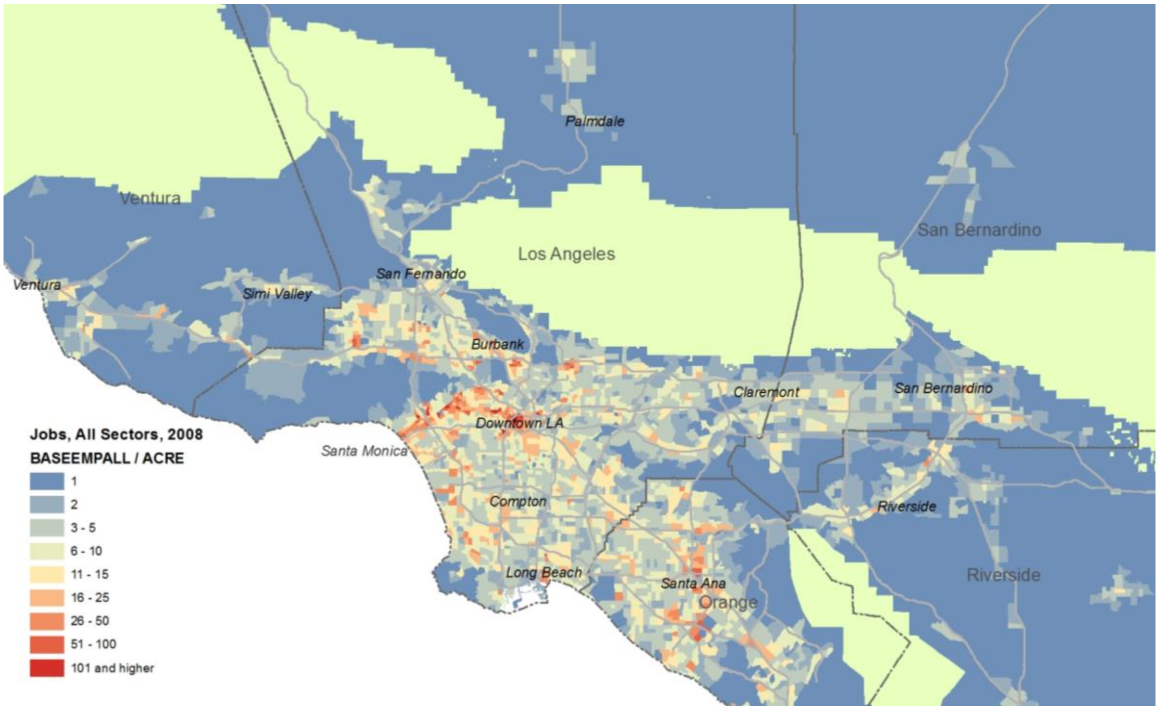


Figure 3.1 Employment Density, Jobs in All Sectors per Acre, 2008

In assessing relationships among the speed, proximity, and accessibility variables just discussed, we are presented with a vast number of potential parameter combinations; we must choose a specific time impedance value for the gravity-based accessibility function, and we must choose network distance cutoff thresholds for both speed and proximity calculations. We address this problem of myriad modeling permutations in two primary ways. First, we selected our gravity model parameter value by drawing from the accessibility literature. Such model parameter values typically range from approximately 0.05 to 0.5, with many values close to 0.2 (Handy & Niemeier, 1997; Grengs et al., 2010; Sweet, 2014). Using this 0.2 value for β, we then selected speed and job proximity threshold values of 10 kilometers based on the tightness of the resulting empirical associations among the variables (as determined by the goodness of fit of linear models). Second, we tested the robustness of our findings by running descriptive models for a wide range of parameter combinations. While we focus our presentation on a single representative set of parameters, the same broad relationships reported here hold for a wide range of the parameter value combinations we tested. Table 3.1 provides a summary of the accessibility, proximity, and speed statistics associated with our selected model parameters.

Table 3.1 Summary Values for Accessibility, Proximity, and Speed Variables, Measured at the TAZ Level

Statistic	Mean	Standard Deviation	Minimum	Median	Maximum
Average Peak-Hour Speed (km/hr; distance threshold = 10 km)	47.5	6.1	20.7	47.1	80.0
Employment Proximity Count (distance threshold = 10 km)	265,640	226,803	0	230,612	1,002,659
Employment Accessibility Index (decay parameter = 0.2)	75,537	52,123	0	74,744	301,498

Note: All proximity and accessibility measures are calculated for the full set of 3,999 TAZs in the five-county region. The 10km-threshold speed value is calculated for 3,977 TAZs, however, as there is a small set of TAZs for which no TAZ-to-TAZ trips are short enough to calculate a valid measure.

Findings

The complex inter-relationships among speed, proximity, and accessibility are demonstrated in paired bivariate comparisons shown in Figure 3.2. These graphs present two clear and sharply contrasting pictures, with employment accessibility very closely linked to employment proximity on the one hand, and with higher speeds actually inversely related to employment accessibility on the other. How can this be? The answer is that these are actual data for Los Angeles and not hypothesized relationships. With all things equal, higher speeds will of course get one to more destinations in a given amount of time, but all things are rarely equal. Higher peak hour speeds, at least in Los Angeles, tend to be in outlying areas where densities are low and jobs sparse. Conversely, jobs tend to be clustered in places where densities are high and traffic congestion chronic. In net, more jobs can be reached in a given amount of time via the crowded streets of Santa Monica, Westwood, Beverly Hills, Hollywood, Koreatown, and Downtown, than on the fast moving freeways and boulevards on the fringes of the metropolitan area. Put in general terms: as speeds increase, the accessibility benefits of lower travel time impedances are more than canceled out by an associated lack of nearby destinations.

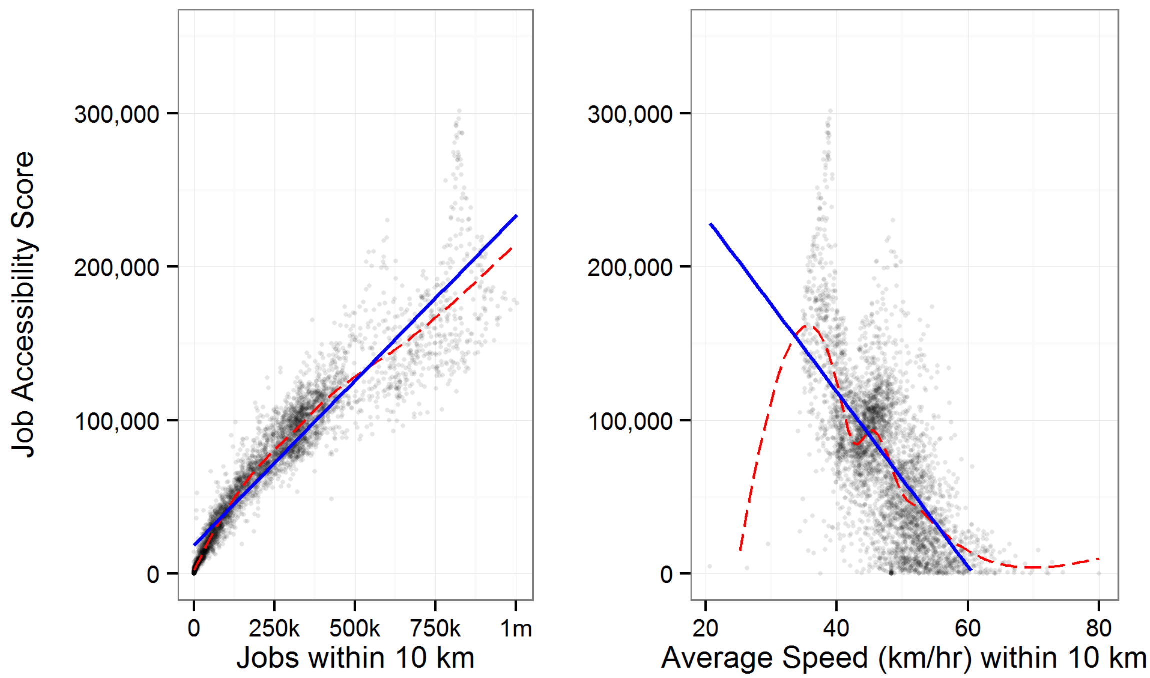
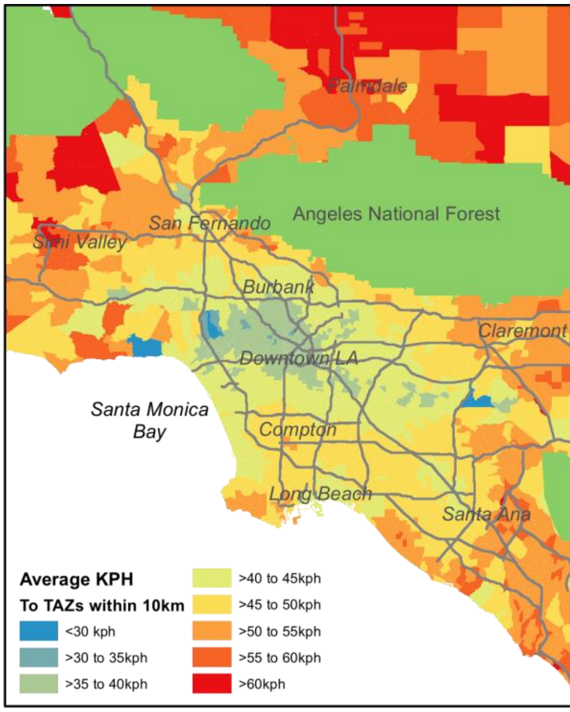


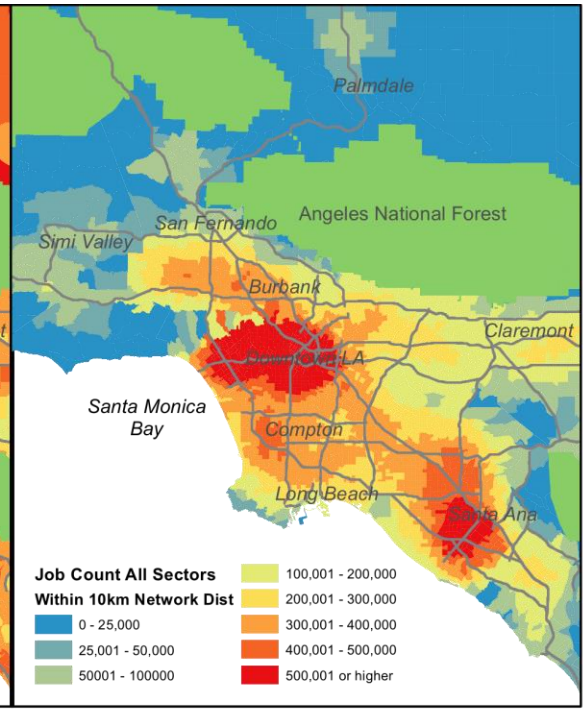
Figure 3.2 Bivariate Graphs Linking Accessibility to Proximity (left) and Speed (right)

This three-way link among accessibility and its two principal components is made clearer by examining all three variables mapped and plotted against one another in Los Angeles, as shown in Figure 3.3. Here, we see TAZ-level maps of speed (top left corner), proximity (top right corner), and accessibility (bottom left corner) all displayed such that higher values take warmer colors and lower values take cooler colors. Several observations jump out from these maps. As discussed above, speed and proximity in metropolitan Los Angeles do display a strong, negative relationship, with their respective coloration patterns displaying as rough inverses of one another. Also, corroborating the plots in Figure 3.2, the coloration of speed appears as an inverted version of the accessibility color pattern, while the coloration of proximity is very tightly aligned with that of accessibility. These qualitative visual observations are bolstered by the scatterplot in the lower right panel. Here, we again see a distinct and very nearly linear negative relationship between proximity (running horizontally) and speed (running vertically). This plot also displays the accessibility values of traffic analysis zones of different speeds and accessibilities. Again, we see a very clear trend of accessibility values increasing from left to right on the graph (indicating a strong proximity-accessibility relationship). The upper left corner of this scatterplot shows many low-accessibility TAZs, while the lower right corners has many high-accessibility TAZs. This pattern makes clear the overall negative relationship between speed and accessibility.

