# IMPACT OF TRANSPORT INFRASTRUCTURE ON FIRM FORMATION AND POST-ENTRY PERFORMANCE: A CASE STUDY IN HUDSON COUNTY, NEW JERSEY

by

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ABSTRACT OF THE DISSERTATION

Impact of Transport Infrastructure on Firm Formation and Post-Entry Performance: A Case Study in Hudson County, New Jersey

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New establishments play an important role in urban and regional economic development (Acs, 2006; Shukla & Waddell, 1991). Because of the assumption of economic agglomeration, many believe that firms will cluster to share information and take advantage of a pooled labor force, to increase communication, as well as to lower transportation costs. Empirical evidence confirm that transport infrastructure can lead to agglomerations of economic activity (Chatman, Noland, & Klein, 2016; Maoh & Kanaroglou, 2009). Therefore, it seems reasonable that businesses may locate close to transit stations to take advantage of the easy access to transportation for their businesses, the agglomeration externalities/competition of co-location, the nearby amenities, and policy incentives provided by local governments. Consequently, it is critical to understand what factors determine where new establishments will form. However, the relationship between public transit systems and new establishment patterns remains largely unclear. What are the determinants of business formation in a densely developed

urban areas? How do the determinants of business formation differ across sectors? And how do local contexts (i.e., master plans, local tax incentives) contribute to the process of establishment birth and subsequent survival? What implications does new establishment formation have for urban land use and contemporary urban form?

With the assumption that transport infrastructure is a key determinant of new establishment birth and subsequent survival, this dissertation investigates the impacts of changes in the accessibility provided by the Hudson Bergen Light Rail (HBLR) on the spatial patterns of new establishments. Data is derived using geographic information systems (GIS) and the National Establishment Time-Series (NETS) database. Negative binomial models and GEE models are constructed to evaluate the associations of new establishments in different sectors with proximity to rail stations; and determinants of new establishment survival are estimated with Cox Proportional-Hazards models. Additionally, qualitative research can provide us with more specific and contextual understanding of determinants of firm formation. Therefore, how local development policies and attitudes might influence business formation is examined through individual interviews and archival research. By mapping predicted probabilities for each industry and comparing these with observed densities, this dissertation identifies the extent to which locational preferences translates into aggregated land use patterns, revealing how transportation infrastructure influences business location choices and urban land use structure.

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# Chapter One

## Introduction

State and local governments develop or expand transit systems to stimulate economic development. So billions of dollars have been spent on fixed rail transport infrastructure in the past three decades (Freemark, 2014). Many of these rail systems are described as a catalyst for economic growth and development. As additional cities consider constructing or expanding their transit systems, it is important to understand rail transit's external benefits: does rail transit cause agglomeration economies? If rail transit is an important source of economic growth, how does transit intensify job opportunities and population in cities? Existing literature reveals some evidence of possible external benefits from transport infrastructure (Chatman & Noland, 2011). But studies focus on residential property values around station areas (e.g.Kim & Lahr, 2014). Although changes in properties values can quantify the economic impact of transit infrastructure investments to some extent, the potential effects of intensifying employment opportunities and economic agglomeration are not fully captured.

My dissertation research is inspired by the case study of Noland et al. (2014) on Portland and Dallas to study new firm agglomeration and transit access. Their study examines whether new firms are more likely to form around rail station areas in Portland and Dallas regions using the National Establishment Time Series (NETS) database. They find that new establishments tend to cluster near rail transit stations in greater Portland but not in the greater Dallas.

I explore factors that determine where new establishments will locate as well as their subsequent survival rates in Hudson County, New Jersey. Due to the existence of

economic agglomeration externalities, many believe that establishments will cluster to share tacit or explicit information and/or pool labor. This implies communication, and to lower transportation costs. With the hypothesis that transport infrastructure directs where new establishments locate, I will explore the impacts of changes in the accessibility of new light rail services on the location patterns of new firms and their subsequent survival in Hudson County, New Jersey.

Hudson County is a relevant case for studying transit access and establishment formation is that, a traditional urban area that had and continues to have plans to construct rail transit. Hudson County is densely urbanized and within a major metropolitan area with high land, infrastructure, and labor costs. The county has many pre-World War II industrial sites built that require redevelopment/infill development. This creates particular difficulties for development, such as land assembly and regulatory constraints. In addition, Hudson County has long suffered from traffic congestion and has recently invested in a multimodal transit system not only serves existing commuters, but also to spur future urban development.

Both location theories and new economic geography (NEG) emphasize the influence of transport costs on the attractiveness of a location to firms, and consequently the births of new business establishments. On the one hand, location theories suggest that geographical proximity can generate external benefits, known as agglomeration economies. Agglomeration economies can arise from clustered economic activities. The availability of public infrastructure, such as transport networks, create urbanization economies that also can influence a firm's production costs through labor. On the other hand, new economic geography emphasizes transport costs as a location factor in a

market with imperfect competition and different degrees of interregional labor mobility. Consequently, transport becomes an important factor that influences entrepreneurs' location decisions. Empirical evidence confirms that transport infrastructure can lead to agglomerations of economic activity (Chatman & Noland, 2014; Holl, 2004c; Maoh & Kanaroglou, 2009), hence, it seems reasonable that businesses may locate close to transit stations to exploit ready access to transportation for their employees and customers, the co-location of competition and complement of businesses, nearby amenities, and other urban infrastructure (e.g., water and sewer capacity) , and policy incentives provided by local governments.

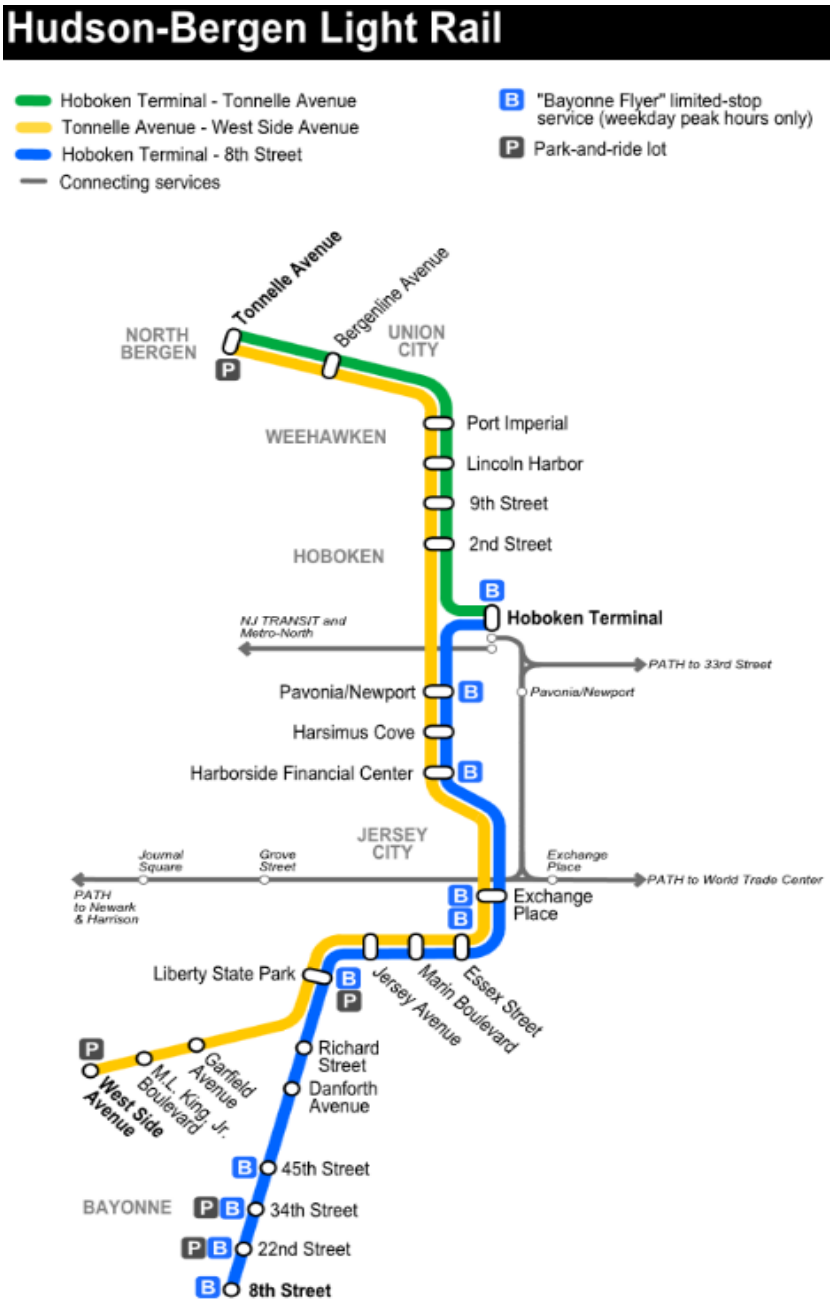


Figure 1.1: Hudson-Bergen Light Rail

My study covers the Hudson-Bergen Light Rail (HBLR) network (see Figure 1.1), which first opened in April 2000 and opened its latest station in 2011. It has 24 stations and provide regular service (from 5 AM to 2 AM daily) to municipalities along the Hudson River, from Bayonne at its southernmost, to Jersey City, Hoboken, Weehawken,

Union City and to North Bergen at its northernmost. According to NJ Transit (2017), average daily ridership of the HBLR was 51,939 in Fiscal Year 2017, and one-way adult fare is $2.10 with various frequent passenger discount plans. This fare includes free transfers to connecting NJ Transit buses. During peak hours headways are 5 minutes, but they fall to 20 minutes during off peak travel times. The HBLR enhances connectivity to major transportation terminals of Hoboken, Pavonia-Newport and Exchange Place, which connect passengers to lower and midtown Manhattan, other parts in New Jersey, as well as to Philadelphia, Boston and Washington, DC. The HBLR network serves as a useful case not only because it is relatively new, but also because the municipalities that HBLR serves have been undergoing development since the late 1980s (Hudson County, 2012).

## 1.1 Background of Hudson County

### 1.1.1 Hudson County since the 1970s

Hudson County's economy was built on industrial, port, and railroad activities. It experienced an economic boom during WWI with building for wartime efforts. However, just like many other traditional industrial urban areas, the county lost much of its population to the suburbs after WWII. Additionally, there was a loss of jobs in the area with the start of globalization and transition to the post-industrial economy. By the 1970s, Hudson County's waterfront area was dominated by abandoned rail yards, empty manufacturing sites, and contaminated land.

As costs in New York City accelerated, developers opted to rehabilitate housing stock in Hudson County from the mid-1980s. Much of it concentrated in Jersey City and Hoboken. In addition, firms in FIRE (finance, insurance, and real estate sectors)

industries (such as Merrill Lynch and Morgan Stanley) began to move into the area during the 1990s. New Jersey Governor Thomas H. Kean believed that transit would aid economic development along the Hudson River waterfront area and directed the New Jersey Department of Transportation to study how transit system best serve the waterfront area. This inquiry resulted in the conception and development of the Hudson Bergen Light Rail (HBLR).

Municipalities along the Hudson River waterfront area used various redevelopment tools available to stimulate Transit Oriented Development (TOD) along the HBLR system. These tools include the New Jersey Redevelopment and Housing Law, New Jersey Urban Enterprise Zones Act, Payment in Lieu of Taxes (PILOT), and Brownfield and Contaminated Site Act. Development continued and has expanded to other municipalities along the waterfront area in the 2000s (Hudson County, 2012), despite to several major economically harmful events, including the 9/11 attacks (2001), the financial crisis in 2007-2008, Hurricane Irene (2011), and Hurricane Sandy (2012).

### 1.1.2 Population and Income

According to the American Community Survey (ACS) 2006-2010[1] 5-year estimated data, Hudson County residents use transit and non-motorized modes to work at much higher rates than the rest of New Jersey (47.8% versus 14.2%). Yet, despite the extensive transit systems in the region, mode split for the commute trip is very different within the county. Typically, residents in municipalities within the light rail system service area travel to work by public transportation and non-motorized modes at much

[1] I used ACS 2006-2010 instead of ACS 2011-2016 because the NETS data covers 1990-2013 only.

higher rates. Except Bayonne (21.4%) and North Bergen (27.9%), all municipalities within the HBLR service areas have more than 39% of residents travel to work by public transportation, and Hoboken has the highest share, with over 56% of residents using transit modes for their commute and 10.2% residents using bicycles or walking to work. In contrast, fewer residents in East Newark, Harrison, Kearny and Secaucus use transit services for their trip. Less than 20% of residents in Kearny and Secaucus take transit to work, and around 26% in East Newark and Harrison.

The economy in Hudson County has shown a significant change since the 1980s. By looking at decennial census data and ACS data, median household income levels have increased from $46,211 in 1980 to $54,348 in 2010 (adjusted to 2009 chained dollars). Although the state has seen a decrease in median household income from 2000 to 2010 due to the financial crisis, Hudson County has still maintained a slight increase of 1.6% within the same period. However, both the county and the state have experienced a decrease in median household income from 2010 to 2014, due to the recession and trigger events (i.e., hurricane Sandy).

Table 1.1 Median Household Income Changes in Hudson County and New Jersey

(Adjusted to 2009 chained Dollars)

| | Hudson County | New Jersey |
|---|---|---|
| 1980 | $46,221 | $63,625 |
| 1990 | $52,866 | $69,982 |
| 2000 | $53,488 | $73,349 |
| 2010 | $54,348 | $68,640 |
| 2014 | $53,669 | $65,581 |

Population has also grown from 556,972 in 1980 to 669,520 in 2014. Table 1.2 shows employment share by major industrial sectors and how these have changed over time in northern New Jersey (Bergen, Hudson, and Passaic Counties). According to statistics from the New Jersey Department of Labor and Workforce Development,[2] these major sectors combined have been relatively stable in terms of their share of total employment size in Northern New Jersey. Yet, manufacturing has experienced the largest reduction in employment, dropping from more than 17 percent in 1990 to only 6.5 percent in 2014. In contrast, the education and health services sector has experienced a large growth in regional employment share. Professional and business services sector, and leisure and hospitality sector also have grown substantially during the same period. Industry shares of employment in Hudson County have changed somewhat among these major industries. Most notably, the share of employment in the manufacturing sector is only 3.4 percent, much lower than the region's average; and the financial activities sector

[2] New Jersey Labor Force Estimates by Area, http://lwd.state.nj.us/lpaapp/app?service=page&page=LabForceEst

has a much higher share of employment than the region's average, at the rate of 15.1 compared to the state rate of 7.5 percent.

Table 1.2 Share of Employment in Major Industrial Sectors in Northern New Jersey

| | Northern New Jersey | | | Hudson | |
|---|---|---|---|---|---|
| | 1990 | 2000 | 2014 | 2014 Estimated Employment | |
| Manufacturing (30) | 17.4% | 11.8% | 6.5% | 8,450 | 3.4% |
| Trade, Transportation, and Utilities (40) | 26.1% | 25.2% | 23.3% | 61,000 | 24.2% |
| Financial Activities (55) | 7.0% | 8.0% | 7.5% | 38,050 | 15.1% |
| Professional and Business Services (60) | 13.9% | 15.5% | 15.7% | 34,850 | 13.8% |
| Education and Health Services (65) | 8.8% | 11.8% | 16.7% | 49,500 | 19.7% |
| Leisure and Hospitality (70) | 5.5% | 5.7% | 7.6% | 17,750 | 7.1% |

### 1.1.3 Hudson's Economic Landscapes

The key sectors in New Jersey are: biotech, life sciences and pharmaceuticals, information and communications technology, advanced manufacturing, transportation and logistics, and financial services.[3] State and local agencies support entrepreneurial activities, implying the state has a supportive environment for firm formation and growth. And the New Jersey Economic Development Authority (NJEDA) offers a wide variety of financing, tax credit, incentive, and assistance programs to stimulate firm formation, growth and relocation.[4]

Hudson County has received EDA grants for about 14 projects since 1995, and at least 6 EDA funded projects are for the (re)construction of transportation infrastructure

[3] http://www.nj.gov/njbusiness/at-a-glance/employers/
[4] http://nj.gov/njbusiness/financing/

(for instance, the reconstruction of Westside Avenue)[5]. In addition, Hoboken City, Jersey City and West New York are eligible for the NJEDA's urban transit hub program.[6] This program allows these municipalities to use EDA funding and assistance to develop transit-related projects. Other than loans, bonds, tax incentive, technologies and policy assistants from NJEDA, various state and local agencies are engaged in economic growth in Hudson County as well. For example, the Hudson County Chamber of Commerce was established in 1888 to provide services to business in Hudson County. Beyond policy support, the proximity to New York City also connects the county to one of the most robust urban economies worldwide.

But there are also constraints that prevent businesses from locating in New Jersey. They include high taxes, high costs for property and high labor costs. For example, the current sales tax in New Jersey is 6.625 percent, while Pennsylvania is at 6 percent and New York is at 4 percent. But New York City has additional sales tax of 4.5 percent and Philadelphia has additional city income tax of 3.89 percent. Additionally, as indicated in the article from *Business News Daily* (2016), small business owners also identified fear of future disasters, particularly hurricane and flooding, as a concern.

Hudson County ranks second among counties in which people work within in the state according to the 2006-2010 American Community Survey, with 245,911 workers based on workplace geography (10.1 % of state total). And Jersey City, Secaucus, Hoboken, and Kearny all rank within the top 20 among the states 565 municipalities throughout the state as a workplace.

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[5] Hudson County Gov. Division of Planning, 2010 Comprehensive Economic Development Strategy (CEDS)

[6]There are 13 municipalities under NJEDA's urban transit hub program throughout the state.

Table 1.3 Number of Workers Based on Workplace Geography: 2006-10[7]

| Rank | Municipality | County | Number of workers |
|---|---|---|---|
| 1 | Newark | Essex | 163,812 |
| *2* | *Jersey City* | *Hudson* | *123,998* |
| 3 | Trenton | Mercer | 51,994 |
| 4 | Atlantic City | Atlantic | 51,128 |
| 5 | Elizabeth | Union | 50,819 |
| 6 | New Brunswick | Middlesex | 40,536 |
| 7 | Toms River | Ocean | 40,032 |
| 8 | Paterson | Passaic | 39,618 |
| 9 | Hackensack | Bergen | 38,395 |
| 10 | Paramus borough | Bergen | 37,812 |
| 11 | Camden | Camden | 33,217 |
| *12* | *Secaucus town* | *Hudson* | *32,241* |
| 13 | Vineland | Cumberland | 32,026 |
| 14 | Clifton | Passaic | 31,781 |
| 15 | Morristown town | Morris | 25,623 |
| 16 | Princeton borough | Mercer | 23,279 |
| *17* | *Hoboken* | *Hudson* | *21,343* |
| 18 | Linden | Union | 20,242 |
| 19 | Passaic | Passaic | 19,841 |
| *20* | *Kearny town* | *Hudson* | *18,492* |

Micro-level longitudinal public data for establishments are difficult to obtain. Using data retrieved from Youreconomy.org (YE), Figure 1.4 shows the trends of establishments in New Jersey and Hudson County between 1995 and 2013. The number of establishments in Hudson County has continuously risen since the 2000s with growth rates higher than the state average (see Table 1.4).

[7] Data source: New Jersey Department of Labor and Workforce Development http://lwd.dol.state.nj.us/labor/lpa/LMI_index.html

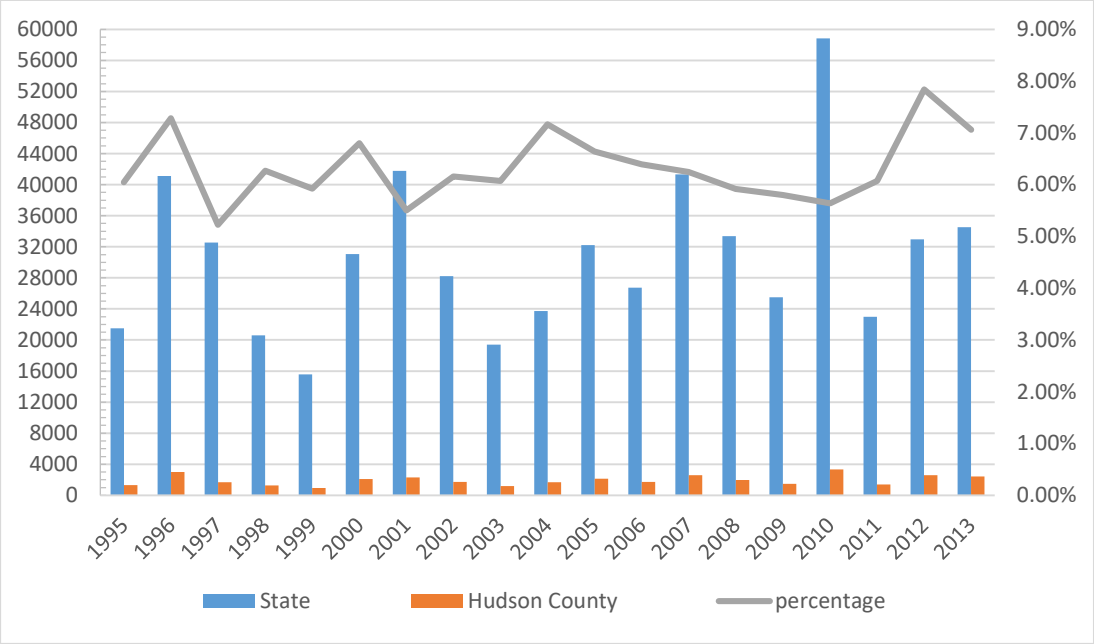


Figure 1.2 Total New Establishments in Hudson County and New Jersey, 1995-2013[8]

Table 1.4 Survey of Business Owners (SBO): Statistics for All U.S. Establishments

| Year | Hudson County | | New Jersey | |
|---|---|---|---|---|
| | total number of establishments | percent change | total number of establishments | percent change |
| 2002 | 46,277 | | 708,837 | |
| 2007 | 55,520 | 20.0% | 781,622 | 10.3% |
| 2012 | 61,484 | 10.7% | 792,088 | 1.3% |

While Table 1.4 shows a perpetual rise in the number of establishments in Hudson County. But it is not clear if the HBLR is the cause. By probing into the association between access to HBLR and establishment births in Hudson County, I hope to gain a better understanding of the impacts of access to transit on establishment formation

[8] Exclude self-employed. Data retrieved from www.youreconomy.org

### 1.1.4 Transit Service in New Jersey

The rail system is relatively dense in New Jersey compared to other states across the country: there are three light rail lines (Hudson-Bergen line, Newark line, and River line), eleven heavy rail commuter lines (Northeast Corridor line, Princeton Branch, North Jersey Coast line, Raritan Valley line, Main line, Bergen County line, Pascack Valley line, Meadowlands Rail line, Montclair-Boonton line, Morristown line, and Gladstone Branch), Port Authority Trans-Hudson (PATH), Amtrak, and PATCO. In total, they cover about 5,823 square miles (67% of state landmass) throughout the state (New Jersey Transit, 2017). NJ Transit began to operate most of its commuter rail service from 1983. After 30 years of operation, it now operates all passenger rail within the state, except for Amtrak, PATCO, the Port Authority Trans-Hudson (PATH). and two SEPTA regional rail lines in the Trenton line, and the West Trenton line; each of which cross the border from New Jersey to access a single station. The rail system in New Jersey has been expanded since the 1990s: for example, the new Midtown Direct service was doubled in the 1990s, and a few new stations were opened in the 2000s. One at Secaucus enabled direct access to Manhattan for many in Bergen and Passaic counties.

There are multiple transportation options that connect Hudson County with other towns in the metropolitan area. This includes the commuter rails, PATH and ferry service. And the HBLR connects these regional transit services with other municipalities within the county. Hoboken and Secaucus are the two major public transportation hubs for heavy rail service: nine out of eleven commuter rail lines have stops in these two municipalities. PATH, a 24/7 rapid transit system connects two major CBDs in the

region: Newark, and the lower and midtown Manhattan in New York City via Harrison, Jersey City and Hoboken.

Transit service is important to New Jersey's economic landscape. The current NJ Transit system serves over 220 stations with 295,173 passenger trips on an typical weekday (NJ Transit, 2015), It links the entire state, which is comprised of two major job centers: metropolitan New York City and metropolitan Philadelphia. In addition, transit service is particularly important in the New York-New Jersey-Philadelphia corridor due to inherent auto traffic congestion problems affiliated with Manhattan's island geography and New Jersey's role as a crossroads for the Northeast U.S.

### 1.1.5 Previous Studies on HBLR

Some scholars have studied the Hudson Bergan Light Rail (HBLR) since its inception to investigate the line's impacts and potential. Two studies have looked at change in transit ridership and have concluded that the Hudson Bergen Light Rail promotes transit ridership in Hudson County (Liu, 2009; Liu, Deng, Chu, Liu, & Li, 2015). Another case study has found that brownfields have been remediated and developed near HBLR stations in Jersey City and Hoboken (Gorewitz et al., 2006)**.** Kim and Lahr (2014) investigate residential property repeat-sales data from 1991 to 2009 in Hudson County and found that residential property values are influenced by proximity to HBLR stations, with appreciation rates dropping with distance from HBLR stations and dissipate at one quarter of a mile from HBLR stations. Gordon et al. (2013) also call for a future HBLR extension from Bayonne to Staten Island as a "gap-filler" to spur transit

ridership and future development. Yet, there is no study exploring the external economic influence of the HBLR on businesses.

### 1.2 Research Questions

Stimulating economic development by concentrating businesses and jobs near transit stations can be an important reason to develop transport infrastructure. But the relationship between public transit systems and development patterns of new establishments remains largely unknown, especially at a fine geographic scale. Thus, I plan to explore whether blocks closer to a HBLR station experience more establishment openings in Hudson County, New Jersey.

I have two focal research questions I intend to answer through my study. Does the change in accessibility through improved transit services, new infrastructure, and built environment, alongside the reduction in transportation costs, affect the birth of businesses? That is, do new establishments tend to co-locate with transit facilities? Second, the location choice of new establishments also affected by the presence of other nearby establishments, creating what appears to be an economic agglomeration, either competitive or cooperative. The change in accessibility brought by new transit service, with the consequent reduction in transportation costs, could affect the spatial distribution of business establishments. Additionally, the nearby available opportunities, as well as the presence of other businesses that may generate agglomeration, can influence the location of a new firm.

- What are the determinants of business formation in a densely developed urban area?

- Are the impacts of rail service on establishment birth in a densely developed urban area similar to those discovered in previous studies? [9]
- How do the determinants of business formation differ across sectors?
- How do local contexts (for example, local development plans, local tax incentives) contribute to the process of establishment birth and survival?

I attempt to answer these questions by considering the following issues. First of all, I intend to capture the effects of the accessibility of the new light rail service on business formation, using Hudson County as my study area. Second, my analysis will consider the presence of spatial spillovers from nearby businesses and infrastructure simultaneously. Third, detailed level spatial and firm-level factors will be included via geographic information systems (GIS) and the National Establishment Time Series (NETS) data set to construct econometric models. Fourth, my analyses will cover a comprehensive set of sectors not just manufacturing. Last, but not least, I will conduct interviews and make field observations to better understand the historical economic landscape of the study area and to identify possible contextual processes or factors that can be associated with business formation and subsequent survival.

Business closures and relocations provide useful information on the relative importance of location characteristics. In this sense a solid understanding of business survival is of interest too. Yet, our understanding of why some businesses survive longer than others remains insufficiently studied. Therefore, unveiling success factors could provide insight into firm location preference. Scholars from various disciplines have

[9] Noland et al. (2014) conduct a case study on transit access and new firm agglomeration in Portland and Dallas and find positive relationships between new firm formation and rail station proximity.

investigated issues such as business formation, post-entry performance (growth and survival), relocation, and closure (Audretsch & Mata, 1995; Fotopoulos & Louri, 2000; Mata, Portugal, & Guimaraes, 1995) But mainstream industrial economics analyses has been largely non-spatial in nature. The role of location, once entry is established, has not been analyzed much at all (Fotopoulos & Louri, 2000). For example, with a focus on firm age, Sahin and Pugsley (2015) studied firm dynamics in the U.S. using the Business Dynamics Statistics (BDS) database and found business cycle properties and the lifecycle dynamics of firms remained largely unchanged. They treated establishments in U.S. states, omitting differences across states that might affect firm dynamics.

Including a spatial dimension to the analysis of establishment survival at the micro scale leads to the following research questions:

- Does the survival of new businesses differ significantly among different areas?

Thus, following the analysis of determinants of firm formation in Hudson County, I will also try to explore the association between business' survival and access to transit infrastructure.

Additionally, recent literature emphasizes the importance of space in firm dynamics because accounting for location factors can yield new insights into economic phenomena that are not captured in a spatial model.

- Is a micro geographical scale suitable for analyzing industrial dynamics?
- What are the implications of business formation to urban land use and contemporary urban form?

I will perform statistical probes for answers to these questions using spatial factors, which will be supplemented structured interviews with planning professionals, government officers, and developers from Hudson County.

### 1.3 Dissertation Outline

The remainder of my dissertation is structured as follows. In Chapter Two, I will introduce the relevant theories and literature on business formation, agglomeration and subsequent survival. The theoretical background on new business formation has been developed in various disciplines, and scholars in different theoretical fields have conducted empirical studies on the topic. My discussion of the literature mainly focuses on the impacts of transport on firm locations, knowledge spillovers, agglomeration economies, and firm survival. Data and research methods will then be introduced in Chapter Three. Sections in this chapter explain in detail that the processes of selecting datasets and approaches for this research project. In Chapter Four, I discuss my case study to understand public officers and developers' perspectives of transit access and new establishment births. My in-depth analysis of interviews with public officers and local developers provides contextual understandings about the relationship between access to public transit services and new business formation in my study area. The following three chapters, Chapter Five and Chapter Six are the analysis of the distribution of new establishments, and patterns of their formation; and Chapter Seven will be the analysis of their post-entry performance, respectively. I begin the analysis by presenting evidence on the spatial and temporal patterns of new establishments in Hudson County, New Jersey. Chapter Five focuses on the application of spatial analysis tools to explore and describe

the temporal-spatial patterns of businesses among different sectors within Hudson County in relationship to the access of transit service. Chapter Six focuses on the application of negative binomial and generalized estimating equations (GEEs) regression models analyzing factors that are associated with new establishments birth, and follows with a detailed discussion of establishment formation by industry and business employment size. In Chapter Seven, I take advantage of NETS data to study new establishments' post-entry performance using both nonparametric and semi-parametric approaches. I focus on the application of survival modeling. By exploring the relationship between establishments' post-entry performance and their proximity to transport infrastructure, this chapter contributes to our understanding of the post-entry performance of new establishment in a U.S. urban region, as well as providing important implications for policies designed to promote the survival of new business. Chapter Eight contains the summarized findings of this dissertation research, discusses contributions of my study, suggests polies and alludes to possible future studies.

# Chapter Two

# Theories and Existing Studies

## 2.1 Theoretical Background

Theories on new business formation stem from various disciplines, and a growing number of scholars have conducted empirical studies on the topic. My discussion of the literature in this chapter focuses on the impacts of transport on firms' location choice, industrial dynamics, agglomeration economies, entrepreneurial activities and knowledge spillovers, and firm survival.

### 2.1.1Transport Infrastructure

Transportation is key to the location of most industries in terms of costs for goods transport; service delivery, travel costs for employees and customers; and so on. Land use theories, location theories, and new economic geography (NEG) provide theoretical frameworks that examine the relationship between transport and firm births.

From the perspective of land use, Ricardo (1891) explains that land rent differs due to the variances in land quality and labor productivities. Von Thunen (1966) added space and, hence, transport costs to model land uses in a pre-industrial landscape to optimally locate agricultural production for his plantation. Alonso (1964) follows this by updating the model to the industrial city, lending a better understanding of central business districts (CBD). Alonso's bid rent relates urban land uses to urban land values, suggesting households tradeoff: between land costs, transportation costs, and the amount of land they desire, given the location and amount of jobs. These theories constitute the theoretical economic framework in many land use and location choice models. For

example, Lee (1982) formulated a model that predicts the probability that any given firm of a particular type is ideally able to out-bid other types of firms for a specific site.

Models in new economic geography emphasize the importance of transport costs under the imperfect market competition, alongside market size, market integration, and economies of scale in explaining the location of economic activity (Krugman, 1991). The critical underlying assumption is that: transport infrastructure improvements (or new transport infrastructure) affect the spatial distribution of businesses by providing better access to markets, and better transport connections can make areas more attractive for firms. Hence, improving transport infrastructure can influence transportation costs, agglomeration economies/competition, market size, and subsequently the spatial distribution of economic activities.

### 2.1.2 Entrepreneurship

Theories linking entrepreneurship and economic growth emerged from multiple fields. Schumpeter (Schumpeter, 1942) suggests that more entrepreneurs leads to greater economic growth. Baumol (2002) suggest that new establishments can create a large share of new jobs and often offer "productive innovation".

Endogenous growth theory links entrepreneurial activities to economic growth as well. Schmitz (1989) conceptualizes a model, in which new business formation is endogenous to economic growth and arises from rational decision-maker's choosing either to be an employee or an entrepreneur. But some scholars (Acs, Braunerhjelm, Audretsch, & Carlsson, 2009) argue that the endogenous growth framework offers no

insight into the role that entrepreneurial activities play in the transmission of knowledge spillovers since knowledge is a necessary condition to most growth models.

Another line of theoretical arguments has emerged from the field of industrial evolution or evolutionary economics (Audretsch, 1995; Jovanovic, 1982b). Scholars suggest that entrepreneurs are agents of change. They bring new ideas and stimulate economic growth through firm competition.

There appear to be two major approaches in the study of entrepreneurship. The first tries to explain who entrepreneur are, and the second focuses on regional variations in firm formation by exploring structural variations at aggregated geographical areas. Studies following the first approach focus on factors such as personality, human capital, ethnic origin. They find that entrepreneurship is associated with family tradition, entrepreneurial vison, education, and work experience (Blanchflower & Oswald, 1998; Chell, Haworth, & Brearley, 1991; Evans & Leighton, 1989; Storey, 1994). Studies stemming from the second approach explore regional variations in new business formation. Some scholars suggest that cities and regions function as “incubators” of creativity and innovation in spurring regional growth. For example, Duranton and Puga (2001) discuss the role that diversified cities play in fostering innovation. Jacobs(1961) explains cities are “open” systems that attract people from different backgrounds and the diversity that stimulates their creative capacities. Lucas (1988) follows Jacobs’s insights and argues that cities are “collectors” of human capital: they create new ideas and, hence foster economic growth.

### 2.1.3 Firm Survival

Scholars have drawn on different theoretical perspectives to examine spatial proximity and firm survival. These perspectives rely upon different assumptions about the relationship between firm survival and spatial proximity. Institutional theory highlights the embeddedness of economic actors and argues that geographic clustering enhances the possibilities of survival (Staber, 2001). Ecological theory focuses on the nature and distribution of resources available (Aldrich, 1999). It predicts that high-density business clusters reduce survival chances due to the enhanced competitive environment. A third perspective, random action theory, argues that spatial proximity is unrelated to firm survival because of the ambiguity and fortuitousness involved in the relationships among business actions and outcomes (Singh, House, & Tucker, 1986).

## 2.2 Literature Review

There are many factors that affect the location of new businesses. Factors that affect firm location choice tend to depend on firm-specific characteristics, the locality and the importance of ties to other organizations and other areas; access to markets, suppliers, capital, and information; labor supply (quality, cost, and quantity); government incentives and regulations; built environment and economies of scale. I now review the existing relevant literatures in the following section.

### 2.2.1 Industrial Dynamics

The literature on organizational ecology emphasizes the importance of firm-level characteristics, such as firm age and firm size, to explain firm location choice and growth

(Jovanovic, 1982a; Schutjens & Wever, 2000). In general, firm formation studies follow either an ecological approach or a labor market approach to identify the correlates for firm births. The former models the rates of firm births, exemplified by Sutaria and Hicks (2004), who estimates manufacturing plant formation patterns in Texas from 1976 to 1991 using Metropolitan Statistical Area (MSA) data. They show that mean establishment size, prior entry and exit dynamics, availability of financial capital, and changes in unemployment rates influence the formation of new manufacturing plants. Some conventional variables, like population or income dynamics, had no apparent influence. In contrast, the labor market approach models the labor force size. Kangasharju (2000), for example, uses region panel data to analyze the formation of small businesses in Finland. He finds that establishment size of existing firms is most statistically significant. This accords with the assumption that small firms are "seedbeds for future entrepreneurs". In addition, industry-specific characteristics are also important, because different industries experience different cyclical influences, and some are more mobile than others (Holl, 2004c; Neffke, 2009) . However, Breheny and McQuaid (1987) suggest that it is critical to distinguish two types of factors: those influence the specific region that a business chooses, and factors that influence the choice of a specific site within the region.

### 2.2.2 Transport and Accessibility

A discussion of the economic impacts of transport infrastructure has emerged and grown since the 1980s (Mikelbank & Jackson, 2000). Early aggregate studies confirmed a positive relation between access to transport infrastructure and economic growth

(Aschauer, 1989; Mas, Maudos, Pérez, & Uriel, 1996). For example, Haughwout (1997) finds that transport investments in central cities affect suburban house values. Button et al. (1995) explore the importance of transport and related infrastructure in stimulating local economic development by measuring the influence of transport facilities on the occupancy of new building in Scotland. They find that local transport infrastructure are elements in the search criteria once a firm decides to relocate. Such earlier studies mainly focus on the aggregate economic influences of transportation investment, so the micro-economic importance of transport infrastructure, and how it affects the spatial pattern of economic activities remains largely unclear (Haughwout, 1999; Holl, 2006).

Even findings from empirical studies on the impacts of transport infrastructure improvement on economic activity are inconclusive. Boarnet (1998) shows that infrastructure benefits in one county come at the expense of other competing counties in California. Chandra and Thompson (2000) find similar outcomes that new interstate highways raise earnings in the counties that get the new interstate highway and reduce earnings in neighboring counties. More recently, Schuetz (2015) examines whether new rail stations stimulate retail employment in California, and finds that new transit stations do not appear to be associated with retail employment. Mikelbank and Jackson (2000) suggest that the effects of transport infrastructure attach to its network character.