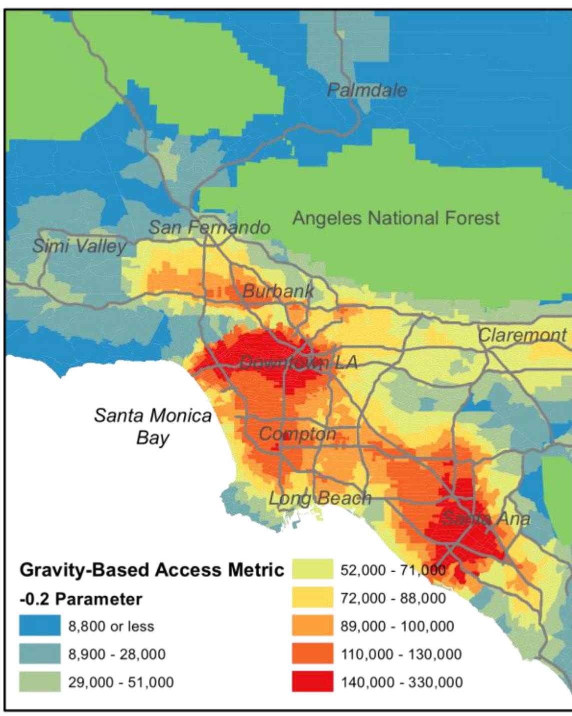
To more directly evaluate the patterns depicted in Figure 3.3, we specified three ordinary least squares (OLS) regression models, accounting for accessibility in terms of speed, proximity, and a combination of the two. The results of these models are shown in Table 3.2. To better facilitate comparison among the models, each variable has been scaled, such that the standard deviation is one and the mean is zero. Model 1 shows that, in the absence of other predictors, a one standard deviation increase in speed corresponds to a 0.62 standard deviation *decrease* in employment accessibility, whereas Model 2 shows that by itself a one standard deviation increase in proximity to jobs corresponds to a 0.93 *increase* in accessibility. When both



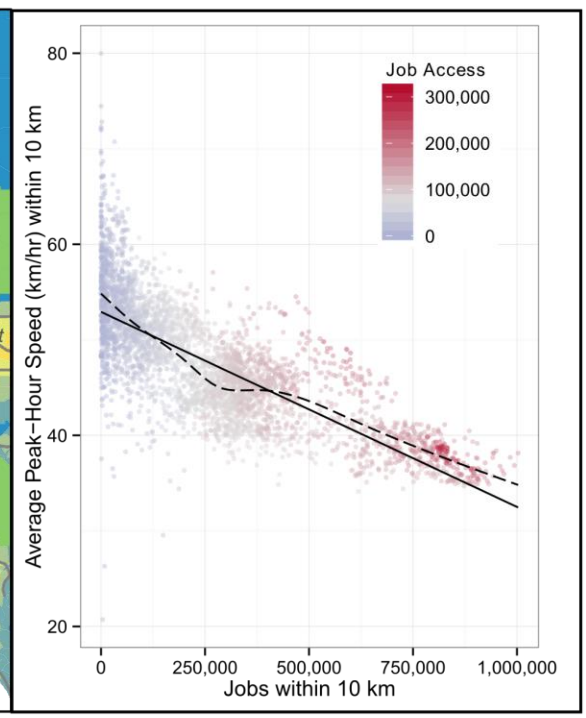
(a) Average Peak Period Speed to TAZs within 10km (network distance)



(b) Total Employment within 10km (network distance)



(c) Gravity-Based Access to Jobs (0.2 decay parameter)



(d) Scatterplot of Speed vs. Job Proximity, Colored by Job Access

Figure 3.3 Speed, Proximity, and Accessibility Plotted Against Each Other, Cartographically and by Color-Coded Scatterplot

Table 3.2 OLS Employment Accessibility Model Results

	Dependent variable:		
	Employment Accessibility Score, Scaled		
	(1)	(2)	(3)
Peak-Hour Speed, Scaled	-0.687***		0.078***
	(0.012)		(0.009)
Employment Proximity, Scaled		0.925***	0.980***
		(0.006)	(0.008)
Constant	0.014	0.009*	0.013**
	(0.012)	(0.006)	(0.006)
Observations	3,977	3,999	3,977
R^2	0.451	0.872	0.874
(Standard errors in parentheses)		*p<0.1; **p<0.05; ***p<0.01	

independent variables are included in the same model, proximity maintains its strength as a predictor of accessibility. After accounting for proximity, the sign for speed switches – speed now becomes a positive predictor of accessibility – but it is still not a powerful predictor and does little to increase the explanatory power of the model. Why does the sign for the effect of speed on job accessibility switch from negative to positive in the combined model? This is because proximity is already accounting for most of the variance in job accessibility, so that we can think of the measure of speed in this model as the marginal effect on job accessibility after controlling for the effects of proximity. So while proximity mostly explains job access, given some level of proximity, it is of course better to travel faster rather than slower in reaching jobs.

As all variables here are scaled, they can be directly compared to one another, and in Model 3 we see that a one standard deviation change in proximity has ten times the effect on accessibility as does a similar change in speed. Likewise, looking at the different models' respective R^2 values, we see that adding proximity to the speed model results in a very large jump in predictive success, with the percentage of variance explained increasing from 38.3

percent to 87.0 percent. In comparison, the proximity-alone model (Model 2) accounts for 86.6 percent of the variance in accessibility, nearly as much as the model that includes *both* speed and proximity as predictors. From these models, we see strong evidence that proximity to employment is largely what drives employment accessibility in the Los Angeles region. While the relative contributions of speed and proximity to regional employment accessibility in Los Angeles are clear, this does not mean that the predominant role of proximity holds in all parts of the region. Perhaps increasing job density is the primary predictor of increasing employment access in some areas, while speed plays a greater role in access to jobs in others. Relatedly, perhaps *within* a given area (either high- or low-accessibility) where job proximity is roughly similar, the effect of speed on accessibility will be positive (and more in line with the average traveler's and elected official's intuition), as suggested by Model 3 above. To test these questions, we partitioned the traffic analysis zones into different community groupings, using Los Angeles County community designations within LA County, and U.S. Census place designations outside of LA County, and county boundary files for non-LA unincorporated places (Geurs & van Wee, 2004; LA County, 2015). In doing so, we obtained 337 different community groupings with an average of approximately 11.5 traffic analysis zones per community.

Figure 3.4 shows how the relationships among our three variables of interest vary within given communities. We repeat the scatterplot shown in Figure 3.2, this time highlighting (by color coding) community-specific points. While the overall regional pairwise relationship between speed and accessibility is clearly negative, the relationship between speed and accessibility flips when just examined within these four example areas: Compton (a relatively low income inner-ring suburb), Downtown LA, Palmdale (a lower-middle income suburb on the fringe of the metropolitan area), and Santa Ana (a working class satellite central city in Orange County). The results can be split into two distinct patterns: communities with higher average speeds exhibit lower average levels of accessibility (which is consistent with the regional patterns reported above), but higher speed locations *within* the selected communities correspond to (at times much) higher levels of accessibility. So within a given community, the ability to move faster over the road network does indeed increase accessibility (as intuition, motorists, and elected officials would all suggest).

While the patterns depicted in Figure 3.4 are interesting and suggestive, little can be reliably inferred from four communities selected arbitrarily from a set of 337. To establish a more rigorous understanding of these intra- and inter-community relationships, we specified a set of three hierarchical (or multi-level) linear models corresponding to those shown in Table 3.2 above. To directly model the difference between intra- and inter-community relationships, we follow Raudenbush and Bryk (1992) by applying a technique of "group mean centering." Using this technique, we calculate the mean value of the (scaled) speed and proximity variables within each community designation. We then additionally specify a value corresponding to the difference in speed and proximity values observed in each local traffic analysis zone from their respective community means, thereby centering this new variable and allowing us to directly model intra-community effects. We carried out this hierarchical modeling using the "lme4" package within the R statistical programming language (Gelman & Hill, 2007).

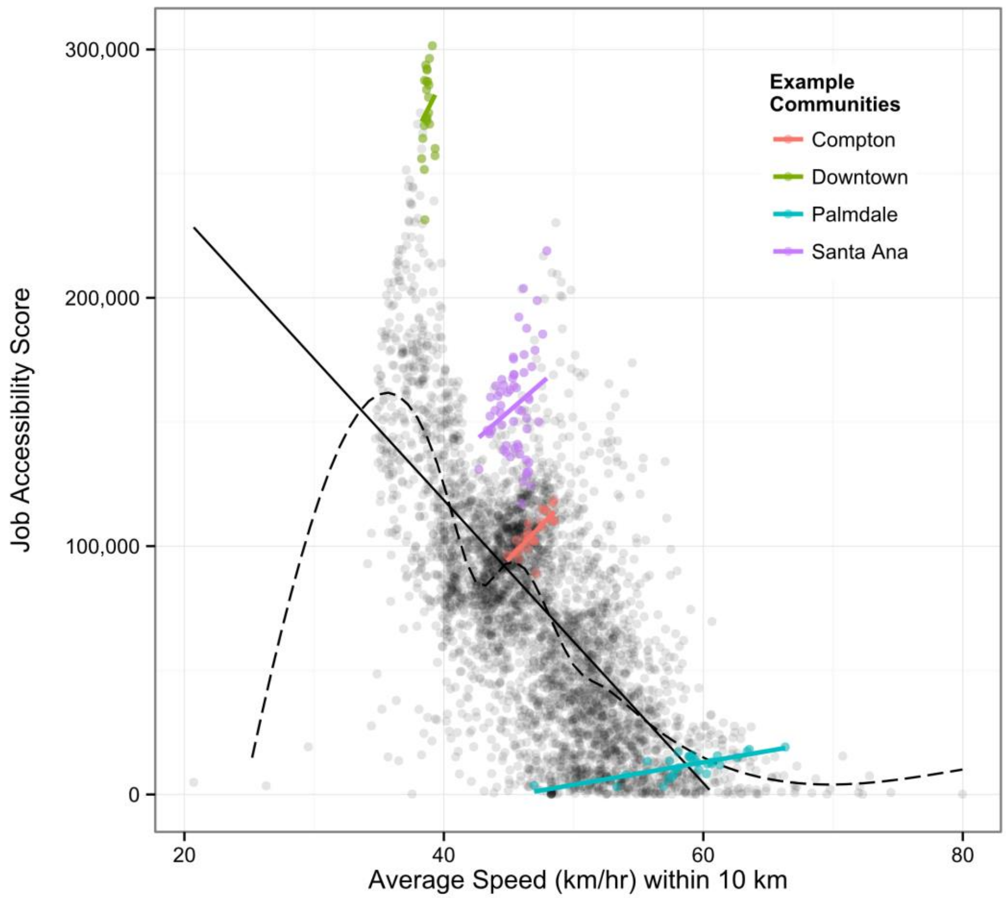


Figure 3.4 Region-Wide Relationship Between Speed and Accessibility, Overlaid with Selected Community-Level Relationships

The results of this multilevel modeling, depicted in Table 3.3, are striking, and they corroborate the sample relationships shown in Figure 3.4. Looking first at the contextual effects of speed on accessibility (Model 1), we see that the accessibility score of a traffic analysis zone is strongly negatively predicted by that the average speed of that zone's parent community. Conversely, we see that within each community, increases in speed are actually (modestly) associated with increases in accessibility. This is exactly what one would predict by observing Figure 3.4.

Table 3.3 Hierarchical Linear Model Output for Relationships among Speed, Proximity, and Accessibility Variables

	Dependent variable:		
	Employment Accessibility Score, Scaled		
	(1)	(2)	(3)
Scaled Peak-Hour Speed, Community-Level Mean	-0.618***		0.073***
	(0.037)		(0.023)
Scaled Peak-Hour Speed, Within-Community Difference from Mean	-0.012		0.172***
	(0.038)		(0.027)
Scaled Proximity to Employment, Community-Level Mean		0.977***	1.024***
		(0.017)	(0.025)
Scaled Proximity to Employment, Within-Community Difference from Mean		0.942***	0.966***
		(0.036)	(0.035)
Constant	-0.164***	-0.013	-0.008
	(0.035)	(0.015)	(0.015)
Observations	3,977	3,998	3,977
Log Likelihood	-1,085	1,084	1,304
Akaike Inf. Crit.	2,183	-2,155	-2,583
Bayesian Inf. Crit.	2,227	-2,111	-2,508
(Standard errors in parentheses)	*p<0.1; **p<0.05; ***p<0.01		

Turning to Model 2, we see a parallel of the corresponding results in Table 2; increases in job proximity are tightly linked to increases in job accessibility. Interestingly, and in contrast to the relationship for speed, this effect of proximity on accessibility is very similar both among and within communities. Finally, Model 3 (just as with the corresponding model shown in Table 2) shows an opposite effect for speed. When accounting for proximity, the increases in average speed of a zone's parent community correspond to slight increases in accessibility, and the effects of within-community increases in speed are greatly amplified. Still, as with the corresponding model in Table 2, proximity substantially outweighs speed in its effect on accessibility, both in terms of inter- and intra-community differences.

Interpretation

The findings presented here yield a number of important implications for transportation and land use decision makers, as well as for researchers. Most notably, the results confirm at the neighborhood and community levels in metropolitan Los Angeles what other researchers have found in a comparison among different regions (Levine et al., 2012): (1) there is a clear tradeoff between proximity to destinations and average vehicular travel speed, and (2) proximity does a great deal more work in accounting for neighborhood-level access to destinations than does speed. These relationships among speed, proximity, and accessibility are continuous and nearly linear across the region as a whole. While it is clear that proximity is by far the primary predictor of accessibility at the neighborhood level across the Los Angeles region, the results presented here show interesting and important complexities with respect to the community-level context of average speed. Namely, after accounting for the proximity of jobs, the average vehicular speeds estimated across a broader community make very little difference to a neighborhood's accessibility levels within that community. Speed variation *within* communities, however, can have substantially greater effects on accessibility (though these effects are still much weaker than those of between- and within-community differences in proximity).

These results suggest some important lessons for city and regional policymakers. First, as shown in Table 3, the strength of community-level proximity and the weakness of community-level speed in predicting accessibility make clear the potential harms of restricting development in order to avoid congestion. While the fear of clogged roadways is perhaps the most common reason for denying new development, this reaction is likely to have a negative effect on overall accessibility levels across a community's neighborhoods (Manville, Beata, & Shoup, 2013), even when we restrict our definition of accessibility to just that conferred by automobility. Conversely, the findings shown in Table 3 may justify a careful targeting of infrastructure enhancements aimed at speeding up vehicular travel. While positioning communities – whether on the periphery of the region or otherwise – as low-proximity and high-speed is likely to be largely ineffectual in improving accessibility outcomes, our results indicate that within-community improvements in travel speed can yield meaningful accessibility benefits. Provided that these increases in travel speed are achieved without reducing the number of nearby destinations, local traffic mitigation improvements may indeed yield better overall travel outcomes for residents of affected neighborhoods. While we examine vehicular speeds in this analysis, local enhancements to travel speeds that do not involve capping or reducing destination density may involve other modes, whether walking, biking, or well-planned transit.

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Chapter 4: Congestion and the Location of New Business Establishments

As discussed in Chapter 2, the economic performance of metropolitan areas is primarily determined by the goods and services that their basic (tradable) industries produce and export to national and global markets. Whether and to what extent traffic congestion affects the location and growth tradeable industries is examined in this chapter.

To refresh, the distribution of basic industries is highly uneven within and across nations; different regions specialize in the production of a different range of goods and services. Los Angles is renowned for being the home of the entertainment industry, for example. At the core of industrial specialization are the productivity advantages that firms in basic industries gain from clustering together. By clustering together in space, firms of these industries are able to reduce the cost of, and increase the efficiency in, accessing industry skills-specific workers and specialized input suppliers, which emerge to service the clusters (Krugman, 1991). Furthermore, as noted in Chapter 2, such spatial clustering enhances information spillovers, since the flow of information has been shown to display a high "friction to distance" (Marshall, 1961; Jaffe et al., 1992; Feldman, 1994).

Research has found that the productivity advantages of firm clustering are highly localized *within* metropolitan areas (Arzaghi & Henderson, 2008; Rosenthal & Strange, 2003). For example, theory would suggest that an entertainment firm in Malibu does not benefit from access to the "Hollywood" cluster to the same extent as a firm in West Hollywood. The transportation network, therefore, is critical to the scale and efficiency with which firms and employees in particular industries are able to interact and transact with one another. In the pages that follow we explore the spatial relationship between key industries in the Los Angeles economy and examine how delays on the transportation network affect interaction within the regional economy; we do this by analyzing how proximity and congestion jointly affected new start-up firms across an array of commercial/industrial sectors.

Key Industries

The data analysis for this report focuses on six primary industries (five basic, one non-basic): the advertising, apparel manufacturing, entertainment, information technology, and securities and commodity industries, while a sixth "non-basic" industry, supermarkets and groceries, is analyzed for comparison. The industries were selected to cover a range of key exporting sectors for which the nature of production is different, so that the findings presented here are not biased towards the particularities of a certain industry type. Each industry is defined using the North American Industrial Classification System (NAICS). The advertising industry is defined by code 5418 and apparel manufacturing by code 3152. The IT industry is comprised of four sub-sectors: semiconductors (NAICS codes 333295 and 33451), electrical components (3344), computer and communications hardware (3341 and 3342), and software (518 and 5415). The entertainment industry is primarily comprised of two sub-sectors: the motion picture and video industry (5121) and the sound recording industry (5122). The securities and commodities industry is defined by code 523 and supermarkets and grocery stores are defined by NAICS code 4451.

Table 4.1 below details total employment for each industry in the Los Angeles region in 2008 and the number of new establishments in each industry for 2009 (this time period matches the most recent years for which travel delay data were available). Employment and new establishment counts were drawn from the National Establishment Time Series, while the average annual salary, which is also presented for each industry in 2008, is drawn from the Quarterly Census of Employment and Wages (QCEW).

Table 4.1 Descriptive Statistics for Key Industries in Los Angeles

	Advertising	Apparel Manufacturing	Enter-tainment	Information Technology	Securities and Commodities	Grocery Stores
Total 2008 Employment	60,598	54,185	125,055	318,680	108,277	115,497
New 2009 Establishments	528	105	2,307	1,107	3,840	652
Average Annual Salary	$75,356	$32,783	$90,223	$84,972	$193,062	$27,200

Source: National Establishment Time Series and Quarterly Census of Employment and Wages

In 2008, approximately 125,000 people were employed in the entertainment industry in the region. While many readers might be surprised by how few people are employed in "Tinseltown," the Los Angeles region accounted for fully half of the nation's total entertainment industry employment in 2008. Apparel manufacturing is another industry in which the Los Angeles region accounts for a large share of national employment; the region accounts for 37 percent of such jobs nationally. By contrast, Los Angeles accounted for roughly 5 percent of all jobs nationally. These two industries in particular demonstrate the extent to which certain industries are very highly concentrated in just a few regions across the country. Across the industries of enquiry, we see a wide range of average annual salaries. To place the wages paid by each industry in context, the region-wide average full-time salary was $49,052 across all industries in 2008.

Figures 4.1 and 4.2 below display the distribution of employment in each of the six industries across the region. The entertainment industry is clearly concentrated in a corridor running from central Los Angeles to the City of Santa Monica, with little activity located in the rest of the region. The IT industry, by contrast, is more geographically dispersed with two major centers discernible around the City of Irvine in Orange County, and west of the San Deigo (I-405) Freeway in Los Angeles County. As we would expect, there is no discernible cluster in the "non-basic" groceries industry, which we would expect to be dispersed to reflect the broad distribution of consumer demand across the region. Apparel manufacturing is highly localized in Downtown and in South Los Angeles. The advertising industry follows a similar pattern to the entertainment industry, extending from central Los Angeles to Santa Monica, but also with some significant clustering in Orange County as well.

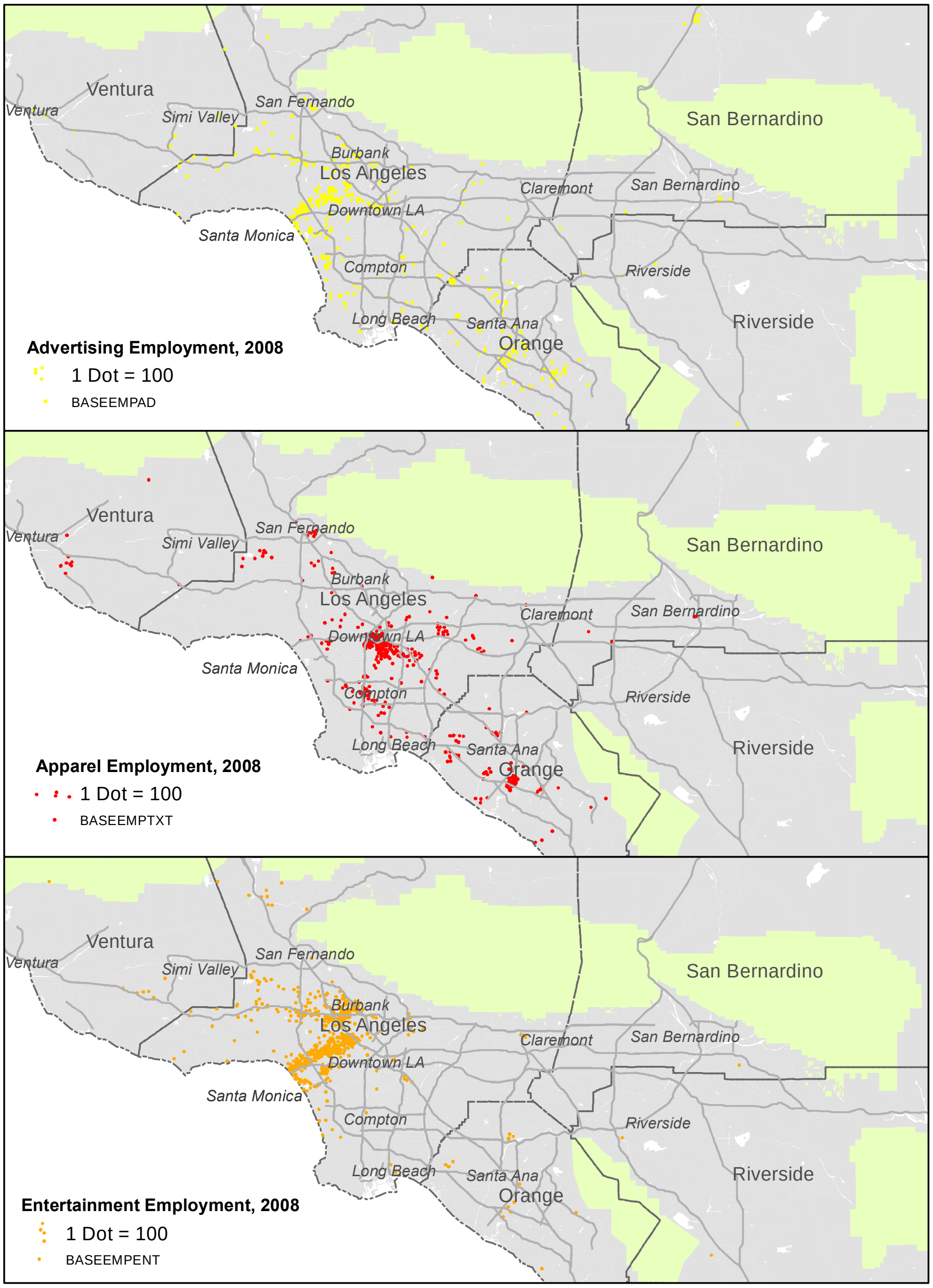

Figure 4.1 The Geographic Distribution of Advertising, Apparel, and Entertainment Employment in Greater Los Angeles in 2008