Some recent studies provide empirical evidence for the influence of transport investment on the spatial distribution of new manufacturing plants (Holl, 2004a, 2004b, 2006). Holl (2004a) confirms that the road network affects the spatial distribution of new manufacturing plants in Spain by increasing attractiveness of municipalities adjacent to transport infrastructure. He finds the influence varies by sector. Specifically, except for

those in “chemical products”, all new plants tend to prefer locations close to transport networks. Mejia-Dorantes et al. (2012), who analyze the impacts of a new metro line on firm location in Madrid, Spain, confirm that business location is related to urban accessibility. Melo et al. (2010) investigate the relationship between new firm formation and the availability of transport infrastructure in Portugal. They find that both rail and road networks are important factors to new firm formation.

Alternatively, a few scholars have adopted a survey/interview approach to examine the importance of transport on firm location decisions (Hodgkinson, Nyland, & Pomfret, 2001; Leitham, McQuaid, & Nelson, 2000). Recently, Guthrie and Fan (2016) investigate the benefits of and obstacles to transit-oriented development from the developers’ perspectives via interviews. They find that high costs of land in station areas and development regulations are the major constraints to new development. These studies generally also show that new transport infrastructure enable firms to consider a wider range of locations, so that the availability of transport infrastructure is usually part of a set of factors in a location decision.

Still, some scholars argue that the distribution of benefits from transport infrastructure investment remains largely unclear due to the mobility of firms (Puga, 1999; Venables, 1996). Furthermore, with the increasing importance of information flows, e-commerce, and rapidly decreasing costs of transport over the past few decades, some scholars cast doubt on the importance of transport infrastructure on firm location decisions. Giuliano (1988) argues that there is no consistent relationship between transport improvements and location choices, except for the early construction of the highway network. Similarly, Bartik (1989) investigates location factors for small business

start-ups at the state level and find no significant effects from highway density. Forkenbrock and Foster (1996) arrive at a similar conclusions: access to highways has become less important in businesses' location decisions. Fernald (1999) finds that vehicle-intensive industries benefit from the growth in road networks in the U.S., but road-building does not appear unusually productive. Additionally, Banister and Berechman (2003) argue that the impacts of transport infrastructure on firm location might be limited in areas with very dense transportation networks and highly localized around the new facility (for example, an airport or train station).

These studies point to an important issue, if one exists at all, of geographic scale when discussing the importance of transport infrastructure as a determinant of firm formation. When transport infrastructure is similar among regions, the effects of new transport infrastructure become more relevant to specific sites that gain accessibility advantages. For example, a study of firm location in the Chicago region finds that new businesses cluster closer to freeways (Kawamura, 2001). Similarly, other empirical studies also support that firms favor locations closer to interregional road networks that provide better accessibility (Holl, 2004a). Yet, many existing empirical studies focus on manufacturing sectors in Europe and so provide limited policy implications for the United States.

Since firms in different sectors are likely to be influenced differently by location factors due to their different input and output requirements, it is very likely that determinants of firm formation also differ by sector. This is particularly important, since service sectors are replacing manufacturing industries in advanced economies. Empirical studies can help enable a better understanding of the impacts of transport infrastructure

improvements on firm formation in the United States. Given that most existing studies examine locational effects of transport investment on the manufacturing at an aggregate geographic scale, it is important to conduct detailed analysis of locational effects of transport infrastructure improvements on different sectors and at different spatial scales.

The quality, efficiency, and cost of transportation systems affect employers' ability to access labor pools. Therefore, investing in transport infrastructure can increase the possibility of agglomeration economies via labor pooling and knowledge spillovers (Drennan & Brecher, 2012). Studies examining the links between public transit and the labor market mainly focus on job accessibility. Sari (2015) studied the relationship between the construction of a tramway line and labor market outcomes in France and found that the tramway project helped to reduce unemployment by improving access to job centers. Ozbay et al. (2003) found that accessibility changes are significantly related to changes in income and employment growth in the New York-New Jersey metropolitan area. Faulk and Hicks (2010) explore the broader impacts of transit and find that medium-sized cities with a bus system have lower unemployment rates and higher employment growth. In a more recent study, Faulk and Hicks (2016) find that counties with transit systems are associated with lower employee turnover rates, which benefits businesses by reducing their costs associated with training new employees and/or better employee-employer matches.

Some researchers focus on the relationship between transport investments and economic benefits. Public transit can increase economic efficiency by reducing congestion-related expenses for firms by enhancing accessibility and providing alternatives to the automobile. Studies find that traffic congestion reduces the size of

labor catchment areas, limits business markets, increases costs to compensate for congestion, and raises business-related transportation costs (Eddington, 2006; Weisbrod, Vary, & Treyz, 2003). These phenomena create problems for both workers and employers. Mass transit can make urban economies more efficient by intensifying firm density in a small area. For example, Drennan and Brecher (2012) estimate the effects of public transit use on office rents for Metropolitan Statistical Areas (MSAs), and find that the effect of transit use on office rents is positive in places with a high concentration of office space in the CBD. Kang (2010) evaluates the impact of a bus rapid transit (BRT) system and finds that BRT service increases employment density and therefore benefits creative industries and service sectors in Seoul, Korea. Mejia-Dorantes et al. (2012) evaluate the links between changes in transport infrastructure and economic development, finding that distance to subway stations is a key determinant of firm location. In brief, although the relationship between accessibility and economic development varies by location and occurs only in some sectors, empirical studies show evidence of the economic benefits of improved public transit service on businesses.

### 2.2.3 Agglomeration Economies

Economies of agglomeration are not a new concept. This refers to the decline in average cost as more production accumulates within a specified geography. Both theoretical and empirical studies show that agglomeration economies are an important source of uneven distribution of economic activities and economic growth across cities and regions. The driving mechanism in agglomeration economies is that larger agglomerations improve productivity, which consequently leads to higher economic

growth. For instance, Graham (2007), who examines the links between agglomeration, productivity and transport investment; confirms that denser economic activity leads to positive externalities, particularly in service industries.

The major underlying benefits of economic agglomeration are: the concentration of employment, shared available venture capital, shared resources, and information exchanges. Because shared labor pools, knowledge spillovers, economies of scale, and investments in public amenities all affect firms' location decisions, agglomeration economies play a critical role in location decisions. Chinitz (1960) showed that the high cost of intra-city communication should cause firms to concentrate within a central core. And this core area would be divided into districts, each specialized in a particular industry, such as commercial banking. At the local level, activities may either concentrate in a polycentric pattern or disperse in a more regular pattern. Consequently, the effects of agglomeration economies on firms can differ across sectors, space, and time(De Groot, Poot, & Smit, 2009; Martin & Simmie, 2008; McCann & Folta, 2008).

Imperfect competition can agglomerate analogously. This raises the spectre of the conditions under which do firms opt to co-locate? Little is known about the importance of agglomeration economies to individual firm's location decisions (Acs & Armington, 2004). Early empirical studies use aggregated data with cities, regions or industries as the basic analysis unit on agglomeration. These past work provide limited insights to the effect of agglomeration economies on firms' location choice and subsequent performance. In recent years, some scholars use micro-level data to study agglomeration. For example, Graham and Melo (2009) use micro-level longitudinal data to analyze the impact of agglomeration externalities on worker hourly earnings. Noland et al. (2014) use

NETS data with block-level socio-economic data to analyze the relationship between firm births and access to rail stations around both Portland, Oregon and Dallas, Texas. The absence of empirical studies can be ascribed to data limitations and confidentiality restrictions. As agglomeration economies are microeconomic in nature and indirectly foster regional growth through their effects on firms' location decisions and performance, more micro-level analysis is needed (Martin & Simmie, 2008; Neumark, Zhang, & Wall, 2006).

Empirical work on agglomeration economies can be characterized by a large diversity of approaches. Most early work (pre- 1990s) simply use population to measure urban agglomerations since those studies assume a constant population elasticity of productivity for cities (e.g. Sveikauskas, Gowdy, & Funk, 1988). Ciccone and Hall (1993) use employment (place of work) density instead to better capture the productivity benefits of clustered economic activities. More recent studies adopte new measures that are not restricted to geographic boundaries (Graham, 2007; Graham & Kim, 2008; Rice, Venables, & Patacchini, 2006). Another group of literature builds on sector-specific localization economies, which stem from transport cost savings of firms, input-output relations, human capital externalities, and knowledge spillovers (Henderson, 2003). Empirical studies in this approach show that the relation between agglomeration and growth is ambiguous and indecisive mainly due to issues associated with model specification, scale of time and space, data aggregation, and definitions of growth (Beaudry & Schiffauerova, 2009; De Groot et al., 2009). In brief, I account for recently developed agglomeration effects that stem from specialization and diversity in local economies.

One type of external economy arises from knowledge. Audretsch and Feldman (1996) introduce the notion of a relationship between agglomeration and regional performance that results from knowledge spillovers and entrepreneurship. Many studies argue that knowledge spillovers tend to be bounded by geographical proximity of entrepreneurs, high-tech firms and research institutions; and that geographical proximity facilitates knowledge sharing and subsequent innovation. Case studies provide empirical evidence, and econometric analysis show that knowledge spillovers are quite localized (Audretsch & Feldman, 1996; Cooke, 2001). Because new knowledge generates benefits to other agents through different spillover mechanisms, it is necessary to understand the geographical structures that are associated with these positive spillovers for economic development policies to stimulate the knowledge-based economy in society. Consequently, it is necessary to understand how firms or entrepreneurs decide where to form their new businesses because these spatially bounded externalities are related to their decisions.

Economic growth models show that knowledge spillovers between economic agents play an important role in the economic growth and innovation process, leading to external economies of scale in production (Romer, 1986). Additionally, knowledge spillovers appear to lead to localization economies agglomeration (Henderson, 2003). Santarelli and Vivarelli (2007) review the process of entrepreneurship, firm birth, and survival and find that social capital (i.e., interpersonal relationships) helps new firms get started, indicating agglomeration and knowledge spillovers can be a key to new firm formation. Oort and Bosma (2013) find that human capital, patenting activity, and entrepreneurship facilitate productivity and are all linked to regional economic

performance. But little is known about specifics of the externalities related to knowledge spillovers.

Accessibility is often conceptualized under the framework of urbanization economies. Accessibility benefits can stem from transport infrastructure, better accessibility to various resources (such as information, larger labor markets, potential customers, suppliers, and knowledge institutions). Because transport-based accessibility can lead to cost efficiencies, it is considered a benefit that emerges from spatial externalities (Rietveld, 1995). Although measures of proximity to transport infrastructure have been applied in various empirical urban economics studies (Leitham et al., 2000; Shukla & Waddell, 1991), the influence of transport infrastructure is often implicitly acknowledged in urban and regional interaction (De Bok & Van Oort, 2011). Hence, some scholars (Eberts & McMillen, 1999; Fingleton, McCann, & Fingleton, 2007) suggest that transport infrastructure should be separated from urban density and represented explicitly in empirical research because it is conditioned on spatial interaction. De Bok and Sanders (2005) suggest that measures of proximity to transport infrastructure can be significant determinants in the location preferences of firms. But empirical evidence explicitly on the relationships between accessibility and new firm formation are limited.

Because economies of distance and the transportation of products and information are important features of the economic agglomerations, it should be obvious that accessibility and agglomeration are intertwined. A firm's physical accessibility to other locations within the urban region generates distinct local advantages (Geurs & Van Wee, 2004). Since the 1990s, a growing body of empirical literature has emerged that explores

whether spatial circumstances lead to agglomeration economies (Rosenthal & Strange, 2003, 2004). Although empirical studies suggest that both accessibility externalities and agglomeration economies are important determinants of the uneven distribution of economic activities across cities and regions, our knowledge about the importance of these phenomena for firms' actual location choice remains largely unclear**.** Bok and Oort (2011) confirm that agglomeration and accessibility attributes are significant determinants for a firm's relocation decision, but firm level attributes are more important than are agglomeration and proximity to transport infrastructure at least in the Netherlands.

### 2.2.4 Entrepreneurial Activities and Knowledge Spillovers

Economists have long emphasized the critical role of entrepreneurship for economic growth because entrepreneurs are prime movers of economic change (Schumpeter, 1934, 1947). But there is much heterogeneity within the broad category of entrepreneurship (Davidsson, 2006; Santarelli & Vivarelli, 2007). Measures of entrepreneurship vary in the following ways: business startups, new establishment or self-employment. Due to the inconsistency of the term in both theoretical and empirical studies in the field, it is difficult to synthesize across studies to define commonality in "entrepreneurship".

Many studies have confirmed that entrepreneurship is important for labor markets in the U.S. (Acs, 2006; Haltiwanger, Jarmin, & Miranda, 2013; Neumark, Wall, & Zhang, 2011)**.** For instance, Acs (2006) finds that higher rates of entrepreneurial activity are strongly associated with faster growth in local economies. Haltiwanger et al. (2013)

investigate the relationship between different types of firms and employment growth, and confirm that startups and young businesses play a key role in both gross and net job creation. Acs and Armington (2004) identify that differences in levels of entrepreneurial activity, diversity among geographically proximate industries, and the extent of human capital are all positively associated with growth rates in all sectors other than manufacturing. A number of studies also highlight that in addition to stimulating economic growth, entrepreneurship also generates social benefits, like increasing technological change to catch up with more developed ones (Acs, Audretsch, Braunerhjelm, & Carlsson, 2012; Acs & Varga, 2005).

Studies on the geography of entrepreneurship mainly focus on determinants of spatial variations of new establishment, and many recent empirical studies explore the geography of entrepreneurship (Acs & Storey, 2004; Keeble & Walker, 1994; Keeble & Wever, 1986; Koster, 2007; Tamasy, 2006). In the search for economic effects of entrepreneurship in recent years, there has been increasing attention to the spatial dimension of entrepreneurial activities (Acs & Storey, 2004; Bosma & Sternberg, 2014; Bosma, 2009; Reynolds, 1994). For instance, Bosma and Sternberg (2014) investigate how entrepreneurship activities vary across European cities and confirm that spatial contexts are important for firm formation, because urban areas are more entrepreneurial than their counterparts. However, how location factors affect individual firm location choice behavior or firm performance remains largely unclear. There seems to be two main reasons for this omission: conceptually, it is hard to link the performance of individual firms to regional characteristics in models; empirically, it is difficult to analyze firm locational choice and growth in a spatial context due to the scarcity and high cost of

longitudinal firm level data (Audretsch & Dohse, 2007). My analysis applies a firm-level longitudinal dataset that allows the analysis of firm birth at a fine geographic scale. This could enable me to fill a gap in the existing literature.

### 2.2.5 New Firms Survival

The knowledge of what happens after firms enter a market is also important. The effects of new firms on employment and the growth of the economy can depend on how long they survive. Performance outcomes of new establishment located in geographic proximity to one another remain largely unclear, because analysis of new firm survival had not receive much attention until the 1980s (Lin, Tung, & Huang, 2006). Although there are empirical studies on the influence of transport infrastructure on firm formation, surprisingly, very few studies actually explore the relationship of new establishment' accessibility to transport infrastructure and their post-entry survival and expansion.

Typically, firm survival rate refers to the fraction of the total number of firms that survived for at least *t* years (for example, Agarwal & Audretsch, 2001). Accordingly, the *t*-years new firm survival rate is measured by the fraction of the total number of newly established firms that survived after *t* years (Lin et al., 2006). Some studies interpret the firm survival rate as the probability of survival, and if a firm exists in a given year, it is coded with a value of "1" for a binary variable (Cressy, 1996; Evans, 1987; Staber, 2001). Additionally, some studies interpret firm survival rates indirectly through firm exit rates (Acs, Zhang, & Armington, 2007; Keeble & Walker, 1994).

There is a growing body of literature on firms' post-entry performance, and many researchers have focused on what relate to new firms' survival (Audretsch & Mahmood,

1995; Geroski, Mata, & Portugal, 2010; Holmes, Hunt, & Stone, 2010; Mata & Portugal, 2002; Mata et al., 1995). Those determinants of firm survival have been classified into firm, industry, and locational factors. Major firm-specific factors include firm size, post-entry performance, capital and resource constraints, and the timing of entry (Bayus & Agarwal, 2007; Dowell & Swaminathan, 2006; Helfat & Lieberman, 2002; Klepper, 2002; Mata et al., 1995). For industry-specific factors, industry-specific capital, technology, market, and technological regime appear to play important roles in new firm survival (Audretsch & Mahmood, 1994; Mata & Portugal, 2002; Romanelli, 1989).

In addition to human capital and financial capital, scholars also believe intangible assets are critical for the survival of new firms (Augier & Teece, 2005; Hormiga, Batista‐Canino, & Sánchez‐Medina, 2011; Lichtenstein & Brush, 2001). They identify relational capital, such as location, reputation, relationships with other businesses and customers, support from informal relations, and so forth that are important for the survival of start-ups. New businesses are more likely to fail because of the initial absence of entrepreneurial experience and trust from customers. For example, Abatecola and Uli (2016) find that organizational routines, entrepreneurial orientation and proactivity, and experience are key entrepreneurial competencies that can improve the survival chances of new establishments in the service industry. The instability among start-ups negatively affects their survival in their early years.

According to the literature above, some characteristics relevant to firm survival, for example, are firm size, ownership, and sector. But most studies focus on manufacturing firms or treat all new establishments as the same. In the light of this, existing studies might have some incorrect conclusions because business cycles, average

scale, location preference, and so forth differ by industry and region. Therefore, it is desirable to model firms' survival by size and sector separately, because there are strong economic grounds to believe that firms at different sizes/industries are affected differently by different factors.

Given the size of the database adopted in this dissertation research, I will be able to analyze separately the factors affecting the survival of establishments with different entry-size and industrial sector. As such, my study will contribute to our understanding of new establishment' post-entry performance in a U.S. urban region, as well as to provide valuable implications for policies designed to promote the growth and survival of new establishment.

Location matters. It offers factors necessary for a new firm to grow. Geographic proximity enables firms to enjoy positive agglomeration externalities that can enhance their survival. Firms can gain relative advantage through technological knowledge spillovers (Audretsch & Feldman, 2004) and access to information about business opportunities (Shane, 2000). So larger agglomerations can potentially decrease the potential of failure for new establishments, and the experience might spread (Leone & Struyk, 1976). For example, Klepper and Simons (2000) find that firms can survive longer if they are located in the geographic center of their industry. In contrast, some scholars find that firm location does not affect firm life length. When Holmes et al. (2010) investigate new firm survival in the North-East region of England, they find that firm-specific, macroeconomic and industry-specific variables have important implications for firm survival, but specific firm location does not.

Scholars argue that geographic concentration can constrain new firm survival, because proximity increases spatial competition. For instance, Sorenson and Audia (2000) find that geographic concentration lead to firm failure and the distribution of production places constraints on entrepreneurial activities. Staber (2001) finds that spatial proximity increases competition between firms and result in higher mortality rates in Germany's knitwear industry. Hormiga et al. (2011) conduct surveys with business owners and confirm that proximity and accessibility to customers are important for commercial and retail businesses. These findings seem to suggest that more study is necessary for further understanding of new establishment' post-entry performance.

My study will contribute to the literature by providing an additional empirical example of new firm survival at a fine geographic scale in a historically densely developed urban area. In addition, because my analysis treats firms by sector, I also hope to unmask the differences between sectors in terms of post-entry performance and link survival to transport proximity.

**2.3 Summary**

Dense entrepreneurial activities seem to indicate economic growth (Wilken, 1979). This is because earlier literature shows that a large share of new jobs is created by the formation and expansion of small- and medium-sized firms (Armington & Odle, 1982; Birch, 1979). Reynolds (1994) examines economic growth and autonomous firm dynamics in the U.S. between 1986 and 1990 and finds that firm births appear to be necessary for regional economic growth. Thus, it seems reasonable to investigate the characteristics of determinants of firm birth. The location of a new firm is critical to its

later performance and subsequent survival because the intensity of competition it depends on the density of nearby competitors (Carroll & Wade, 1991). Given that relocation can be costly, many entrepreneurs must make the nearly irreversible decision of where to create a new firm. So, understanding the processes of firm formation can shed light on urban growth processes. In addition, to the extent that countries and regions differ in urban and transportation planning policies, I think more empirical studies are necessary to identify both possible general and spatially specific location factors in explaining new firm births in the U.S.

If determinants of firm formation and post-entry performance show similar characteristics and patterns in many regions across many countries, it would suggest a general theory of firm formation. But determinants of new firm formation and subsequent survival are surprisingly diverse and findings on that often contradictory. Still, there seems to be some reasonable rationales for such inconclusive outcomes: (1) the lack of standardization with regard to counts of new businesses across studies, (2) different measures of economic growth, and (3) different socio-economic control variables across countries and regions, and (4) the general omission of spatial dimensions. Hence, my study can add evidence about these relationships.

Only a few studies examine spatial and temporal patterns of new establishments. Considering the lack of attention of previous U.S. studies to the role of transport infrastructure on firm formation and subsequent survival, my research also contributes to the literature by providing empirical evidence for the influence of transit infrastructure investment on the distribution and spatial patterns of new establishments in a wide range of sectors in Hudson County, New Jersey.

There have been very limited studies, especially with comprehensive analysis focusing on the impacts of new rail lines on firm formation at a fine geographical level (Chatman et al., 2016; Figueiredo, Guimaraes, & Woodward, 2002; Graham & Melo, 2009; Holl, 2004c; Noland et al., 2014). My dissertation fills this gap by using a firm-level dataset, the National Establishment Time Series (NETS) database, and econometric modeling on firm formation and firm survival at the census block level.

Given the lack of institutional and perspectives that can be captured statistically, I also perform qualitative research with public officers/planning professionals, local developers, and business owners to gather perspectives on the role of transit access on firm formation. This also helps fill research gaps by providing a deeper understanding of local differences that might influence firm dynamics. Although the data used in my study relate to only one metropolitan area in the U.S., the results are likely to have wider relevance, because industrial performance at both regional and national level is significantly affected by the ability of new establishments to survive and grow.

# Chapter Three

# Data and Research Methods

## 3.1 Datasets and Variables

I will explain datasets and variables used in my analysis in this section. Literature suggests consideration of the following three groups of potential determinants: 1) establishment level internal factors, 2) external factors, and 3) locational factors. For internal factors, the National Establishment Time Series (NETS) are used for detailed individual firm characteristics. External factors from various public databases are collected and analyzed. Agglomeration will be measured using population density and the concentration of employment.

### 3.2.1 The National Establishment Time Series (NETS) Database

The (NETS) is a longitudinal database created by Walls and Associates (2003) based on Dun & Bradstreet (D&B) Market Identifier File. It is useful to describe the dynamics of entrepreneurial activities by following millions of establishments from the 1990s to the present. NETS data include name of business, type of firm ownership, the self-reported North American Industry Classification System (NAICS) codes, size, location (street address), county identifiers, and other firm-demographic information. In addition, this dataset indicates whether an establishment is a stand-alone firm or a branch, including a code that links branches to their headquarters. Since the unit of measurement of NETS is a business establishment, it allows us to track when the establishment started, relocated, died (closure), was absorbed by another firm, or simply continued operations in each year subsequent to 2013.

In recent years, scholars have increasingly adopted NETS in their empirical studies in a wide range of topics. For example, NETS is used in multiple studies to evaluate business dynamics and employment growth (Neumark et al., 2011; Neumark et al., 2006). Mach and Wolken (2012) also use NETS to track firm survival in a study of how credit availability impacts small firm survivability. Fleming and Goetz (2011) use county-level NETS data to analyze whether per capita density of locally owned businesses affects local economic growth in the United States. They find a positive relationship between density of locally owned firms and per capita income growth for small firms (10-99 employees) but the density of large non-local owned firms (more than 500 employees) has a negative effect on growth. Schuetz (2014) uses the NETS to calculate employment densities, finding retail employment decreases around intra-city rail stations, and weak evidence that suburban stations gain retail employment. Chatman et al. (2016) examine the relationship between access to transit and new business formation with the NETS data in a negative binomial model in Portland and Dallas . In brief, previous empirical studies indicate the NETS dataset can be a useful database to study firm dynamics and business cycles.

The NETS dataset has both advantages and limitations like many other longitudinal datasets. The major advantage of the database is that it covers firms and establishments for the entire country annually. These advantages make NETS useful to capture the variation of all industries across time and space. However, scholars have pointed out that earlier D&B data do a poor job in capturing new businesses and total employment levels (Davis, Haltiwanger, & Schuh, 1996; Neumark et al., 2006). Because the NETS database is constructed using more recent D&B data, scholars confirm that

data quality is not a serious concern (Neumark et al., 2011). But data imputation for the NETS dataset might be problematic. According to Neumark et al. (2011), NETS imputes employment size for establishments, especially for small businesses, which limits the robustness of the dataset. Therefore, Neumark et al. remove establishments with imputed employment data in four different ways in their study. Echeverri-Carroll and Feldman (2017) compare the 2013 and 2014 NETS vintages, and find a drop in new establishment counts in the NETS between 2011 and 2013, with large revisions extending back from the end of the time series. This suggests the need for caution in interpreting the data near the end of the NETS dataset, and the authors suggest dropping the latest two years (2012-2013) of coverage. Although the NETS database is not without flaws, its complete coverage of businesses and detailed firm level information are the advantages that I value most for my study. To control for the potential influence of employment imputation, establishments with all imputed employment data will be dropped, and models for firms in different size classes will be estimated based on the number of workers. In addition, my analysis only covers establishments that are identified as either "stand-alone" or "headquarter". Therefore, firm and establishment are identical in my study.

### 3.2.2 Socio-economic Data

Major socio-economic factors related to establishment births in past studies include but are not limited to: population density, labor quality and quantity, land price, proximity to educational institutions, local land market demand/supply, GDP, and local policies. Data for these variables were collected using multiple sources and are summarized in table 3.1.

Table 3.1 Potential Variables Used in Models

| Potential variables | Sources |
|---|---|
| Firm level variables: number of existing firms, number of birth, number of death per year, etc. | NETS |
| Industry-level variables: Firm density by sector by year; Organizational size (average size of firms by sector by town); average wage by sector; and other firm-demographic information | NETS |
| Travel distance to train station/HWY entrance by walking/driving? (by road network) | calculated using GIS |
| Distance to CBD | calculated using GIS |
| Dummy of CBD | calculated using GIS |
| Distance to New York, Newark and Philadelphia | calculated using GIS |
| Open land by municipality at different times (1995, 2002, 2007) (Potential acres for development that exclude built up land, water area and preserved land) | New Jersey state government |
| Yearly GDP | Bureau of Labor Statistics |
| Demographic- percent black, percent Hispanic, rent, percent w/t car, mode of commute to work, | U.S. Census |
| Population density by block group | U.S. Census |
| Labor force- per capita median wage, median household income (census/yearly estimate) | Bureau of Labor Statistics |
| Labor force-total population w advanced degree (census/yearly estimate) | Bureau of Labor Statistics |

### 3.2.3 Locational Factors

The quality of accessibility is measured in terms of proximity to the closest HBLR and PATH train station. I use GIS to calculate travel distances from individual block to its closest HBLR station and PATH stations based on station opening dates for each year in the dataset using GIS. The HBLR system began operating in 2000 with most expansion occurring between 2002 and 2006 towards the north and south along the waterfront areas. The last station opened in 2011 in the southern corner of the county in Bayonne. I also calculate spatial distances to the closest central business districts (CBDs) in New York City (mid-town Manhattan and lower Manhattan), Jersey City and Newark; and to major cities (New York, Newark, and Philadelphia).

## 3.2 Case Study

It is impossible to gain a comprehensive understanding of business formation, the failure, longevity, and spatial patterns of firms without taking into account contextual factors. Modeling can be a great tool to investigate "what-if" questions, but alone, they cannot perfectly explain why some factors affect patterns of a firm's specific formation and how the various factors actually interact. Therefore, it seems to me that an analysis beyond econometric modeling is essential to truly understand the development processes and some of the specific contexts in which these developments happen. Case studies provide valuable and contextualized descriptive insights on those "how and why" questions.

Model outcomes cannot provide us with specific contextual explanations about how various determinants affect a firm's formation or whether jobs created by a new firm

or firms benefit local residents. Therefore, I conducted structured interviews to get a deeper understanding of the role that transit access plays in new firm births and survival. I also used data collected in my qualitative work to guide my model construction.

My qualitative work explores how city officials/planners, developers and entrepreneurs understand firm dynamics and determinants of firm formation, especially whether the accessibility to an HBLR station plays an important role in affecting firm entry or exit within the study area. I conducted structured individual interviews to collect first hand data. I used snowball sampling to contact additional interviewees to collect data with the help of local professionals. I interviewed until my responses were saturated. It is challenging to arrange focus groups with professionals and business managers in various organizations in different areas. Interviews are more manageable, and therefore I conducted a series of individual interviews with officers from local or state agencies, who deal with the design and implementation of development plans and business stimulation projects. I asked these local professionals how well the municipality implements various policies related to establishment formation, and what the benefits and constraints of establishment birth were in their area. Did access to public transit benefits establishment creation and overall business duration? I also interviewed developers/business owners to understand determinants of establishment formation and subsequent survival from their perspective: What key determinants affected the formation of businesses in the selected area? Did access to public transit important in determine firm location?

I designed an interview protocol (see Appendix) from which I asked questions. The approach was flexible, so that interviews were not limited to the questions on the protocol, but extended to additional relevant and potentially important information. I

conducted one interview at the beginning to test how well my protocol worked with participants. A finalized protocol was developed from this interview and was applied in the formal interviews.

Each interview took from 30 to 60 minutes. I conducted twelve interviews in total, after which saturation seemed to be achieved, i.e., I was not learning much additional useful information from interviewees. All interviews were via telephone or in person, depending on the negotiation between the researcher and the interviewee. All interviews were recorded, transcribed, and coded for analysis.

The process of data analysis was run in parallel with the process of data collection. I coded and transcribed interviews using a qualitative analysis package NVivo immediately following the interview. In this way, I was able to follow up with the interviewee and improve the protocol. Additionally, recurring themes from archives, observation field notes, and interview transcripts were coded to help determine whether the data I collected was saturated.

In addition, I reviewed related news reports, government documents (county economic development plans, municipality master plans, minutes of planning and zoning board meetings, etc.) and other relevant documents collected from various state and local agencies. My archival analysis mainly focused on the actual implementation of economic stimulus packages, TOD projects, and other relevant policies in my study area. In the course of this work, I tried to answer the following few questions: Are there any supporting policies that have been initiated to promote entrepreneurial activities? How have these programs been applied and how they might impact firm formation in the area?

### 3.3 Modeling Firms' Location Patterns

Based on the discussions on accessibility and agglomeration in prior sections, I developed the following hypotheses on the locational preference of locating a new firm:

1. New establishment will locate close to transport infrastructure access points (train stations, highway entrances, airports and seaports)
2. Preferences for accessibility to transit infrastructure differ by sector, benefits are more likely for FIRE firms and some service industries
3. Firms locate to take advantage of localization externalities (proximate to own-sector specialized locations, to diversity locations, to the markets)

In order to evaluate the effects of local determinants, especially the impacts of transportation infrastructure on firm formation in my study area, I estimated different econometric models to explore the association between various factors and firm birth. I began my analysis with negative binomial models to explore determinants of firm birth across the study areas. I also tested hypotheses listed above when constructing my models.

Prior research on aggregated firms' location patterns followed a random utility maximization framework, applying multinomial logit (MNL) models across states and regions (Bartik, 1985; Manski & McFadden, 1981; McFadden, 1974). But discrete choice modeling using MNL models has serious problems at fine geographic scale due to the large amount of alternative locations and the likely violations of the independence from irrelevant alternatives (IIA) assumption (Kim, Waddell, Shankar, & Ulfarsson, 2008). To avoid the potential IIA problem and inefficiency of random sampling of alternatives at

micro levels of geography, some researchers have investigated count models to predict number of firms located at fine geographic scales (Coughlin & Segev, 2000; Henderson & Becker, 2000). For example, Kim et al. (2008) modeled employment location patterns using both count models and multinomial logit models and found that both count models and MNL models largely agree on major trends, but count models provided more insightful details.

The Poisson distribution plays a fundamental role in the theory of point processes in count models. The major advantage of the Poisson regression is that it naturally deals with the "zero" problem. Furthermore, Poisson regressions possess the property of "no interaction" between points or "complete spatial randomness". Because of these basic assumptions, the Poisson distribution is practically useless for a spatial point pattern analysis as most spatial patterns present some sort of interaction among the points. What is more, count data do not usually respect the mean – variance equality restriction. In other words, point density varies strongly over space with a tendency for clusters: such that the observed density is high in some regions and is low in others.

The negative binomial distribution (NBD) is, therefore, more appropriate than the Poisson distribution because it accounts for such overdispersion. NBD is overdispersed, meaning its variance is greater than its mean. The extension of the NBD, the negative binomial regression (NBR) provides a useful generalization that allows for heterogeneity on the mean (Hausman, Hall, & Grilichesi, 1984). It is popular for handling a count-dependent variable. First presented by Greenwood and Yule (1920) to model accident statistics, it has been widely used to model count data since then. Because establishment'

location choices are heterogeneous in their Poisson rates, the NBR, which allows for covariates, seems more appropriate for investigating my research questions.

The NBR approach has some limitations, however. For longitudinal studies, or data that can be grouped, the assumption of observations are independent is not feasible, suggesting the likelihood-based model must be adjusted to account for the extra correlation (Hilbe, 2011). Generalized estimating equations (GEEs), or population average (PA) models are one solution by adding parameters based on correlated observations. The advantage of GEE models over negative binomial models is that a specific correlation structure can be assumed within panels in GEE models.

Another potential problem of NBR approach is zero-inflation. Although the NBR can capture zero-inflation problems to some extent, it is insufficient if the process is both overdispersed and zero-inflated. For instance, the reason for zero establishment births at a particular location may be due to physical constraints, such as zoning or parking requirements. One possible solution would be to apply a zero-inflated negative binomial (ZINB) model to incorporate both processes (Henisz & Macher, 2004; Kim et al., 2008).

I tested a series of statistical models to compare their advantages and limitations respectively during my analysis process. In order to control the influences derived from other public transit services (like PATH and ferries) I tested alternative models. I use models that trace back to 1991 (before the HBLR system was open) to incorporate the influences from other transit services, and compared them with models that only covered time periods between 1999 and 2013.

### 3.4 Modeling New Firms' Post-Entry Performance

There are three hypotheses to be tested by duration analysis in this research:

1. Firm survival rates differ by sector and by size (employment) and age within the region
2. Larger firms tend to survive longer
3. Accessibility to a train station benefits firm survival.
4. Both good economic conditions and higher levels of available human capital in the local market enable firms to exist longer

I tested the hypotheses listed above. I began my analysis with non-parametric survival analysis of new establishments. Then, survival models are used to measure possible impacts of local determinants on business duration from 1991 to 2013.

Hazard models have been widely used to identify particular circumstances or characteristics that influence the probability of establishment survival. Despite the popularity of the hazard model in biometrics and reliability testing, duration modeling has had few applications in urban planning. Some scholars adopted this method to estimate post-entry performance of new establishment (Audretsch & Mahmood, 1995; Fotopoulos & Louri, 2000; Holmes et al., 2010; Honjo, 2000; Mahmood, 2000). For example, (Audretsch & Mahmood, 1995) found that establishment-specific characteristics are important for duration of new establishment.

The survival data in my study are measured on a discrete basis. The baseline hazard is constructed based on the probability of survival for the entire sample period

(1990-2013). Additionally, I also modeled firms' survival by size and sector separately, because there are strong theoretical grounds for believing that firms of different sizes/industries will be affected differently by different variables. Given the size of the database used, I am able to analyze separately the factors determining the survival of firms with different entry-size and for different industrial sectors.

### 3.5 Analysis Procedures

My analysis begins with a description of the spatial patterns of new establishment and selected socio-economic variables. These descriptive statistics can provide evidence of whether and how firms cluster within my study area. But we should understand that such an analysis does not help to explain the factors that may associate with those patterns. Therefore, I also investigate the extent of the contribution of different factors that help explain the birth of establishments in Hudson County.

Location choice models rely on firm characteristics, agglomeration attributes and accessibility measurements. Depending on data availability, the literature has employed a large variety of indicators for firm formation**.** In general, population density, levels of specialization, sector diversification of location and urbanization tend to be used to capture agglomeration economies. Average establishment size and measurements of human capital (for example, labor cost, labor force quality, etc) have also been widely used to capture factors that influence production. Proximity to transport infrastructure, and accessibility to labor markets, and major cities, are introduced as accessibility measures.

For internal factors, I used the National Establishment Time-Series database (NETS) for detailed individual establishment characteristics, such as year the business was established, last year of business registration, size (number of employee), establishment age, sector, address, and revenue. External factors from various public databases (for example, Census, BLS and so forth) were collected as well. Agglomeration was measured using population density, the concentration of employment and specific industries (measured by location quotients). Labor force was measured by using median wage income. Level of human capital was measured by percent with bachelor's degree or higher. The availability of financial capital often facilitates entrepreneurs' efforts to start new businesses. Since financial capital flows are global, it is not possible to measure the difference at a micro scale. Because my study area is small and blocks are used as the basic analysis unit, I assume the availability of financial capital is the same across the entire study area for any particular year of my study. This economic factor is not included in the modeling exercise but may warrant future consideration.

I processed data using both a statistical package, STATA, and a Geographic Information System (GIS) developed by ESRI. GIS is an important tool for fundamental spatial analysis operations, such as calculating travel distance, travel time, and spatial relationships in this study. For example, I calculated the travel distance from each firm to the closest train station through the street network. This increases confidence in the analysis through the use of network distances between points. Furthermore, GIS enables my research to adopt a spatial statistical approach to the analysis of urban settings.

# Chapter Four

## Perspectives on Public Transit and Developments

As a nucleus for transit-oriented growth, The HBLR system leads to increasing transit ridership and subsequent demands for new developments near station areas. Of course, "build it, and they will come" is not always a feasible strategy because development does not necessarily follow new transit lines (Hurst & West, 2014; Loukaitou-Sideris & Banerjee, 2000). What is more, with the growing popularity of transit-accessible locations, lower-income residents and small employers can be priced out at station areas, resulting in concerns about social inequity.

Despite a growing body of literature on the demands for and benefits of transit infrastructure investment and transit-oriented development, little research has been done to date to examine how stakeholders themselves understand these related concepts.

How do planners and local governments integrate transit access with development plans, urban policies and processes to stimulate economic growth? How can planners and local governments motivate more developers to build in station areas? How do developers and business owners perceive transit access in their location decisions? When and where do developers choose to build, and what motivates them? These are important questions for successful transit investments and future growth in the region.

In this chapter, I aim to explore the stakeholders' experiences and attitudes towards, and interest in development around rail station areas. The stakeholders include planners, local government professionals and private developers. My study proceeds from an underlying hypothesis that significant obstacles (for example, high cost of land and land assembly) stand in the way of commercial development in station areas in Hudson

County, which consequently discourages new firm births. Therefore, I conduct in-depth structured interviews with stakeholders to understand their attitudes towards the development of the HBLR system and their perceptions and experience of the economic impacts of the light rail system.

In this study, I conducted interviews with stakeholders identified in the region. Interviews took place from September 2016 through January 2017. Twelve people in total, including eight planners and local government professionals, and four developers/commercial real estate brokers (two of them are also entrepreneurs themselves in the study area) were interviewed. Four interviews took place in person and the rest were conducted via phone calls. The nature of the call depended on interviewees' preference and availability. All participants were assured of privacy and confidentiality, and all names referenced in this dissertation are arbitrary pseudo-.

I used the NVivo software package to conduct two computerized content analyses: word frequency analysis and topic co-occurrence analysis. Electronic coding allowed for efficient cross-referencing of a large amount of information from interviews. This approach helped uncover co-occurrences of important topics that could be valuable for acknowledging the shared understandings of participants. In addition to using computerized analysis, I also read and reread interview transcripts to identify recurring themes across the interviews.

Interview questions revolved around the following themes:

- What makes transit access important from participants' perception and experience?

- What factors do participants perceive as important for selecting locations for new development projects/new establishment (businesses)?
- What possible obstacles exist for location decisions of projects/new establishment (businesses)
- What actions might make transit-accessible sites more attractive for mixed-use/commercial development?

## 4.1 Transit Access and Development

I used word-frequency analysis because it was helpful to gain a simple, yet, comprehensive first look at recurring themes from the interviews. Figure 4.1 shows the 150 words used most frequently in interviews related to transportation and development. More frequently used words are shown in larger font while the smaller fonts indicate less frequently used words during the interviews. The importance of "transit" and "opportunity" illustrates a recurring theme: participants perceived Hudson County as a place where development opportunities emerge, especially with easy access to transit as a catalyst to spur development.


Figure 4.1 Frequently Used Words

Transit services play a key role for residents and workers in Hudson County in their daily life. “PATH” (acronym for Port Authority Trans-Hudson), “transit” and “congestion” are important transportation-related words in the interviews, with two other related words “commute” and “ferry”. Planners and local governments perceive light rail system as crucial for integrating existing transit modes, especially PATH in the region, and subsequently scaling up development opportunities. Because PATH provides timely service between Newark, and both Midtown and Downtown Manhattan 24/7, it has been an important public transit option for workers to commute between Hudson County and Manhattan for decades. Only three municipalities in Hudson County have PATH stations

(Harrison, Hoboken, and Jersey City). The HBLR system affordably connects residents to PATH services.

Many participants pointed out that transit access is especially important in Hudson County because of road traffic congestion. Traffic congestion impacts not only the work commute to and from Manhattan, but also within the county. light rail provided timely transit services for commuters that mitigates traffic congestion within the county and connects with other transit modes. More importantly, according to some respondents, residents can also ride the light rail for safe, efficient, and affordable non-work trips, which subsequently encourages leisure activities in the county and benefits local businesses.

One experienced local developer put it this way:

> *"…they (local people) don't really shop or dine in North Bergen or West New York…people like to go to Jersey City and Hoboken to have fun."*

Waterfront areas are in high demand for combination of river view and ferry services. The growing popularity of ferry services in the past two decades also makes commuting between the County and New York City (Manhattan and Brooklyn) more convenient. Both city planners and developers agree that the HBLR system scaled up opportunities for both commercial and luxury residential development projects along the light rail sections close to the waterfront. Some participants identified access to transit stations (either PATH or HBLR) as "attractive". Two of the developers interviewed had built mixed-use projects close to light rail stations in the waterfront areas. The following

quotes from a local government officer indicated the importance of the light rail system for economic development:

> *"…it (HBLR) created huge development opportunities for smart growth in Jersey City…and I personally think there are missed opportunities in north Hudson that the light rail could have done along the waterfront… West New York, Guttenberg…maybe they (NJ Transit) will do it in the future, but I think it is the missed opportunity.*"

Three other frequently mentioned words "community", "politics" and "works" emphasize another important topic, regulations. "Community" and "politics" were mentioned repeatedly in the conversations regarding HBLR development processes, permitting processes of new development projects, regulatory structures and local political processes. For development projects in station areas, achieving democratic agreements from the city and local community is a major task. From the perspective of private developers, such relationships are important to their site selection process when one city is considered "easy to work with" and the other considered more difficult to work with. For example, Shawn, a developer/entrepreneur in the region, explained his experience that once the community agrees on the project, regulatory approval process become very easy. The following quote from Shawn illustrates this sense:

> *"…when I did the X project, there are two powerful groups in City B… to make sure projects they like moved forward and projects they don't like got stopped…so as soon as we got project X, we invited them in for the conversation…"*
>
> *Me: "to work with the community, right?"*
>
> *"Yes, you bring the community and planners together…to address their concerns…the approval process will become much easier"*
>
> *Me: "much easier?"*
>
> *"You can get approval in one night (one planning meeting) if you got their agreements…You have to go through this process (to talk with people)"*

"TOD", "demand", and "amenities" are words frequently mentioned by participants, indicating the third important theme in my interviews: developers have a general interest in sites with easy access to transit service in Hudson County. Developers stated a clear preference for higher-density in station areas. According to my respondents, the demand for housing and mixed-use sites is "always high" in the region, and transit access is always an important "amenity". Particularly, developers point to desirable sites in neighborhoods in Jersey City due to high market demand, availability of land, and transit access as an important amenity. All mentioned that amenities in a neighborhood would increase the desirability of a site, at least for residential development.

Participating developers also expressed interest in moving towards a more collaborative model with cities for promoting denser development, especially TOD projects. They perceived strong growth potential for TOD, and they understand TOD and denser development as desirable in the region, given "demands are always high". Developers introduced me to a group called "New Jersey Mixed-Use Developers" (MXD), an affiliate of the New Jersey Builder Association (NJBA), created by a group of local developers. More than fifteen developers are members of MXD. Some MXD developers have residential, commercial or mixed-use development projects in Hudson County. MXD advocates for policies and regulations for mixed-use development.

Developers consider transit access an important amenity to site selections: some are even willing to pay for infrastructure improvements or construct new stations to attain denser development. For example, Karl (planning professional) and Shawn (developer) both mentioned an infill development plan proposed by a group of local developers to fund the construction of a potential new HBLR station in exchange for

permits to build with higher density: *"we would allow for additional density...for all buildings (in this area), to generate money to pay for the new station."*

The above quote suggest that some interviewees have common interest in the potential of new stations along HBLR: there is broad perception that access to transit service is beneficial in the area, and developers are expecting a robust market for such prosperities. The combination of strong demand in the local market and the advantage of transit access make TOD attractive along the HBLR line, especially in Jersey City.

But some participants suggested there is insufficient "capacity" for such development. "Capacity" is another key word in my interviews. It has a dual meaning: the capacity of space for future development and the capacity of the light rail system. Participants express contrasting opinions on "capacity". This suggests that "capacity" may be a potential obstacle for new development in Hudson County. So, I discuss obstacles for new development and new business formation in Hudson County in the next section.

**4.2 Obstacles**

Although interviewees broadly consider transit access desirable, and that light rail has had positive impacts on development in the study area, it has run into some obstacles: high land prices, limited buildable land around existing rail stations, zoning regulations and difficulty in land assembly, capacity of current transit systems, and so forth.

As terms of "capacity" of space, several participants contend that high-density development does not always consider the needs of existing residents, especially in dense urban areas like Hudson County. One experienced city planner in the region told

me that since the city is “almost built out” with high-density, amenities like open space, libraries and so forth are more desired by local residents, implying a lack of capacity for the development of new residential and office/commercial space. As a result, amenities, such as playgrounds, kindergartens, parks, and so forth are more critical need for families in future infill/redevelopment projects: so that existing residents can more easily share the benefits of them.

In terms of the capacity of the HBLR system, some transportation professionals and planners point to concerns about the capacity of the existing light rail system. With continued growing ridership in the past 17 years, the light rail has almost reached its capacity. This results in difficulties in adding more stations or extending the line while also maintaining affordable and efficient service. They also argue that developers will build in some neighborhoods even without a new light rail station, and access to transit services is more like a “selling point” for their projects than serving potential residents or firms, and “they (developers) will provide shuttle service to their clients anyway”.

High land cost is a major constraint for median/small developers to build in station areas because land owners “ask for crazy amounts of money” for the land. One developer pointed to sites along the waterfront in Weehawken and told me how dramatically the land value had changed over the past 30 years. Moreover, gentrification leads to conflict between local governments, current residents, developers, and future residents. On the one hand, some developers believe new development projects (both residential and commercial) can bring in new opportunities for local economics, as well as improving the property tax base. On the other hand, lower income residents/workers who rely on transit for their commute to work might be priced out from their current

location. One city planner put it in this way during our conversation on HBLR station allocation:

> *"these two (light rail) stations were there (assigned to these locations) to serve lower income neighborhoods, the social and economic disadvantage communities."*

Sites along the HBLR systems are generally small. Therefore, assembling large lots for development projects is time-consuming, costly, and involves complicated negotiation processes with local residents and planning boards. Because most of the county has been built out, developers tend to seek larger sites that are previously industrial along the waterfront or transit lines to avoid expensive fees for land reassembly or cost of regulatory processes. Although developers are motivated to build on expensive, transit-served sites in hopes of profit, difficulties in assembling parcels and overcoming regulatory processes constraint such developments. Still, some developers place a premium on transit access in selecting sites. One local developer mentioned there was a proposed development plan to create a multi-block development zone near one of the light rail stations. It will enable assembling of large lots with higher density. Yet, the plan was turned down:

> *"…typically, sites are small in the station areas…cannot resemble large sites, and therefore, large developers just don't have interest in it (to invest) …"*
> *Me: "How about applying for permissions to reassemble larger lots?"*
> *"…here is the thing: legally you can do it, but politically they won't do it…it is the political consideration and they will vote it out..."*
> *Me: "what political consideration?"*

*"(silent for at least 10 seconds) …I cannot answer until you turn it (the recorder) off."*

*(The rest of the conversation was not recorded because my participant refused to discuss more in details on this topic with recording. But my participant explained that various conflicts, especially political conflicts, exist among stakeholders in the regulatory process for development projects in the study area.)*

In addition, regulatory issues are mentioned repeatedly by some planners and developers as "a big constraint", "the number one question" in promoting developments. For example, according to New Jersey Municipal Land Use Law, for any development involving property located within 200 feet of an adjoining municipality boundary, the development shall receive approval from both municipalities (NJ Rev Stat § 40:55D-12 (2013)). Examination of the interview transcripts shows that complexity, zoning regulations, increasing costs and time caused by regulatory regimes ill-suited to redevelopment projects, and so forth, are mentioned as major obstacles for development projects along the light rail system in some municipalities. The following example comes from a developer with both residential and commercial experience in Hudson County:

*Me: "Can you tell me where are you planning to build?"*

*"Sure… we have a piece of land here (downtown Jersey City), here (Hoboken)…and…here (a neighborhood in Bayonne close to a light rail station) …"*

*Then he pointed to another area on the map (southernmost Bayonne with old rail tracks and abandoned industrial sites) "You don't want to build here for sure, legislation is too complicated..."*

*Me: "too complicated?"*

*"Yes, they (the land) have different owners. Not worth the effort to settle… And if we move a 10-minute walk from the station (he pointed to a different neighborhood in Bayonne), we can have larger sites...that were previously industrial buildings."*

Moreover, political conflicts among different stakeholders sometimes complicate the approval of development plans. During conversations about a specific major development plan that was killed, I have heard many different voices. Participants described it as a "political battle", a competition between planners, the planning board, the mayor, neighboring municipalities, the court, NJ Transit, developers, and people who don't want it— "it is none of my business". One participant in the planning professional/government officer group put it out this way:

> *James: "They (NJ Transit) don't like to talk about projects they don't have funding for, "if they don't have funding for it, it does not exist" …"*
> *Me: "But I know some developers are willing to fund it."*
> *James: "Yes…but the mayor got concern that the 'gorgeous views' will be blocked (laughing) … so he killed it…He killed it in silence, no one knows. It is so stupid. It is a great plan."*
> *Me: "The plan didn't go to the planning board?"*
> *James: "NEVER… (sigh) Although we once presented it to home owners in the area, and they loved it…and have asked 'when will this happen'…"*

According to participants from both planning professionals and developers, some municipalities are more pro-development with flexible attitudes towards development projects. Jersey City is considered the "most flexible" and "supportive" in planning and regulatory processes. It has developed a more collaborative model promoting denser development, especially in its downtown and station areas. Interviewees also agreed that the current regulatory process and policies in Jersey City have positive ways of encouraging both residential and commercial developments.

Settling the tensions between demands for development and limited capacity is another key issue, especially for municipalities of smaller sizes. Local government officers/planners suggest that demands from the real estate market are always high, yet,

desire for open space, schools and other social services have limited the capacity in the land market for new development projects in some neighborhoods. According to many participants, even though local governments, residents, and developers try to collaborate in order to achieve agreement on better development plans, the fragmentation of planning/zoning regulations, the lack of consistent leadership, resources and support from the state and the region has largely limited the resources local communities can rely on.

One local government professional put it this way:

> *Me: "What do you mean that 'we need more leadership'?"*
> *Frank: "We need a legal framework, and we need resources from the state…there has been zero leadership from the state… It has been the failure of the governor Christie and his administration…because everything begins from the top…"*
> *Me: "Even though the county and local municipalities are collaborating?"*
> *Frank: "Right… outside our communities, we have no ability to affect changes outside our borders …especially for those statewide issues…for example, the Transportation Trust Fund…which is broke and they don't fix it…"*

**4.3 New Firm Births**

Generally, local government professionals and planners have a good understanding about where large firms prefer to settle or move in. And all of them mentioned that the county has strong location advantages (especially along the waterfront areas) for firms, since Manhattan is right across the Hudson river. Their knowledge about where smaller firms tend to start and expand, however, is somewhat limited. This suggests that the economic benefits of transit services are likely underestimated. To some extent, the gap in understanding might be attributed to the fact that it is more difficult tracking the patterns of smaller firms.

For the planning professional/local officers group, when being asked questions such as "in which part of the city are there a growing number of firms/businesses in the past few years?", only a few participants understand where new establishments tend to locate and what factors business owners care about when looking for a site. On the other hand, developers and commercial real estate brokers seem to have better knowledge of this issue. They perceive the market is "full of opportunities" with strong growth potential for firms and businesses. Owning multiple businesses in Jersey City, including a real estate brokerage company, Ben shared his story with me about his experience of doing business in Hudson County. Originally from California, Ben opened his first business in Jersey City in the earlier 2000s after a trip to New York/New Jersey:

*Ben: "This place (Jersey City) lacks competition and is full of potential…So I decided to move to here"*
*MC:" Lacks competition in the 2000s?"*
*Ben: "Yes, in the 2000s...and the community is underserved."*
*MC: "Underserved?"*
*Ben: "Yes, with the (this large) population and income, it is definitely underserved compared to New York…and with more affordable rents."*
*MC: "So how about other cities in Hudson (County), like Hoboken, Bayonne, and else?"*
*Sam: "…Hoboken is not underserved… and why not Bayonne or other neighborhoods in the area? it is because of the (population) density, the customer base…is different."*

Another developer put it in this way:

*Shawn: "The market is now changing… not just the young generation like to live in cities, the baby-boomers are moving back to urban areas…they have money, and they also want to have fun in cities…"*

Although transit access is not the primary location factor for developers or firms, it may be a deciding factor for otherwise similar sites. Both developers and brokers expressed interest for sites with convenient transit access. Participants frequently identified convenient access to transit as desirable in their site-selection decisions. This is specially the case for sites close to PATH stations or along the waterfront, which are in high demand. According to my participants, property values and rents of office/commercial space have increased a lot in those areas in the past two decades. Access to the light rail is considered less important compared to PATH access. One participant put it in this way:

> *Ben: "Many of my customers are looking for sites close to PATH stations, Journal Square…You know; it is so easy to get my customers to sign a lease "*
> *M.C.: "How about access to the light rail?"*
> *Ben: "Ummm…they prefer PATH. I think the light rail is good, but I don't have a customer specifically looking for a site close to light rail stations."*

Although they perceive the region is full of opportunities, some significant obstacles remain to attract businesses. First of all, some participants (both planning professionals and developers) point out that demand and supply for large office space in Hudson County as a whole have decreased since the mid-2000s. Developers and planners also mentioned that the changes in configurations of office space[10] and the high risks of office space development made the construction of office space less attractive than the construction of residential housing, mixed-use, or commercial space.

[10] According to Carl and Shawn, open space, co-working space, LOFT and other nonconventional workspaces are getting popular

One urban residential and commercial developer spoke at length about preferring to build residential/mixed-used development. In his opinion, the construction of office space is "too risky" and future revenue generated from office development projects is "unpredictable" because it is difficult to secure long-term contracts with larger employers. Other participants suggested that the workplace has changed dramatically in the past two decades. They mentioned that "young people don't work in office cube anymore", "…they prefer shared-office because it saves them lots money compared to traditional office", "it is easier to work at home these days" and "Lofts are trendy[11]".

Two participants (in the public sector) suggested that municipalities should have an official who helps recruit tenants for office and commercial space. This will benefit the developers who might be reluctant to build more office/commercial space because of the risk of not having long-term tenants, as well as bring in new jobs to the area. They found of desire for transit access shows if constraints are removed, it is possible to see expansion of new businesses in Hudson County.

In our conversation on firms' location preferences, Jack explained why downtown Jersey City is attractive to large FIRE firms that had previously been located in Manhattan/Brooklyn. First of all, Jersey City has plenty of large, old industrial sites for development in the 1990s and 2000s, and rents are much lower than in Manhattan. In addition, convenient "transit services for their employees" and the "gorgeous views" of the Hudson River are amenities that companies value, especially large companies. More importantly, Jersey City has specialists who recruit and attract larger firms in the region within the metro area to locate in the city.

[11] For example, the following article explain the trends in workplace: "Shared Work Spaces Spread, Mixing Styles and Services", Christine Negroni, *New York Times*, 2017 July 25.

Yet, Jack also mentions the lack of policies and strategies to attract new establishments to locate or for firms to relocate to Hudson County, even New Jersey in general. He believes they have become an obstacle to economic growth: developers will not build due to the high risk of recruiting tenants on their own, companies do not have an interest in relocating or a preference to locate in Hudson County versus Manhattan/Brooklyn due to perceived differences in branding and work cultures *("it is just not New York")*, and so forth. More importantly, firms do not always have sufficient information on the benefits of locating in Hudson County compared to other areas in the region.

This conversation also brings in the issue of new firm births vs. firms' relocation. Many big FIRE companies actually have relocated to Hudson County from Manhattan. They moved jobs into Hudson County at the cost of job losses at their prior location, which means, they bring the shift of job opportunities within the metropolitan area or among nearby states rather than a real increase in job opportunities. Large companies that relocated can receive "huge subsidies" (for example, tax savings) from the state as well. Having multiple transit options is a key amenity to companies, although it is not as important as rent and tax incentives within their location decisions.

### 4.4 Conclusions

There is a broad perception from participants that transit access in Hudson County is beneficial. According to planners and local officers, the HBLR system is a catalyst that spurs economic development. Private developers believe that light rail benefits both residential and commercial development around station areas. PATH is also an amenity

important to development projects, and certain PATH stations (for example, the Journal Square station) are more important than one light rail station. In addition, developers have shown consistent interest in sites with easy access to transit service along the waterfront areas of Hudson County. Developers also state a clear preference for the higher density nearby stations.

As a space of study, Hudson County is relevant to many regions (particularly for traditional urban areas) now building rail transit. In particular, it is within a major metropolitan area, and has many neighborhoods that were traditionally "bed room communities" for New York City. Most of Jersey City's land has been built out, but with many abandoned old industrial sites and rail tracks. Therefore, many development projects in Hudson County were infill (re)development in the past three decades, according to my conversations with participants.

The process of infill (re)development in the County has some inherent barriers that other traditional urban areas are facing as well: the scarcity of land supply, high cost of land, costly land assembly and site preparation processes, high labor costs, resistance from residents, and regulatory constraints. Disagreement on development projects (site selection, density, zoning codes, building codes, and so forth) is another example of the conflicts among different stakeholders and interest groups in Hudson County. Local residents, municipalities, and developers sometimes have opposing opinions on infill development/redevelopment projects near station areas. Jersey City is generally considered more flexible with respect to development projects. Participants also acknowledge that relationships with local governments and residents are important, and better leadership from the state is desired.

Developers and business owners seem to know more about transit access and business patterns than do planners/local officers. Developers express concerns about future ability to recruit long-term employers and about the changes in workers' work-environment preference. They believe access to PATH stations is more important than is access to light rail stations for major employers. Jersey City is considered competitive in the market to attract firms in that its rents are relatively affordable: it has a higher density, customer base than do other municipalities in northern New Jersey.

Findings in this chapter are important and useful for the modeling analysis in coming chapters. First of all, according to interview participants, the design and location of the HBLR system are not purely based on existing agglomeration of employment or growth potential nearby stations. The location of each light rail station was determined collectively by municipalities, planners, NJ Transit, and communities with different purposes. But the lack of developable land is a major constraint to developments in some neighborhoods; and this will be considered later in the modeling exercise. Some contextual information is important for development patterns in Hudson County and new firm births, but maybe impossible to include in the modeling work (for example, regulation issues, tax incentives for firms, specialist that help recruit firms to locate in Hudson County, and so forth). So, some key variables will be omitted and special discussion will be reserved for this in the analysis of model outcomes.

# Chapter Five

## Firm Location and Transit Access

The birth of new businesses may be an unmeasured external benefit of new transport infrastructure. But little is known about what enables new firm formation, especially at the micro level. Therefore, I think it is critical to understand the of firm births. If the improvements of transport infrastructure can influence firm formation, it is possible that transportation policy can be a useful tool in promoting economic growth. Unlike those fast-growing areas in most existing studies, Hudson County is a traditional industrial urban area. Due to the political, economic and policy variances in different states/regions, observations from previous study areas might not hold true in traditional industrial urban areas of New Jersey. For urban and transportation planners, it is important to understand the reasons for such differences because new establishments can be bastions of job creation and regional growth; moreover, the densification of new establishments may suggest the presence of external agglomeration benefits. In this chapter, I descriptively analyze Hudson County using NETS.

The State of New Jersey Department of Community Affairs tracks certificates of occupancy issued by construction officials as buildings are completed.[12] According to the inventory of buildings, most development projects in Hudson County concentrated in municipalities served by the HBLR system. Between 2000 and 2014, more that 8.6 million square feet of new office space were built in municipalities with HBLR stations (The county total was about 8.9 million square feet in the same period), with most of in

[12] New Jersey Department of Community Affairs, Certificates of Occupancy: http://www.state.nj.us/dca/divisions/codes/reporter/co.html

Jersey City. In addition, more than 870,000 square feet of new retail space was built in HBLR municipalities during the same period, with almost half of them located in Bayonne.

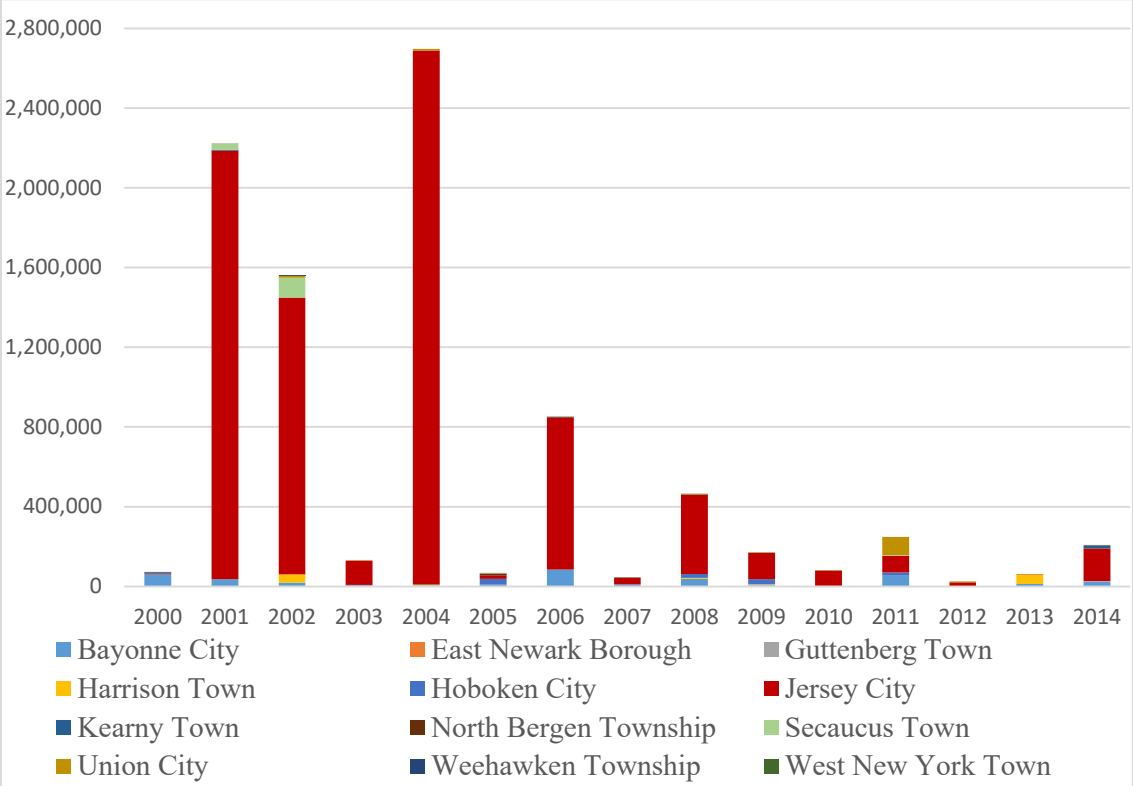


Figure 5.1 Total Office Square Feet Created in Hudson County from 2000 to 2014[13]

[13] Sources: New Jersey Department of Community Affairs, Certificates of Occupancy

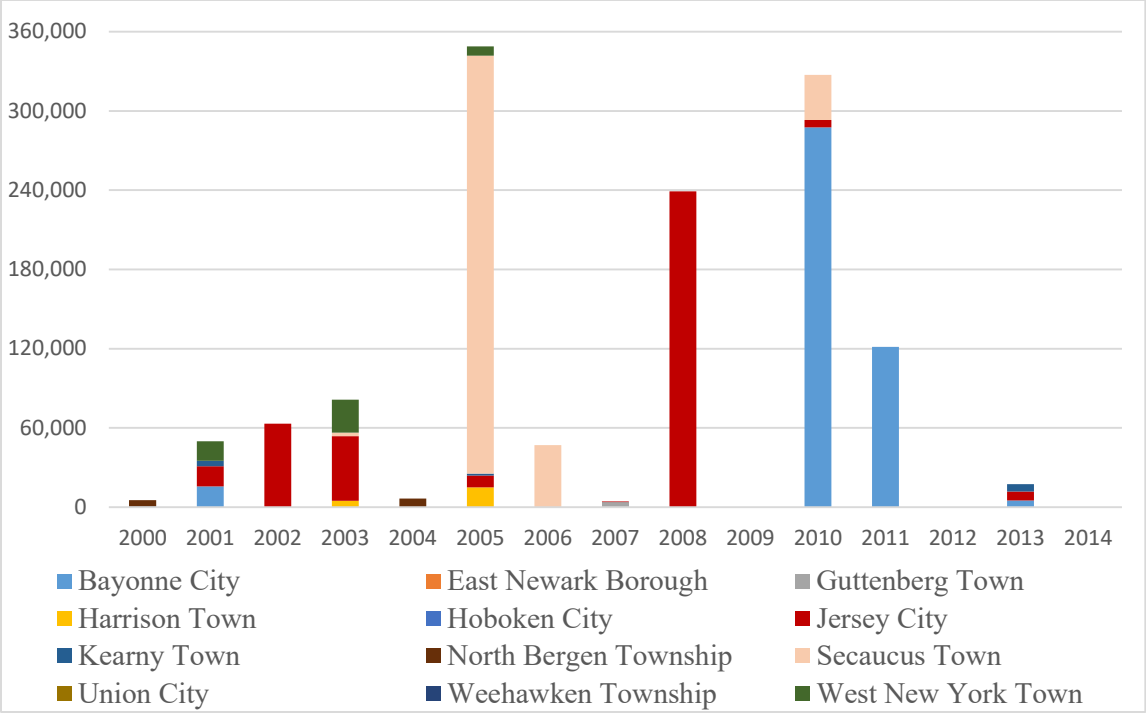


Figure. 5.2 Total Retail Square Feet Created in Hudson County from 2000 to 2014[14]

Some major development projects have been built near HBLR stations over the past two decades. For example, the 30-acre Bayonne Crossing Shopping Mall, which opened in 2010, is located within a half-mile of the 22nd Street Station in Bayonne. In Jersey City, the Liberty Towers (constructed in 2003), with 648 residential rental units, 28,000 square feet of retail space and 798 parking spaces is near Essex Street station.

Because municipalities are not required to provide the actual location of individual projects to the state, this database can only be used to track the general development processes and patterns. That is, it is difficult to identify the precise location of each project and its distance to a particular HBLR station. The NETS dataset applied in my study, however, is at a fine geographic scale. It includes the latitudinal/longitudinal

[14] sources: New Jersey Department of Community Affairs, Certificates of Occupancy

coordinates of each establishment. This makes possible modeling each establishment's access to transit stations.

### 5.1 Descriptive Analysis

For Hudson County, New Jersey, from 1991 to 2013 the National Establishment Time Series (NETS) dataset has a total of 89,686 records. The use of the NETS data requires some caution. First of all, the dataset lists firms in each year from 1991 to 2013, regardless of whether they originated within the study area. For example, the dataset could contain data of establishment N from 1999 to 2008, although it was founded in Michigan and relocated to the study area only in 2000. So I eliminated such records when counting new establishment births for this study. Second, according to Echeverri-Carroll and Feldman (2017), the use of last two years of NETS data (2012-2013) requires extra caution due to changes in NETS. This change resulted in fewer records captured during the last two years. Third, I used a Manhattan metric of 0.5 miles on as opposed to a Euclidean distance to identify establishments as being "near" HBLR stations.

Establishments with missing location data (longitude and latitude) or that could not be geocoded are excluded. The total number of establishments by year are classified into different groups based on their mean employment size: larger establishments with more than five employees, one group for smaller establishments with five or fewer employees and another group that exclude single employee establishments. Table 5.1 summarizes the total number of establishments for each group. In this dataset, 25.8 percent of existing establishments have five or more employees, and 26.2 percent have a single employee (i.e., freelancer or sole proprietor).

Table 5.1 Total number of Establishments by Mean Employment Size (source: NETS data)

| | All Establishments | Emp>1 | Emp>5 | Emp<=5 |
|---|---|---|---|---|
| 1991 | 16,521 | 13,935 | 6,419 | 10,102 |
| 1992 | 16,485 | 13,804 | 6,363 | 10,122 |
| 1993 | 17,384 | 14,509 | 6,640 | 10,744 |
| 1994 | 18,947 | 15,700 | 6,723 | 12,224 |
| 1995 | 21,044 | 17,472 | 6,947 | 14,097 |
| 1996 | 21,114 | 17,324 | 6,913 | 14,201 |
| 1997 | 22,987 | 18,787 | 7,024 | 15,963 |
| 1998 | 23,152 | 18,577 | 7,039 | 16,113 |
| 1999 | 22,646 | 17,886 | 6,928 | 15,718 |
| 2000 | 22,070 | 17,244 | 6,947 | 15,123 |
| 2001 | 23,227 | 18,109 | 6,992 | 16,235 |
| 2002 | 24,364 | 18,941 | 6,947 | 17,417 |
| 2003 | 25,301 | 19,220 | 6,881 | 18,420 |
| 2004 | 25,419 | 19,049 | 6,759 | 18,660 |
| 2005 | 26,735 | 19,620 | 6,734 | 20,001 |
| 2006 | 28,672 | 20,560 | 6,800 | 21,872 |
| 2007 | 30,236 | 21,435 | 6,759 | 23,477 |
| 2008 | 33,532 | 23,011 | 6,703 | 26,829 |
| 2009 | 36,286 | 24,223 | 6,634 | 29,652 |
| 2010 | 31,303 | 21,164 | 6,055 | 25,248 |
| 2011 | 36,714 | 23,074 | 5,835 | 30,879 |
| 2012 | 34,565 | 23,159 | 5,852 | 28,713 |
| 2013 | 33,101 | 22,699 | 5,677 | 27,424 |

I also classified establishments into eleven U.S. Bureau of Labor Statistics' Supersectors. The following table shows the summary of all NETS establishments in Hudson County by sector.

Table 5.2 Number of Establishments by Supersector (1991-2013) (source: NETS data)

| Industry | Employees | Percentage |
|---|---|---|
| **Goods-Producing Industries** | **9,909** | **11.9%** |
| 1.Natural Resources and Mining | 137 | 0.2% |
| 2.Construction | 5,686 | 6.8% |
| 3.Manufacturing | 4,086 | 4.9% |
| **Service-Providing Industries** | **73,495** | **88.1%** |
| 1.Trade, Transportation, and Utilities | 24,859 | 29.8% |
| 2.Information | 2,233 | 2.7% |
| 3.Financial Activities | 7,279 | 8.7% |
| 4.Professional and Business Services | 19,643 | 23.6% |

| Industry | Employees | Percentage |
|---|---|---|
| 5.Education and Health Services | 6,090 | 7.3% |
| 6.Leisure and Hospitality | 4,483 | 5.4% |
| 7.Other Services | 8,613 | 10.3% |
| 8.Government | 295 | 0.4% |
| **TOTAL** | **83,404** | |

Five supersectors comprise 72.2% of all establishments that formed within Hudson County from 2000 to 2012: Manufacturing (NAICS 31, 32, 33); Trade, transportation, and utilities (NAICS 42,44,45,48,49,22); Financial activities (NAICS 52,53); Professional and business services (NAICS 54,55, 56); and Leisure and hospitality (NAICS 71, 72). Trade, transportation, and utilities sector, financial activities sector and professional and business services sectors are the largest sectors with new firm birth, respectively (Figure 5.3).

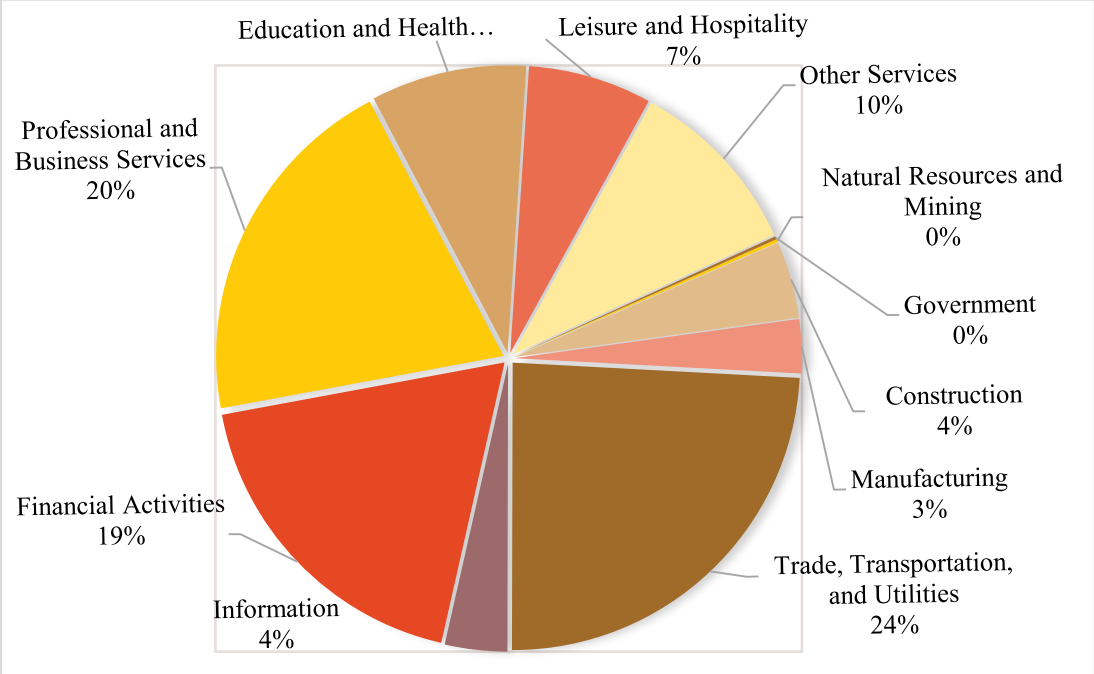


Figure 5.3 Compositions of New Establishments by Supersector: 2000-2012 (source: NETS data)

**5.2 Analysis of Firm Location by Industry**

In this section, I examine the NETS data with a series of statistical and spatial techniques in order to describe the distribution of firms of the following industries: manufacturing; trade, transportation and utilities; information, financial activities (FIRE); professional and business services; education and health services; and leisure and hospitality. I selected these sectors due to their relative magnitude and growth within the study area. These descriptive analyses address the following two questions about the effects of station proximity:

1. What is the overall distribution of establishments near light rail station locations?
2. Are there any industries that are more likely to locate near transit stations?