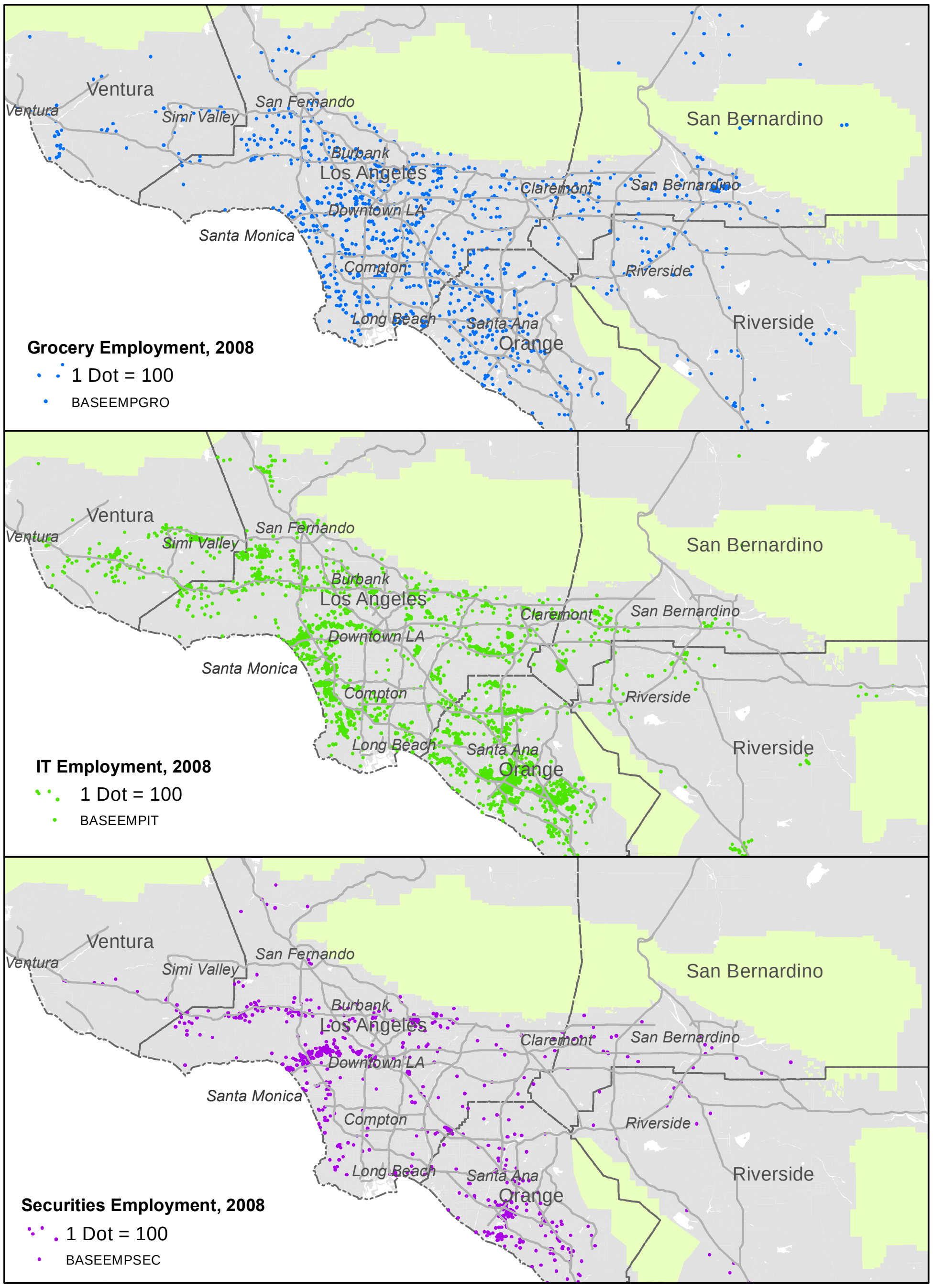

Figure 4.2 The Geographic Distribution of Grocery, Information Technology, and Securities Employment in Greater Los Angeles in 2008

Finally, the securities and commodities industry is primarily clustered in a corridor west of Downtown Los Angeles stretching to the ocean.

Statistical Analysis

The patterns of employment by economic sector in the maps above display a high degree of localization (clustering), with the expected exception of (non-basic) grocery employment. Part of this spatial concentration, of course, has to do with natural geography. For example, there is no industrial activity in the region's state parks and national forests. Another contributor to the observed spatial patterning of employment is land use zoning. A relatively small share of the total regional area is zoned for commercial or industrial activity. However, both of these constraints apply generally to grocery stores as well as office and industrial space, but we see far more clustering in the location of the "basic" industry employers than we do with grocery stores. As noted earlier, scholars believe that this clustering facilitates the firm-to-firm interactions that comprise production networks and enhance information spillovers.

There are many ways to explore the spatial relationship between firms of the same industry in a regional economy. But as we are particularly concerned about whether and to what extent traffic congestion affects regional economic development, we focus in this chapter on the location decisions of *new* business establishments for each industry. We do this because commercial location decisions are "sticky," in that it may take a lot of traffic to push an already established firm out of a congestion area into another part of the region, or to another region altogether. But for firms just setting up shop, the decision about where to locate must consider available space, the cost to rent or buy, access to customers and appropriately skilled labor, and whether traffic, crime, or other disamenities make otherwise attractive locations less appealing. Therefore, our analysis centers on the location of new firms relative to the location of other similar firms and traffic congestion.

There is a large body of research that analyzes the factors that influence the location of new business establishments (Rosenthal & Strange, 2003, 2010; Arzaghi & Henderson, 2008). For the most part, business location is framed as a discrete choice problem in which profit (utility) maximizing firms decide to locate in one site from among a set of alternative locations (Guimarães et al., 2004). The owners of new business establishments are assumed to be utility maximizers in that they seek to locate new establishments in those parts of a country or region where they believe their business has the best chance to succeed. The success of a given business establishment is determined by a multitude of factors, including (1) agglomeration economies, which were described in Chapter 2, (2) the cost of factors of production (such as wages and land), and (3) government actions such as tax rates, public safety, and land use regulations. However, this literature has been largely silent when it comes to examining the role that traffic congestion plays in determining the location of business activity within regions.

Today, modeling business location decisions, for the most part, relies on so-called count statistical models, such as Poisson or negative binomial (NB) regression models, both of which are derived from the Poisson distribution (Arzaghi & Henderson, 2008; Guimarães et al., 2004; Kim et al., 2008). The Poisson distribution is used to model counts of discrete events or occurrences (the number of businesses in a neighborhood or the number of police stops on a block, for example). Given the rare occurrence of such "events," they do not conform to the normal distribution (or bell curve) common to so many studied phenomena, which makes most linear statistical models used to study continuously distributed outcomes unsuitable for analysis of firm start-ups. Negative binomial models are often preferred in business location modeling because, unlike with Poisson models, they allow for a wider distribution in the outcome variable (referred to as over-dispersion). In cases where there is a large number of zeros amongst the observed unit of analysis (in this case, a large number of zones in which no new firms locate), a zero-inflated negative binomial model is preferred. The zero-inflated model adds an additional computational component to account for an observed number of zeros that exceeds what would be expected from the best fitting negative binomial distribution. Such an excess of zeroes may arise due to the impossibility for enterprises to locate in particular places (because of zoning constraints, for example) or because new establishments determine that the characteristics of some sites would not enable them to maximize their profits (perhaps due to relative remoteness within a region).

The models presented below help us to explore the relationship between where new business establishments locate and existing patterns of same industry activity within the Los Angeles region. Once a decision has been made to locate in the LA region, a business owner or manager can choose from more than roughly 4,000 neighborhoods or districts (defined here as traffic analysis zones, or TAZs), if zoning allows. The median size of a TAZ is 1.73 square kilometers. The outcome (or "dependent") variables in this analysis are, respectively, the number of new business establishments in each industry sector that chose to locate in a given TAZ in 2009. In these models, the level of industry activity for each sector from each TAZ was calculated at transportation network distance thresholds of 5, 5-10, 10-20, 20-30 and 30-45 kilometers. Statistical controls for population, racial/ethnic population distribution, average household income, and overall employment are included for each TAZ analyzed in this basic model.

The data for this statistical analysis are drawn from three primary sources: the National Establishment Time Series (NETS) proprietary micro dataset released by Walls and Associates, transportation network travel time data developed by the Southern California Association of Governments (SCAG), and socio-demographic data from the U.S. Census Bureau's American Community Survey (ACS). Please see chapter 3 for descriptions of the NETS and SCAG data in further detail. The ACS sociodemographic data provide population estimates averaged over the years 2005 through 2009 at the census tract level, from which we spatially interpolated figures at the closely matched traffic analysis zone level.

Two area household income control variables are included in our statistical models that allow for two different ways in which income might affect the location of new starts. Absolute income levels are continuous and used in the models in both linear and squared (or quadratic) terms. The squared term was included after inspection of the data revealed a relative abundance of firm starts near the middle of the neighborhood income spectrum and a relative paucity in both very high and very low income neighborhoods. Including this squared term allows increases in neighborhood income level to predict more firm starts up to a point, after which further increases in income would be associated with fewer firm starts (such a scenario would correspond to a positive coefficient for the linear income term and a negative coefficient for the squared income term). In addition, each variable was standardized, which means the value of each variable for each TAZ has been divided by its standard deviation. This enables the relative effect of each coefficient for each variable to be directly compared with the other variables.

The employment and population in each TAZ were used to specify the zero component of the two-part modeling process. Each independent (explanatory) variable is "lagged" by one year compared with the dependent (outcome) variable in order to control for the fact that there is likely a lag between the conditions that lead to the decision to locate a new start-up firm and the start-up actually opening its doors for business. Thus, we control for endogeneity by having, for example, independent variables relate to 2008 while the dependent variable relates to 2009.