First, I conduct a spatial analysis of location quotients (LQs) to analyze the distribution of various industries in relation to HBLR stations. A LQ is industry's share of a regional economic measure (i.e., jobs) divided by the industry's share of the national total for the same measure. A location quotient basically quantifies a particular industry's relative concentration in the region as compared to the nation.

I then conduct further spatial analysis of LQs for the FIRE industries near individual HBLR station areas using the 2008-2010 NETS data. Particularly, for establishments that relocated to Hudson County, I only considered employment data and the count of existing establishments in the years in which they were physically located within the county.

Table 5.3 compares LQs of selected industries within the HBLR station areas (<=0.5 mile) to those in other areas of Hudson County from 1999 to 2011, at three-year increments using the establishment-level employment data from the NETS database. An LQ larger than 1.0 suggests the area near HBLR stations have a relatively high concentration of establishments. Higher LQs values indicate relatively higher concentrations. The LQs of Manufacturing industries increased continuously 0.26 to 0.73 within the station areas from, indicating that manufacturing became more concentrated near station areas in the 2000s. The LQs of FIRE industries vary both near station areas and otherwise as they vary in a range from 5.04 to 3.60, from and 0.62 to 1.11, respectively. Clearly, LQs for FIRE establishments are much higher near station than they do further from them. For example, the LQ near stations was 4.26 in 2008, compared to 1.08 away from the station areas. This indicates that FIRE jobs are more likely to locate close to HBRL stations than otherwise. Moreover, LQs near stations decreased while values outside of station areas tended to grow during the same period. This suggests that FIRE establishments show agglomeration near stations in general.

The LQs of Information grew rather radically near stations, increasing from 1.00 in 1999 to 5.15 in 2011. They contradictorily dropped from 2.39 to 1.29 outside station areas from 1999 to 2011. This indicates that firms in Information industries are choosing to relocate near station areas.

Professional and business services industries show different LQ patterns: they grew from 0.87 to 1.50 outside station areas, but were relatively stable near stations. LQs for the education and health services industries have displayed increasing trends near stations since the mid-2000s, but have shown less variation outside the station areas. This

indicates that more establishments in this industry are choosing to locate near stations. Lastly, LQs for leisure and hospitality services industries were relatively stable outside station areas, although clos to station areas appeared some variation as LQs ranged from 0.51 to 0.66.

Table 5.3 Location Quotients of Selected Industries within[15] and outside the HBLR Station Areas (source: NETS data)

| | 1999 | 2002 | 2005 | 2008 | 2011 |
|---|---|---|---|---|---|
| **Within Station Area LQ** | | | | | |
| Manufacturing | 0.26 | 0.32 | 0.34 | 0.70 | 0.73 |
| Trade, Transportation & Utilities | 0.93 | 1.02 | 0.95 | 0.72 | 0.76 |
| Information | 1.00 | 2.20 | 3.50 | 4.27 | 5.15 |
| FIRE | 5.04 | 5.01 | 4.70 | 4.26 | 3.60 |
| Professional & Business Services | 1.40 | 1.25 | 1.15 | 1.21 | 1.32 |
| Education & Health Services | 0.48 | 0.49 | 0.43 | 0.55 | 0.66 |
| Leisure & Hospitality Services | 0.59 | 0.60 | 0.66 | 0.51 | 0.52 |
| **Outside Station Area LQ** | | | | | |
| Manufacturing | 1.07 | 0.87 | 0.64 | 0.69 | 0.70 |
| Trade, Transportation & Utilities | 1.73 | 1.85 | 1.97 | 1.69 | 1.64 |
| Information | 2.39 | 2.53 | 1.55 | 1.97 | 1.29 |
| FIRE | 0.79 | 0.62 | 0.85 | 1.08 | 1.11 |
| Professional & Business Services | 0.87 | 1.26 | 1.23 | 1.38 | 1.50 |
| Education & Health Services | 0.72 | 0.67 | 0.76 | 0.79 | 0.77 |
| Leisure & Hospitality Services | 0.51 | 0.50 | 0.56 | 0.50 | 0.43 |

Figure 5.4 and Figure 5.5 show the number of establishments by industry within and outside the HBLR station areas respectively from 1998 (two years before the operation of the light rail) to 2013. Within the station areas, the total number of firms has increased substantially in the 1990s and the 2000s, however, the count of establishments generally decreases across industries after 2011. This might be due to the time it takes for

[15] Within station areas: equals or less than 0.5 mile from a station.

a new establishment to enter into the D&B database (Echeverri-Carroll & Feldman, 2017). Therefore, I focus following analyses on the period between 1998 and 2011.

The total number of establishments rose 152 percent from 1998 to 2011 in the study area. What is more, there has been a great deal of variations in the number of firms for the industries selected. All super-sectors except for Information and FIRE had higher growth rates within the station areas than outside of them. From 1998 to 2011, percent growth of establishments in the FIRE industries is 160.7 percent within station areas and 170 percent outside station areas, while information firms grew 183.8 percent and 196.8 percent within and outside the station areas respectively. Although the number of firms in these two industries grew faster outside station areas, the count of jobs created was higher within station areas.

Within the station areas, Professional and business services establishments grew best, with an increase of 445.9 percent from 1998 to 2011; while the Education and health services establishments ranked second, with an increase of 219 percent during the same period. In general, the Leisure and hospitality industries, and establishments of Education and health services also experienced consistent growth. Establishments in the Trade, Transportation, and Utilities industry also experienced steady growth and almost doubled the number of establishments near stations, and percent growth outside station areas was lower than within station areas. Manufacturing establishments show the lowest growth rates among all supersectors selected.

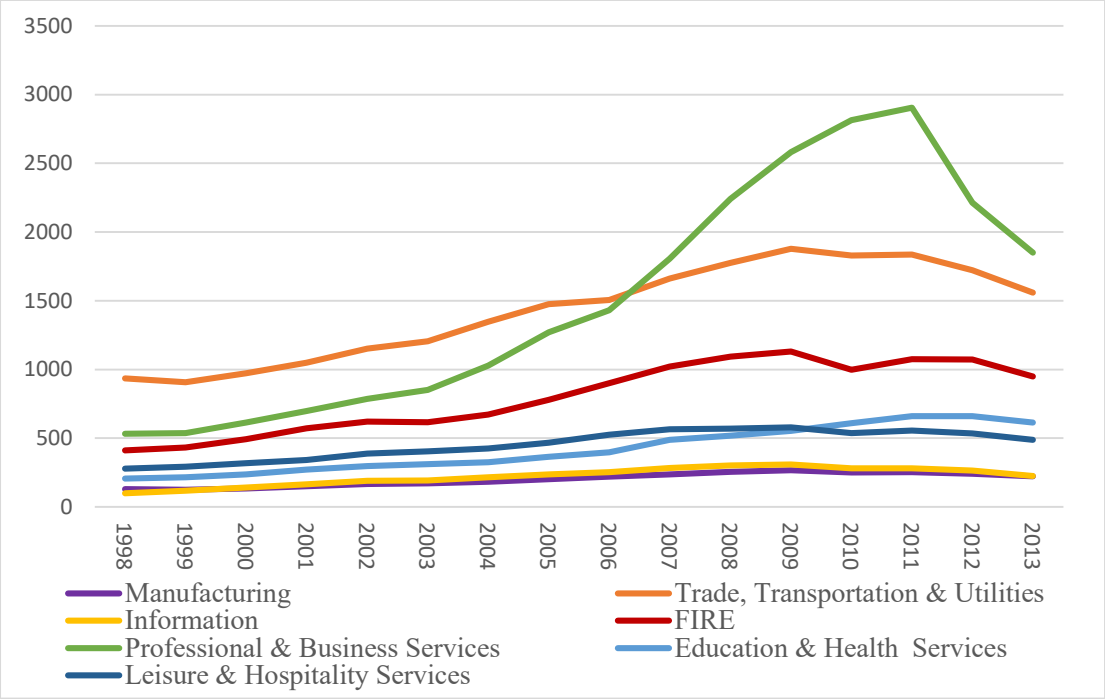


Figure 5.4 Count of Existing Establishments by Industry within the Station Areas, 1998-2013 (source: NETS data)

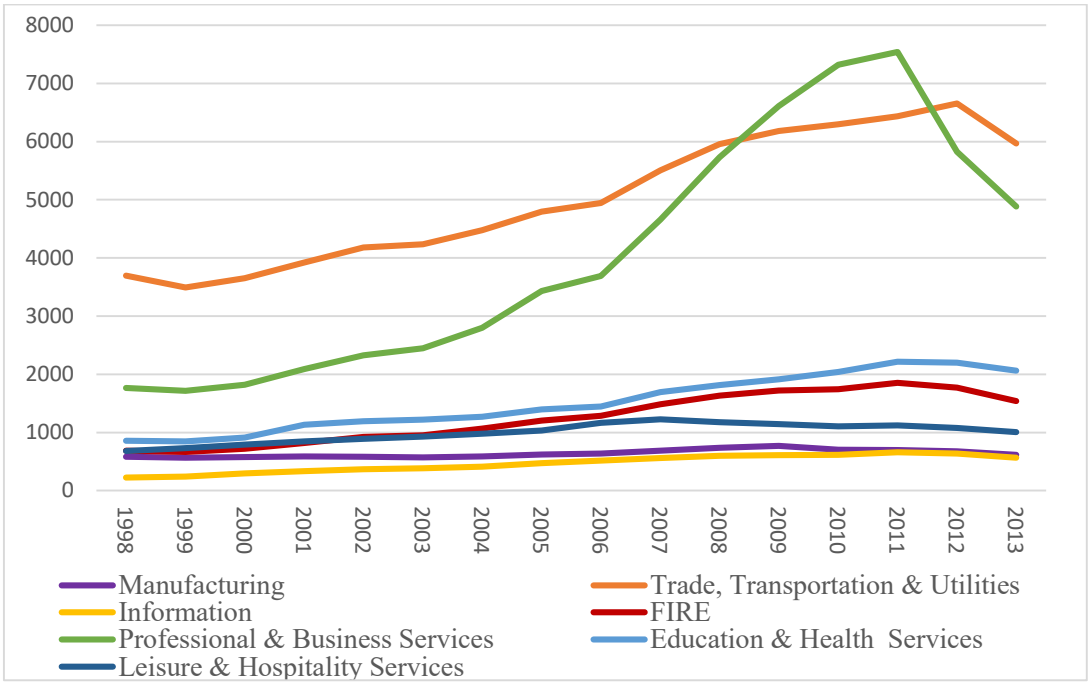


Figure 5.5 Count of Existing Establishments by Industry outside the Station Areas,1998-2013 (source: NETS data)

I summarized the overall trend of firm distribution across space with a simple spatial statistical indicator. The standard deviational ellipse is a common measure of central tendency, dispersion, and directional trends for a set of points. It allows us to see if the distribution of features (establishments) has a particular orientation. Figure 5.6 shows directional distributions of firms in all industries in 1991, 2000, and 2010, respectively, in Hudson County. The insert map shows the mean centers of establishment distribution within Hudson County. The size of oval represents the magnitude of geographic extent of establishment distribution. Ovals on this map suggest that establishment distribution became slightly more spatially dispersed in Hudson County over the study period, with the smallest oval representing 1990, and the largest one representing 2010. The direction of dispersion is moving east toward the Hudson River, i.e., closer to the light rail system, and also in a southeastly direction. The centroid of all establishments moved southwest during the 1990s and jumped toward the southeast during the 2000s. Establishments became more dispersed between 1990 and 2010.

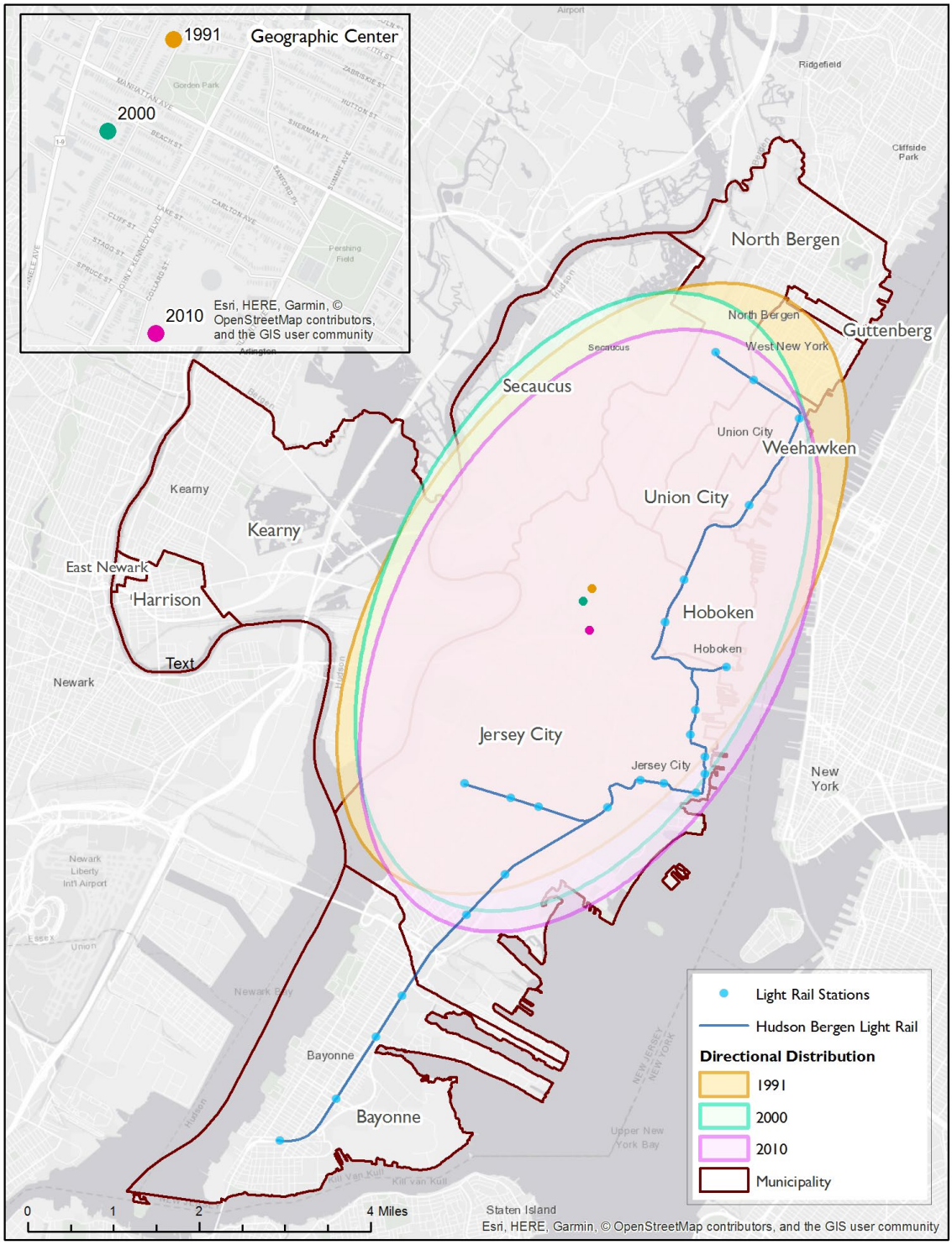


Figure 5.6 Directional Distribution of Firms in Hudson County, New Jersey

Establishments of different sizes have different needs for space, capital, and other resources; and often have a different economic impact on regional economies. Table 5.4 shows yearly growth rate of FIRE firms from 1998 to 2011 by employment size within and outside the light rail's station areas, respectively. Establishments are grouped into sole proprietors, small firms with less than five employees, and large firms with five and more employees.

Table 5.4 Yearly Growth of FIRE Firms (%) by Geographic Areas: 1998-2011 (source: NETS data)

| Year | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **within** | | | | | | | | | | | | | |
| sole | 9.1% | 13.3% | 11.8% | -1.3% | -4.0% | 4.2% | 4.0% | 1.3% | 12.7% | -3.4% | 8.1% | -10.8% | 3.6% |
| 2-5 emp | 0.8% | 13.9% | 19.4% | 13.8% | -0.5% | 11.9% | 19.9% | 22.9% | 16.6% | 9.4% | 5.2% | -12.5% | 7.8% |
| > 5 emp | 11.4% | 14.2% | 12.4% | 1.8% | 1.2% | 4.2% | 12.0% | 1.0% | 4.0% | 4.4% | -5.6% | -8.9% | 8.6% |
| **outside** | | | | | | | | | | | | | |
| sole | 5.9% | -4.2% | 5.1% | -6.3% | -1.5% | 11.3% | 5.4% | 2.6% | 11.9% | 5.6% | 7.4% | -6.4% | -1.1% |
| 2-5 emp | -10.4% | 11.6% | 22.5% | 23.5% | 3.2% | 13.0% | 16.0% | 9.7% | 19.6% | 11.6% | 6.1% | 3.3% | 6.8% |
| > 5 emp | 8.7% | 11.3% | 0.0% | -3.0% | 6.8% | 8.1% | 7.5% | -1.5% | -1.5% | 4.1% | 0.5% | -6.4% | 12.6% |

FIRE industries of all sizes showed variations of growth rates between 1998 and 2011. In particular, yearly growth rates showed more variation within station areas than outside stations for FIRE firms of all sizes. Moreover, variations of yearly growth rates were higher for small firms than for sole proprietors or larger firms in both geographic areas.

Sole proprietors have yearly growth rates ranging from -10.8 percent to 13.3 percent, and -6.4 percent and 11.9 percent respectively within and outside of station areas. Sole proprietors also share similar growth trends within and outside of the station areas, with net growth of 56.4 percent and 39.3 percent from 1998 to 2011, respectively.

Small (2-5 employees) FIRE firms' net growth increased both within and outside of the station areas during the same period: 223.9 percent and 250.7 percent respectively. Small firms' yearly growth rates range from -12.5 percent to 23.5 percent within station areas, while the range outside of station areas is -10.4 percent to 19.6 percent. Larger firms experienced more net growth within the station areas than outside, with 76.3 percent and 55.8 percent net growth respectively between 1998 and 2011. In particular, larger FIRE firms had experienced a decrease of net growth between 2009 and 2010 during the recession within station areas.

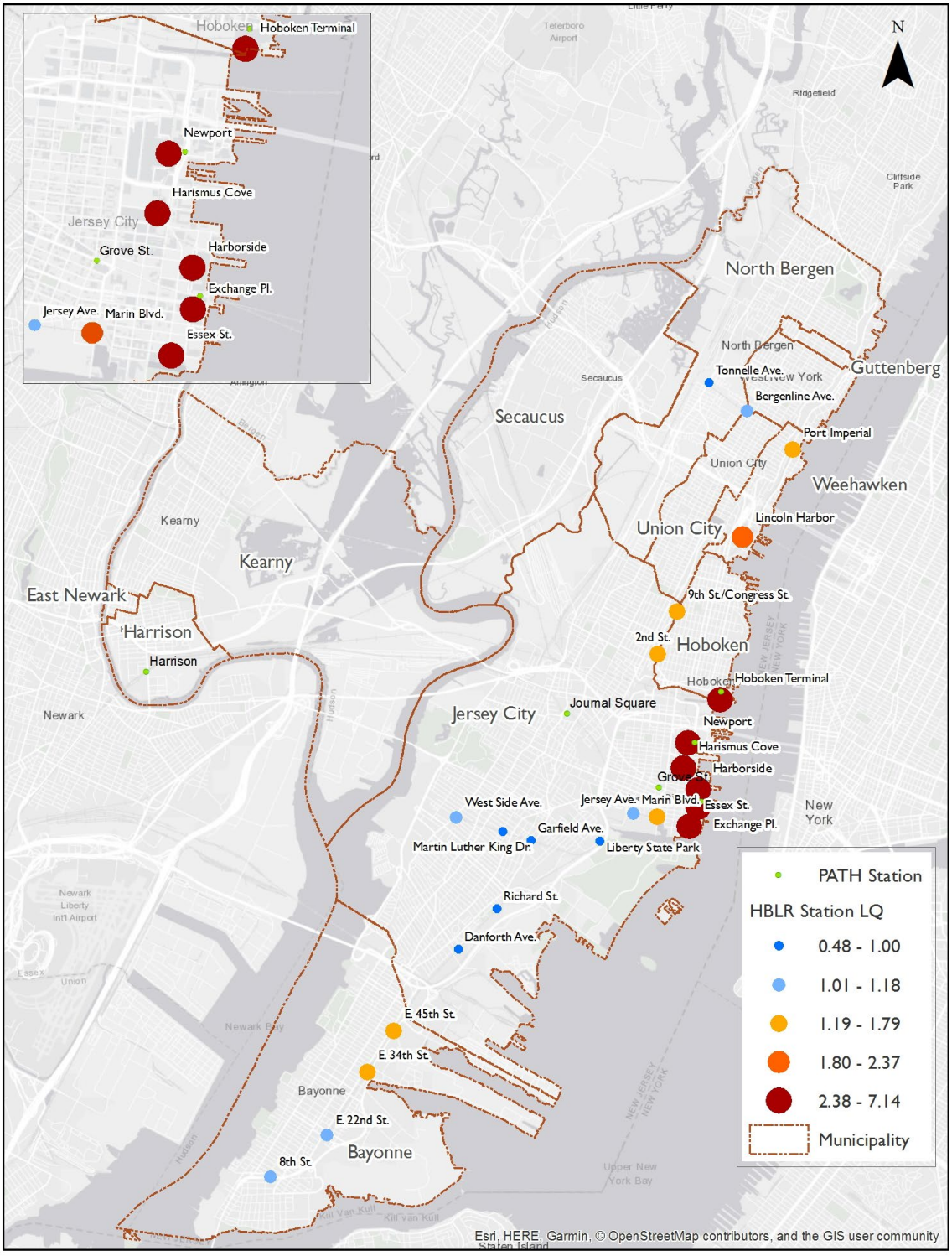


Figure 5.7 FIRE Industries LQ Values by Station (2009-11) (source: NETS data)

Figure 5.7 shows the LQs of FIRE firms in individual HBLR station areas using data between 2009-2011. Larger symbols indicate higher LQs. Station areas with high LQs in FIRE industries are mostly concentrated in downtown Jersey City, where values higher than 2.38 existed. Harborside Station had the highest LQ (7.14). In addition to stations in downtown Jersey City, LQs were also high in the Hoboken terminal station areas, which form a transit hub. In addition, some stations in Weehawken, Hoboken, and Bayonne also have high LQ values, ranging from 1.19 to 2.37. Low LQ values are distributed widely across other parts of the study area. Liberty State Park, Richard St., Danforth Ave., Garfield Ave., and MLK Dr. stations in Jersey City, and the Richard St. station in North Bergen township all have LQs less than 1.00. The lowest LQ is the Liberty State Park station (0.48).

Next, firms did not originally form in Hudson County, or classified as a 'branch' were excluded from further analysis. Such firms were excluded since I only wanted to consider the formation of standalone or headquarters as a "new establishment". And establishments that originally formed outside Hudson County were considered to have relocated to the study area. The resulting dataset included approximately 59,784 establishment births across all years. The data were then aggregated to the Census block level (Census block boundaries for the year 2010 were used to incorporate socio-economic data from the Census): for instance, establishment births and failures were counted for each Census block. There were 4,301 Census blocks (blocks with water bodies only were excluded) in Hudson County, and multiplied by 22 years, yielding a data set with approximately 99,384 records. Figure 5.8 shows Census blocks and the HBLR system in Hudson County.

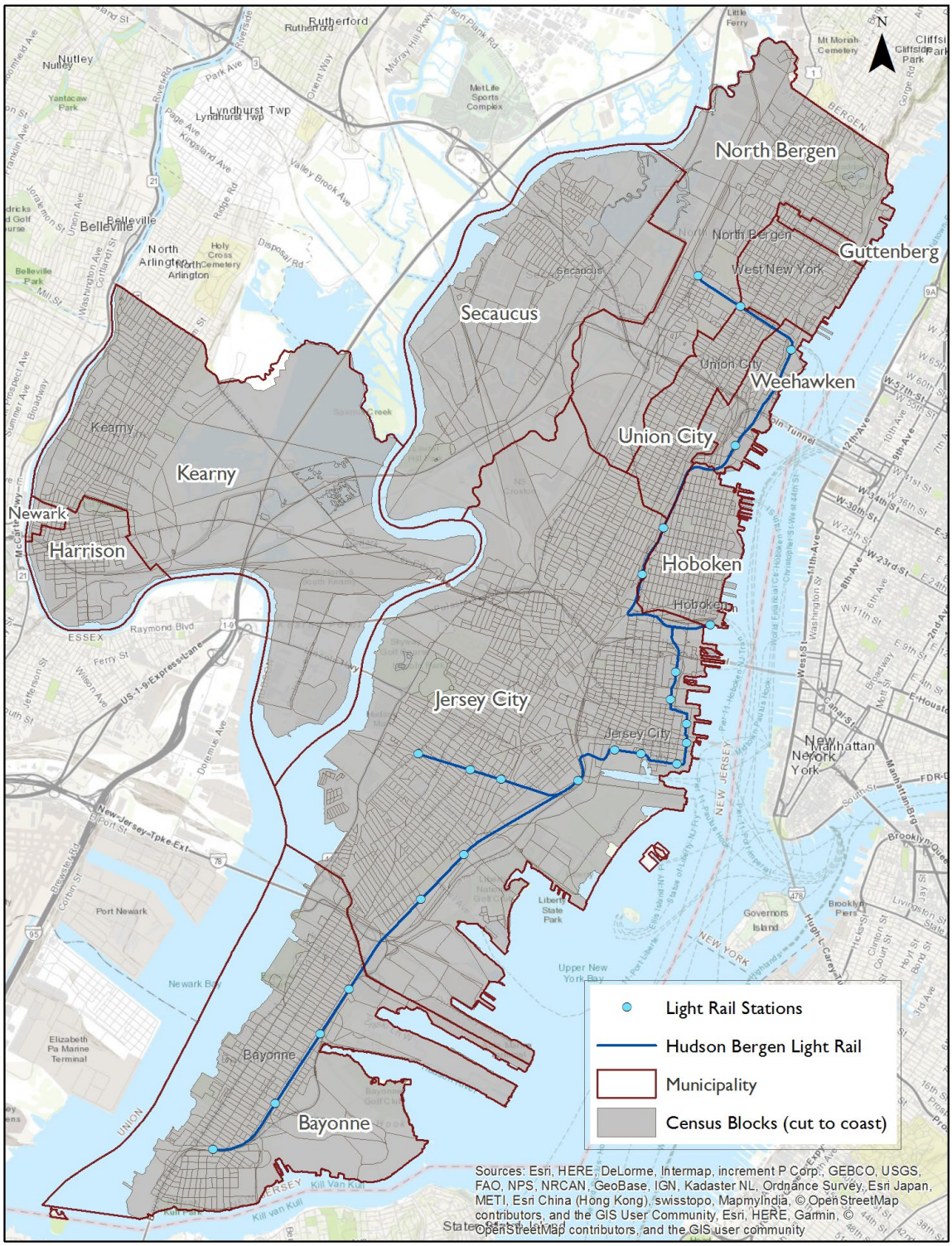


Figure 5.8 Census Blocks in Hudson County, New Jersey

### 5.3 Descriptive Analyses of New Firm Births

In this section, I evaluate new establishments of different supersectors and variety of sizes-- establishments are classified into 11 supersectors based on their NAICS codes. A group of data subsets is also created to explore the extent to which effects vary for new establishments of different sizes. The number of new establishments gets substantially larger over time. Many of the new establishments are small, and between year 1991 and year 2013, the count of establishment's doubles. Sole employee establishments experience a growth of more than 300 percent during the period.

Figure 5.9 illustrates the general trend of net establishment growth rates between 1991 and 2012. There is net growth in the 2000s that varies from 7.6% to 71.5 % for all establishments as a whole. Yet, some years in the study area experiences net declines in establishments: 1998-1999, 2009, and 2011-2012, all near recessions. The year 2012 has the steepest decline in the new growth rate over the entire period. This might be due to economic recessions and trigger events (for example, Hurricane Sandy). Another possible explanation for the decline of net growth is a problem of getting complete counts in the last two years of this data set, as mentioned in previous sections.

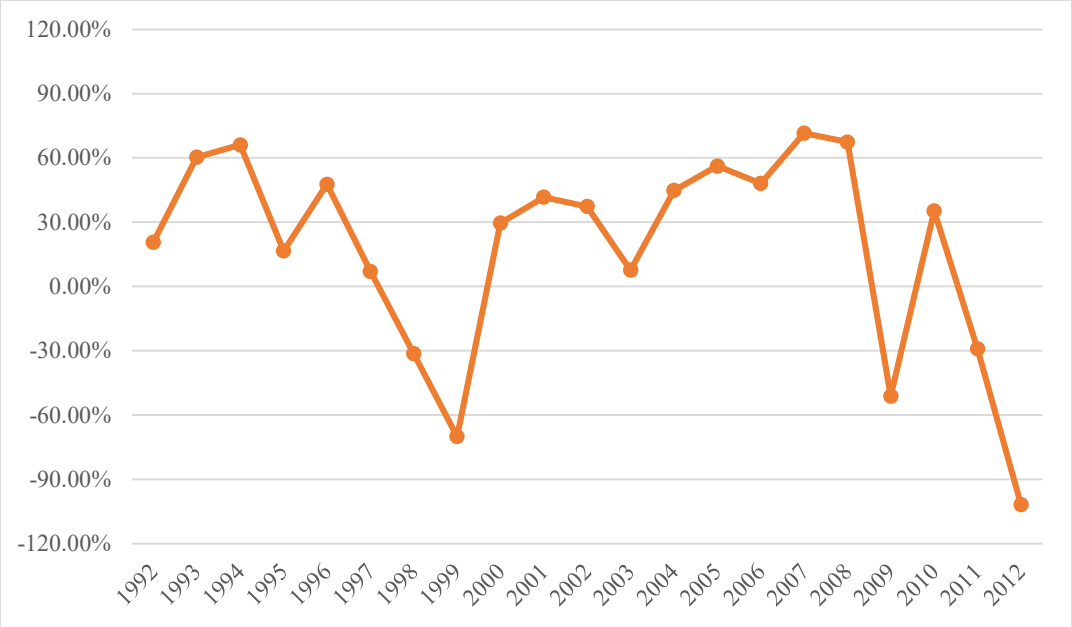


Figure 5.9 Net New Firm Growth Rates for Hudson County: 1991-2012 (source: NETS data)

Figure 5.10 shows firm births per year as a percentage of the number of firm births in 1991. In 2000s, the count of new establishment's experiences growth before the financial crisis, and much of the growth during the study period can be attributed to smaller firms. But the count of establishment births for larger firms declines after the mid-2000s. Indeed, more than one third of all new establishments has only one employee as they enter the market, only six percent enter with more than five employees. Average entry size differs by industry. Manufacturing firms have a markedly higher average entry size (7 employees) than do other sectors. The Other services establishments have an average entry size of just 2, which is the lowest among all supersectors. One possible explanation for the substantial growth of sole proprietors in recent years is that more and more people register their own companies for tax and liability purpose. Another possible

reason is people who work as independent contractors instead of being employed in a regular job increased since the financial crisis.

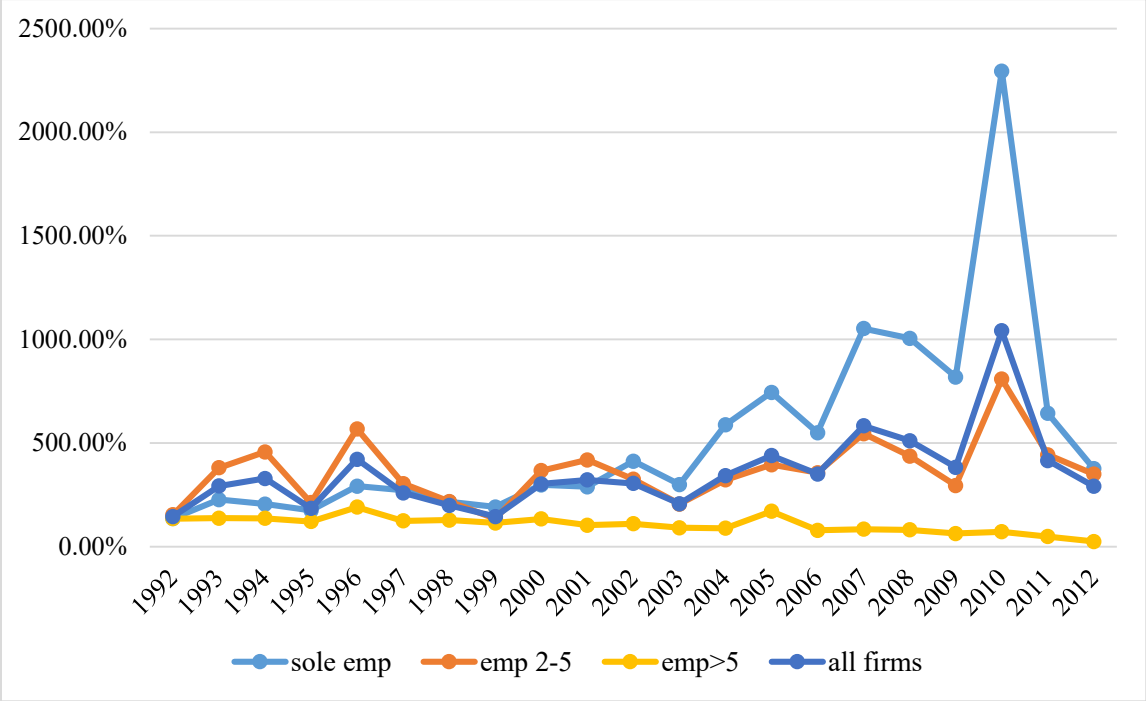


Figure 5.10 Hudson County Establishment Births Compared with Births in 1991 (source: NETS data)

While smaller firms are typically considered to be incubators of innovation, this analysis explores the relationships between the formation of firms of different sizes and their proximity to transit. Firm growth in Hudson County has shown patterns similar to economic cycles: steady growth in the 1990s and 2000s excepts for years in recession (for example, series of global economic financial crisis in the late 1990s, [16] dot-com bubble in early 2000s and the great recession in late 2000s). The decline of new firm births in 2011 and 2012 might be from the changes of NETS data vintages. Smaller firms exhibit much higher growth rates than larger firms. Specifically, sole employee firms

[16] Asian financial crisis in 1997, Russia in 1998, and Argentina in 1999

have seen a continued high growth rates in the 2000s. A possible reason might be attributed to the fact that people tend to seek alternative sources of income by starting their own businesses in the depth of recessions.

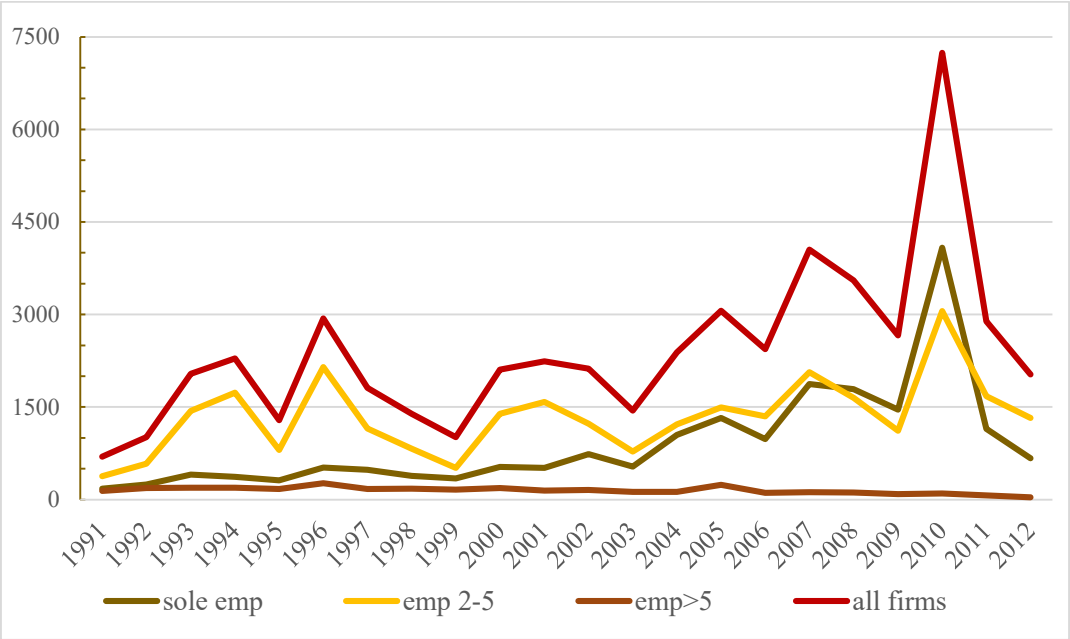


Figure 5.11 Total Number of New Establishments by Employment Size 1991-2012*(5mi) (source: NETS data)

### 5.3.1 By Firm Size

In the NETS database for Hudson County, 37% of all firm births over the study period have less than two employees on average and 57% have 2-5 employees, only 7% of firms have more than five employees on average. In addition, smaller firms tend to survive for fewer years than do firms with more than five employees. On average, firms with more than five employees survive 8.4 years while firms with five or less employees survive 5 years. This suggests that smaller firms are more vulnerable than are larger firms or that smaller firms, which survived longer grow and thus became larger firm sizes. Firms cluster by size in different municipalities of Hudson County. About 38 % of firms

with more than five employees locate in Jersey City and about 10% locate in Hoboken and Secaucus, respectively. About 37% of firms with five or fewer employees locate in Jersey City, 11% in Union City and 10% in North Bergen. This suggests that establishments of different sizes respond differently to rail accessibility and local agglomerations. Based on this, I will construct models for firms of different sizes (based on mean employment size) in which I compare coefficients on proximity to rail station and local agglomeration.

### 5.3.2 By Industry

Establishments were also identified by industry to explore the extent to which the impact of transit proximity affected establishment births vary across industries. Table 5.5 summarizes the average number of firm births in selected industrial sectors from 1991 to 2012.