Table 4.2 Predictors of New Apparel Establishments by Sector, 2009

	Firm Starts Dependent Variable, by Sector:					
	Ad.	Apparel	Ent.	IT	Sec. & Comm.	Grocery
	(1)	(2)	(3)	(4)	(5)	(6)
Same Industry Employment within 1 km	0.027	0.177***	0.090***	0.085***	0.069***	0.042**
	(0.031)	(0.033)	(0.026)	(0.024)	(0.019)	(0.020)
Same Industry Employment w/in 1-5 km	0.100**	0.140	0.175***	0.062*	0.127***	0.033
	(0.049)	(0.087)	(0.022)	(0.036)	(0.023)	(0.053)
Same Industry Employment w/in 5-10 km	0.123**	0.310**	0.296***	0.005	-0.008	-0.002
	(0.059)	(0.123)	(0.027)	(0.046)	(0.027)	(0.073)
Same Industry Employment w/in 10-20 km	0.066	-0.053	0.313***	0.126**	-0.017	-0.109
	(0.082)	(0.148)	(0.036)	(0.050)	(0.032)	(0.097)
Same Industry Employment w/in 20-30 km	0.055	-0.026	0.284***	-0.118*	0.072**	0.174*
	(0.077)	(0.148)	(0.036)	(0.064)	(0.032)	(0.099)
Same Industry Employment w/in 30-45 km	0.033	-0.003	0.150***	0.044	0.021	-0.077
	(0.064)	(0.154)	(0.037)	(0.054)	(0.027)	(0.080)
Total Employment in TAZ	0.188***	-0.054	0.334***	0.166***	0.367***	0.116**
	(0.041)	(0.092)	(0.029)	(0.031)	(0.021)	(0.039)
Median Income in TAZ	0.366	-0.029	0.464***	0.029	0.279***	-0.291**
	(0.203)	(0.443)	(0.129)	(0.119)	(0.077)	(0.147)
Median Income Squared in TAZ	-0.304	-0.127	-0.270**	0.062	-0.026	0.228*
	(0.189)	(0.482)	(0.108)	(0.101)	(0.063)	(0.131)
Population in TAZ	0.081	-0.196	0.178***	0.051	0.194***	0.174**
	(0.063)	(0.482)	(0.040)	(0.042)	(0.022)	(0.046)
Percent Hispanic in TAZ	-0.200	-0.178	-0.567***	-0.356***	-0.347***	0.040
	(0.074)	(0.136)	(0.053)	(0.050)	(0.032)	(0.052)
Constant	-1.654***	-3.165***	-1.407***	-0.986***	-0.283***	-1.514***
	(0.113)	(0.277)	(0.052)	(0.074)	(0.029)	(0.094)
Observations	3,906	3,906	3,906	3,906	3,906	3,906
AIC	0.73	0.204	1.4	1.173	2.342	0.927
BIC	-27,725	-29,680	-25,236	-26,080	-21,740	-26,993

(Standard errors in parentheses) *p<0.1; **p<0.05; ***p<0.01

The model results confirm what theory would predict; namely, that firms of tradable industries seek to locate in close proximity to one another. That said, there are differences in the degree to which new establishments seek to locate close to existing levels of same-industry activity across the sectors under investigation. For each tradable industry (except for entertainment), we see that the level of same industry activity after a range of 10 kilometers (a distance of roughly 6.25 miles) does not significantly predict the location of new business establishments at a level of confidence of 90 percent or higher, all else being equal. The degree of spatial clustering for these industries, therefore, is highly localized within the region. For the advertising and apparel industries, the level of same industry employment within the 5-10 kilometer threshold (roughly 3-6 miles) best predicts the location of new establishments for the respective industries, while for the IT industry, the level of employment within 1 km best predicts the location of new IT establishments and, for securities and commodities, the level of same industry employment within 1-5 km best predicts the location of new establishments. Overall, for these industries there is a clear localization effect. New establishments for each sector seek to locate close to existing patterns of same industry activity within the region, and in the case of the IT industry, new start-ups seek to locate very close to one another.

In the entertainment industry, the level of same industry employment up to a distance of 45 km (28 miles) helps to predict the location of new establishments, at a level of confidence of 95 percent or higher, all else held constant. This suggests that the agglomeration effects of the entertainment industry are not as highly localized as is the case for the other industries. Finally, the level of existing grocery store activity is a significant predictor of the location of new grocery establishments at a scale of 1 kilometer, with a 95 percent level of confidence, but unlike the other industries, not at greater scales. The association between new grocery stores and existing stores at this scale likely has to do with the nature of zoning, which limits where grocery stores can locate such that competitors are frequently located in close proximity. But grocery stores are otherwise distributed broadly to be convenient to consumers in all parts of the region. Thus, many cities are home to grocery stores, and many cities zone only a portion of their land for commercial activity, which means that grocery stores that serve such communities will, by virtue of the zoning process, be clustered together. All in all, there is a high degree of clustering for the industries of investigation within the Los Angeles region, which theory tells us is rooted in the desire of firms to reduce the costs of transacting with other firms and accessing information. The significance and effect of income, race/ethnicity, and population vary by industry and display no clear patterns.

The Effect of Congestion

To this point, the analysis in this chapter has not accounted for the effect of traffic congestion on the location of new business establishments. To the models presented in Table 4.2 above, a measure of congestion is also included in those depicted below. For each of five network distance thresholds (5, 10, 20, 30 and 45 km), the average speed to and from a given TAZ and from all other TAZs within each of these thresholds was calculated for the AM peak commute period using the SCAG data and process described in Chapter 3. The result is a measure of traffic delay from every neighborhood or district to every other neighborhood or districts at ranges from 5 kilometers (measuring local congestion effects) to 45 kilometers (measuring broader, sub-regional congestion effects). If congestion acts as a diseconomy of scale (is a cost of crowding), firms should locate in those parts of the region where congestion is relatively low (average speeds are high) and avoid those locations where congestion is relatively high (average speeds are low). For each industry, six separate models have been executed to account for average speeds at each threshold described above.

For the apparel and grocery industries, the speed between a TAZ pair, across each distance threshold, was not a significant predictor of the location of new establishments, suggesting that congestion plays little role in the start-ups in these sectors. Interesting results emerge with the other industries, most of which are similar with the notable exception of the entertainment industry. In the entertainment industry, the speed at which it is possible to travel to and from a given TAZ within 5 kilometers is a negative predictor of new establishments. In other words, at this scale, slower moving parts of the region actually see more new establishments forming than faster moving parts of the region. However, at scales of 10 kilometers and greater, faster speeds are associated with more new entertainment establishments. For the IT and securities and commodities industries, faster speeds at thresholds of 10 km or less negatively predict new establishments for the respective industries. For the advertising industry, faster speeds positively predict new establishments at scales of less than 5 kilometers, but negatively predict them at a scale of 45 km.

Overall, the speed variable (which is the inverse of average levels of traffic delays) produces interesting results. In two of the six studied industries, traffic speeds have no effect on the location of start-ups, in two cases they have mixed effects, and in two cases they have negative effects only. In no case are lower levels of traffic delays consistently positively associated with new firm start-ups. Put another way, with two exceptions, traffic congestion either has no statistically significant effect on new firm start-ups, or it is positively associated with start-ups.

First, and as expected, the level of congestion, from site-adjacent to sub-regionally, has no statistical effect on the location of grocery employment. Nor does it have any effect on apparel manufacturing employment, which tends to be low skill, low wage work often performed in very small shops that would appear to benefit less from knowledge spillovers than other, higher-skill tradable industries examined here.

Second, in two industries, advertising and entertainment, congestion has (diametrically) different effects at local and broader scales. In advertising, site-adjacent (within 1 km) traffic speeds are positively associated with new firm start-ups, though at a sub-regional (45 km) scale, traffic speeds are negatively associated with advertising firm start-ups. In the entertainment industry, the situation is the reverse: lower site-adjacent traffic speeds (i.e. higher levels of traffic congestion) increase the likelihood of entertainment firm start-ups, while higher area to sub-regional (10-45 km) traffic speeds are positively associated with start-ups.

Third, in the IT and securities and commodities industries, area congestion is in most of the models unrelated to start-ups, though when there is a statistically significant effect it is always negative – at 1 km for the IT industry, and at the 1, 5, and 10 km radii for the securities and commodities industries.

Finally, for each of the industries analyzed, the coefficients for proximity are in all cases more powerful predictors of firm start-ups than are the coefficients for the speed variables. Given the results of our analysis of the mobility-proximity-accessibility nexus reported on in Chapter 3, these results should not be surprising. Thus, the location of new tradable industry establishments is explained more by proximity to other similar firms and nearby labor than they are by the speed with which one firm can access other firms or workers can access job sites.

Table 4.3 Predictors of New Apparel Establishments in Los Angeles, 2009

	Distance Threshold for Speed Independent Variable:					
	1 km	5 km	10 km	20 km	30 km	45 km
	(1)	(2)	(3)	(4)	(5)	(6)
Same Industry Employment within 1 km	0.181***	0.181***	0.183***	0.182***	0.181***	0.182***
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
Same Industry Employment w/in 1-5 km	0.155*	0.167*	0.174*	0.161*	0.152*	0.156*
	(0.089)	(0.092)	(0.094)	(0.094)	(0.093)	(0.093)
Same Industry Employment w/in 5-10 km	0.342**	0.365**	0.388***	0.358**	0.333***	0.343**
	(0.130)	(0.135)	(0.146)	(0.149)	(0.143)	(0.142)
Same Industry Employment w/in 10-20 km	0.010	-0.042	-0.067	-0.034	0.004	0.013
	(0.152)	(0.163)	(0.174)	(0.190)	(0.191)	(0.189)
Same Industry Employment w/in 20-30 km	0.042	-0.073	0.093	0.058	0.031	0.044
	(0.153)	(0.133)	(0.170)	(0.171)	(0.173)	(0.174)
Same Industry Employment w/in 30-45 km	0.103	0.116	0.138	0.122	0.091	0.107
	(0.172)	(0.173)	(0.179)	(0.193)	(0.199)	(0.205)
Total Employment in TAZ	-0.063	-0.061	-0.060	-0.063	-0.063	-0.063
	(0.093)	(0.092)	(0.093)	(0.093)	(0.093)	(0.093)
Speed Variables	0.010	0.126	0.190	-0.073	0.036	0.015
	(0.125)	(0.234)	(0.282)	(0.322)	(0.336)	(0.351)
Median Income in TAZ	0.216	-0.179	-0.195	-0.223	0.217	0.222
	(0.605)	(0.609)	(0.608)	(0.604)	(0.603)	(0.605)
Median Income Squared	-0.517	-0.489	-0.508	-0.524	-0.516	-0.521
	(0.1791)	(0.797)	(0.798)	(0.793)	(0.790)	(0.792)
Population in TAZ	-0.172	-0.177	-0.170	-0.170	-0.171	-0.170
	(0.195)	(0.195)	(0.195)	(0.194)	(0.195)	(0.195)
Percent Hispanic in TAZ	-0.143	-0.153	-0.154	-0.145	-0.141	-0.142
	(0.143)	(0.145)	(0.149)	(0.144)	(0.144)	(0.144)
Constant	-3.312	-3.288	-3.290	-3.305	-3.319	-3.312
Observations	3,076	3,076	3,076	3,076	3,076	3,076
AIC	0.207	0.207	0.207	0.207	0.207	0.207
BIC	-23,964	-23,964	-23,964	-23,964	-23,964	-23,964

(Standard errors in parentheses) *p<0.1; **p<0.05; ***p<0.01

Table 4.4 Predictors of New Advertising Establishments in Los Angeles, 2009

	Distance Threshold for Speed Independent Variable:					
	1 km	5 km	10 km	20 km	30 km	45 km
	(1)	(2)	(3)	(4)	(5)	(6)
Same Industry Employment within 1 km	0.031	0.031	0.031	0.031	0.032	0.033
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
Same Industry Employment w/in 1-5 km	0.104**	0.102**	0.105**	0.095*	0.089*	0.078
	(0.049)	(0.051)	(0.052)	(0.051)	(0.050)	(0.050)
Same Industry Employment w/in 5-10 km	0.123**	0.121**	0.124**	0.112*	0.102*	0.091
	(0.060)	(0.061)	(0.063)	(0.062)	(0.062)	(0.061)
Same Industry Employment w/in 10-20 km	0.052	0.049	0.055	0.019	-0.011	-0.052
	(0.083)	(0.088)	(0.094)	(0.099)	(0.096)	(0.095)
Same Industry Employment w/in 20-30 km	0.067	0.064	0.067	0.049	0.028	-0.007
	(0.080)	(0.081)	(0.083)	(0.084)	(0.084)	(0.085)
Same Industry Employment w/in 30-45 km	0.030	0.028	0.032	0.002	-0.031	-0.093
	(0.070)	(0.074)	(0.079)	(0.084)	(0.086)	(0.090)
Total Employment in TAZ	0.164***	0.165***	0.165***	0.166***	0.167***	0.164***
	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
Speed Variables	0.142**	-0.004	0.015	-0.084	-0.177	-0.337**
	(0.057)	(0.108)	(0.139)	(0.147)	(0.145)	(0.156)
Median Income in TAZ	0.385	0.395	0.391	0.386	0.362	0.337
	(0.249)	(0.250)	(0.248)	(0.246)	(0.247)	(0.156)
Median Income Squared	-0.370	-0.378	-0.374	-0.369	-0.345	-0.313
	(0.256)	(0.257)	(0.255)	(0.254)	(0.254)	(0.247)
Population in TAZ	0.092	0.093	0.093	0.093	0.092	0.088
	(0.070)	(0.070)	(0.070)	(0.070)	(0.070)	(0.070)
Percent Hispanic in TAZ	-0.221	-0.219***	-0.218***	-0.223***	-0.226***	-0.230***
	(0.079)	(0.078)	(0.078)	(0.079)	(0.078)	(0.078)
Constant	-1.598	-1.601	-1.600	-1.606	-1.612	-1.627
Observations	3,076	3,076	3,076	3,076	3,076	3,076
AIC	0.77	0.772	0.772	0.772	0.772	0.77
BIC	-22,227	-22,227	-22,227	-22,228	-22,229	-22,232

(Standard errors in parentheses) *p<0.1; **p<0.05; ***p<0.01

Table 4.5 Predictors of New Entertainment Establishments in Los Angeles, 2009

	Distance Threshold for Speed Independent Variable:					
	1 km	5 km	10 km	20 km	30 km	45 km
	(1)	(2)	(3)	(4)	(5)	(6)
Same Industry	0.097***	0.097***	0.100***	0.099***	0.097***	0.096***
Employment within 1 km	(0.026)	(0.026)	(0.027)	(0.027)	(0.026)	(0.026)
Same Industry	0.166***	0.179***	0.186***	0.189***	0.189***	0.190***
Employment w/in 1-5 km	(0.022)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
Same Industry	0.285***	0.300***	0.321***	0.321***	0.320***	0.321***
Employment w/in 5-10 km	(0.028)	(0.029)	(0.030)	(0.030)	(0.030)	(0.030)
Same Industry	0.292***	0.350***	0.361***	0.388***	0.383***	0.377***
Employment w/in 10-20 km	(0.039)	(0.047)	(0.040)	(0.047)	(0.047)	(0.045)
Same Industry	0.318***	0.344***	0.128***	0.368***	0.373***	0.373***
Employment w/in 20-30 km	(0.039)	(0.039)	(0.047)	(0.047)	(0.042)	(0.042)
Same Industry	0.078*	0.101**	0.128***	0.132***	0.138**	0.148***
Employment w/in 30-45 km	(0.044)	(0.045)	(0.047)	(0.047)	(0.049)	(0.050)
Total Employment in TAZ	0.298***	0.315***	0.314***	0.309***	0.307***	0.309***
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
Speed Variables	-0.088**	0.092	0.207***	0.218***	0.218**	0.228***
	(0.039)	(0.070)	(0.079)	(0.083)	(0.086)	(0.088)
Median Income in TAZ	0.640***	0.600***	0.591***	0.623***	0.641***	0.652***
	(0.165)	(0.164)	(0.163)	(0.163)	(0.164)	(0.163)
Median Income Squared	-0.541**	-0.509**	-0.503***	-0.531***	-0.548**	-0.557**
	(0.159)	(0.159)	(0.158)	(0.158)	(0.159)	(0.159)
Population in TAZ	0.218***	0.203***	0.202***	0.203***	0.204***	0.205***
	(0.048)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
Percent Hispanic in TAZ	-0.580***	-0.586***	-0.581***	-0.579***	-0.576***	-0.576***
	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)
Constant	-1.437	-1.432	-1.432	-1.414	-1.412	-1.407
Observations	3,076	3,076	3,076	3,076	3,076	3,076
AIC	1.472	1.473	1.471	1.471	1.471	1.471
BIC	-20,074	-20,071	-20,077	-20,076	-20,076	-20,076

(Standard errors in parentheses) *p<0.1; **p<0.05; ***p<0.01

Table 4.6 Predictors of New IT Establishments in Los Angeles, 2009

	Distance Threshold for Speed Independent Variable:					
	1 km	5 km	10 km	20 km	30 km	45 km
	(1)	(2)	(3)	(4)	(5)	(6)
Same Industry Employment within 1 km	0.093***	0.094***	0.092***	0.089***	0.089***	0.088***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
Same Industry Employment w/in 1-5 km	0.037	0.047	0.051	0.054	0.055	0.056
	(0.036)	(0.037)	(0.036)	(0.036)	(0.036)	(0.036)
Same Industry Employment w/in 5-10 km	0.001	-0.031	-0.006	-0.007	-0.007	-0.006
	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)
Same Industry Employment w/in 10-20 km	0.097*	0.099*	0.100*	0.102*	0.102*	0.103*
	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
Same Industry Employment w/in 20-30 km	-0.107	-0.110	-0.107	-0.096	-0.094	0.091
	(0.067)	(0.068)	(0.069)	(0.068)	(0.068)	(0.067)
Same Industry Employment w/in 30-45 km	-0.040	-0.030	-0.024	-0.012	-0.008	0.000
	(0.060)	(0.061)	(0.061)	(0.063)	(0.065)	(0.065)
Total Employment in TAZ	0.143***	0.144***	0.150***	0.144***	0.144***	0.144***
	(0.031)	(0.032)	(0.032)	(0.031)	(0.031)	(0.031)
Speed Variables	-0.147***	-0.081	-0.044	-0.004	0.006	0.025
	(0.035)	(0.051)	(0.055)	(0.058)	(0.058)	(0.060)
Median Income in TAZ	0.173	0.104	0.060	0.030	0.026	0.021
	(0.140)	(0.144)	(0.142)	(0.138)	(0.137)	(0.136)
Median Income Squared	-0.030	0.015	0.051	0.071	0.074	0.075
	(0.125)	(0.128)	(0.125)	(0.123)	(0.123)	(0.122)
Population in TAZ	0.049	0.038	0.034	0.033	0.033	0.033
	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)
Percent Hispanic in TAZ	-0.300***	-0.321***	-0.329***	-0.336***	-0.338***	-0.340***
	(0.052)	(0.053)	(0.053)	(0.049)	(0.049)	(0.052)
Constant	-0.939	-0.933	-.916	-.904	-.904	-.900
Observations	3,076	3,076	3,076	3,076	3,076	3,076
AIC	1.212	1.217	1.217	1.217	1.217	1.217
BIC	-20,874	-20,859	-20,858	-20,857	-20,857	-20,857

(Standard errors in parentheses) *p<0.1; **p<0.05; ***p<0.01

Table 4.7 Predictors of New Securities and Commodities Establishments in Los Angeles, 2009

	Distance Threshold for Speed Independent Variable:					
	1 km	5 km	10 km	20 km	30 km	45 km
	(1)	(2)	(3)	(4)	(5)	(6)
Same Industry Employment within 1 km	0.064***	0.063***	0.063***	0.065***	0.064***	0.065***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Same Industry Employment w/in 1-5 km	0.122***	0.112***	0.114***	0.124***	0.126***	0.127***
	(0.023)	(0.024)	(0.024)	(0.024)	(0.024)	(0.023)
Same Industry Employment w/in 5-10 km	-0.021	-0.032	-0.035	-0.021	-0.020	-0.018
	(0.028)	(0.029)	(0.030)	(0.029)	(0.029)	(0.029)
Same Industry Employment w/in 10-20 km	-0.044*	-0.059*	-0.064*	-0.500	-0.049*	-0.044
	(0.034)	(0.035)	(0.037)	(0.038)	(0.038)	(0.038)
Same Industry Employment w/in 20-30 km	0.063*	0.055	0.051	0.063*	0.063	0.065*
	(0.034)	(0.034)	(0.034)	(0.036)	(0.036)	(0.037)
Same Industry Employment w/in 30-45 km	-0.038*	-0.054*	-0.061*	-0.045	-0.045	-0.042
	(0.030)	(0.032)	(0.034)	(0.037)	(0.038)	(0.040)
Total Employment in TAZ	0.350***	0.349***	0.354***	0.354***	0.353***	0.353***
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
Speed Variables	-0.048*	-0.094**	-0.096*	-0.037	-0.033	-0.022
	(0.025)	(0.044)	(0.056)	(0.059)	(0.058)	(0.062)
Median Income in TAZ	-0.202**	0.211**	0.195**	0.179*	0.178*	0.177*
	(0.095)	(0.095)	(0.095)	(0.094)	(0.094)	(0.095)
Median Income Squared	0.002	0.008	-0.008	0.019	-0.020	-0.020
	(0.086)	(0.086)	(0.086)	(0.086)	(0.086)	(0.086)
Population in TAZ	0.188***	0.187***	0.184***	0.184***	0.184***	0.184***
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
Percent Hispanic in TAZ	-0.373***	-0.379***	-0.380***	-0.378***	-0.378***	-0.377***
	(0.034)	(0.034)	(0.035)	(0.035)	(0.034)	(0.034)
Constant	-0.244	-0.250	-0.249	-0.247	-0.247	-0.247
Observations	3,076	3,076	3,076	3,076	3,076	3,076
AIC	2.359	2.358	2.359	2.36	2.36	2.36
BIC	-17,347	-17,348	-17,346	-17,344	-17,344	-17,344

(Standard errors in parentheses) *p<0.1; **p<0.05; ***p<0.01

Table 4.8 Predictors of New Grocery and Supermarket Establishments in Los Angeles, 2009