Table 5.5 Firm Births by Supersector (source: NETS data)

| | Mean | Max | Min |
|---|---|---|---|
| Manufacturing | 93 | 166 | 44 |
| Trade, Transportation, and Utilities | 771 | 1,849 | 318 |
| Financial Activities | 221 | 586 | 45 |
| Professional and Business Services | 840 | 3,207 | 164 |
| Education and Health Services | 195 | 501 | 62 |
| Leisure and Hospitality | 144 | 267 | 58 |

Existing literature on firm birth generally focuses on the manufacturing plants, as has the literature on agglomeration economies. But I hypothesize that the manufacturing sector may be less sensitive to transit proximity compared with other sectors because it tends to consume more land, and because urban zoning/land use regulations on manufacturing firms tend to be tougher. Instead, I hypothesize that firms in service-

providing industries (i.e., retail trade, leisure and recreational services) are likely to locate and grow near transit since municipalities encourage mixed-use and transit-oriented development. Therefore, it seems prudent to analyze specific industry sectors other than manufacturing.

### 5.4 New Firm Distribution Patterns

The spatial distribution of establishment births is uneven within Hudson County: a surprising share locates in Jersey City. Jersey City is the major job center in Northern New Jersey, and directly across the Hudson River from Manhattan. For all firms created between 1991 and 2012, over 37 percent locate in Jersey City, followed by Union City (10.8 percent), North Bergen (9.1 percent), and Hoboken (9.1 percent). Secaucus, however, had only 5.7 percent of the new establishment born during the same period. Figure 5.10 shows the number of new establishment by municipality from 1991 to 2012, and it clearly illustrates the unevenness in new business formation. Table 5.6 shows the share of new firms compared to share of population, and share of landmass by municipality. In general, the share of new firms is associated with the share of population.

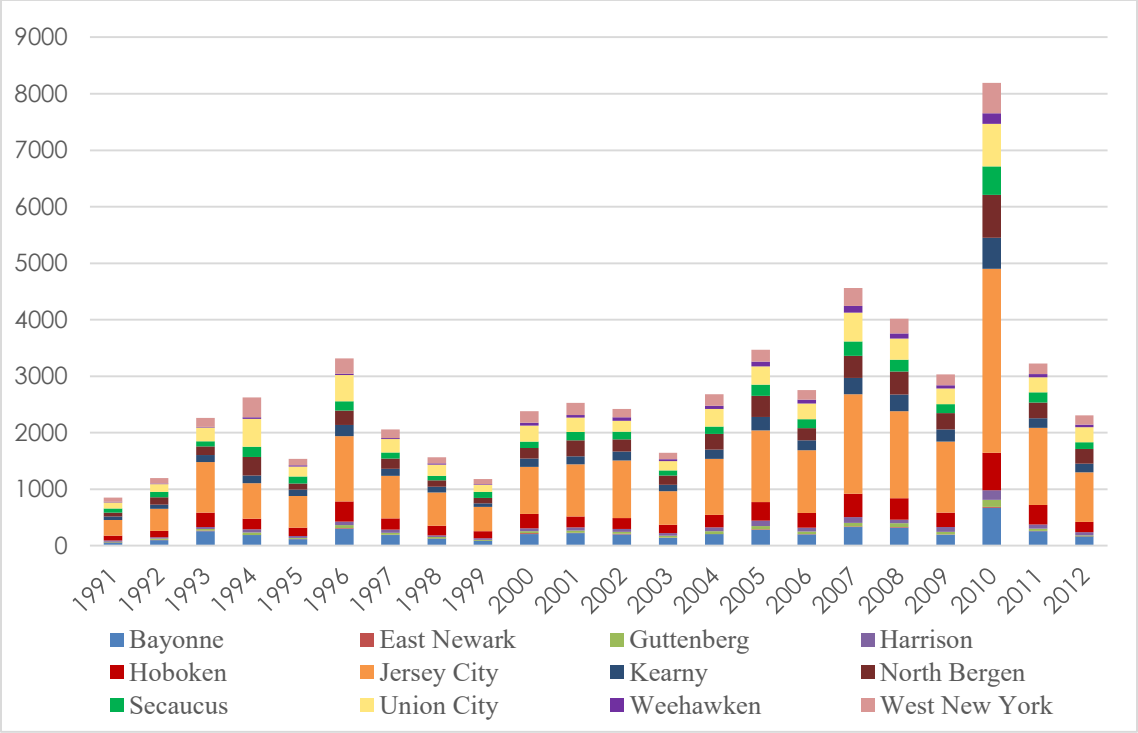


Figure 5.12 Distribution of New Firm Births: 1991-2012 (source: NETS data)

Table 5.6 Share of New Firms (1991-2012) Compared to Share of Population

| Municipality | Share of land area | Share of population | Share of new firms |
|---|---|---|---|
| Bayonne | 12.6% | 10.2% | 8.0% |
| East Newark | 0.2% | 0.4% | 0.3% |
| Guttenberg | 0.4% | 1.8% | 1.5% |
| Harrison | 2.6% | 2.4% | 2.2% |
| Hoboken | 2.8% | 6.3% | 9.1% |
| Jersey City | 32.0% | 39.4% | 37.6% |
| Kearny | 19.0% | 6.7% | 6.4% |
| North Bergen | 11.1% | 9.6% | 9.2% |
| Secaucus | 12.6% | 2.6% | 5.7% |
| Union City | 2.8% | 11.0% | 10.8% |
| Weehawken | 1.7% | 2.2% | 1.8% |
| West New York | 2.2% | 7.5% | 7.3% |
| Hudson County | 100.0% | 100.0% | 100.0% |

The spatial distribution of establishments also varies by sector: 42.3 percent of firms in the information sector and 43.1 percent of FIRE sector firms locate in Jersey

City. But just in 27.3 percent of firms in manufacturing locate in Jersey City. Following by Jersey City, Union City also shows firm concentration in nine sectors: 14.2 percent of manufacturing firms locate in Union City, and 12 percent of education and health services firms, and other services firms respectively. Hoboken also has a concentration of some industries: 13.1 percent of information firms, 12.3 percent of financial services firms, and 12.7 percent of leisure and hospitality firms locate in Hoboken. For the construction sector, 13 percent locate in Bayonne and 11 percent locate in Kearny. In contrast, limited firms locate in Harrison, East Newark, Guttenberg and Weehawken: on average, less than 2 percent of firms in each sector locate in any of these four municipalities.

Establishment density is very high in Hudson County, and Table 5.7 and Figure 5.13 show the change in new establishment density by distance to station. There is a general pattern of increasing density of new establishments closer to light rail stations. Large new establishments tend to associate with proximity to transit stations compared to smaller establishments, perhaps reflecting greater agglomeration benefits that such firms obtain. New establishment density for larger establishments increases at a faster rate when closer to HBLR stations than sole employee establishments and smaller establishments, implying that larger establishments are more likely to form and locate near rail stations.

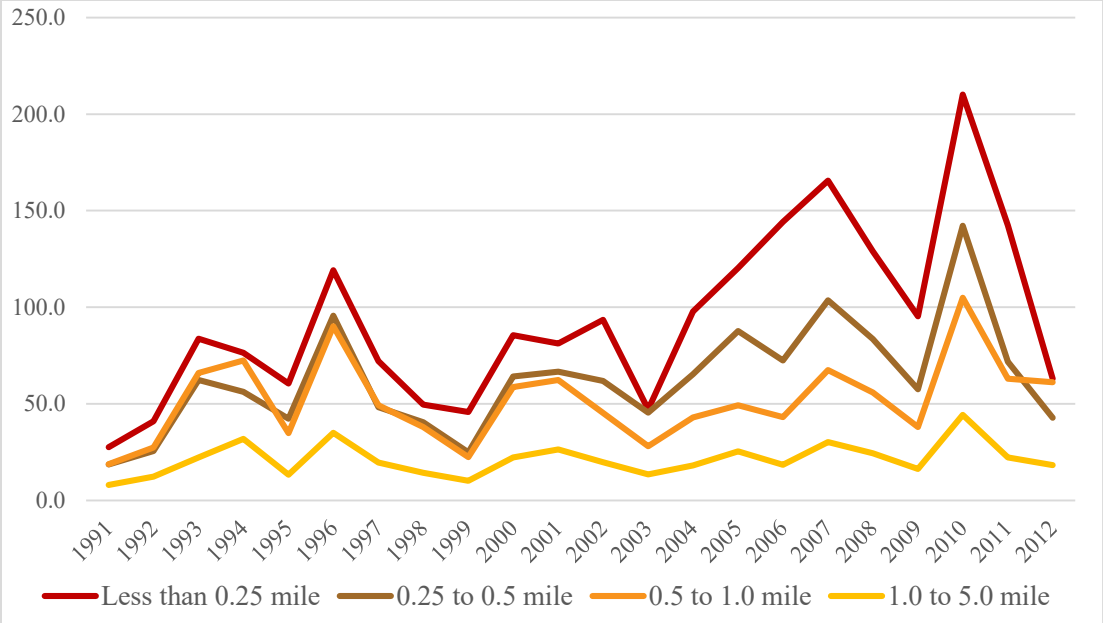


Figure 5.13 New Establishment Density (per Square Mile) from HBLR Stations (1991-2012)

Table 5.7 New Establishment Densities (per sq mile) by Distance from HBLR Stations (1991-2012)

| Distance to HBLR Station | All Firms | Sole Worker Firms | More Than 1 Worker | 2-5 Worker | More Than 5 Workers |
|---|---|---|---|---|---|
| Less than 0.25 mile | 5154.0 | 1053.3 | 2050.3 | 1771.1 | 279.2 |
| 0.25 to 0.5 mile | 3630.1 | 872.2 | 1378.9 | 1227.1 | 151.8 |
| 0.5 to 1.0 mile | 2952.7 | 675.4 | 1138.7 | 1035.7 | 103.0 |
| 1.0 to 5.0 mile | 1225.7 | 294.8 | 465.5 | 422.4 | 43.0 |

The relationship between distance to a rail station and new establishment density varies by industry. Higher establishment birth rates are found in closer to light rail stations for most sectors. The only exception, natural resources and mining sector, is not surprising. For instance, new establishment density of Financial activities within 0.25 mile of a light rail station is 3.04 times higher than within a 0.5 to 1-mile of one. Financial activities and Professional and business services tend to concentrate in areas

within 0.25 mile from a station, and the concentration decreases quickly for 0.5 mile is reached. Trade, transportation and utilities cluster in areas within a mile of a station, and the concentration decreases soon thereafter. Although the density of new establishments for most other industries also decreases with distance from a light rail station, their patterns are not as strong as the industries discussed above. For urban and transportation planners, it is important to understand the reasons for the different patterns. However, because new establishments can drive job creation and, hence, regional growth; since the densification of new establishments may also be caused by external agglomeration benefits.

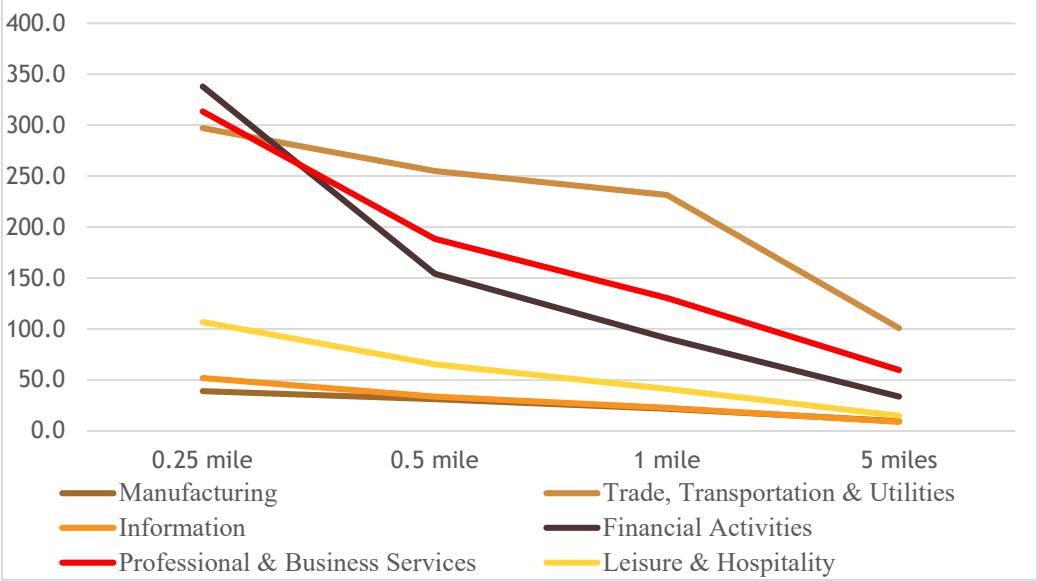


Figure 5.14 New Establishment Densities (per Square Mile) from HBLR Stations by Industry[17] (2000-2012)

[17] For establishments with more than one employee on average

The following maps show the density of establishment births per square mile, alongside the rail transit service areas in Hudson County over time: there are multiple spots of firm concentration in Hudson County, and most are located in Jersey City. Within Jersey City, there are consistent increases in new establishment in the downtown area along the waterfront and to a lesser extent, around the Journal Square PATH station. There is visible new establishment growth in the western part of the county along the HBLR light rail line and the extent of establishment birth concentration becomes larger over years. Such establishment birth concentrations have expanded steadily in the 2000s.

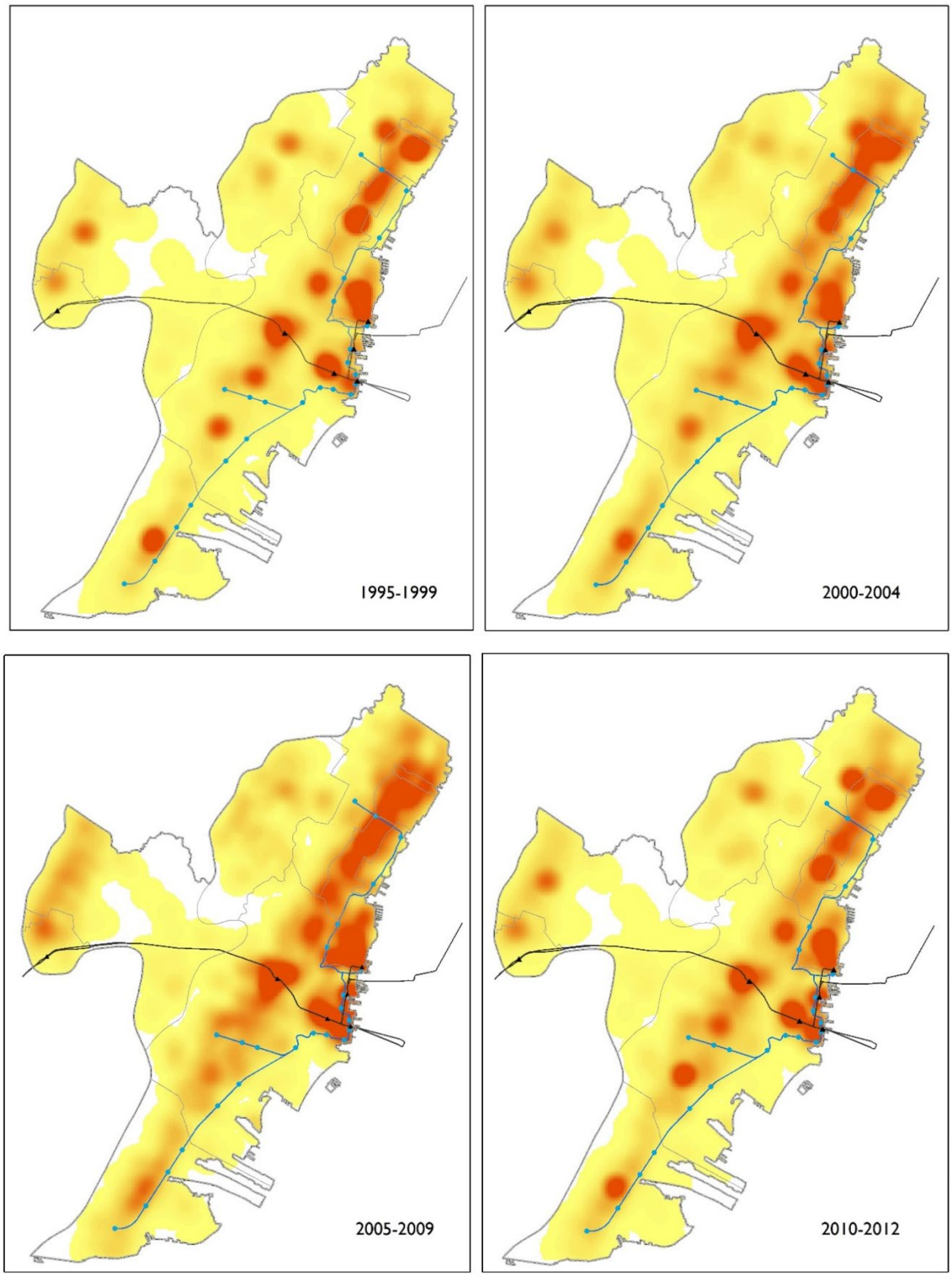


Figure 5.15 Firm Densities in Hudson County, New Jersey (1995-2012)

The hot-spot analysis map shows the overall spatial patterns of establishments in Hudson County. There are three main establishment clusters in Jersey City: the Journal Square PATH station, the waterfront areas along the light rail line including two PATH stations, and Grove Street HBLR station. Union City, West New York, Bayonne, Hoboken, and Secaucus also show smaller establishment clusters, many in downtown areas.

In brief, before controlling for other factors, the descriptive analysis suggests that the birth of new establishments is strongly associated with proximity to light rail stations in Hudson County. According to the yearly panel data set, the density of new establishments was much higher within 0.25 mile and 0.25 to 0.5 mile rings from HBLR stations than it was in a 0.5 to 1-mile ring or for those beyond the 1-mile radius. The density of establishment births also grows throughout the mid-2000s. Industries, again, present differences with distance to a rail station. FIRE and Professional and business service sectors tend to be associated with access to rail, but the association is less pronounced for other sectors. Further verification is required to confirm this tentative result. These associations might be partly related to the proximity to HBLR stations or even coincidental. Only controlled statistical analysis can tell. For example, proximity to other rail stations (commuter rail and PATH), proximity to ferry piers, distance to major highways, CBDs and so forth could force such an apparent association. I examined a variety of industries for the association to the operation of new light-rail stations and the creation of their new establishments.

# Chapter Six

## Modeling New Firm Formation

A key hypothesis here is that establishments are more likely to form and locate in areas with better transit access. NETS data allows the modeling of spatial and temporal changes in establishment births. Random effects, negative-binomial regression models and negative-binomial, GEE regression models were used to determine associations between births of new establishments and proximity to rail stations (HBLR stations and PATH stations), controlling for local measures of agglomeration, and controls socio-economic variables at the census tracts level and other spatially correlated factors, for example, proximity to CBDs.

I count firm births at the census block level. This results in a time series of count data. In such panels, it is common to have correlated measurements, excessive zeros and clustering. Ignoring such effects in model estimation can result in biased or inefficient outcomes (Hilbe, 2011). Because there is a large number of blocks (60-75% of all blocks, depending on the firm size modeled) with no firm births (zero counts) during the 21-year period, count models are the most appropriate approach for this study. The negative binomial distribution is used instead of the Poisson distribution for the count model used since it relaxes the restrictive assumption of equivalence between the mean and the variance of the Poisson regression (Hilbe, 2011).

For panel data, using fixed effects models is attractive because it is a good way to control for unobserved heterogeneity. However, when data come from a larger population with more panels, random-effects estimators are more efficient than fixed-effects estimators (Hilbe, 2011) . A modest amount of inconsistency from the use of random

effects models can be tolerated in return for the increased efficiency and the ability to model the effects of constant-within-group covariates. I also adopt negative binomial generalized estimating equation (GEE) models to estimate the effects of proximity to rail stations on new establishment births. Unlike the random-effects models, this approach models the average response of individuals, while sharing the same predictors across all panels. The benefit of the GEE approach is that the correlation matrix can be arbitrarily parameterized (Hilbe, 2011). I apply an autoregressive (AR) relationship, which assumes that there is a decrease in the correlation coefficient values with increased time. Negative binomial GEE models are an extension of standard NB models, and the construction of NB-GEE models follows the following steps: 1. model a standard negative binomial model to obtain the value of α; 2. Construct a NB-GEE model with α from step one using selected correlation structure. Outcomes from the GEE models were compared to outcomes from the random effects NB models.

**6. 1 Variables**

I mapped annual establishment births by Census blocks, (the key dependent variable for analysis), using 2010 Census geography boundaries: census block *i* has the count of *j* firm birth in year *t*. I used the Census block centroids to measure Census blocks that are in proximity to rail stations: within half mile, half to one mile, and five miles of rail stations (HBLR and PATH).

I also included stations that were opened in a given year. The HBLR, began operating in 2000 with most expansions occurring between 2002 and 2006 towards the north and south along the waterfront areas. The last station opened in 2011 at the

southernmost corner of the county in Bayonne. I also measured spatial distances to the central business districts (CBDs) in New York City (midtown Manhattan and lower Manhattan), Jersey City, and Newark.

The association between new business formation and proximity to rail stations is derived from the NETS data on firm locations, year established, deaths, relocation, industry classifications (according to the North American Industry Classification System (NAICS) two-digit codes), sizes (based on employment size) and sales. Because this dataset does not include information on establishment births for the initial year or establishment deaths for the final year (for example, information such as employment size and sales for an establishment created in year 2000 began in the following year), my analysis is limited between 1991 to 2012. NETS made it possible to examine how the births of new establishments within Hudson County have changed over 22 years and how establishment births might be influenced by proximity to stations of the new HBLR system that opened in 2000.

Table 6.1 provides summary statistics for the variables included in the analysis. The dependent variable is the number of firm births in a given census block *i* in year *t*. Independent variables include measures of various distances, measures of firm activities (i.e., business closure) in a given census block for year *t*, and socio-economic at the census tract level. Some factors are not captured in my model analysis due to limitations of data availability: firm entry barriers (like start-up costs, brand identity, switching costs, and so forth), market growth rates, capital (financial capital and human capital), commercial strategies, and so forth.

Table 6.1 List of Variables

| Variable | Measure | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| **newfirm** | Count of new establishment in census block i | 0.7 | 2.6 | 0.0 | 147.0 |
| distance_HBLR | Travel distance to HBLR stations (1,000 ft) | 11.114 | 11.081 | 0.016 | 41.713 |
| HBLR_d5 | 1 if the travel distance to a HBLR station is <=0.5 mile, otherwise 0 | 0.187 | 0.390 | 0 | 1 |
| HBLR_d1 | 2 if the travel distance to a HBLR station is 0.5-1.0 mile, otherwise 0 | 0.234 | 0.423 | 0 | 1 |
| HBLR_d0 | 3 if the travel distance to a HBLR station is larger than 0.5 mile, otherwise 0 | 0.580 | 0.494 | 0 | 1 |
| PATH_d5 | 1 if the distance to a PATH station is <= 0.5 mile, otherwise 0 | 0.118 | 0.322 | 0 | 1 |
| PATH_d | 1 if the distance to a PATH station is greater than 0.5 mile, otherwise 0 | 0.882 | 0.322 | 0 | 1 |
| distance_midNYC | Distance to mid-town Manhattan (1,000 ft) | 26.714 | 12.446 | 9.533 | 56.770 |
| distance_JC | Distance to downtown Jersey City (1,000 ft) | 20.361 | 10.165 | 0.000 | 39.706 |
| distance_EWR | Distance to downtown Newark (1,000 ft) | 35.278 | 11.322 | 5.929 | 58.305 |
| firm_total | Total existing firms in a given census block | 20.157 | 61.185 | 0 | 1506 |
| newfirmL1 | First lag of new establishment in census block i | 0.661 | 2.282 | 0 | 141 |
| firm_density | Density of firms (firm per square mile) | 382.528 | 881.236 | 0 | 30,011 |
| firm_DENL1 | First lag of firm density in census block i | 369.794 | 886.611 | 0 | 30,011 |
| firm_die | Number of firm dead in census block i | 0.486 | 2.506 | 0 | 125 |
| firm_dieL1 | First lag of firm dead in census block i | 0.431 | 2.503 | 0 | 125 |
| NResource | Count of firms in Natural Resources sector in census block i | 0.001 | 0.037 | 0 | 1 |

| Variable | Measure | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| Construction | Count of firms in Construction sector in census block i | 0.049 | 0.318 | 0 | 20 |
| Manufacturing | Count of firms in Manufacturing sector in census block i | 0.022 | 0.200 | 0 | 17 |
| Trade | Count of firms in Trade sector in census block i | 0.184 | 1.025 | 0 | 100 |
| Information | Count of firms in Information sector in census block i | 0.020 | 0.164 | 0 | 11 |
| FIRE | Count of firms in FIRE sector in census block i | 0.053 | 0.404 | 0 | 54 |
| ProfSer | Count of firms in Professional services sector in census block i | 0.191 | 0.771 | 0 | 34 |
| EDUser | Count of firms in Education services sector in census block i | 0.047 | 0.284 | 0 | 10 |
| Leisure | Count of firms in Art and Leisure services sector in census block i | 0.035 | 0.225 | 0 | 13 |
| OthSer | Count of firms in Other Services sector in census block i | 0.074 | 0.378 | 0 | 20 |
| Government | Count of firms in Government sector in census block i | 0.001 | 0.026 | 0 | 2 |
| chg_DEVland | Change of developable land (acre) in census block I from 1995 to 2007 | -0.349 | 3.536 | -119.3 | 25.53 |
| HHincome | Median household income (in 2009 chained dollar) | | | | |
| POPden | Population density (person per square mile) | 1,765,935 | 6,257,883 | 0 | 437,000,000 |
| p_Hispanic | Percent of Hispanic population | 0.353 | 0.537 | 0 | 1.977 |
| p_BLACK | Percent of black and African American population | 0.103 | 0.496 | 0 | 1.782 |
| p_BA | Percent of at least bachelor's degree | 0.264 | 0.436 | 0 | 1.045 |
| p_fborn | Percent of population that are foreign born | 0.333 | 0.432 | 0 | 0.800 |

The key variable of interest was the distance of each Census block (centroid) to its nearest HBLR station. Distance to HBLR stations are measured by both travel distance and a set of distance bands (dummy variables). The dependent variable is the number of firm births in a given census block *i* in year *t*. Independent variables include measures of various distances, measures of firm activities (i.e. firm closure) in the block *i* in year *t*, and socio-economic data at the census tract level. Because the light rail system began operation in 2000, travel distance to HBLR stations in 1999 was treated the same as in year 2000. For years before 1999, the distance was set to 5 miles for all blocks with the assumption that effects of proximity to the light rail diminish with distance and become minimal beyond 5 miles. Otherwise, all data before 1999 would be dropped from the analysis due to missing data before the operation of the HBLR.

First, a model with travel distance measures to the closest HBLR station was estimated. Second, three distance threshold dummy variables were introduced to the model: whether a census block is within a half-mile radius from a HBLR station, between half and one mile from a HBLR station, or a distance greater than one mile, respectively. This is based on the assumption that blocks that are farther away from HBLR stations may offset the effects of proximity to rail transit on agglomeration (Nelson et al., 2013; Padeiro, 2013). Thus, adding these variables draws a better picture between of the effects of proximity to rail transit on agglomeration. Other location variables include: dummy variables to control whether the centroid of a census block is within 0.5 mile from a PATH station, Euclidean line distance to the CBD in Manhattan, Jersey City, and Newark to control for CBD effects.

To control for industrial agglomeration effects, a set of firm-specific variables are created. Firm density (number of firms per square mile), counts of existing firms and deaths per year, as well as a one-year lag of each of these variables are used at the Census block level. To control for the effects of land supply, change in developable land (acre) at Census block level was also calculated based on land use and land cover data retrieved from the New Jersey Department of Environmental Protection. To control for other factors that might influence firm births and agglomeration, a series of socio-economic variables is also included in this study. These include population density, the percentage of the Census tract population who identify as Black or African American, Hispanic or Latino, or foreign born; percent of population in the labor force with at least a bachelor's degree, and median household income. All of these socio-economic control variables are measured at the Census tract level, using data from the Decennial Census for 1990, 2000; and the five-year American Community Survey (ACS) for the years from 2009 to 2013. Annual estimates use a steady growth rate interpolation of the Census data for the years between decennial Census data. In addition to Census control variables, I also include a set of municipality dummy variables to capture the differences among municipalities (i.e.: local policies, tax incentives, and so forth).

I estimate models for the entire data set (all establishments). Subsets with larger firms, sole employee firms, the major NAICS industrial sectors, as well as a subset of data that only includes establishments formed between 1999 and 2012 (time period parallel to the operation of the light rail system). Parameter estimates in all models are statistically significant or nearly so with a high level of confidence. This is attributed to the large size of the dataset used.

## 6.2 Models by Firm Size

### 6.2.1 Random Effects Models

Table 6.2 presents model outcomes (incidence rate ratios) by firm size with and without distance band dummies using random effects negative binomial models. The model for all establishments (the entire data set) suggests that establishment births decrease with distance away from a HBLR station. With and without distance band dummies, the incidence rate ratios (IRR) for distance to HBLR stations is 0.984 and 0.982 respectively. In model 1, IRR for establishment births in blocks located within a half mile (1.051) and between half and one mile (1.064) from the nearest HBLR station are significant and greater than 1. This suggest that while holding all else equal, blocks that are within a half-mile buffer from a HBLR station have 1.05 times more establishment births (for blocks located between half and one mile, 1.06 times) than blocks that are more than one mile from the nearest HBLR station. These outcomes suggest that proximity to the light rail system has a moderate influence on establishment births in Hudson County.

## Table 6.2 Results of Random Effects, Negative Binomial Models

| | All Firms | | with >1 Emp | | with <=5 Emp | | with >5 Emp | |
|---|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 |
| Distance to HBLR Station(1,000 feet) | 0.9836*** | 0.9820*** | 0.9975*** | 0.9931*** | 0.9818*** | 0.9800*** | 1.0136*** | 1.0108*** |
| HBLR Station Distance | | | | | | | | |
| <= 0.5 mile | 1.0505* | | 1.0499* | | 1.0607** | | 1.1584* | |
| 0.5 to 1 mile | 1.0638** | | 1.0325 | | 1.0671** | | 1.0348 | |
| > 1 mile (ref. cat.) | | | | | | | | |
| PATH Station Distance | | | | | | | | |
| <=0.5 mile | 1.3290*** | 1.3252*** | 1.7940*** | 1.8758*** | 1.2509*** | 1.2475*** | 3.3138*** | 3.3807*** |
| >0.5 mile (ref. cat.) | | | | | | | | |
| Distance to CBD (1,000 feet, mid-town Manhattan) | 1.0253*** | 1.0257*** | 1.0027 | 1.0077 | 1.0317*** | 1.0322*** | 0.9664*** | 0.9667*** |
| Change of Developable Land (Acre) | 1.0391*** | 1.0391*** | 1.0349*** | 1.0354*** | 1.0389*** | 1.0389*** | 1.0233*** | 1.0235*** |
| Firm Variables | | | | | | | | |
| Number of Firm Deaths (in previous year) | 0.9809*** | 0.9810*** | 0.9837*** | 0.9797*** | 0.9806*** | 0.9806*** | 0.9946** | 0.9945** |
| Number of Firms (in previous year) | 1.0070*** | 1.0070*** | 1.0065*** | 1.0098*** | 1.0072*** | 1.0072*** | 1.0096*** | 1.0097*** |
| Socio-economic Variables | | | | | | | | |
| Median HH Income (in 2009 chained $) | 0.9999*** | 0.9999*** | 1.0000** | 0.9999 | 0.9999*** | 0.9999*** | 1.0000 | 1.0000 |
| Percent Hispanic | 8.1790*** | 8.0262*** | 1.8408*** | 2.3600*** | 10.8673*** | 10.6344*** | 0.5021*** | 0.4811*** |
| Percent with BA degree | 8.7804*** | 8.7128*** | 1.1252 | 1.344* | 12.8524*** | 12.7391*** | 0.1549*** | 0.1478*** |
| Municipality | | | | | | | | |
| Bayonne (ref. cat.) | | | | | | | | |
| East Newark | 0.9786 | 0.9879 | 0.7123 | 1.0454 | 1.0556 | 1.0645 | 1.0789 | 1.1122 |
| Guttenberg | 2.9054*** | 2.8910*** | 2.7452*** | 2.8805*** | 3.0440*** | 3.0271*** | 1.2094 | 1.2174 |
| Harrison | 1.0996 | 1.1064 | 0.9110 | 0.9221 | 1.1172 | 1.1246 | 0.5912** | 0.5989** |
| Hoboken | 2.7405*** | 2.7681*** | 2.5657*** | 3.2448*** | 2.9438*** | 2.9766*** | 1.5222 | 1.5360 |
| Jersey City | 1.5293*** | 1.5377*** | 1.2952** | 1.4325*** | 1.6991*** | 1.7092*** | 0.6313** | 0.6349** |
| Kearny | 1.18080** | 1.1844** | 0.8007** | 0.8928 | 1.2585*** | 1.2628*** | 0.3402*** | 0.3418*** |
| North Bergen | 1.2064 | 1.2134 | 1.0859 | 1.2295 | 1.3232** | 1.3317** | 0.4427*** | 0.4492*** |
| Secaucus | 0.8943 | 0.8840 | 0.4989*** | 0.7137** | 1.0128 | 1.0002 | 0.3540*** | 0.3472*** |
| Union City | 2.2384*** | 2.2614*** | 2.5471*** | 2.5712*** | 2.4099*** | 2.4384*** | 1.0335 | 1.0558 |
| Weehawken | 1.0249 | 1.0363 | 0.7833 | 1.1070 | 1.1579 | 1.1723 | 0.2985*** | 0.3003*** |
| West New York | 1.7466*** | 1.7778*** | 1.9868*** | 2.125*** | 1.8623*** | 1.8995*** | 1.1209 | 1.1566 |
| Constant | 41.75356*** | 42.8798*** | 167.3166*** | 135.3084*** | 26.1361*** | 26.9045*** | 814.906*** | 853.2637*** |
| N | 86,961 | 86,961 | 86,961 | 86,961 | 86,961 | 86,961 | 86,961 | 57,947 |
| Log-likelihood | -75279.2 | -75282.6 | -56831.4 | -40549.5 | -72854.1 | -72857.8 | -12578.8 | -12580.3 |
| Chi2 | 5215.3 | 5198.9 | 2372.8 | 1714.3 | 5757.4 | 5738.2 | 901.0 | 896.0 |

note: *p<0.1, ** p<0.05, ***p<0.01.

Other models by establishment size suggest that establishment births are associated with station proximity whether firm size is considered or not in model estimation, and this relationship varies by establishment size. In models for establishments with more than one employee and for firms with five or less employees, the IRR for distance to the nearest HBLR station is similar to the model for all firms. IRRs in these models are smaller than 1, suggesting that establishments are more likely to form in blocks closer to HBLR stations. For the model with more than five employees, IRR is greater than 1, and this suggests that larger new establishments located farther from stations, all else equal. However, the effects of proximity to HBLR on the birth of establishments are limited, because IRRs are so close to one in these models.

Distance band variables indicate that distance still matters. Model 7 suggests that larger establishments are more likely to locate within a half mile of the nearest HBLR station compared to a location more than a mile away. For establishments with five or fewer employees, the distance band variables in model 5 suggest that blocks within either a half-mile or between a half mile and a mile have 6.1% and 6.7% percent more establishment births than do blocks that are more than a mile from the nearest station.

Dummy variables for proximity to a PATH station (0.5-mile radius) are statistically significant across all models. Incidence rate ratios for larger establishments (model 7) and smaller establishments (model 5) are 3.3138 and 1.2509, respectively. It means blocks within half mile from a PATH station have higher establishment births rates of 3.31 times and 1.25 times for larger establishments and smaller establishments, respectively. These results suggest that access to PATH service has significant influence on establishment births regardless of establishments' employment size.

Both proximity to a CBD (midtown Manhattan) and developable land[18] are associated with establishment births. The signs and magnitudes for distance to CBD differ by size. Blocks that are closer to the CBD have more births of larger establishments: with all other variables held constant, a Census block has 3.4% fewer establishment births for each 1,000 feet further from the CBD. However, for smaller firms, blocks located farther away from the CBD have more establishment births (3.2% more for each 1,000 feet).

Incidence rate ratios for the two firm variables conform to expectations. Across all employment sizes, the presence of existing establishments is associated with more establishment births while the presence of more establishment deaths is associated with fewer establishment births. For smaller establishments (model 5), the counts of establishment deaths within the census block has a larger negative effect on the birth of establishments, and the count of establishments has a smaller effect. But for larger establishments (model 7), the influences of establishment deaths and existing establishments are minimal with IRRs of 0.99 and 1.01, respectively.

Most socio-economic control variables are statistically significant for all models, but some are unimportant with low incidence rates. This indicates that influences of some variables are not that important. Population density is excluded because of multicollinearity. Median household income is not important with low IRR values close to 1.0 in all models. Both percent Hispanic and percent with a bachelor's degree are statistically significant across all models and the parameter values are relatively high compared to other socio-economic variables in most models. For all firms and smaller

[18] Land supply is calculated using 2002 Land use/land cover data from New Jersey Department of Environmental Protection.

firms, both Census variables are positively associated with establishment births, but they are negatively associated with the formation of larger establishments. This implies that relationships between socio-economic factors and establishment births differ by employment size.

The results for models of other employment sizes indicate that, whether or not employment size is considered as a factor, establishment births are associated with proximity to rail stations. Outside of models of larger establishments alone, proximity to HBLR stations is positively related to new establishment births. The distance parameters for the model of smaller firms (<=5 employees) is similar to that for all firms. Yet, the effects are not that important because for every 1,000 feet more distant from a station, the possibility of having a new firm decreases only about 1%. In models for larger firms with more than five employees, the signs of incidence rate ratios for distance to station are different: larger firms tend to form farther away from rail stations. Yet the distance band dummy for within a half mile or for a half mile and a mile from the station remain both significant and positive for all models. This implies that these blocks are more likely to have new firm births when compared to blocks located more than one mile from a light rail station. The contradiction between the distance variable and distance threshold dummies suggests that the influence of the rail station is limited and is offset by blocks that are far away from HBLR stations.