	Distance Threshold for Speed Independent Variable:					
	1 km	5 km	10 km	20 km	30 km	45 km
	(1)	(2)	(3)	(4)	(5)	(6)
Same Industry Employment within 1 km	0.047**	0.047**	0.047**	0.046**	0.046**	0.046**
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Same Industry Employment w/in 1-5 km	0.042	0.046	0.044	0.027	0.025	0.018
	(0.054)	(0.056)	(0.057)	(0.057)	(0.056)	(0.056)
Same Industry Employment w/in 5-10 km	-0.010	0.019	0.023	0.007	0.006	-0.002
	(0.074)	(0.074)	(0.076)	(0.075)	(0.075)	(0.075)
Same Industry Employment w/in 10-20 km	-0.060	-0.052	-0.049	-0.063	-0.066*	-0.078
	(0.099)	(0.100)	(0.100)	(0.103)	(0.102)	(0.102)
Same Industry Employment w/in 20-30 km	0.165	0.181*	0.180*	0.151	0.149	0.139
	(0.105)	(0.107)	(0.108)	(0.107)	(0.107)	(0.106)
Same Industry Employment w/in 30-45 km	-0.030	-0.032	-0.025	-0.033	-0.037	-0.065
	(0.090)	(0.090)	(0.090)	(0.093)	(0.096)	(0.101)
Total Employment in TAZ	0.120***	0.122***	0.121***	0.120***	0.120***	0.120***
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
Speed Variables	0.073	0.098	0.091	-0.003	-0.016	-0.085
	(0.048)	(0.080)	(0.097)	(0.108)	(0.109)	(0.116)
Median Income in TAZ	-0.140	-0.134	-0.116	-0.098	-0.099	-0.106
	(0.215)	(0.216)	(0.214)	(0.214)	(0.214)	(0.214)
Median Income Squared	-0.072	-0.072	-0.089	-0.103	-0.102	-0.095
	(0.246)	(0.248)	(0.246)	(0.246)	(0.246)	(0.245)
Population in TAZ	0.126**	0.131**	0.134**	0.136**	0.136**	0.135**
	(0.060)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)
Percent Hispanic in TAZ	-0.002	0.002	0.004	0.011	0.012	0.018
	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)
Constant	-1.598	-1.596	-1.602	-1.608	-1.608	-1.612
Observations	3,076	3,076	3,076	3,076	3,076	3,076
AIC	0.931	0.931	0.931	0.931	0.931	0.931
BIC	-21,740	-21,739	-21,738	-21,737	-21,737	-21,738

(Standard errors in parentheses) *p<0.1; **p<0.05; ***p<0.01

The foregoing statistical models of firm start-ups in Tables 4.2-4.8 align with the notion that accessibility to same-sector firms is a major factor in predicting tradable sector firm start-ups, and that it is physical proximity rather than free-flowing traffic that is the primary component of such accessibility. Recall from Chapter 3 that all-firm accessibility, as measured via gravity-weighted travel times to surrounding employment, is overwhelmingly driven by proximity, rather than by speed. Figure 4.3 below shows a similar relationship holding for the individual economic sectors under investigation here. As with the bottom-right panel of Figure 3.2 in Chapter 3, these graphs show a clear correspondence between greater proximity to firms of a given sector (as measured over a 10 km network radius) and greater accessibility (as represented graphically by warmer color tones), while there is little such correspondence between speed (again, as measured over a 10 km network radius) and accessibility.

This relationship between 10 km speed, 10 km sector-specific firm proximity, and accessibility is made numerically explicit in Table 4.9. As with the directly analogous Table 3.3 in Chapter 3, the sector-specific multilevel models relating speed and employment proximity to employment accessibility show that, for each sector, proximity matters to a much greater extent in predicting accessibility. As in Chapter 3, each initial speed, proximity, and accessibility variable is scaled by dividing by its standard deviation, allowing for direct comparison of coefficient values. The speed and proximity variables are then decomposed into inter- and intra-community components. The resulting multilevel model shows that what held for all-sector employment access also holds for sector-specific access, with proximity to employment playing a large role at both the community and neighborhood level,[5] with speed playing a

[5] Communities, as described in corresponding multilevel models in Chapter 3, could also be described as sub-regions; they are larger geographical units (such as Downtown LA, Compton, Hollywood, etc.), and consist of an average of about a dozen neighborhood analysis zones.

proportionally much smaller role, and with neighborhood-level variations in speed accounting for a greater degree of variance in accessibility than community-level variations.

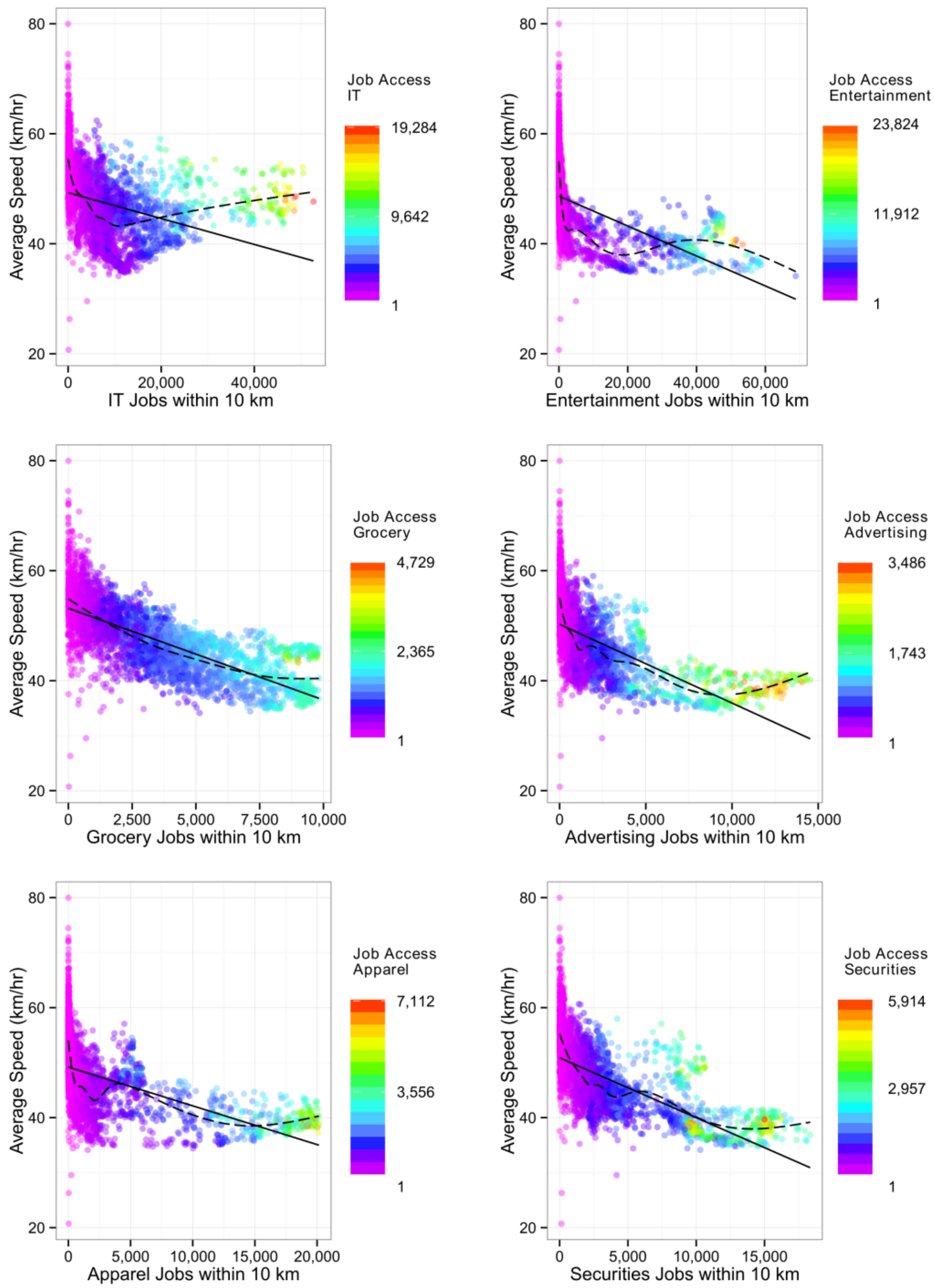

Figure 4.3 Average Peak-Hour Speed Plotted Against Sector-Specific Employment Proximity, Colored by Sector-Specific Job Accessibility

Table 4.9 Hierarchical Linear Model Output for Relationships among Speed, Proximity, and Accessibility Variables for Specific Sectors

	Dependent variable:					
	IT Firms, Scaled Access	Entertainment Firms, Scaled Access	Grocery Firms, Scaled Access	Advertising Firms, Scaled Access	Textile Firms, Scaled Access	Security Firms, Scaled Access
	(1)	(2)	(3)	(4)	(5)	(6)
Scaled Peak-Hour Speed, Community-Level Mean	0.112***	-0.015	0.093***	-0.010	-0.019	0.045*
	(0.016)	(0.013)	(0.023)	(0.017)	(0.016)	(0.024)
Scaled Peak-Hour Speed, Within-Community Difference from Mean	0.120***	-0.002	0.129***	0.109***	0.044	0.085***
	(0.027)	(0.048)	(0.030)	(0.027)	(0.042)	(0.032)
Scaled Proximity to Same-Sector Employment, Community-Level Mean	0.995***	0.972***	1.032***	0.950***	0.947***	0.930***
	(0.018)	(0.014)	(0.024)	(0.017)	(0.017)	(0.026)
Scaled Proximity to Same-Sector Employment, Within-Community Difference from Mean	0.615***	0.967***	0.822***	0.722***	0.857***	0.812***
	(0.034)	(0.106)	(0.033)	(0.040)	(0.086)	(0.061)
Constant	0.001	0.005	-0.004	-0.017	0.007	-0.014
	(0.014)	(0.011)	(0.015)	(0.013)	(0.013)	(0.018)
Observations	3,977	3,977	3,977	3,977	3,977	3,977
Akaike Inf. Crit.	-1,027	-918	-793	-1,717	-2,110	-180
Bayesian Inf. Crit.	-951	-842	-718	-1,641	-2,035	-105

(Standard errors in parentheses) *p<0.1; **p<0.05; ***p<0.01

To conclude our accessibility modeling of firm start-ups, we finally carry over an analogous multilevel model structure to the negative binomial new start-ups models shown in Tables 4.2-4.8. As with the models presented in Table 3.3 in Chapter 3 and Table 4.8 here, the multilevel model structure allows us to discern between effects at the broader community (sub-regional) level and effects at the narrower neighborhood level. This modeling specification has further advantages in that it accounts for systematic differences across sub-regions, such as might be produced by different growth-related ordinances and clustered exposures to amenities and disamenities.

With all speed and proximity variables again based on 10 km network radii, we see that the results corroborate those seen in the zero-inflated negative binomial models in Tables 4.2-4.8. Namely, for all tradable sectors, the total number of firms within a 10 km radius of a TAZ is strongly predictive of more firm starts. This effect tends to be most certain when predicted at the aggregate community level, though intra-community differences in proximity to same-sector firms do tend to further predict firm starts. Conversely, variation in speed, whether considered at the community or neighborhood level, appears to have very little effect on firm starts. The one major exception is for entertainment firms, which see significantly fewer starts, controlling for other neighborhood attributes, in communities with higher average travel speeds. In other words, as with the previous models, higher levels of local area congestion are associated with more new entertainment firm starts, not less.