Figure 6.1 shows the cumulative effects of distance dummies and all travel distance coefficients as a function of distance from HBLR stations for the models listed in Table 6.2. The lines plotted in the chart are calculated as $y=\alpha + (travel\ distance * \beta)$, where $\alpha$ is the coefficient for distance dummies and $\beta$ is the coefficient for distance from

the closest light rail station. For example, in model 1, the predicted effect when distance to a HBLR station is zero feet should be: *0.0492+ (0 *-0.0165) =0.0492*.[19]

It is clearly possible that the difference in results between large establishments and smaller establishments is reflects differences in employment size. The lines for model 1 and model 5 mostly overlap. This graph clearly shows that, in general, the effects of being near a HBLR station on establishment births is limited, and they are positive within half mile from a station. For smaller establishments, there is a sharp drop-off one-mile away from a station and the effect becomes negative. The predicted effects for larger establishments are always positive and increase in in all distance bands: Census blocks within a quarter mile, between 0.75 and 1 miles, and more than 1.25 miles from a HBLR station.

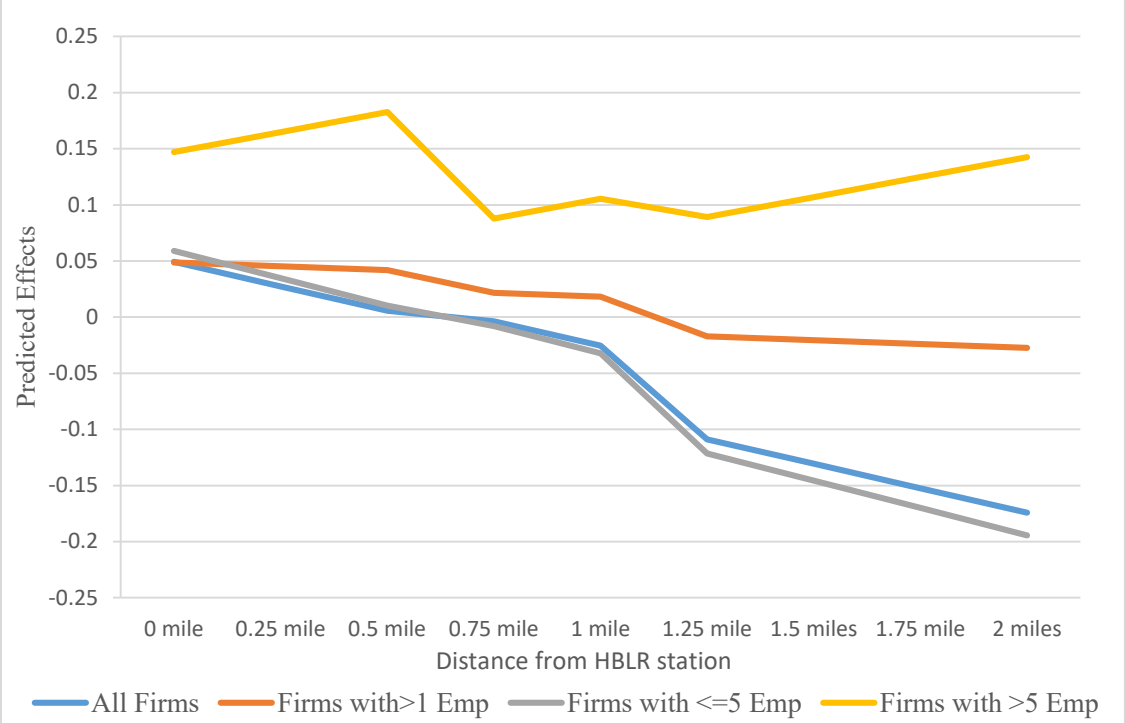


Figure 6.1 Predicted Effects of HBLR Station Distance Variables by Firm Size

[19] Conversion between coefficient and IRR of count model regression: IRR=exp(β)

### 6.2.2 Random Effects Models vs. GEE Models

Table 6.3 summarizes model outcomes for a set of random effects models and GEE models. As described in previous sections, unlike the random-effects model, which is subject-specific, GEE models are population-averaged models for which marginal effects are averaged across individuals. They are considered robust because the correlation matrix can be arbitrarily parameterized and they model the average response of individuals that share the same predictors across all of the panels (Hilbe, 2011). I applied the autoregressive (AR) correlation structure for my GEE models because it allows the correlations to diminish over time.

Random effects models and GEE models show similar outcomes for different panel models. The results suggest that whether initial employment size is a factor or not, establishment births are associated with proximity to HBLR and PATH stations. Other than models (NB-4 and GEE-4) for larger firms alone, proximity to a HBLR station has a positive association with new establishment births. For larger firms, every 1,000 feet farther away from a station, the likelihood of a new firm increases about 1% in the random effects model and 3.3% in the GEE model. This indicates that larger firms tend to form in blocks farther away from rail stations. The distance parameters for models with smaller firms (<=5 employees) is similar to models for all firms. Yet, the effects are not that important because for every 1,000 feet farther away from a station, the likelihood of a new establishment only decreases about 1.6% in the random effects model and 1% in the GEE model.

The distance band dummies suggest that blocks within 0.5 mile or between 0.5-1 mile from a rail station are both significant and positive for all models, implying that

these blocks are more likely to have new establishment births compared to blocks located more than a mile from a light rail station. The contradiction between the distance variable and distance threshold dummies might suggest that influence of the rail station is limited and is offset by blocks that are farther away from rail stations.

Discussions in the following paragraphs focus on GEE models for establishments with more than one employee (GEE- 2) and larger establishments (GEE-4). According to the incident rate, for establishments with more than one employee, when holding all else equal, blocks that are within 0.5 mile from a HBLR station have 1.74 times more establishment births than blocks that are more than one mile away. Blocks that are between 0.5-1 mile from a station have 1.03 times more establishment births than blocks that are more than one mile away from HBLR stations. Similar results are also found in the GEE-4 model with more than five employees. The distance band dummies indicate that blocks within half mile or between half and one mile are both significant, with all other variables controlled for. Blocks located less than 0.5 mile from HBLR stations have 1.76 times more establishment births than blocks that are more than one mile away; and blocks within 0.5-1 mile have 1.19 times more establishments than those located more than a mile from a HBLR station.

Table 6.3 Results of Negative Binomial Models and Negative Binomial, GEE Models

| | All Firms | | with >1 Emp | | with <=5 Emp | | with >5 Emp | |
|---|---|---|---|---|---|---|---|---|
| | NB-1 | GEE-1 | NB-2 | GEE-2 | NB-3 | GEE-3 | NB-4 | GEE-4 [2] |
| Distance to HBLR Station(1,000 feet) | 0.9836*** | 0.9901*** | 0.9975*** | 0.9987*** | 0.9818*** | 0.9873*** | 1.0136*** | 1.0325*** |
| HBLR Station Distance | | | | | | | | |
| <= 0.5 mile | 1.0505* | 1.1901*** | 1.0499* | 1.1371*** | 1.0607** | 1.1727*** | 1.1584* | 1.7553*** |
| 0.5 to 1 mile | 1.0638** | 1.0833** | 1.0325 | 1.0332 | 1.0671** | 1.0783* | 1.0348 | 1.1915* |
| > 1 mile (ref. cat.) | | | | | | | | |
| PATH Station Distance | | | | | | | | |
| <=0.5 mile | 1.3290*** | 1.4272*** | 1.7940*** | 1.7725*** | 1.2509*** | 1.3803*** | 3.3138*** | 2.7534*** |
| >0.5 mile (ref. cat.) | | | | | | | | |
| Distance to CBD ,000 feet, mid-town Manhattan) | 1.0253*** | 1.0293*** | 1.0027 | 1.0141*** | 1.0317*** | 1.0327*** | 0.9664*** | 0.9899 |
| Change of Developable Land (Acre) | 1.0391*** | 1.0459*** | 1.0349*** | 1.0436*** | 1.0389*** | 1.0472*** | 1.0233*** | 1.0274*** |
| Firm Variables | | | | | | | | |
| Number of Firm Deaths (in previous year) | 0.9809*** | 0.9627*** | 0.9837*** | 0.9668*** | 0.9806*** | 0.9635*** | 0.9946** | 0.9632*** |
| Number of Firms (in previous year) | 1.0070*** | 1.0493*** | 1.0065*** | 1.0492*** | 1.0072*** | 1.0485*** | 1.0096*** | 1.0394*** |
| Socio-economic Variables | | | | | | | | |
| Median HH Income (in 2009 chained $) | 0.9999*** | 0.9999*** | 1.0000** | 0.9999*** | 0.9999*** | 0.9999*** | 1.0000 | 0.9999 |
| Percent Hispanic | 8.1790*** | 7.10889*** | 1.8408*** | 4.0447*** | 10.8673*** | 8.0337*** | 0.5021*** | 1.3140 |
| Percent with BA degree | 8.7804*** | 10.3857*** | 1.1252 | 2.9480*** | 12.8524*** | 13.2609*** | 0.1549*** | 0.3809** |
| Municipality | | | | | | | | |
| Bayonne (ref. cat.) | | | | | | | | |
| East Newark | 0.9786 | 1.0551 | 0.7123 | 0.7532 | 1.0556 | 1.0952 | 1.0789 | 0.4678* |
| Guttenberg | 2.9054*** | 2.6142*** | 2.7452*** | 1.9290*** | 3.0440*** | 2.8031*** | 1.2094 | 1.0758 |
| Harrison | 1.0996 | 0.9037 | 0.9110 | 0.6624*** | 1.1172 | 0.9569 | 0.5912** | 0.2556*** |
| Hoboken | 2.7405*** | 4.2314*** | 2.5657*** | 3.5160*** | 2.9438*** | 4.4470*** | 1.5222 | 2.9740*** |
| Jersey City | 1.5293*** | 1.7295*** | 1.2952** | 1.3245*** | 1.6991*** | 1.8292*** | 0.6313** | 0.9596 |
| Kearny | 1.18080** | 1.0337 | 0.8007** | 0.6194*** | 1.2585*** | 1.1367 | 0.3402*** | 0.1827*** |
| North Bergen | 1.2064 | 1.4136*** | 1.0859 | 1.0223 | 1.3232** | 1.5184*** | 0.4427*** | 0.4421*** |
| Secaucus | 0.8943 | 1.2212 | 0.4989*** | 0.7648* | 1.0128 | 1.2903* | 0.3540*** | 0.4633** |
| Union City | 2.2384*** | 2.5450*** | 2.5471*** | 2.0635*** | 2.4099*** | 2.7338*** | 1.0335 | 1.1348 |
| Weehawken | 1.0249 | 1.5929*** | 0.7833 | 1.0750 | 1.1579 | 1.7353*** | 0.2985*** | 0.8067 |
| West New York | 1.7466*** | 1.9718*** | 1.9868*** | 1.6423*** | 1.8623*** | 2.0744*** | 1.1209 | 1.1599 |
| Constant | 41.75356*** | 9.9888*** | 167.3166*** | 13.8081*** | 26.1361*** | 8.0531*** | 814.906*** | 3.2070** |
| N | 86,961 | 86,961 | 86,961 | 86,961 | 86,961 | 86,961 | 86,961 | 57,947 |
| Log-likelihood | -75279.2 | | -56831.4 | | -72854.1 | | -12578.8 | |
| Chi2 | 5215.3 | 7052.9 | 2372.8 | 5944.0 | 5757.4 | 7204.3 | 901.0 | 2101.4 |

note: *p<0.1, ** p<0.05, ***p<0.01. Model 1: random effects models. Model 2: GEE models

IRR's for the PATH dummy variable are also statistically significant in all GEE models, and have positive effects on establishment formation. For establishments with more than one employee, blocks located within 0.5 mile from PATH stations have 1.77 times more establishment births than other areas, and in the GEE-4 model, blocks located within 0.5 mile from PATH stations have 2.75 times more establishment births. The magnitudes of the PATH distance band variable are higher than the magnitudes of the HBLR distance band variables in all GEE models. This suggests that the influences of PATH stations on establishment births are stronger than those of HBLR stations. Additionally, the incidence rate ratios are significantly larger in models for larger establishments (GEE-4) than those in models for smaller establishments (GEE-3). These results support my qualitative interviews that found that companies have more interest to site close to PATH stations than HBLR stations.

Distance to the CBD and change of amount of developable land are associated with establishment births in both GEE-2 and GEE-4 models. Although distance to the CBD is associated with new establishment births, the incident rate ratio is relatively small, so the effect is minor and much less than the effect of developable land. Land supply is an important factor for establishment formation in Hudson County, and blocks with more developable land tend to have more establishment births, and this influence is stronger for smaller establishments than larger establishments, with IRR of 1.0436 and 1.0274, respectively.

Two firm-specific variables are statistically significant. As expected, the number of existing establishments are positively associated with establishment births, but more establishment deaths are associated with fewer establishment births. For every unit

increase in existing establishments (in previous year), the rate of having a new establishment is expected to increase 4.9% and 3.9% in GEE-2 and GEE-4, respectively. The number of firm deaths in the previous year has a similar negative effect for GEE-2 and GEE-4 models.

Signs and the magnitudes for socio-economic variables are mixed between GEE-2 and GEE-4. Not all of the socio-economic control variables are statistically significant. Percent Hispanic, and percent with bachelor's degree are statistically significant, while median household income is statistically insignificant.

### 6.3 Models with a Subset of Time Periods

A major reason to use a shorter period is to better capture the potential influences of HBLR on new business formation as the system begins operation in 2000. Prior to that time, distances from stations in the 1990s are imputed as five miles (based on the assumption that impacts of rail station on establishment births diminish with distance and become minimal beyond five miles). The imputed distances to HBLR stations might result in biased estimators. So I create a subset of data that only includes NETS data between 1999 and 2012. Year 1999 was included based on the assumption that the firm-forming effects of the new light rail system anticipate their operation.

Therefore, two groups of GEE models are presented in Table 6.4 based on mean employment sizes: group A for the entire period (1991-2012) and group B for years 1999-2012. The signs and magnitudes for most variables in the two period models are very similar. As shown by the station distance variables and distance threshold dummies, the relationships between establishment births and proximity to rail stations for all firm

sizes are statistically significant in both groups. This suggests that including NETS data from the 1990s does not bias the result.

Table 6.4 Negative Binomial, GEE Model Outcomes of Different Time Periods

| | A-1 Model III | B-1 Model IV | A-2 Model III | B-2 Model IV | A-3 Model III | B-3 Model IV | A-4 Model III | B-4 Model IV |
|---|---|---|---|---|---|---|---|---|
| Distance to HBLR Station(1,000 feet) | 0.9901*** | 0.9891*** | 0.9987*** | 0.9934*** | 0.9873*** | 0.9869*** | 1.0305*** | 1.0325*** |
| HBLR Station Distance | | | | | | | | |
| <= 0.5 mile | 1.1901*** | 1.1496*** | 1.1371*** | 1.075* | 1.1727*** | 1.1336*** | 1.7489*** | 1.7553*** |
| 0.5 to 1 mile | 1.0833** | 1.0492 | 1.0332 | 0.9926 | 1.0783* | 1.0464 | 1.2072** | 1.1915* |
| > 1 mile (ref. cat.) | | | | | | | | |
| PATH Station Distance | | | | | | | | |
| <=0.5 mile | 1.4272*** | 1.3966*** | 1.7725*** | 1.7520*** | 1.3803*** | 1.3568*** | 2.7984*** | 2.7534*** |
| >0.5 mile (ref. cat.) | | | | | | | | |
| Distance to CBD (1,000 feet, mid-town Manhattan) | 1.0293*** | 1.0268*** | 1.0141*** | 1.0144*** | 1.0327*** | 1.0290*** | 0.9918 | 0.9899 |
| Change of Developable Land (Acre) | 1.0459*** | 1.0481*** | 1.0436*** | 1.0449*** | 1.0472*** | 1.0494*** | 1.0276*** | 1.0274*** |
| Firm Variables | | | | | | | | |
| Number of Firm Deaths (in previous year) | 0.9627*** | 0.9693*** | 0.9668*** | 0.9763*** | 0.9635*** | 0.9692*** | 0.9495*** | 0.9632*** |
| Number of Firms (in previous year) | 1.0493*** | 1.0493*** | 1.0492*** | 1.0490*** | 1.0485*** | 1.0489*** | 1.0389*** | 1.0394*** |
| Socio-economic Variables | | | | | | | | |
| Median HH Income (in 2009 chained $) | 0.9999*** | 0.9999*** | 0.9999*** | 0.9999*** | 0.9999*** | 0.9999*** | 0.9999** | 0.9999 |
| Percent Hispanic | 7.10889*** | 4.9901*** | 4.0447*** | 3.5515*** | 8.0337*** | 5.4059*** | 1.4635 | 1.3140 |
| Percent with BA degree | 10.3857*** | 7.2711*** | 2.9480*** | 2.7486*** | 13.2609*** | 8.7308*** | 0.5363* | 0.3809** |
| Municipality | | | | | | | | |
| Bayonne (ref. cat.) | | | | | | | | |
| East Newark | 1.0551 | 1.4685* | 0.7532 | 1.0768 | 1.0952 | 1.5799** | 1.1457 | 0.4678* |
| Guttenberg | 2.6142*** | 2.8157*** | 1.9290*** | 1.9511*** | 2.8031*** | 2.9798*** | 1.4392 | 1.0758 |
| Harrison | 0.9037 | 1.1484 | 0.6624*** | 0.8150 | 0.9569 | 1.2331 | 0.3898*** | 0.2556*** |
| Hoboken | 4.2314*** | 4.4227*** | 3.5160*** | 3.7546*** | 4.4470*** | 4.5805*** | 2.8998*** | 2.9740*** |
| Jersey City | 1.7295*** | 1.8731*** | 1.3245*** | 1.4380*** | 1.8292*** | 1.9540*** | 0.9482 | 0.9596 |
| Kearny | 1.0337 | 1.2206*** | 0.6194*** | 0.7348*** | 1.1367 | 1.3351*** | 0.2586*** | 0.1827*** |
| North Bergen | 1.4136*** | 1.6192*** | 1.0223 | 1.1429 | 1.5184*** | 1.7326*** | 0.5739** | 0.4421*** |
| Secaucus | 1.2212 | 1.2252 | 0.7648* | 0.8129 | 1.2903* | 1.2745 | 0.5238** | 0.4633** |
| Union City | 2.5450*** | 2.8132*** | 2.0635*** | 2.1021*** | 2.7338*** | 2.9870*** | 1.4205 | 1.1348 |
| Weehawken | 1.5929*** | 1.9346*** | 1.0750 | 1.3479 | 1.7353*** | 2.0431*** | 0.6530 | 0.8067 |
| West New York | 1.9718*** | 2.3501*** | 1.6423*** | 1.8451*** | 2.0744*** | 2.4608*** | 1.3924 | 1.1599 |
| Constant | 9.9888*** | 11.7315*** | 13.8081*** | 13.7330*** | 8.0531*** | 9.9663*** | 2.7749** | 3.2070** |
| N | 86,961 | 57,947 | 86,961 | 57,947 | 86,961 | 57,947 | 86,961 | 57,947 |
| Log-likelihood | | | | | | | | |
| Chi2 | 7052.9 | 5212.7 | 5944.0 | 5122.4 | 7204.3 | 5203.4 | 2661.8 | 2101.4 |

note: *p<0.1,** p<0.05, ***p<0.01; model I: 1992-2012; model II: 1999-2012

### 6.4 Models by Industry Sector

Leisure and hospitality services and Manufacturing may benefit from better labor access via rail service, while FIRE, Educational services and Professional services may benefit from knowledge spillovers that are more likely to occur in areas with dense transit service for social interaction. Table 6.5 summarizes model outcomes by six selected industries using GEE models. The dependent variable for these models is the number of establishments in each NAICS supersector category at a given Census block. Signs and magnitudes of factors differ by sector, indicating that industries should be treated differently when studying industrial agglomeration.

Model results suggest that proximity to a PATH station (within half mile) is positively related to establishment births in all six industries. Magnitudes for the PATH station dummy are relatively high across industries, with incident rates ranging from 1.48 for the Trade, transportation and utilities industries to 2.29 for Leisure and hospitality services. The result suggests that Census blocks located within a half mile to a PATH station are more likely to have establishment births compared to otherwise and vary by industry. Similarly, positive relationships are found within half mile for all industries except for the Trade, transportation and utilities; and between half and one mile in proximity to a light rail station in FIRE, Educational and health services, and Leisure and hospitality Services.

The number of existing firms in a block is positively associated with establishment births across industries, with IRR ranging from 1.0294 to 1.0484. This suggests that localized inter-industry agglomeration economies. The number of firm deaths is significant and negative for all industries, with IRR ranging from 0.9455

(Education and health Services) to 0.9829 (Leisure and hospitality Services). The fact that the number of firm deaths is negative suggests evidence of competition effects in the study area.

Table 6.5 GEE Model Results for Selected Supersectors

| | **Manufacturing** | **Trade** | **FIRE** | **Professional Services** | **Educational Services** | **Leisure Services** |
|---|---|---|---|---|---|---|
| Distance to HBLR Station(1,000 feet) | 1.0149*** | 0.9972 | 0.9865*** | 0.9638*** | 1.0114*** | 1.0068* |
| HBLR Station Distance | | | | | | |
| <= 0.5 mile | 1.4489*** | 1.0610 | 1.3850*** | 1.1059* | 1.3725*** | 1.6300*** |
| 0.5 to 1 mile | 1.2083 | 1.0190 | 1.1576* | 1.0498 | 1.5735*** | 1.1987** |
| > 1 mile (ref. cat.) | | | | | | |
| PATH Station Distance | | | | | | |
| <=0.5 mile | 1.7510*** | 1.4762*** | 1.9483*** | 1.3360*** | 1.9946*** | 2.2927*** |
| >0.5 mile (ref. cat.) | | | | | | |
| Distance to CDB (1,000 feet, mid-town Manhattan) | 1.0219** | 1.0216*** | 1.0218*** | 1.0493*** | 1.0278*** | 1.0209*** |
| Change of Developable Land (Acre) | 1.0351*** | 1.0361*** | 1.0381*** | 1.0458*** | 1.0788*** | 1.0341*** |
| Firm Variables | | | | | | |
| Number of Firm Deaths (in previous year) | 0.9709*** | 0.9509*** | 0.9652*** | 0.9545*** | 0.9455*** | 0.9829*** |
| Number of Firms (in previous year) | 1.0323*** | 1.0462*** | 1.0395*** | 1.0417*** | 1.0484*** | 1.0294*** |
| Socio-economic Variables | | | | | | |
| Median HH Income (in 2009 chained $) | 0.9999** | 0.9999*** | 0.9999*** | 0.9999*** | 0.9999*** | 0.9999*** |
| Percent Hispanic | 6.0676*** | 9.3925*** | 4.3133*** | 8.2182*** | 5.2598*** | 4.8631*** |
| Percent with BA degree | 2.9759** | 3.9950*** | 21.6594*** | 61.2996*** | 13.6360*** | 5.1159*** |
| Municipality | | | | | | |
| Bayonne (ref. cat.) | | | | | | |
| East Newark | 2.4218 | 0.6794 | 0.2995 | 2.3609*** | 0.0506*** | 1.0297 |
| Guttenberg | 4.0636*** | 1.9180*** | 2.9990*** | 6.0148*** | 2.3555** | 2.5221*** |
| Harrison | 0.5484** | 0.6762** | 0.8063 | 1.9971*** | 0.3024*** | 0.6043* |
| Hoboken | 5.4043*** | 3.5666*** | 4.0112*** | 7.3796*** | 2.9472*** | 5.1850*** |
| Jersey City | 1.5780** | 1.5195*** | 1.4874** | 2.8175*** | 1.1632 | 1.4273* |
| Kearny | 0.5906*** | 0.70278*** | 0.6592** | 2.3810*** | 0.4105*** | 0.3448*** |
| North Bergen | 1.6694 | 0.9885 | 1.4626 | 2.9580*** | 1.0827 | 0.8129 |
| Secaucus | 0.8857 | 1.0194 | 0.6895 | 2.6430*** | 0.8490 | 0.7268 |
| Union City | 4.0424*** | 1.7922*** | 3.2141*** | 5.4862*** | 2.3451** | 2.2923*** |
| Weehawken | 1.8646 | 1.2284 | 1.7745* | 3.6645*** | 0.6134 | 2.0146** |
| West New York | 4.0924*** | 1.5210** | 2.3404*** | 3.9976*** | 1.5795 | 1.6586* |
| Constant | 0.2008*** | 4.3083*** | 0.8405 | 1.1609 | 0.9429 | 0.7744 |
| N | 86,961 | 86,961 | 86,961 | 86,961 | 86,961 | 86,961 |
| Log-likelihood | | | | | | |
| Chi2 | 2150.6 | 4661.8 | 3845.7 | 5922.4 | 2751.1 | 2323.2 |

note: *p<0.1,** p<0.05, ***p<0.01

In Hudson County, establishment births in the Trade, transportation and utilities industries have a smaller relationship with proximity to a light rail station than in the other industries. In Manufacturing, Professional and business services, and Leisure and hospitality services a higher establishment birth rate is found within the half mile radius, but a higher establishment birth rate is found in FIRE, and Education and health services in the half and one-mile radius. The IRR ranged significantly within half mile of rail, from no statistical significance in the case of Trade, transportation and utilities industries to 1.63 in Leisure and Hospitality services.

Figure 6.2 shows predicted effects of HBLR station variables on selected industries for the GEE models. The figure clearly shows that the effect of being near a HBLR station on a particular block's establishment births differs by industry. Lines for FIRE, and Professional and business services are similar: the effect is positive for distance within half mile from a station and there is a sharp decrease after a half mile and the effect becomes negative, and another decrease when distance is more than one mile.

The effects of being near a HBLR station on establishment birth is largest on the Leisure and hospitality services sector, and similarly, there are two sharp drops at half mile and at one mile from a station. Yet, the effect became minimal beyond one mile from a station. The line for the Trade, transportation, and utilities industries is close to zero, indicating the being close to a light rail station has minimal influence on the births of new establishments. The graphs for Manufacturing, Education and health services, and Leisure and hospitality services are similar after a mile: there is a small increase, and the effect is positive. These results might be explained by the fact the FIRE industries would benefit from the locational advantages in proximity to Manhattan and information

exchanges in the area. Because biotech, life sciences and pharmaceuticals are key industries in the state according to the New Jersey Economic Development Authority, and there are several higher education institutes in the county, it is likely that Education and health services firms can benefit from the concentration of labor and capital in the local market.

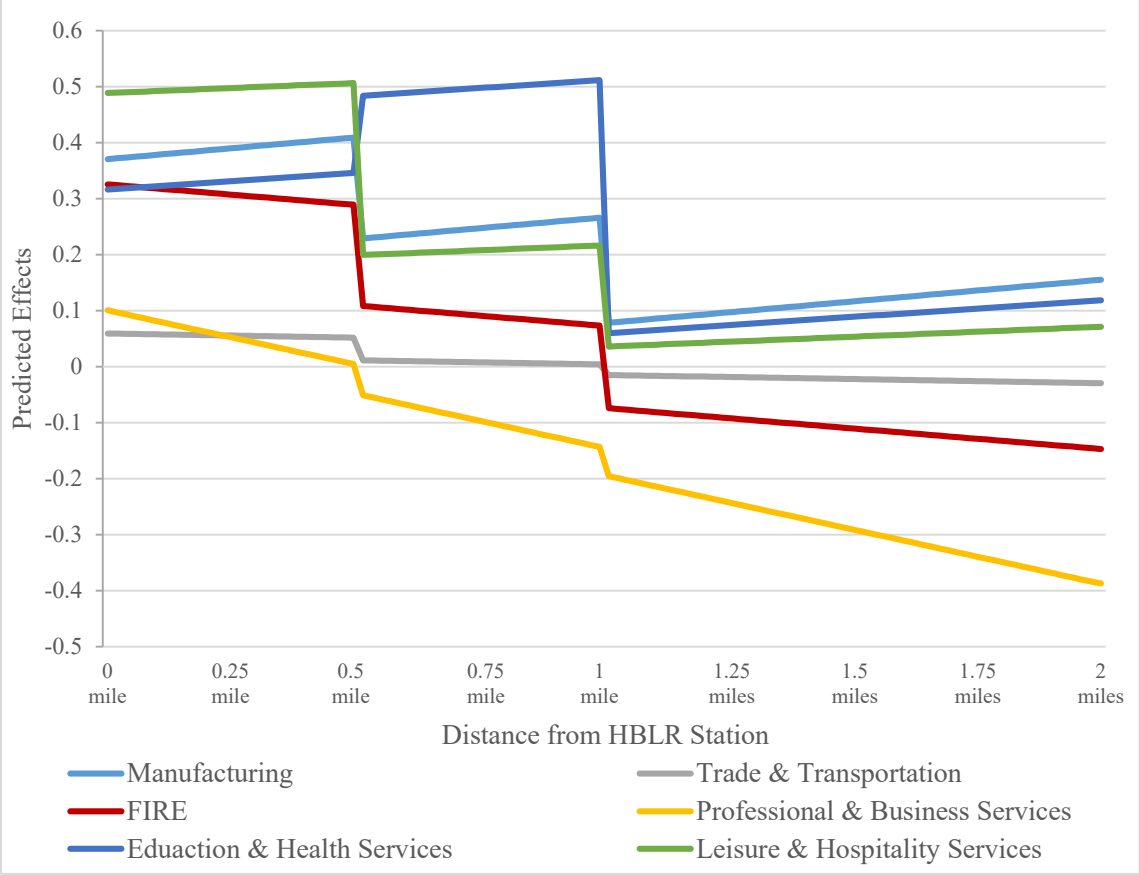


Figure 6.2 Predicted Effects of Station Distance Variables by Industry

## 6.5 Discussion and Conclusions

In general, the rate of new establishment births declines with distance from HBLR stations, and access to PATH appears to be another important determinant of establishment births. Initial employment size and sectors also matter. Firm deaths per

year and total existing firms per year are statically significant across models, implying these are also associated with establishment births. Network distance to HBLR stations and distance threshold variables for rail access (HBLR and PATH) are statistically significant across most models. It suggests that proximity to rail stations is associated with new establishment formation in Hudson County. Magnitudes of distance variables differ by models, indicating that influences of proximity to rail access on establishment births vary by employment size and industry. Selected socio-economic variables are statistically significant in some models. This might partially be due to the limitation of the original data.

Additionally, results from GEE models by industries confirm that industries vary in their preferences for proximity to a rail station. The Financial activities sector, Educational and health services sector, and Leisure and hospitality sectors benefit more from the access to rail, and less so for other sectors. This might be credited to the county's locational advantage (close to Midtown-Manhattan and Lower-Manhattan), the presence of multiple education institutes, and leading industries in the state. (Biopharmaceuticals and healthcare are leading industries in New Jersey.)

The analysis above indicates that there are clear differences in the association between establishment creation and proximity to growing and improved transit systems. Because of the general assumption that new establishments generate growth and the concentration of new establishments can lead to agglomeration benefits (via labor pooling and knowledge spillovers), it is important for urban planners to understand why such phenomena occur. Hudson County not only has relatively new and extensive rail systems, but also substantial bus, ferry, and bike-share services. Yet, the results show that

new establishments tend to cluster in certain areas. For example, the transit system on the east side of Hudson County also provides a better multimodal transit system for residents/workers and better rail transit services than municipalities in the west side of the Hackensack river. Therefore, establishments can have larger catchment areas for more customers and labor, employees can have better access to work, and residents can have better access for leisure activities via transit service. These factors likely increase the attractiveness to new startups to locate on the east side of the Hackensack River.

According to information obtained from interviews and my archival study, Jersey City has adopted many policies to promote development near rail stations and within its CBD areas. These policies include restrictions on off-street parking in the historical downtown, project based zoning regulation variances to encourage infill development within the CBD and along light rail stations, and so forth. These policies have led to more infill development in the downtown area than elsewhere, and many of those naturally occur near rail stations and along the waterfront areas. Additionally, Jersey City has more vacant land/abandoned industrial sites for redevelopment compared to other smaller municipalities, which potentially encourage investments in Jersey City and subsequent firm clusters in the center of Jersey City.

There are some factors that might limit firm concentration near transit in Hudson County. First of all, insufficient supply of developable land is one major barrier, according to the perceptions of interview participants and model results. As a traditional industrialized urban area, many parts of the county are built up, making assembly large tracts for some industries very difficult. Second, many recent redevelopment projects in Hudson County have been conversion of vacant industrial and commercial space into

residential/mixed-use projects, given the high demand for housing in the area. The competition between residential and industrial/commercial land uses might limit the scale of firm densification near station areas. Third, preferences towards workspace configurations have been changing in the past two decades: open space working environment, shared/flexible office, and LOFT become more and more popular. These decreases the demand for traditional office space. In addition, zoning laws, planning regulations and parking requirements limit the potential to densify firms under the current planning regimes.

# Chapter Seven

# New Firms' Post-Entry Performance

In this chapter, I study the survival of new establishments in Hudson County using the NETS database. I employ both nonparametric analysis and Cox proportional hazards models to analyze duration phenomena, to explore the relative importance of industry-specific, firm-specific, and locational factors in explaining the time between the birth of establishments and their closure. I find that firm size at founding, the sector it is in, as well as its industry's growth are critically determine new establishments' survival. Access to transit is associated with establishments' lifetimes but a causal relationship cannot be drawn.

## 7.1 Nonparametric Analysis

In this section, I study the duration of new establishments in Hudson County and measure for how many years they stay in the market. I begin my new establishment' survival analysis with nonparametric models, which include life-table and Kaplan-Meier estimates. The dataset covers 22 years, and all establishments either fail, relocate (censored), or are still operating in the last year of the NETS data (censored). In statistics, censoring indicates a condition in which the value of an observation is partially known or when a value occurs outside the range of the dataset. Therefore, censored data refers to firms that were still operating or that relocate outside the study area by the time data are last updated. Overall, the number of failures is 34,687 (58%). The incidence rate for number of failures divided by the time at risk is 11.2%. We expect 1/9 of firms to fail annually.

More than a third of all new establishments had only one employee when they entered the market. Just six percent of firms entered the market with more than five employees. Average entry size differs by industry. Manufacturing firms tended to have a higher mean entry size (seven employees). The Other services sector had an average entry size of two employees, the lowest among all industries. The following analysis results indicate substantial differences in the survival rates by initial firm size and industrial sector.

First, I grouped new establishments by their initial employment sizes and presented them in a cohort life table (table 7.1). Life tables were originally devised to show the probability that an observation will survive/die before the next time interval. It is a long-term way to measure a population's life expectancy (longevity) (Mills, 2011). Table 7.1 shows the proportion of each time interval's risk that an establishment leaves the market during the time interval. Therefore, these are conditional probabilities (or hazards for failure) of firms' death once in the market in *n*th period, given that the establishment did not fail before the *n*th period. Hazard functions describe patterns of firm failure with time, and they are sensitive to the unique risks associated with each successive period. The survival functions accumulate information across time (in my study, it is years). In brief, by examining the variation over time in the magnitude of the hazard function, we can identify when establishments are more likely to exit the market. The following functions represent how to construct a life table analysis:

D*t* = number of establishment who die during time interval *t*

C*t* = number of establishment are censored (relocated) during interval *t*

N*t* = number of establishments who are event free and considered at risk during interval *t* (the number alive as my result of interest is firm death)

N*t** = the average number of establishments at risk during interval *t*, and it is computed as follows: N*t** =N*t*-C*t*/2

Q*t* = proportion dying during interval *t*, Q*t* = Dt/N*t**

P*t* = proportion surviving interval *t*, P*t* = 1-Q*t*

S*t* = cumulative survival probability, which refers to the proportion surviving past interval *t*, and it is computed as follows:

$$S_{t+1} = P_{t+1} * S_t$$

Table 7.1 Life Table for New Establishment by Initial Employment Size in Hudson County

| Years after formation | Sole Emp | | | 2 to 5 Emp | | | >5 Emp | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | Cumulative Survival | Hazard | n | Cumulative Survival | Hazard | n | Cumulative Survival | Hazard |
| 0-1 year | 21,669 | 0.840 | 0.174 | 36,715 | 0.876 | 0.133 | 3,643 | 0.938 | 0.064 |
| 1-2 years | 17,457 | 0.697 | 0.186 | 30,637 | 0.751 | 0.153 | 3,364 | 0.853 | 0.095 |
| 2-3 years | 13,384 | 0.594 | 0.160 | 24,565 | 0.639 | 0.162 | 2,974 | 0.759 | 0.116 |
| 3-4 years | 9,382 | 0.518 | 0.136 | 18,347 | 0.559 | 0.133 | 2,529 | 0.690 | 0.096 |
| 4-5 years | 7,566 | 0.458 | 0.122 | 15,168 | 0.501 | 0.110 | 2,211 | 0.629 | 0.092 |
| 5-6 years | 5,925 | 0.412 | 0.106 | 12,542 | 0.457 | 0.093 | 1,926 | 0.579 | 0.082 |

Overall, there is a clear distinction between large, small, and sole employee establishments according to the life table. Large firms face lower hazard rates across all periods. Immediately after formation, large firms have a hazard rate of just 6.4% while sole and small firms face rates of 17.4% and 13.3%, respectively. This means 6.4% of large firms, 17.4% sole entrepreneur and 13.3% small firms only survived their first year of operation. During the five-year period after startup, more than half of sole employee

firms fail. The probability of a large firm being active five years after establishment is 62.9%. It is just 50.1% for small firms, and 45.8% for sole employee firms, respectively. Furthermore, the hazard rates are relatively stable and low for large firms, at about 9.1% over the first five-years. On the other hand, small firms have mean hazard rates of 13.1 % over the five-years, and sole employee firms have mean hazard rates of 14.7% over the five-years.

Previous studies find that firm hazard rates generally follow an inverted U-shape pattern (Kaniovski & Peneder, 2008; Mahmood, 2000). Figure 7.1 shows the hazard rates of establishments in the NETS data for Hudson County. Data present left-skewed inverted U-shape patterns, indicating that there is an increasing risk of failure after an establishment's first year, followed by lower risks in subsequent periods after a given turning point for firms of different sizes. It appears that it takes roughly a year longer for small and large firms to reach the turning point compared with sole employee firms. These patterns also indicate that initial size is associated with establishment survival, but these observed relationships call for further investigation. Sole employee firms are more sensitive in the market and are more likely to fail during the first year in the market, possibly due to sole entrepreneurs having a limited resource endowment. For larger firms, possible rational to explain their lower hazard rates is that larger establishments tend to have better access to financial capital (or less dependent on external capital) and subsidies, and they are relatively less vulnerable to negative environmental pressures compared to sole/small firms.


Figure 7.1 Hazard Rates by Firm Size in Hudson County (1991-2013)

The Kaplan-Meier estimator of the survival function is another nonparametric statistic widely used to estimate the length of time until event happened. It incorporates information from both censored and uncensored observations available (Hosmer Jr, Lemeshow, & May, 2011). It is typically used to estimate how long people remain unemployed after a job loss. I adopted it to measure how long a firm survives before exiting the market. The Kaplan-Meier survival estimates below (Figure 7.2) shows that at any point in time, larger firms in Hudson County tend to have higher survival rates. According to the survival functions, sole employee firms and small firms have similar survival rates, and on average, larger firms (with more than five employees when entering the market) are 25% less likely to exit the market than all smaller firms after the first five-years.

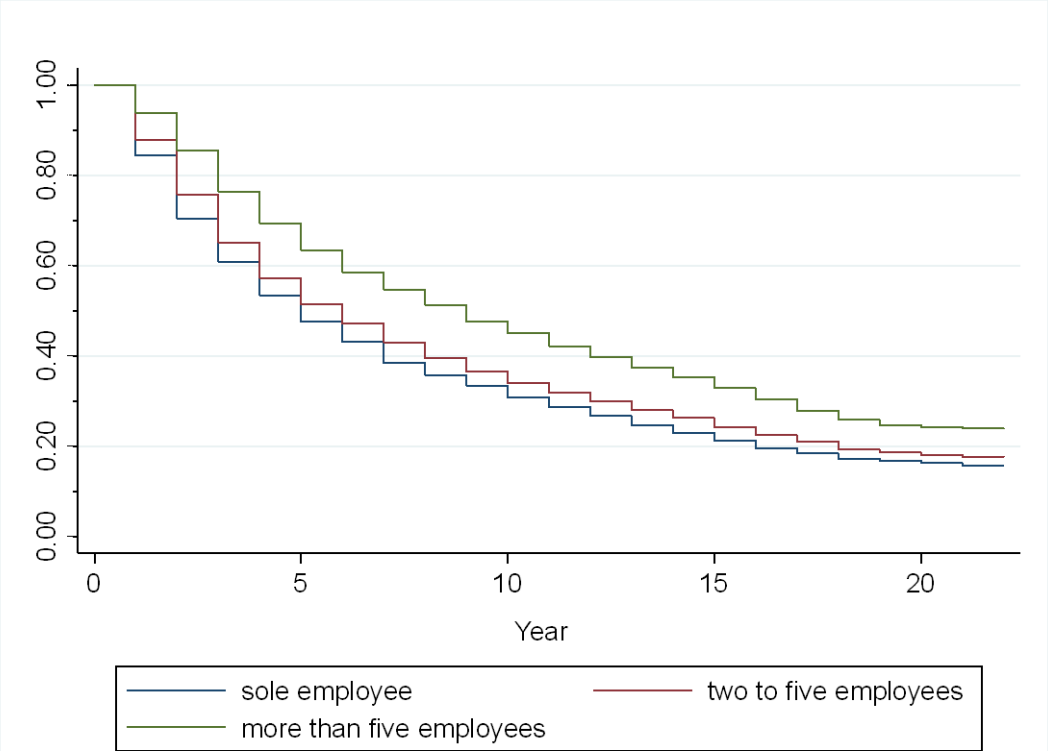


Figure 7.2 Kaplan-Meier Survival Estimates by Firm Entry-Size

In addition, the following graph (Figure 7.3) plots survival functions by the mean employment size of a firm. There are some differences in the survival functions when measured using average firm size. While measuring with mean size, large firms tend to have higher survival rates over the entire period. And the differences on average survival rates are greater between large firms versus small and sole employee firms at all times.

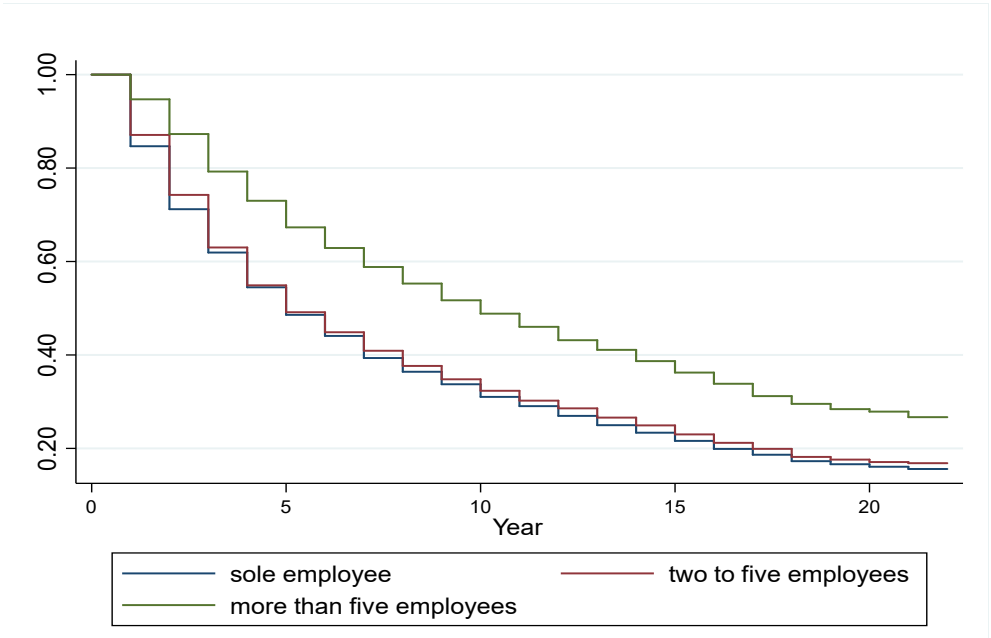


Figure 7.3 Kaplan-Meier Survival Estimates by Mean Employment Size

Firms in certain sectors are more prone to closure. During the first period immediately after entering the market, the Professional and business services sector has the highest hazard rate of over 21 percent. A possible rational is that as Professional and business services is growing rapidly[20], competition within this industry also increase the possibility of failure for startups in this sector. Another possible reason is that two main subsector industries, temporal help services and professional and technical services, are more likely to suffered during recessions (Conlon, 2011). In contrast, the Education and health services sector has the lowest hazard rate of 7.5 percent during the same period. Five-years after starting, less than half of all firms remain active in the following sectors: Trade, transportation and utilities (47.5%), Professional and business services (43%), and

[20] According to Bureau of Labor Statistics, this industry accounted for the largest job gains among all major industries in recent years https://www.bls.gov/opub/ted/2015/professional-and-business-services-accounted-for-25-percent-of-job-gains-in-2014.htm

Other sectors (47.9%). Meanwhile, only 34.5% of firms in Education and health services sector failed during the same period. Such differences might contribute to the differences in competition and demand of different sectors, as well as the industrial structure in the local market.

Table 7.2 Life Table for New Establishments by Industrial Sector in Hudson County

| | Manufacturing | | Trade | | Financial Activities | | Professional Services | | Edu. & Health Services | | Leisure & Hospitality | | Other Services | | Other Sectors | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Years after formation | Survival | Hazard | Survival | Hazard | Survival | Hazard | Survival | Hazard | Survival | Hazard | Survival | Hazard | Survival | Hazard | Survival | Hazard |
| 0-1 year | 0.881 | 0.127 | 0.878 | 0.130 | 0.889 | 0.117 | 0.806 | 0.215 | 0.927 | 0.075 | 0.896 | 0.110 | 0.907 | 0.097 | 0.887 | 0.120 |
| 1-2 years | 0.758 | 0.150 | 0.742 | 0.167 | 0.767 | 0.147 | 0.659 | 0.201 | 0.842 | 0.096 | 0.782 | 0.135 | 0.798 | 0.128 | 0.764 | 0.149 |
| 2-3 years | 0.647 | 0.159 | 0.617 | 0.184 | 0.643 | 0.177 | 0.564 | 0.155 | 0.763 | 0.098 | 0.682 | 0.137 | 0.704 | 0.126 | 0.644 | 0.171 |
| 3-4 years | 0.562 | 0.140 | 0.536 | 0.141 | 0.562 | 0.135 | 0.488 | 0.143 | 0.704 | 0.081 | 0.616 | 0.101 | 0.631 | 0.109 | 0.556 | 0.146 |
| 4-5 years | 0.508 | 0.102 | 0.475 | 0.120 | 0.507 | 0.102 | 0.430 | 0.126 | 0.655 | 0.071 | 0.564 | 0.089 | 0.576 | 0.090 | 0.479 | 0.148 |
| 5-6 years | 0.460 | 0.099 | 0.427 | 0.107 | 0.458 | 0.102 | 0.386 | 0.110 | 0.617 | 0.060 | 0.525 | 0.073 | 0.536 | 0.072 | 0.433 | 0.101 |

The life table (Table 7.2) and the Kaplan-Meier survival (Figure 7.4) estimates show that survival rates in the Education and health service sector are markedly higher than all other sectors. This is somewhat surprising given the typically higher start-up costs and larger employment size in the manufacturing sector. One possible explanation is that establishments in Education and health services are more likely to receive public subsidies and tax incentives than other industries. After the Education and health services sector, Leisure and hospitality, and Other services sectors have survival rates that are higher relative to remaining industries. On the other hand, the survival rates of the Professional and business sector are the lowest over the entire observation period.

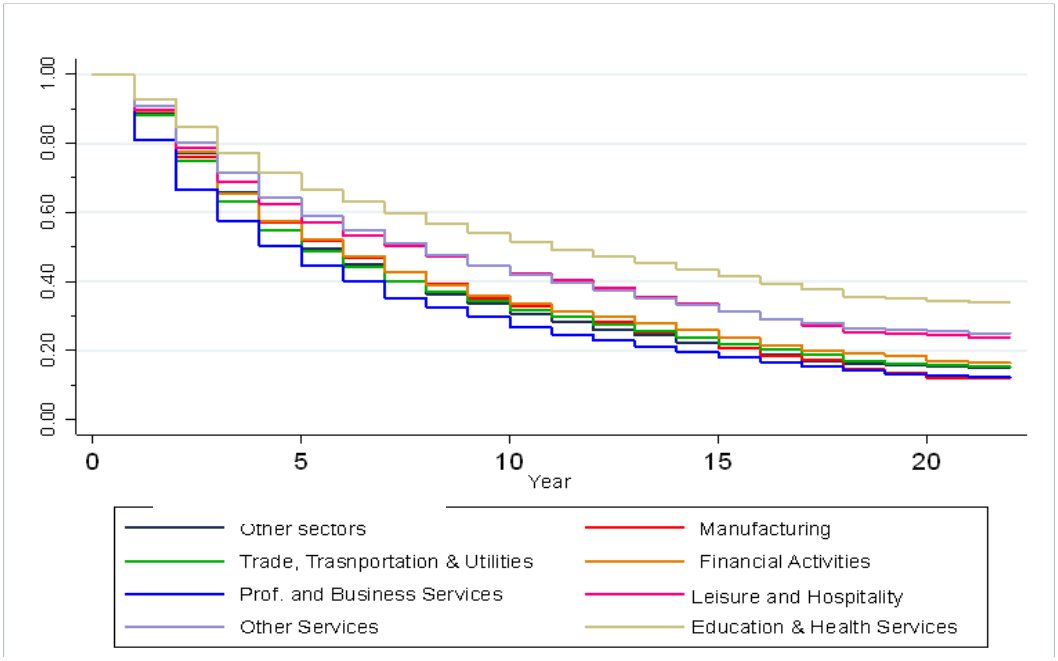


Figure 7.4 Kaplan-Meier Survival Estimates by Sectors

Figure 7.5 shows the hazard rates during the first six years of selected industries. Except from Professional and business services, other industries have shown inverted U-shape patterns, which compromise findings in other studies.

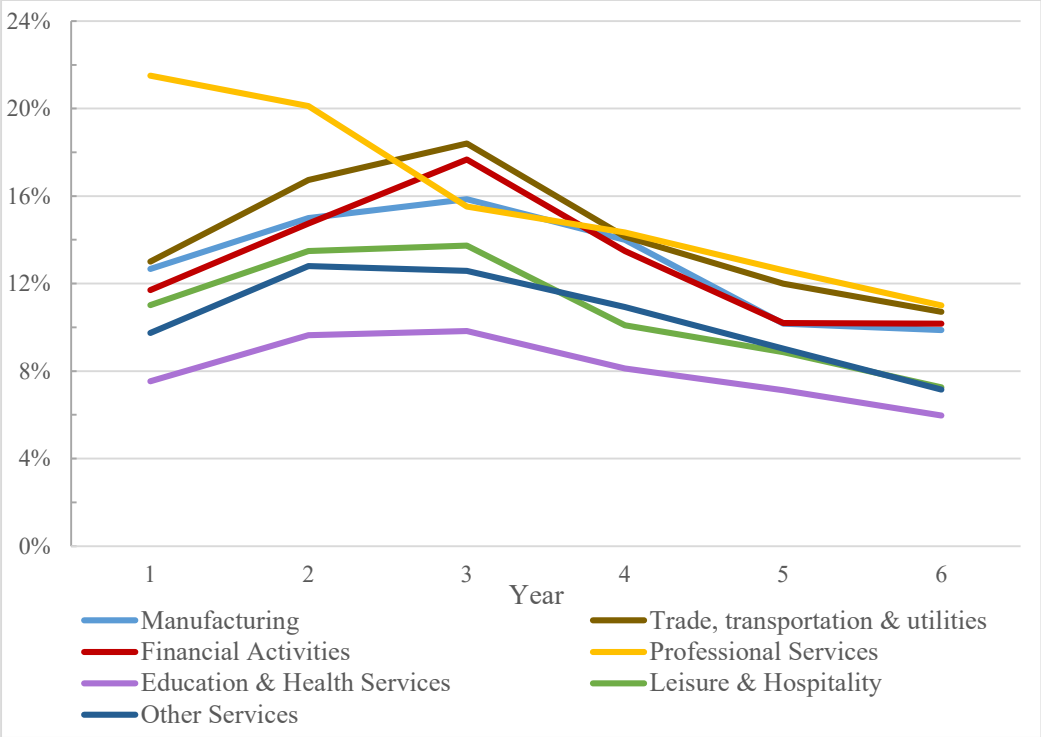


Figure 7.5 Hazard Rates by Industry in Hudson County

Life-tables with establishments' proximity to HBLR stations by employment size are also created. Table 7.3 shows the trends of accumulated survival rates of firms by three distance bands: within 0.5 mile, 0.5 to a mile, and more than a mile from a HBLR station. For sole employee firms within 0.5 mile from HBLR, only 38.7% of them survived after a five-year period, and 51.5% of those located more than a mile from HBLR survived after a five-year period. Meanwhile, large firms located closer to HBLR have higher survival rates compared to those located further away within the five-year period: 64.5% for those within 0.5 mile from a HBLR station, 63.9% for those between 0.5-1 mile, and 62.2% for those more than a mile. Similarly, small firms located more than a mile from a HBLR station have lowest survival rates of 47.2%, and those located within 0.5 mile and 0.5-1 mile have survival rates of 53.3% and 54.3%, respectively.

Before controlling for the influences of other variables, the results in the life-table indicate that the proximity to transit infrastructure is associated with the survival of new establishments.

The description and estimation of the event time distributions discussed in this section assumes a single homogeneous group of establishments. But I intend to identify factors that affect the occurrence and timing of establishment failure in the following analysis.

Table 7.3 Life Table for New Establishments by Size in Proximity to HBLR Stations in Hudson County

| | sole employee | | | | | | small firms (2-5 employees) | | | | | | large firms (>5 employees) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Years after | within 0.5 mile | | 0.51-1 mile | | beyond 1 mile | | within 0.5 mile | | 0.51-1 mile | | beyond 1 mile | | within 0.5 mile | | 0.51-1 mile | | beyond 1 mile | |
| formation | Survival | Hazard | Survival | Hazard | Survival | Hazard | Survival | Hazard | Survival | Hazard | Survival | Hazard | Survival | Hazard | Survival | Hazard | Survival | Hazard |
| 0-1 | 0.804 | 0.217 | 0.814 | 0.205 | 0.872 | 0.136 | 0.904 | 0.101 | 0.892 | 0.115 | 0.858 | 0.153 | 0.946 | 0.056 | 0.939 | 0.063 | 0.934 | 0.068 |
| 1-2 | 0.637 | 0.232 | 0.648 | 0.227 | 0.752 | 0.148 | 0.799 | 0.124 | 0.787 | 0.125 | 0.719 | 0.176 | 0.861 | 0.094 | 0.869 | 0.078 | 0.845 | 0.100 |
| 2-3 | 0.534 | 0.176 | 0.545 | 0.174 | 0.646 | 0.152 | 0.690 | 0.147 | 0.682 | 0.143 | 0.603 | 0.175 | 0.769 | 0.113 | 0.789 | 0.097 | 0.750 | 0.120 |
| 3-4 | 0.454 | 0.162 | 0.459 | 0.170 | 0.573 | 0.119 | 0.606 | 0.130 | 0.602 | 0.125 | 0.526 | 0.137 | 0.704 | 0.087 | 0.677 | 0.153 | 0.684 | 0.091 |
| 4-5 | 0.387 | 0.160 | 0.399 | 0.141 | 0.515 | 0.108 | 0.533 | 0.127 | 0.543 | 0.103 | 0.472 | 0.109 | 0.645 | 0.088 | 0.639 | 0.058 | 0.622 | 0.096 |
| 5-6 | 0.342 | 0.122 | 0.367 | 0.083 | 0.463 | 0.106 | 0.484 | 0.096 | 0.496 | 0.092 | 0.430 | 0.093 | 0.605 | 0.064 | 0.568 | 0.117 | 0.574 | 0.080 |

**7.2 Model Design**

Here I explore the determinants of new establishment' post-entry performance. In particular, I examine whether establishments that locate close to transit stations survive longer. To explore factors that affect establishment survival, it is necessary to investigate data concerning the duration of the life of a given establishment. I adopt a hazard rate approach. The dependent variable in my models is the number of years that the establishment survived. Establishment failure is defined by an establishment's closing. The probability that an establishment is alive up to a certain point in time is estimated by the survival function. Hence, the hazard rate at time *t* is the establishment's probability of failure over a given period. Existing studies of the survival of new establishments have been constrained by the available detailed firm level data. In order to conduct a detailed analysis of establishment duration, it is important to have a sufficiently large sample of data that covers a relatively long time period with both births and deaths of establishments.

The choice of covariates is determined by previous studies and prior expectations based on theory. As indicated in the literature chapter, by using firm-specific, industry-specific, macroeconomic variables data, and locational data, it should be possible to identify the main factors that affect establishment survival. My expectation is that larger establishments are likely to survive longer than other sizes due to the availability of financial capital. In particular, NETS allows the identification of each establishment for the year of its establishment, its year of failure, its year of relocation, its initial size (employees), its standard industrial classification (NAICS), and its location. So I account for the following factors: initial employment size, industrial classification, firm density in

any given year, proximity to the closest HBLR and PATH stations, and selected socio-economic factors.

Cox's proportional hazards (PH) model has been widely used for survival analysis in most applications. The basic assumption of the Cox PH model is that any two hazard rates predicted are proportional over time, and we do not need to assume that the baseline hazard function has a specific shape as in parametric hazard models (Therneau & Grambsch, 2013). For this reason, the Cox model is often considered as a semi-parametric model. My analysis will begin with a standard Cox model and extensions of the Cox's regression model (for example, including time dependent variables in the Cox model), which extend the original model with additional flexibility. Results from the most appropriate model will be presented for discussion.

One advantage of Cox proportional hazards regression is that one can fit survival models without assuming a distribution, which is difficult with censoring and covariates with a large dataset. The dependent variable in survival analysis is the hazard rate *h(t)*. It is the probability of establishment closure in time interval *(t1, t2)*. The sign of the hazard ratios indicates the direction of proportional hazards: with hazard ratios larger than one implying increased probability of establishment death, and hazard ratios less than one meaning a longer duration of survive.

In estimating the hazard models, there is one the potential problem caused by heteroscedasticity of the NETS data. For example, initial employment size varies from sole entrepreneur to large establishments with more than one-hundred employees. This heterogeneity of the data might be problematic, so I subdivide NETS data into three groups by initial employment size: sole employee establishments, small establishments

with two to five employees, and larger establishments with more than five employees. This information was augmented by data on specific industries, locational, and socio-economic variables. Models are estimated separately for each group. Using these data, I should be able to identify the main factors that influence establishments' survival.

### 7.3 Relationship between Firm Survival and Independent Variables

The choice of variables uses prior expectations based on theory and existing studies. I hypothesize that establishment survival differs by sector, so I construct models for selected industries separately. In addition, many studies find a positive relationship between firm size and survival (Agarwal & Audretsch, 2001; Disney, Haskel, & Heden, 2003; Persson, 2004). The resulting hypothesis is that larger firms are more likely to have better access to financial capital, and thus an inherent size advantage compared to smaller firms. For small firms, however, enhancing size places extra burden on generating revenue. Thus, the expected outcome is that large establishments face less risk compared to sole and small establishments.

Agglomeration and competition should affect establishment survival. Establishments located within a relatively dense setting could benefit from agglomeration economies, which might enhance their survival (Krugman, 1991; Scott, 1988). In order to measure firm concentration and local conditions, establishment density and counts of establishment failure in the same block in the prior year were used as proxies. Industrial indicators were typically used in previous empirical work on firm survival. But findings have been divided on the relationship between survival and concentration. Wagner (1994) argues that no significant relationship between concentration and survival exists. But

Baldwin and Rafiquzzaman (1995) find statistically significant relationships between firm survival and concentration. Finally, industry-specific dummy variables capture differences in survival rates between different industries.

A core hypothesis of my dissertation is that proximity to transit services is associated with establishment survival. I assume that both hazards and economies of spatial density are conditional upon firm-specific factors. Therefore, new establishments might be able to survive longer in dense concentrations in space, whereas others locating far away from rail stations might fail more quickly. I introduced a group of locational variables. These included dummy variables denoting location within half mile to a PATH station, and a set of distance-band variables that identify proximity to nearby light rail stations, less than half mile, between one-half and one mile, and more than one mile, as well as a variable that measures the distance of each block to its closest HBLR station. These are the same as previously used for the firm formation analysis in Chapter 6.

Other external factors, like percent population with a bachelor's degree (a proxy to measure human capital), annual GDP (a proxy to measure macro-economic environment), annual net growth of firms (a proxy to measure local market), and so forth may have a relationship with the survival of new establishments. However, not all external factors can be captured in model estimation due to the limitation of data availability at a fine geographic scale. So I adopted the following external factors in my model analysis: annual net firm growth, annual firm density, percent population over 25 with a bachelor's degree or above, population density, and percent Hispanic population, all measured at Census block level. Most of these external factors are the same as those used in the firm formation modeling in Chapter 6.

**7.4 Results**

In estimating the hazard models, I divided the dataset into three subsamples on the basis of employment size at the year of founding, and models are estimated separately for selected industries. This subdivision of the data is undertaken to reflect the fact that factors determining firm duration are likely to vary based on employment size and industry. This resulted in a dataset of 18,153 establishments with sole employee, 32,428 for small establishments (2 to 5 employees), and 2,990 for large establishments (more than 5 employees) from 1991 to 2013.

Table 7.4-7.10 show the results of the Cox PH models for establishments at different sizes by industry. Similar to the situation in modeling establishment formation, I also employ models with a subset of periods (1999-2013). The main reason to use NETS data with a shorter time period is to better capture the potential influences of HBLR on the survival of new businesses since the system began operation in 2000. Distances from stations before then were imputed as five miles (This is based on the assumption that impacts of rail station on establishments' survival diminish with distance and become minimal beyond five miles). The imputed distances might result in biased estimators.

It is evident from the model outcomes that there are substantial differences in the factors determining the survival of establishments of different sizes. Signs and magnitudes of location variables vary across models, and this suggests that the associations between locational factors and the survival of businesses vary depending on establishments and industries. A number of variables discussed in previous sections are excluded from the final model since they were found to be insignificant. I will discuss

model outcomes of each selected industry in the following paragraphs, emphasizing models for small (2-5 employees) and large (more than five employees) establishments.

Table 7.4 Cox Regression Results: Manufacturing

| | **All Firms** | **Sole Emp** | **Smaller Firms** | **Larger Firms** | **All Firms 1999-2013** | **Sole Emp 1999-2013** | **Smaller Firms 1999-2013** | **Larger Firms 1999-2013** |
|---|---|---|---|---|---|---|---|---|
| | a1 | a2 | a3 | a4 | s1 | s2 | s3 | s4 |
| **_t** | | | | Haz. Ratio | | | | |
| d_HBLR_1mi | 0.99279 | 1.05081 | 1.02097 | 0.97091 | 0.96984 | 1.06745 | 1.00980 | 0.88448 |
| d_HBLR_0.5mi | 1.04380 | 0.87843 | 1.09628 | 1.08701 | 0.85206** | 0.97506 | 0.85389 | 1.31748 |
| d_PATH_0.5mi | 1.45227*** | 0.94158 | 1.455*** | 1.74050*** | 1.34075*** | 0.95570 | 1.43235** | 4.70778*** |
| dis_HBLR(1,000ft) | 1.01972*** | 1.00637 | 1.02488*** | 1.02392*** | 1.02698*** | 1.05032*** | 1.02289*** | 1.03790** |
| dis_CBD(1,000ft) | 0.99999 | 0.99998* | 1.00001 | 0.99998 | 1.00001 | 0.99997* | 1.00000 | 1.00007** |
| %Hispanic | 0.31171*** | 0.72520 | 0.22793*** | 0.21807*** | 0.14671*** | 0.49315* | 0.11275*** | 14.93296** |
| %Bachelor | 0.27194*** | 0.87499 | 0.23531*** | 0.09419*** | 0.51182*** | 1.36294 | 0.26483*** | 0.68129 |
| net_firm_growth | 1.00000 | 0.99999 | 1.00000 | 0.99998* | 0.99994*** | 0.99999 | 0.99992*** | 0.99989** |
| firm_density | 1.00005*** | 1.00006*** | 1.00005*** | 1.00006*** | 1.00004*** | 0.99998 | 1.00006*** | 1.00004 |
| **city** | | | | | | | | |
| East Newark | 1.24256 | 4.68073*** | 0.44913** | 4.99114*** | 1.98739** | 0.51944 | 3.36347** | 1.09595 |
| Guttenberg | 1.64632*** | 10.54609*** | 1.47947** | 3.60628** | 2.61467*** | 2.04217 | 4.24955*** | 0.00000 |
| Harrison | 1.04848 | 1.06561 | 1.06005 | 2.26578** | 0.92021 | 0.21781** | 0.87043 | 1.69486 |
| Hoboken | 2.22515*** | 0.91638 | 2.46488*** | 6.82327*** | 0.87724 | 0.12706*** | 1.50312 | 11.67293*** |
| Jersey City | 1.17897 | 0.95009 | 1.296* | 1.54627 | 0.97445 | 0.30241*** | 1.05658 | 1.61079 |
| Kearny | 1.16321 | 0.89205 | 1.27137* | 1.56670 | 0.72401* | 0.12555*** | 1.10001 | 0.19699* |
| North Bergen | 1.72576*** | 2.03073** | 1.65761*** | 2.74247*** | 1.48171** | 0.43186** | 1.95922** | 0.19063** |
| Secaucus | 1.25265** | 2.77434*** | 0.85357 | 2.67098*** | 0.83009 | 0.50345** | 1.02661 | 1.93793* |
| Union City | 2.14480*** | 1.52495 | 2.37938*** | 3.35734*** | 2.16772*** | 0.46406* | 2.68089*** | 0.12689** |
| Weehawken | 1.69596*** | 5.16228*** | 2.97697*** | 0.00000*** | 4.15595*** | 0.89387 | 6.30875*** | 0.00000 |
| West New York | 2.37168*** | 1.64116 | 2.17971*** | 7.04543*** | 2.95524*** | 0.84984 | 2.82983*** | 1.60803 |
| **No. subjects** | 2,010 | 485 | 1,259 | 266 | 1,195 | 355 | 742 | 98 |
| **Log likelihood** | -52581.042 | -9568.844 | -29742.777 | -7231.388 | -18136.087 | -4094.873 | -10705.511 | -1191.464 |
| **LR chi2 (20)** | 1463.7 | 345.5 | 1053.34 | 680.72 | 375.46 | 189.54 | 284.45 | 228.26 |

***p=0.001, **p=0.05, *p=0.1

To summarize the findings, I find that there are considerable differences in the factors associated with the survival of new establishments in Hudson County. For locational factors, the influences of proximity to the CBD on establishments' survival are minimal, because the hazard ratios for this distance variable are very close to 1, across industries and firm sizes in both full time period and shorter time period models. Similarly, the influences of proximity to HBLR is limited. Although the hazard ratios of the HBLR distance variable are statistically significant in most models, the magnitudes are relatively small. Across all industries, the largest hazard ratio is 1.040 for large FIRE establishments, suggesting that for every 1,000 feet further away from a light rail station, the risk of death increase 4% (Table 7.6, model a4).

From looking at the hazard ratios, models in Table 7.4 indicate that with all other variables held constant, manufacturing establishments of all sizes (that locate further away from a light rail station) are more likely to fail (death). However, the influence of proximity to HBLR stations is limited as the magnitudes of the hazard ratio are small, ranging from 0.6% to 2.5% respectively across models (a1-a4). The two HBLR distance band dummies are not statistically significant for manufacturing establishments. Except for sole employee establishments, manufacturing establishments that locate within a half mile of a PATH station are more likely to fail compared to otherwise. Small manufacturing establishments are 45.5% more likely to fail and larger establishments are 74% more likely to fail while holding all other variables constant. This can be explained by the fact that land prices are high in locations close to PATH stations and manufacturing generally require larger sites, or it is restricted by zoning requirements.

The association between proximity to a CBD and hazard ratios for manufacturing establishments is not important because the hazard ratios are close to 1 in all models.

While comparing the full models (a1-a4) and models that covered shorter periods (s1-s4), the signs and magnitudes of many independent variables remain similar, but some change substantially (for example, the hazard ratios of the PATH dummy changed from 1.74050 in a4 to 4.70778 in s4). This may be attributed to the fact that sample sizes of some shorter time period models are much smaller (for example, model s4 contains only 98 subjects), and Cox regression is a large-sample method. Another possible explanation is that the imputed "distance to HBLR" for data in year 1991-1998 led to biased estimators.

Table 7.5 Cox Regression Results: Trade, Transportation, and Utilities

| | **All Firms** | **Sole Emp** | **Smaller Firms** | **Larger Firms** | **All Firms 1999-2013** | **Sole Emp 1999-2013** | **Smaller Firms 1999-2013** | **Larger Firms 1999-2013** |
|---|---|---|---|---|---|---|---|---|
| | a1 | a2 | a3 | a4 | s1 | s2 | s3 | s4 |
| **_t** | | | | Haz. Ratio | | | | |
| d_HBLR_1mi | 0.89920*** | 0.81735*** | 0.89802*** | 1.05857 | 0.88978*** | 0.74537*** | 0.89562*** | 1.30068** |
| d_HBLR_0.5mi | 0.98710 | 0.90533** | 0.97733 | 1.29593** | 0.95143* | 0.83684** | 0.92413** | 1.51163** |
| d_PATH_0.5mi | 1.05761** | 0.84360*** | 1.10855*** | 1.24537** | 1.05514* | 0.93980 | 1.08610** | 1.16508 |
| dis_HBLR(1,000ft) | 1.01559*** | 0.99949 | 1.01814*** | 1.03771*** | 1.01857*** | 0.98853** | 1.02112*** | 1.06196*** |
| dis_CBD(1,000ft) | 0.99999*** | 0.99999*** | 0.99999*** | 1.00000 | 0.99998*** | 0.99998*** | 0.99998*** | 1.00001 |
| %Hispanic | 0.63178*** | 0.68766*** | 0.60380*** | 0.49834** | 0.51822*** | 0.46442*** | 0.51216*** | 0.47413* |
| %Bachelor | 0.44468*** | 0.75059*** | 0.36378*** | 0.62541** | 0.35487*** | 0.39849*** | 0.31539*** | 0.44288** |
| net_firm_growth | 1.00000 | 0.99999** | 1.00000 | 1.00001 | 0.99995*** | 0.99998** | 0.99994*** | 0.99995* |
| firm_density | 1.00006*** | 1.00006*** | 1.00006*** | 1.00004*** | 1.00006*** | 1.00004*** | 1.00006*** | 1.00011*** |
| **city** | | | | | | | | |
| East Newark | 0.93152 | 0.45306** | 1.08873 | 32.94034*** | 0.55097*** | 1.10839 | 0.44034*** | |
| Guttenberg | 1.12130** | 0.93948 | 1.14526** | 1.29121 | 0.83797** | 0.74746* | 0.80911** | 3.84114*** |
| Harrison | 0.83929*** | 1.14303 | 0.81490*** | 0.47274*** | 0.55003*** | 0.54250*** | 0.54901*** | 0.74715 |
| Hoboken | 1.18633*** | 1.04228 | 1.26543*** | 0.72839** | 1.12438* | 1.25970* | 1.03682 | 1.76808** |
| Jersey City | 0.96026 | 0.99586 | 0.94938 | 0.90344 | 0.91949 | 0.93070 | 0.84750** | 1.69136** |
| Kearny | 0.84725*** | 0.99892 | 0.83061*** | 0.82595 | 0.64279*** | 0.88797 | 0.59118*** | 0.84144 |
| North Bergen | 1.13335*** | 1.00879 | 1.20822*** | 1.06889 | 1.03269 | 0.87694 | 1.08341 | 0.98217 |
| Secaucus | 1.01444 | 0.92477 | 1.06156* | 0.96372 | 0.85081*** | 1.07618 | 0.77617*** | 1.27759 |
| Union City | 1.03293 | 1.02998 | 1.05106 | 0.79080 | 1.06873 | 1.00580 | 1.00043 | 3.88138*** |
| Weehawken | 0.93441 | 0.97160 | 1.01706 | 0.28120*** | 1.14495* | 1.20139 | 0.93018 | 3.95481*** |
| West New York | 1.06266 | 0.97368 | 1.07187 | 1.07317 | 1.04150 | 1.06006 | 0.98620 | 1.80654* |
| **No. subjects** | 16,348 | 3,876 | 11,566 | 906 | 11,114 | 3,036 | 7,686 | 392 |
| **Log likelihood** | -431272.200 | -80424.461 | -294735.660 | -24651.495 | -188717.080 | -39339.177 | -129714.550 | -6121.799 |
| **LR chi2 (20)** | 6053.75 | 803.67 | 5349.85 | 634.46 | 925.22 | 208.51 | 879.6 | 205.22 |

***p=0.001, **p=0.05, *p=0.1

Table 7.6 Cox Regression Results: Financial Activities (FIRE)

| | **All Firms** | **Sole Emp** | **Smaller Firms** | **Larger Firms** | **All Firms 1999-2013** | **Sole Emp 1999-2013** | **Smaller Firms 1999-2013** | **Larger Firms 1999-2013** |
|---|---|---|---|---|---|---|---|---|
| | a1 | a2 | a3 | a4 | s1 | s2 | s3 | s4 |
| **_t** | | | | Haz. Ratio | | | | |
| d_HBLR_1mi | 1.26710*** | 1.10819 | 1.26357*** | 1.21210 | 1.02843 | 0.67149** | 1.03240 | 1.21474 |
| d_HBLR_0.5mi | 1.20583*** | 2.27191*** | 1.04558 | 1.59532** | 0.94165 | 0.94685 | 0.91121* | 1.50680 |
| d_PATH_0.5mi | 1.05590 | 0.65531*** | 1.14545*** | 2.83725*** | 1.05822 | 0.39312*** | 1.13241** | 1.40049 |
| dis_HBLR(1,000ft) | 1.02013*** | 1.03613*** | 1.01617*** | 1.03985*** | 1.01343*** | 1.00425 | 1.01221** | 1.04890** |
| dis_CBD(1,000ft) | 1.00000 | 0.99995*** | 1.00001 | 1.00008*** | 0.99997*** | 0.99989*** | 0.99997*** | 1.00015*** |
| %Hispanic | 0.80409** | 0.62814 | 0.87379 | 0.49504 | 0.31167*** | 0.07232*** | 0.35756*** | 0.44150 |
| %Bachelor | 0.67898*** | 0.44337** | 0.81102 | 0.10328*** | 0.27575*** | 0.19773*** | 0.30394*** | 0.13194** |
| net_firm_growth | 0.99999 | 0.99998 | 1.00000 | 1.00000 | 0.99998** | 1.00000 | 0.99997*** | 1.00003 |
| firm_density | 1.00005*** | 1.00005*** | 1.00005*** | 1.00003*** | 1.00003*** | 1.00005* | 1.00003*** | 1.00012** |
| **city** | | | | | | | | |
| East Newark | 8.44687*** | | 7.60813*** | | 6.19669** | | 5.38037** | |
| Guttenberg | 0.61088*** | 0.16764*** | 0.67395** | 2.60886** | 0.72435** | 4.97986** | 0.58474*** | |
| Harrison | 1.34000** | 0.70137 | 1.31259** | 2.99170** | 0.70107** | 0.06887** | 0.60969** | 111.2439*** |
| Hoboken | 0.98154 | 0.58377** | 0.81044** | 6.75373*** | 0.62016*** | 0.30263** | 0.54418*** | 9.56783*** |
| Jersey City | 1.06254 | 0.32147*** | 1.01384 | 7.76663*** | 0.66049*** | 0.17436*** | 0.60147*** | 13.30005*** |
| Kearny | 0.78615** | 0.41001*** | 0.78349** | 1.28101 | 0.49750*** | 0.38575* | 0.43152*** | 2.34204 |
| North Bergen | 1.07232 | 0.5736** | 1.00457 | 2.17318** | 0.95377 | 0.63867 | 0.90765 | 2.09006 |
| Secaucus | 0.97193 | 0.80706 | 0.79794** | 3.91847*** | 0.72095*** | 0.45220** | 0.65698*** | 1.23929 |
| Union City | 1.14179 | 0.5128** | 1.07727 | 4.15601*** | 0.78674* | 1.24744 | 0.68916** | 1.19266 |
| Weehawken | 1.07690 | 0.51676** | 0.94829 | 6.41127** | 0.88542 | 0.41614* | 0.84276 | 3.27521 |
| West New York | 1.04550 | 0.45016** | 0.94715 | 7.51678*** | 0.95446 | 0.51656 | 0.86824 | 1.33792 |
| **No. subjects** | 4,684 | 456 | 3,994 | 234 | 3,687 | 279 | 3,285 | 123 |
| **Log likelihood** | -99245.811 | -9160.329 | -78110.049 | -5187.465 | -57118.673 | -2786.215 | -50395.199 | -1280.394 |
| **LR chi2 (20)** | 872.86 | 388.64 | 792.64 | 302.96 | 349.09 | 91.19 | 344.42 | 143.19 |

***p=0.001, **p=0.05, *p=0.1

Controlling for other factors in the first set of regression models (a1-a4), the signs and magnitudes of hazard ratios of locational factors for selected industries are mixed. The hazard ratios of HBLR distance band dummies are different between sole employee/small establishments and large establishments. For example, for sole employee/small establishments in Trade, transportation, and utilities, locating within a half mile radius or between half and a mile radius to a light rail station tend to have lower risks of death. In contrast, larger establishments locating less than a mile from a HBLR station are more likely to fail, with the rate of death increase by 5.8% (<=0.5 mile) and 29.6% (0.5-1 mile), respectively. Similarly, the PATH dummy also indicates that larger establishments within a half-mile distance from a PATH are 24.5% more likely to die.