Table 4.10 Hierarchical Negative Binomial Model Predicting Sector-Specific Starts

	Dependent variable:					
	IT Firm Starts	Entertainment Firm Starts	Groc. Firm Starts	Adv. Firm Starts	App. Firm Starts	Sec. Firm Starts
	(1)	(2)	(3)	(4)	(5)	(6)
Scaled Peak-Hour Speed, Community-Level Mean	-0.105	-0.373***	-0.014	0.071	-0.065	-0.203
	(0.082)	(0.093)	(0.108)	(0.202)	(0.081)	(0.142)
Scaled Peak-Hour Speed, Within-Community Difference from Mean	-0.086	-0.236	0.040	0.076	-0.236	-0.358
	(0.201)	(0.192)	(0.177)	(0.469)	(0.152)	(0.261)
Scaled Proximity to Same-Sector Employment, Community-Level Mean	0.311***	0.628***	0.085	0.669***	0.236***	0.257**
	(0.073)	(0.081)	(0.105)	(0.159)	(0.074)	(0.119)
Scaled Proximity to Same-Sector Employment, Within-Community Difference from Mean	0.218	0.344**	0.099	0.909*	0.184	0.650*
	(0.156)	(0.163)	(0.195)	(0.531)	(0.179)	(0.353)
% African American and Latino	-1.692***	-2.031***	-0.037	-1.854***	-1.446***	-0.966**
	(0.304)	(0.312)	(0.253)	(0.713)	(0.234)	(0.400)
Median Household Income ($10k)	-0.009	0.074	-0.064	-0.181	0.092	0.154
	(0.083)	(0.082)	(0.072)	(0.208)	(0.065)	(0.115)
Income Squared	0.001	-0.002	0.002	0.004	-0.001	-0.008
	(0.004)	(0.004)	(0.004)	(0.012)	(0.003)	(0.006)
Constant	-0.644	-0.818*	-1.509***	-2.181**	-0.060	-2.302***
	(0.436)	(0.443)	(0.371)	(0.973)	(0.335)	(0.582)
Observations	3,914	3,914	3,914	3,914	3,914	3,914
Akaike Inf. Crit.	5,766	6,513	3,950	881	12,149	3,395
Bayesian Inf. Crit.	5,860	6,607	4,044	975	12,243	3,489

(Standard errors in parentheses) *p<0.1; **p<0.05; ***p<0.01

Interpretation

The output reported here provides further evidence that firms of tradable industries seek to locate in close proximity to one another, often at relatively fine-grained spatial scales. For each industry investigated here, other than the entertainment industry, the level of same industry employment has no bearing on the location of a new establishment at a distance of 10 kilometers (6.25 miles) or more. This finding suggests that firm-to-firm interactions and information sharing occurs at highly localized scales. For the entertainment industry, by contrast, same industry activity at greater distances significantly affects the location decisions of new establishments. This suggests that the entertainment industry functions as an economic cluster at a close to region-wide scale.

Given the role that proximity to other firms plays in shaping the location of new establishments across the industries studied here, it stands to reason that the transportation network should play a role in shaping the location of new establishments. After all, the efficiency with which it is possible to travel along different segments of the transportation network should directly influence accessibility. The findings reported here thus might be interpreted in two ways, which are not mutually exclusive. At a local level, we might conclude that congestion plays a limited and inconclusive role in shaping the location of new establishments in the industries examined here. However, at a regional level, it is reasonable to make the case that firms or tradable industries might be seeking to mitigate the effects of congestion on firm-to-firm interactions by locating in close proximity to one another. In other words, to overcome travel delay and travel time unreliability at the regional scale, firms have located in close proximity to one another where they can reduce the effects of travel delay and uncertainty.

Chapter 5: Conclusion

Why do households and firms bother to locate in cities? They are more expensive than small towns and rural areas, often much more expensive. Housing is often cramped, with neighbors living just a few yards away in suburbs and sometimes just a few inches away in big city apartments. Cities are frequently noisy, crime-plagued, and crowded places. Movies sell out, waits for tables at restaurants are common, and traffic congestion is seemingly everywhere. Why bother to live in cities at all?

Access. Households and firms crowd into cities because jobs, friends, medical care, farmers' markets, and so much more are more easily accessed via the congested streets and roads of cities than via the free-flowing roads in small towns and rural areas. This conundrum – that access is often greatest where traffic is heaviest – is at the heart of the analyses in this report. No one likes being stuck in traffic, and all things equal, access is always greater with fewer traffic delays than with more. But the analyses presented here have shown quite clearly that, when it comes to access, all things are rarely equal, and that crowding things together in cities (i.e. increasing proximity) tends to give more to access, than the traffic delays common in densely developed areas take access away.

The novel research presented in this report adds considerable support to the growing chorus of voices arguing for a shift from a mobility-focused view of what urban transportation systems do to an access-focused view of what urban systems do. Mobility – in cars, in trucks, via public transit, and by bike and foot – is a *means* to access, and not an *end* in itself. This shift in perspective is integral to the new urbanist movement touted by many urban designers and exemplified by places such as Playa Vista in West Los Angeles. And it's behind a burgeoning complete streets movement that seeks to evaluate streets as multi-purpose venues for economic and social activity, travel among them, rather than to hold the more traditional view that the success of streets is measured solely in terms of the volume and velocity of the motor vehicles they convey.

We conclude from the empirical analysis presented in this report that transportation network delay, infuriating though it may be, is at best an indirect measure of the ease and quality of social interactions and economic transactions that are the *raison d'être* of cities and their transportation systems. There are indeed ways to reduce urban traffic congestion (that we do not review in detail in this report), though all have proven less politically palatable than congestion itself. We could, for example, greatly expand street and freeway capacity, though this would be very expensive, would require the displacement of many homes and businesses, and in the minds of many would makes cities less sustainable and human-scaled. We could conversely ration scarce road capacity, through approaches as crude as cutting the eligible pool of motor vehicles in half with odd-even license plate days, to elegant solutions like variable electronic road pricing that would adjust the cost of driving to bring road supply and travel demand in balance to keep street and freeway traffic moving smoothly. Neither of these approaches has gained much political traction, despite considerable support for road pricing among many experts. This state of affairs has led noted political economist Anthony Downs to describe traffic congestion as not an intractable problem but the most politically palatable *solution* to the problem of the demand for urban road space regularly exceeding the supply (Downs, 2004).

Access – the ability of travelers to avail themselves of economic and social opportunities in space – is a function of both speed and proximity. This speed/proximity tradeoff is at the heart of regional economic theory, as well as at hotly debated public meetings, where proposals for new, larger developments in already congested areas are fervently discussed. To help inform such debates, we unambiguously found in our analysis of traffic and employment data that proximity (in terms of adjacent development), rather than speed, is the much more critical element in determining the *actual* opportunities to reach desired destinations in metropolitan Los Angeles. In LA, in other words, it's location, location, location, and not faster, faster, faster.

In Chapter 3 we showed that, on average (from a commuter's perspective), more jobs can be reached in a given amount of time via the congested streets of Santa Monica, Westwood, Beverly Hills, Hollywood, Koreatown, and Downtown, than on the fast moving freeways and boulevards on the fringes of the metropolitan area. Put in general terms: as speeds increase, the accessibility benefits of lower travel time impedances are more than canceled out by an associated lack of nearby destinations. However, *within* communities (be it congested West Hollywood or uncongested Lancaster), higher speed locations do correspond to higher levels of accessibility. So while a typical resident of congested West Hollywood enjoys much greater access to employment opportunities than a typical resident of Lancaster, those moving faster in West Hollywood have higher levels of access than those from West Hollywood stuck in traffic.

Our findings also contribute to the study of the firms in basic, or tradeable, industries that drive regional economies – like entertainment and IT in Los Angeles. We find, also unambiguously, that such firms display a high propensity to locate close to one another. For four of the five basic industries we examined (the sole exception was apparel manufacturing), the level of nearby same industry employment was found to strongly influence the location of new establishments, while beyond a distance of 10 kilometers (6.2 miles) the same same-sector firms have no discernable effect on start-ups. Such strong distance-decay effects suggest that firm-to-firm interactions are more important to new tradeable industry firms than access to specialized labor markets via commuting. Further, that same-sector firm access is far more important in explaining start-ups than traffic delays, which exhibit no consistent pattern of association with new firm start-ups; in fact, traffic speed was more often *negatively* correlated with start-ups than positively correlated. Such findings lend no support to the idea that traffic congestion, even in a place like Los Angeles, is chasing away new businesses.

In concert, we find both that accessibility to same-sector firms is a major factor in predicting the location of tradable firm starts, and that physical proximity rather than driving speed (the inverse of traffic delay) is the primary component of such accessibility. Since new business establishments in tradeable industries seek to locate in close proximity to one another, it stands to reason that, all else equal, firms in tradable industries favor proximity under congested conditions over relocation to speedier outlying environs to avoid chronic traffic congestion. In short, we find no evidence in these data that traffic congestion is driving businesses away from congested parts of the LA region.

Beyond their direct implications for planners and policy makers, our findings offer insights for how transportation and land use decision makers might evaluate new development proposals. Rather than focusing on predicted changes to link-level travel flows and intersection level-of-service measures, or on vague notions of the value of low or high densities in general, planning officials would be wise to consider explicitly how predicted changes in neighborhood-level speed and destination proximity will affect residents' access to destinations. As we have shown here, this access can be measured and evaluated in a consistent manner.

We acknowledge that universal measures of accessibility such as the job accessibility measures developed for this report may be insufficient for making this case to skeptical residents that increased development densities will increase their accessibility despite the accompanying increase in traffic congestion. When a resident is concerned about traffic, she is not worried about changes in access to thousands of jobs, but instead about her ability to reach urban amenities such as grocery stores, health care, or any of the other destinations that may or may not be served by the density around them. So while residents and workers in the aggregate may broadly benefit from increases in nearby employment density, individual residents may be made worse off by increasing density and the traffic delays it engenders, reducing access to households' everyday destinations in the process. We might term this "the proximity conundrum," and it is at the heart of debates over the future of metropolitan Los Angeles.

While novel in many respects, the analyses presented here deal solely with access as measured along vehicular networks at estimated vehicular speeds. They do not address the potential effects of the availability of other modes of travel – such as public transit, biking, or walking – on access at highly localized or sub-regional scales. As the vast majority of travel generally, and commuting to and from work specifically, is by private automobile in Los Angeles, we chose to focus on roadway congestion and auto travel as a first step in unraveling the speed-proximity-accessibility nexus. But it is important to keep in mind that places that supply travelers with modes less affected by traffic congestion, such as grade-separated rail transit, bus rapid transit, walking, or biking, may be providing mobility unaccounted for in the speed estimates presented here. These alternatives to driving could be providing some places with a means to "puncture" the miasma of slow traffic, thereby facilitating access even more.

Additional research on within-region trade-offs between proximity and speed can turn the conceptually novel findings presented here into decision-support tools for public officials. While our analyses present a compelling picture of the overall shape of these trade-offs in the Los Angeles region, attributions of cause and effect would be greatly aided by the use of time-series data. In order to make strong claims about the accessibility effects of *changes over time* to proximity and speed, it is important to directly assess such changes. Looking at variations in cross-sectional data, as we have done here, can be highly suggestive, but it is limited in its ability to inform the sorts of predictions that are ultimately of interest to planners and elected officials. Such time series analyses are not trivial to carry out; in addition to expanding the amount of data that need to be collected, they also require that estimations of zone-to-zone travel speeds be not just internally consistent within a given year, but consistent across years. Still, given the analytical benefits of consistent time series, the collection of such data is needed if we are to begin employing conceptually and empirically sound access evaluation planning tools.

In addition to examining changes over time, analysts can better inform transportation and land use decisions by analyzing more specific community-level factors that influence the contextual effects of speed and proximity differences. Such statistical modeling can be done within a hierarchical framework similar to that employed in the models depicted in Chapter 3. In such a framework, various community-level attributes – such as job density in surrounding communities, the presence of highway infrastructure, etc. – can be used to predict where within-community differences in speed and proximity will be more influential with respect to accessibility levels. Along these lines, contextual influences on the speed-proximity-accessibility nexus can also be investigated through the use of structural equation models, similar to those reported by Levine et al. (2012) in their assessment of between-region predictors of accessibility. Such equations allow for the explicit modeling of the interactions among a host of inter-related factors, and can provide decision-makers with a better feel for potentially complex causal pathways. Overall, we expect that continued investigation and an increased understanding of the complex relationships among speed, proximity, and accessibility will further transportation planners' ability to provide useful information to communities and officials as they evaluate opportunities for growth and infrastructure investment in the years ahead.

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