According to the hazard ratios of the HBLR distance variable across models, establishments in most industries are more likely to fail with distance away from a light rail station, ranging from as low as 0.1% to 4% for large establishments in the FIRE industry. This suggests that the influence of proximity to light rail services on the survival of establishments is limited and varies by industry and establishment's initial size. In addition, the magnitudes of the PATH variable are generally larger than the magnitudes of the HBLR distance band variables across models. This implies that the influence of access to PATH on establishments' survival is larger than for the HBLR, regardless of the size of firm and industry.

Hazard ratios indicate that small FIRE and Professional and business services establishments are more likely to fail compared to otherwise when located more than one mile from a light rail station. The rate of death for small establishments in Leisure and hospitality, and Other services that located within half mile from a HBLR station are

27.4% and 20% less than establishments located in other areas. The death rate for small establishments in these two industries that located between half and one mile from a HBLR station are 25.6%, and 17.9% less than otherwise. Similarly, establishments in Education and health services located between half and one mile from a light rail station are 19.4% less likely to fail compared to other areas.

The influences of HBLR distance band variables for large establishments are somewhat different compared to small establishments. The rate of death decreases by 23.2% for establishments in Professional and business services located between half and a mile from HBLR stations. However, FIRE, Education and health services, and Leisure and hospitality are more likely to fail if they located within a half mile from a light rail station at 59.5%, 31.2%, and 69.5%, respectively. Similarly, the hazard ratios of the PATH dummy also suggest that large establishments in FIRE, and Leisure and hospitality are more likely to fail if they located within a half mile from a PATH station.

The signs and magnitudes of hazard ratios in most 1999-2013 models (s1-s4) remain similar when comparing to the full models, with all other factors constant. There are few exceptions. For small establishments, the hazard ratios of the HBLR half to one-mile distance band variable changed from 1.07 to 0.94 in the Professional and business services; and hazard ratios of the HBLR half mile radius dummy changed from 0.73 to 1.30 for Leisure and hospitality. For large establishments, the hazard ratios of the HBLR distance band variables changed from above 1 to less than 1 in Professional and business Services, and Education and health services. These differences between full models and shorter period models might be attributed to smaller sample sizes in models with shorter

time period, and the imputed values in full models for HBLR variables in earlier years (1991-1998). So we should interpret and use these model outcomes with caution.

Firm growth and firm density are statistically significant in most models across industries, but their influences on establishments' survival are not important because magnitudes of hazard ratios are close to 1. Two demographic variables, percent with a bachelor's degree and percent Hispanic are statistically significant in most models (except for a2, s2, and s4). For all selected industries, establishments at all sizes are less likely to fail with more population with a bachelor's degree in the area, while holding all other variables constant. However, the magnitudes vary by industry and firm size.

Table 7.7 Cox Regression Results: Professional and Business Services

| | **All Firms** | **Sole Emp** | **Smaller Firms** | **Larger Firms** | **All Firms 1999-2013** | **Sole Emp 1999-2013** | **Smaller Firms 1999-2013** | **Larger Firms 1999-2013** |
|---|---|---|---|---|---|---|---|---|
| | a1 | a2 | a3 | a4 | s1 | s2 | s3 | s4 |
| **_t** | | | | Haz. Ratio | | | | |
| d_HBLR_1mi | 1.07622*** | 1.02551 | 1.06992** | 0.76834** | 1.00688 | 0.94340* | 1.06133 | 0.52662*** |
| d_HBLR_0.5mi | 1.17026*** | 1.1331*** | 1.06689* | 0.96602 | 1.07462** | 1.04848 | 1.00785 | 0.71254** |
| d_PATH_0.5mi | 0.78814*** | 0.88680*** | 0.72689*** | 0.78257*** | 0.90784*** | 0.99411 | 0.86640*** | 0.36245*** |
| dis_HBLR(1,000ft) | 1.00743*** | 0.98706*** | 1.02283*** | 1.02433*** | 1.00902*** | 0.99928 | 1.02078*** | 1.07233*** |
| dis_CBD(1,000ft) | 0.99997*** | 0.99999*** | 0.99995*** | 0.99997** | 0.99998*** | 0.99999*** | 0.99997*** | 0.99989*** |
| %Hispanic | 0.83838*** | 1.01309 | 0.68742*** | 0.24840*** | 0.71407*** | 0.80769** | 0.71622** | 1.36576 |
| %Bachelor | 0.46583*** | 0.40951*** | 0.47262*** | 0.32529*** | 0.38721*** | 0.38378*** | 0.42873*** | 0.20667*** |
| net_firm_growth | 1.00000 | 0.99999* | 1.00000 | 0.99998** | 0.99997*** | 0.99999 | 0.99996*** | 0.99992*** |
| firm_density | 1.00005*** | 1.00004*** | 1.00006*** | 1.00005*** | 1.00001*** | 0.99999** | 1.00006*** | 1.00003** |
| **city** | | | | | | | | |
| East Newark | 1.09449 | 3.35575*** | 0.53501** | 0.45402** | 1.23205 | 2.00711*** | 0.40632** | |
| Guttenberg | 0.88990** | 1.16069** | 0.54701*** | 1.07617 | 1.11316 | 1.01958 | 0.98047 | 0.10805*** |
| Harrison | 0.87775** | 1.16677* | 0.51697*** | 0.86659 | 1.03273 | 0.95091 | 1.03423 | 0.03942*** |
| Hoboken | 0.97283 | 0.97195 | 0.85814** | 0.62872** | 1.01670 | 0.86377** | 1.17315* | 0.26021*** |
| Jersey City | 0.95009 | 1.02325 | 0.69528*** | 0.69676* | 1.01449 | 0.97550 | 0.90589 | 0.37946** |
| Kearny | 0.76595*** | 1.13203** | 0.48389*** | 0.28193*** | 0.80883*** | 0.82262** | 0.69309*** | 0.05921*** |
| North Bergen | 1.13997*** | 1.07941 | 1.05106 | 0.86918 | 1.15700** | 0.98074 | 1.17803* | 0.19912*** |
| Secaucus | 1.00404 | 1.04401 | 1.09885* | 0.35705*** | 1.07069 | 1.11030* | 1.02608 | 0.20410*** |
| Union City | 0.80671*** | 0.77804*** | 0.67082*** | 1.74479** | 0.97607 | 0.90920 | 0.89648 | 0.10099*** |
| Weehawken | 0.98409 | 1.05258 | 0.69460*** | 1.18998 | 1.12012* | 1.07361 | 0.98279 | 0.17506** |
| West New York | 1.04282 | 0.99386 | 0.94780 | 0.96985 | 1.18317** | 1.08517 | 1.13573 | 0.11183*** |
| **No. subjects** | 16,788 | 9,474 | 6,769 | 545 | 13,911 | 8,755 | 4,855 | 301 |
| **Log likelihood** | -376612.280 | -178181.820 | -151946.900 | -14787.155 | -239818.300 | -141768.810 | -75642.029 | -4046.874 |
| **LR chi2 (20)** | 2736.19 | 854.55 | 3374.34 | 532.96 | 661.51 | 495.66 | 532.94 | 251.46 |

***p=0.001, **p=0.05, *p=0.1

Table 7.8 Cox Regression Results: Education and Health Services

| | All Firms | Sole Emp | Smaller Firms | Larger Firms | All Firms 1999-2013 | Sole Emp 1999-2013 | Smaller Firms 1999-2013 | Larger Firms 1999-2013 |
|---|---|---|---|---|---|---|---|---|
| | a1 | a2 | a3 | a4 | s1 | s2 | s3 | s4 |
| _t | | | | Haz. Ratio | | | | |
| d_HBLR_1mi | 0.83176*** | 0.78933** | 0.80575*** | 1.01718 | 0.82847** | 0.74219** | 0.83546** | 0.67155 |
| d_HBLR_0.5mi | 0.93538 | 0.72345** | 0.97315 | 1.31200* | 1.04726 | 0.68671** | 1.20004** | 0.60506* |
| d_PATH_0.5mi | 0.75892*** | 0.64115*** | 0.81064*** | 0.83323 | 0.86368** | 0.98390 | 0.88058* | 0.39893** |
| dis_HBLR(1,000ft) | 1.01592*** | 0.99774 | 1.01769*** | 1.03354*** | 1.02923*** | 1.00032 | 1.03399*** | 1.05296*** |
| dis_CBD(1,000ft) | 0.99997*** | 0.99999 | 0.99996*** | 0.99996** | 0.99996*** | 0.99995** | 0.99997*** | 0.99991** |
| %Hispanic | 0.31363*** | 0.37996*** | 0.21361*** | 1.55351 | 0.15292*** | 0.33081** | 0.14030*** | 0.05377*** |
| %Bachelor | 0.48283*** | 0.87235 | 0.32161*** | 0.49727* | 0.30993*** | 0.36754** | 0.33176*** | 0.09381*** |
| net_firm_growth | 1.00001 | 1.00000 | 1.00001** | 0.99994** | 0.99998** | 0.99998 | 0.99999 | 0.99993** |
| firm_density | 1.00007*** | 1.00006*** | 1.00007*** | 1.00012*** | 1.00005*** | 1.00004 | 1.00003*** | 1.00020*** |
| **city** | | | | | | | | |
| East Newark | 9.55193*** | | 7.45832*** | | 5.71298** | | 6.37629** | |
| Guttenberg | 0.91577 | 2.26595*** | 0.94214 | 0.04632** | 1.35374* | 1.34935 | 1.21036 | 125.05990*** |
| Harrison | 0.50149*** | 0.77884 | 0.53402*** | 0.00000 | 0.29991*** | 0.24297** | 0.31530*** | 0.00000 |
| Hoboken | 0.83818** | 1.67709** | 0.79691** | 0.21871*** | 0.89554 | 0.39903** | 1.08791 | 0.12143*** |
| Jersey City | 0.84399** | 1.71503** | 0.76561** | 0.34153*** | 0.80767 | 0.62171 | 0.87960 | 0.24538** |
| Kearny | 0.55392*** | 1.36732 | 0.47778*** | 0.27759*** | 0.62134** | 0.39434** | 0.75323* | 0.02688*** |
| North Bergen | 1.05655 | 2.85043*** | 1.07048 | 0.35923*** | 1.51850*** | 0.95910 | 1.63531*** | 0.84714 |
| Secaucus | 0.76779*** | 0.90537 | 0.76414*** | 0.70966** | 0.68898*** | 0.56312* | 0.77538** | 0.15907*** |
| Union City | 1.25054** | 2.59759*** | 1.31538** | 0.27357*** | 1.54260** | 0.86736 | 1.74208*** | 0.66863 |
| Weehawken | 1.14439 | 1.10541 | 1.02876 | 0.78942 | 1.32959 | 0.34647* | 1.89219** | |
| West New York | 1.00914 | 1.79921** | 1.20679 | 0.11586*** | 1.35057** | 0.94189 | 1.73220*** | 0.17037** |
| **No. subjects** | 4,112 | 639 | 3,126 | 347 | 2,974 | 482 | 2,301 | 191 |
| **Log likelihood** | -76687.976 | -10885.626 | -53175.644 | -6205.583 | -33826.323 | -4455.477 | -25360.316 | -1394.392 |
| **LR chi2 (20)** | 1496.8 | 206.54 | 1233.92 | 365.95 | 367.33 | 70.34 | 313.76 | 173.52 |

***p=0.001, **p=0.05, *p=0.1

Table 7.9 Cox Regression Results: Leisure and Hospitality

| | **All Firms** | **Sole Emp** | **Smaller Firms** | **Larger Firms** | **All Firms 1999-2013** | **Sole Emp 1999-2013** | **Smaller Firms 1999-2013** | **Larger Firms 1999-2013** |
|---|---|---|---|---|---|---|---|---|
| | a1 | a2 | a3 | a4 | s1 | s2 | s3 | s4 |
| **_t** | | | | Haz. Ratio | | | | |
| d_HBLR_1mi | 0.82840*** | 0.72136*** | 0.74407*** | 1.69009*** | 1.00493 | 0.90878 | 0.85522* | 2.43545*** |
| d_HBLR_0.5mi | 0.87944** | 0.92721 | 0.72652*** | 1.69532*** | 1.11015 | 1.30471** | 0.99063 | 1.53983** |
| d_PATH_0.5mi | 1.12443** | 1.23824** | 1.09993* | 1.54997*** | 1.07281 | 1.07051 | 1.13281 | 0.99572 |
| dis_HBLR(1,000ft) | 1.00767*** | 1.00216 | 1.00257 | 1.03263*** | 1.03540*** | 1.05441*** | 1.02005** | 1.05675*** |
| dis_CBD(1,000ft) | 0.99999** | 1.00000 | 0.99997*** | 1.00005*** | 0.99998*** | 1.00002 | 0.99995*** | 0.99998 |
| %Hispanic | 0.71649** | 1.45131* | 0.49343*** | 0.33838*** | 0.62751** | 1.57986 | 0.40233*** | 0.32821** |
| %Bachelor | 0.41066*** | 0.92011 | 0.30440*** | 0.37278*** | 0.32721*** | 0.82500 | 0.15499*** | 0.34445** |
| net_firm_growth | 0.99999* | 0.99998 | 1.00000 | 0.99996** | 0.99995*** | 0.99993*** | 0.99998** | 0.99987*** |
| firm_density | 1.00007*** | 1.00009*** | 1.00008*** | 1.00005*** | 1.00001 | 1.00009*** | 1.00004*** | 0.99989*** |
| **city** | | | | | | | | |
| East Newark | 1.39275** | 7.25534*** | 0.70227* | 39.66552*** | 1.17502 | 4.11112** | 0.48262 | 3.27179** |
| Guttenberg | 0.50264*** | 0.15213*** | 0.69882** | 0.23084 | 0.74677 | 0.14937*** | 1.59681** | 0.10198** |
| Harrison | 0.51996*** | 0.25190*** | 0.36443*** | 5.74391*** | 0.31058*** | 0.00000 | 0.25473*** | 0.44074 |
| Hoboken | 0.88358 | 1.23109 | 0.69346*** | 1.41823* | 0.63029*** | 1.07260 | 0.49576*** | 0.58362** |
| Jersey City | 1.02145 | 1.38469* | 0.66060*** | 2.89339*** | 0.85411 | 1.49365* | 0.54430*** | 1.17735 |
| Kearny | 0.62426*** | 0.72638 | 0.50120*** | 1.58663** | 0.48783*** | 0.36597** | 0.58177** | 0.62549 |
| North Bergen | 0.99558 | 1.21824 | 0.75988** | 2.88031*** | 0.84363 | 0.82141 | 0.82402 | 1.12023 |
| Secaucus | 1.07167 | 0.81333 | 1.12231 | 1.86059*** | 0.75036** | 0.50101*** | 0.82964 | 0.75645 |
| Union City | 1.08614 | 0.79626 | 1.08056 | 3.13600*** | 0.86680 | 0.62341* | 0.76784 | 2.89819** |
| Weehawken | 1.46485*** | 1.16714 | 1.08734 | 6.59872*** | 1.18406 | 1.76496** | 0.89748 | 1.53257 |
| West New York | 0.72199*** | 0.65959** | 0.62334*** | 2.22545** | 0.79770 | 0.53588** | 0.69065* | 3.25753** |
| **No. subjects** | 3,123 | 785 | 1,813 | 525 | 2,077 | 573 | 1,164 | 340 |
| **Log likelihood** | -80499.288 | -16652.476 | -43589.782 | -11648.789 | -32424.087 | -7841.949 | -16513.239 | -4222.772 |
| **LR chi2 (20)** | 1425.53 | 547.92 | 991.84 | 421.73 | 338.29 | 175.8 | 258.75 | 229.02 |

***p=0.001, **p=0.05, *p=0.1

Table 7.10 Cox Regression Results: Other Services

| | **All Firms** | **Sole Emp** | **Smaller Firms** | **Larger Firms** | **All Firms 1999-2013** | **Sole Emp 1999-2013** | **Smaller Firms 1999-2013** | **Larger Firms 1999-2013** |
|---|---|---|---|---|---|---|---|---|
| | a1 | a2 | a3 | a4 | s1 | s2 | s3 | s4 |
| **_t** | Haz. Ratio | | | | | | | |
| d_HBLR_1mi | 0.86991*** | 0.94264 | 0.82057*** | 0.85095 | 0.90945** | 0.97614 | 0.88650 | 0.23381*** |
| d_HBLR_0.5mi | 0.87347*** | 1.00822 | 0.80007*** | 1.02855 | 0.87335** | 0.88805 | 0.85645 | 0.39545** |
| d_PATH_0.5mi | 1.07981** | 1.34217*** | 0.95500 | 1.46500* | 0.91470* | 0.99199 | 0.90894 | 0.11737*** |
| dis_HBLR(1,000ft) | 1.00722*** | 0.99015*** | 1.01272*** | 1.03122*** | 1.01907*** | 1.01263* | 1.02849*** | 0.96810 |
| dis_CBD(1,000ft) | 1.00000 | 1.00003*** | 0.99999* | 0.99995** | 0.99998*** | 1.00000 | 0.99998*** | 0.99964*** |
| %Hispanic | 0.82776** | 0.65694** | 0.92335 | 0.91611 | 0.54951*** | 0.64901** | 0.52849*** | 0.00362*** |
| %Bachelor | 0.53388*** | 0.53601*** | 0.53859*** | 0.89004 | 0.26030*** | 0.40321*** | 0.22250*** | 0.00188*** |
| net_firm_growth | 0.99999** | 0.99999 | 0.99999* | 0.99990** | 0.99996*** | 0.99998 | 0.99995*** | 0.99973*** |
| firm_density | 1.00008*** | 1.00006*** | 1.00009*** | 1.00009*** | 1.00009*** | 1.00005*** | 1.00011*** | 1.00009 |
| **city** | | | | | | | | |
| East Newark | 0.55074** | 1.43952 | 0.52997** | 0.00000 | 0.39773*** | 0.26933* | 0.34373*** | |
| Guttenberg | 1.26568** | 2.64066*** | 0.80970* | | 1.21367 | 1.76037** | 0.73166* | |
| Harrison | 1.42255*** | 3.18151*** | 1.00885 | 0.24852** | 0.60349*** | 0.96401 | 0.41340*** | 0.00000 |
| Hoboken | 1.33757*** | 1.60774*** | 1.32908*** | 0.22983*** | 1.10727 | 1.07511 | 1.14727 | 0.04273*** |
| Jersey City | 1.37808*** | 1.74728*** | 1.31327*** | 0.47056** | 1.02725 | 1.68718*** | 0.79078** | 0.02147*** |
| Kearny | 1.03604 | 1.67256*** | 0.91793 | 0.43279** | 0.50440*** | 0.94202 | 0.31395*** | 0.01452*** |
| North Bergen | 1.30271*** | 2.26397*** | 1.04432 | 0.84318 | 1.08413 | 1.69791*** | 0.74869** | 275.69800*** |
| Secaucus | 0.86338** | 1.21493* | 0.76833*** | 0.27596** | 0.75586** | 1.12733 | 0.51058*** | 5.27651** |
| Union City | 1.14554* | 2.11264*** | 0.88552 | 0.43807** | 0.99334 | 1.26292 | 0.80256 | 2.34924 |
| Weehawken | 1.35972** | 5.53735*** | 0.70019** | 23.94907*** | 1.46887** | 3.55629*** | 0.84437 | 0.89026 |
| West New York | 1.27691*** | 2.28277*** | 1.00216 | 0.98178 | 1.07158 | 1.40202 | 0.83052 | 0.27880 |
| **No. subjects** | 6,506 | 2,438 | 3,901 | 167 | 4,595 | 2,022 | 2,493 | 80 |
| **Log likelihood** | -150758.890 | -41105.627 | -94410.274 | -3516.028 | -68009.405 | -23054.285 | -38743.168 | -632.472 |
| **LR chi2 (20)** | 2764 | 504.93 | 2664.98 | 247.57 | 687.39 | 222.89 | 650.49 | 198.67 |

***p=0.001, **p=0.05, *p=0.1

Table 7.11 summarizes the hazard ratios of proximity to transit by industry for small and large establishments in the full models. In general, the influences of these location factors on the survival of establishments are mixed. With the hazard ratio ranging from 1.00 to 1.04, the distance to HBLR variable suggests that an establishment is more likely to fail if located further away from a light rail station. According to the 0.5-mile radius HBLR distance band variable, small establishments in Leisure and Hospitality, and Other services have 27% and 20% less risk of failure if they located within half mile from a HBLR station. All other establishments in the selected industries face higher risks of death if locating within a half mile from a light rail station. From the hazard ratios of the one-mile radius HBLR dummy variable, small establishments in Trade, transportation, and utilities (10%), Education and health services (19%), Leisure and hospitality (26%), and Other services (18%) are less likely to fail if they are located between half-mile and one-mile from a HBLR station. Small establishments in FIRE and Professional and business services are at higher risk if located in the same distance band. The influence of proximity to PATH is also mixed across industries. For Professional and business services, and Education and health services, establishments forming within half mile from a PATH station are less likely to fail, regardless of their initial size. All remaining industries are facing higher risks of death if located within half mile from PATH, with hazard ratios ranging from the lowest of 1.10 for small establishments in Leisure and hospitality, to the highest of 2.84 for large establishments in the FIRE sector.

Table 7.11 Summary of Hazard Ratios for Locational Factors: Small vs. Large Establishments

| | **Manufacturing** | | **Trade, transportation & utilities** | | **FIRE** | | **Prof. & Business services** | | **Edu & Health services** | | **Leisure & Hospitality** | | **Other services** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2-5 emp | >5 emp | 2-5 emp | >5 emp | 2-5 emp | >5 emp | 2-5 emp | >5 emp | 2-5 emp | >5 emp | 2-5 emp | >5 emp | 2-5 emp | >5 emp |
| _t | Haz. Ratio | | | | | | | | | | | | | |
| d_HBLR_1mi | 1.02 | 0.97 | 0.90*** | 1.06 | 1.26*** | 1.21 | 1.07** | 0.77** | 0.81*** | 1.02 | 0.74*** | 1.69*** | 0.82*** | 0.85 |
| d_HBLR_0.5mi | 1.10 | 1.09 | 0.98 | 1.30** | 1.05 | 1.60** | 1.07* | 0.97 | 0.97 | 1.31* | 0.73*** | 1.70*** | 0.80*** | 1.03 |
| d_PATH_0.5mi | 1.46*** | 1.74*** | 1.11*** | 1.25** | 1.16*** | 2.84*** | 0.73*** | 0.78*** | 0.81*** | 0.83 | 1.10* | 1.55*** | 0.96 | 1.47* |
| dis_HBLR(1,000ft) | 1.02*** | 1.02*** | 1.02*** | 1.04*** | 1.02*** | 1.04*** | 1.02*** | 1.02*** | 1.02*** | 1.03*** | 1.00 | 1.03*** | 1.01*** | 1.03*** |

There are several problems that might limit the efficiency of these survival models. First, omitted variables due to data availability at a fine geographic scale might be problematic. Proxies for macroeconomic condition, like GDP, unemployment rates and so forth cannot be obtained for the entire study area beyond the County level, which make including the change in macro-economic environment in model estimation problematic. Secondly, sample size is a problem for some models. Cox regression is a large-sample method (sample-sized for a particular model can be calculated based on effect size) and small-sample sizes might result in biased estimation. For both full- and the shorter-period, there are some models containing insufficient subjects (the smallest sample size has only 98 subjects), suggesting that Cox models tend to underperform with those small samples.

In addition, hazard rates should be interpreted with caution due to sample attrition as time passes (Tamasy, 2006). However, due to the potential problem of a small sample in some industries, the hazard and survival functions are not restricted to five years after firm formation in the analysis. This might lead to biased estimations in some models as well.

# Chapter Eight

# Conclusions

This dissertation study has analyzed the association between access to transit services and the formation of new establishments and their subsequent survival, using the National Establishment Time Series (NETS) Data. It is developed based on the work of Noland et al. (2014) on the access of transit and agglomeration of firms in Portland and Dallas. My study is distinguished from previous work, in that Hudson County is a traditional industrialized urban area that has been largely built out. Policy makers have aimed at stimulating income growth in older urban areas through various economic stimulation, urban redevelopment, and smart growth programs because the U.S. economy has long experienced large inequalities between urban areas and suburban areas. If the improvement of transit services in traditionally industrialized urban areas has external economic benefits on economic activities, transportation could be used as an instrument to stimulate economic development in those areas. My study investigates the relationship between access to transit service of a new light rail system (Hudson Bergen Light Rail, HBLR) and new business formation and survival in Hudson County, New Jersey.

I conducted structured interviews with local planners/government officers, local developers, and business owners. My qualitative study in Chapter 4 aims to understand how do planners and local governments integrate transit access with urban policies and processes to stimulate economic growth, and how do developers and business owners perceive transit access in their location decisions, and what motivates them to build/start a business. These are important questions for successful transit investments and future growth in the region.

I adopted NETS data to analyze the relationships between access to transit services and business formation and subsequent survival at a fine geographic scale. I applied descriptive and spatial statistical analysis tools to visualize and analyze this firm-level data in Chapter 5. In Chapter 6, I applied negative binomial models and generalized estimating equation (GEE) models to estimate the association between access to transit and the formation of new businesses at the Census block level. The location choices of firms determined the growth of cities because of the concentrations of employment generated by firms. Therefore, not only the formation of new establishments was important, but also their post-entry performances. Therefore, I also analyzed the association between transit access and the survival of new establishments using the same dataset as in Chapter 7.

Findings in Chapter 4 suggest that conducting structure interviews in this study provides a deeper understanding of local determinants that influence new business formation. The dynamics of firm formation is complicated and involves different stakeholders, including local governments, planners, developers, business owners, and residents. I conducted twelve interviews (planners/government officers, local developers/brokers, and local entrepreneurs) in total and reviewed master plans and zoning/planning documents for this study.

In general, participants perceive HBLR system as crucial for integrating transit modes within Hudson County and it works as a catalyst to scale up developments near stations. Local developer express clear preference for higher-density development in station areas and some are willing to pay for the construction of new light rail stations. However, some participants in both planning professionals/local governments express

concerns of intensifying density near stations, capacity of the HBLR system, alongside capacity of other social infrastructures. In terms of the relationship between access to transit and the formation of establishments, participants generally consider access to transit "attractive", especially access to PATH services. Local developers and entrepreneurs also expressed concerns over decreased demand for large office space, difficulties with securing long-term tenants, competition between residential and office/commercial land uses, and political conflicts among stakeholders. Additionally, planners and local officials point out the lack of policies supports and leadership are obstacles for new businesses to start in Hudson County.

These findings also point out potential strategies for encouraging firm births/relocation and TOD, both through partnerships with the private sector and public policy changes. Below, I make following policy recommendations to address these issues and perceptions.

1. Reduce costs

Although demand for transit access sites are high, developers may not build on those sites because of the high costs of land and the regulatory process. Therefore, subsidy programs and higher density allowances could offset this obstacle to TODs and encourage economic development in station areas. Developers generally perceive that current regulations (such as density and height limits, zoning regulation, and requirements for affordable housing) that limit them from building profitably in station areas because of high land prices and high labor costs for construction. Creating TOD zones for transit stations, in which developers could build projects with higher densities and lower minimum parking ratios can increase potential returns on investments.

2. Engage with economic development specialists

Economic development in the county might have more success if cities can engage with specialists to attract entrepreneurs/firms. It is important for economic development stimulation efforts to actively reach out to developers and entrepreneurs/firms to understand their needs. Considering amenities and incentives needed by entrepreneurs/firms in planning for new development projects will allow entrepreneurs/firms to more easily share in the benefits. In addition, keeping track of the number and locations of entrepreneurs/firms can help better understand changes of economic activities, which is beneficial for future development plans.

3. Build better alliances

With limited public funds and policy support available, participants call for better policy support and leadership from the region and the state. In order to do so, one key is implementing policies on a regional scale (for example, regional planning) to achieve the desired broad impacts. In addition, policy makers and developers should communicate to better understand the changing market and political environment. Such implementations will require a great deal of regional cooperation and is not easy to achieve. This study has found political barriers that limit cooperation.

4. Diversify transit options throughout the region

Additionally, the region should continue to build a comprehensive transit network with premium local services, such as bus rapid transit (BRT), and share mobility (bike share programs) in popular urban neighborhoods. Such services could offer attractive links with the existing transit systems, extending its development impacts. This also indicates

the importance of integration of all different kinds of transit options and programs beyond immediate station areas.

Findings in Chapter 5 suggest that births of new establishments are associated with proximity to rail stations before controlling for other factors. In addition, the spatial distribution of establishments is uneven within Hudson County, and growth rates of new establishments vary by industry. The total number of establishments has increased substantially in the 1990s and 2000s within the study area. The following five industries: Manufacturing, Trade, transportation, and utilities, Financial activities, Professional and business services, and Leisure and hospitality, comprise more than 70% of all establishments that formed within Hudson County. I also measured yearly growth rates of new establishments by industry using the NETS data. Results suggest the count of new establishments experienced substantial growth before the financial crisis in the 2000s, and much of the growth can be attributed to smaller establishments. Yearly growth rates of new establishments vary by firm size, and the variation of yearly growth rates is smaller for larger establishments than sole/small establishments. Entry size varies by industry as well. Manufacturing establishments have the highest average entry size (7 employees) while the Other Services industry has the lowest average entry size of just 2.

I used location quotients (LQ) to measure the spatial distribution of new establishments of different industries near station areas (<=0.5 mile) from 1999 to 2011 at three-year increments. LQs vary by industry with different growth rates. Information, FIRE, and Professional and business services have LQs greater than 1.0 within station areas, indicating agglomeration near station areas. LQs of Manufacturing, and Education and Health Services have increased from 1999 to 2011, suggesting more establishments in these

two industries are relocating within station areas. Specifically, I used FIRE industry as an example to further analyze the distributions of establishments near individual HBLR stations. Results suggest that establishments in FIRE concentrated around specific HBLR stations, mostly clustered in downtown Jersey City. Other than downtown Jersey City, LQs are also high near a transit hub in Hoboken.

I also visualized the density of new establishments in relationship to HBLR stations. Higher establishment birth rates are found closer to light rail stations for most sectors. FIRE, Professional and business services and Trade, transportation, and utilities experienced the highest new establishment density within half mile from a HBLR station. And the density of new establishments decreased with distance from light rail stations across industries.

Results in Chapter 6 suggest that new establishments located at a higher rate near transit stations than otherwise in Hudson County, when other factors are controlled for. The relationship is larger for PATH stations than HBLR stations across all firm sizes. The relationship of light rail station proximity to new establishments is small. The effects of access to HBLR are smaller for establishments with five employees or less than larger establishments. There are multiple possible reasons for these differences. The PATH connects Hudson County with three major job centers, midtown and lower Manhattan, Newark, and Jersey City, while HBLR provides local services within the county. Local planning policies and regulations might encourage employment densification near rail stations in some municipalities/industries but discourage in others.

Results of the industry-specific models suggest that effects of proximity to transit access on new establishments vary by industry with other factors controlled. In general, new establishments are more likely to form near PATH stations. But the effects of

proximity to light rail stations are mixed and relatively small. For Leisure and hospitality Services, Manufacturing, and Education and health services, the predicted effects are higher within one mile but decrease with distance away from HBLR. Beyond one mile, the predicted effects increased slightly but are relatively small. Predicted effects are positive for FIRE and Professional and business services within half mile from a station and become negative with distance from stations. Being close to a light rail station have very limited effects on the formation of establishments in Trade, transportation, and utilities. In addition, the number of firms in the block is highly significant and positively predict the number of establishment births, suggesting localized inter-industry agglomeration economies. The fact that the number of firm deaths in the previous year is significant and negative for all industries provides evidence of competition effects in the study area.

Findings of establishments' post-entry performance in Chapter 7 suggest that the effects of being close to a rail station is mixed for establishments of different sizes and industries. Nonparametric analysis outcomes suggest that firm hazard rates generally follow an inverted U-shape pattern. This reconfirms findings in previous studies (i.e. Kaniovski & Peneder, 2008; Mahmood, 2000). Both life table analysis and the Kaplan-Meier estimator analysis suggest that larger establishments tend to have higher survival rates compared to sole/small establishments. In general, large establishments are 25% less likely to die after the first five-year of establishment before considering other factors. In addition, establishments in some industries are more prone to death during the first five-year period. Less than half of establishments remain active after this period in Trade, transportation, and utilities, Professional and business services; and Other services. In

contrast, establishments in Education and health services are less likely to fail within the same five-year period.

Results from Cox PH models demonstrate that transit access is associated with establishment survival across industries. My study on the association between transit access and establishment survival is distinguished from previous work in that it estimates hazard functions separately for establishments by size and industry. This division of the data is undertaken because there are strong grounds to believe that factors affect establishments of different sizes differently. The influences of location factors on the survival of new establishments are mixed. Access to PATH is associated with the survival of establishments across industries, but the effects are mixed by establishment size. From hazard ratios of the HBLR distance variable, establishments are more prone to fail with distance away from a light rail station in general, but the effect is somewhat limited in some industries with small magnitudes. The effects of HBLR distance band variables also vary by industry and firm size.

Firm density and annual firm growth are significantly associated with establishments' survival, but their influences are not important because magnitudes of hazard ratios are close to 1. Regardless of industry or initial size, establishments located in a block with a higher percentage of population with a bachelor's degree are less likely to fail, all other factors constant. This suggests that higher quality of human capital is positively associated with the survival of establishments.

In summary, my dissertation contributes to the existing literature of impacts of transit infrastructure on firm formation and survival. First, the spatial pattern of new establishment locations is studied at a fine geographical scale. While most empirical

studies to date have used MSAs, county, or municipality level data, my study focuses on Census blocks. Additionally, literature on agglomeration economies suggest that impacts of transport infrastructure on firm location exist within limited geographic scope (Ellison and Glaeser, 1997; Wallsten, 2001). Thus, impacts from transport infrastructure are likely to affect establishments differently depending on distance to a new rail station. By using micro geographic units for analysis, my study sheds light on the important spatial variations that have not been previously examined.

Secondly, my research pays special attention to the importance of access to different local markets for different industries. Previous empirical studies have confirmed different sectors have different transport requirements, and thus, a different locational preference with regard to transport infrastructure (Holl 2004; Dijk and Pellenbarg, 2004). Given the fact that the emergent dominant sector in U.S. economies is now composed of various advanced producer services, it is critical to study determinants of new business formation beyond manufacturing. However, limited studies have assembled micro-level data other than the manufacturing sector. Rather than estimating only a specific sector or an aggregate model for all sectors like previous studies, I consider how impacts of the new light rail on different sectors might vary in my analysis. My analysis reveals that the growth of new establishments has been very uneven across sectors and spaces in Hudson County. This study therefore fills the gaps in literature by identifying determinants of new business formation in various sectors at the micro-level.

Third, my analysis considers the impacts of mass transit infrastructure investment by combining micro level data with Geographic Information Systems (GIS). Accessibility is measured based on travel distance and travel time from each business to

its closest train station in the transportation networks by using GIS. And some other location determinants that have been confirmed important in previous studies will also be considered in my analyses. Thus, it is possible to reveal new insights of the role of transport infrastructure and the locations of new business establishments with the more accurate micro level data sets, advanced GIS techniques and sophisticated models.

In addition to the analysis of determinants of new business formation, my analysis of new establishment' post-entry performance provides new insights on the effects of transport infrastructure on new establishment' survival. By conducting both nonparametric analysis and hazard modeling of determinants of new firm survival at a fine geographic scale with a firm level longitudinal dataset, my analysis investigates the relationship between access to transit stations and establishment survival with different entry-size for various industrial sectors. These outcomes fill research gaps in existing firm survival studies where spatial variations are generally overlooked.

There are several limitations to the approach applied in this dissertation study. It does not account for the individual impacts of zoning, construction and transit services on new establishment birth and subsequent survival across different municipalities within the metropolitan. This study measures the general socio-economic context for the HBLR system, but does not account for how socio-economic conditions influence the relationship between transit system development and new firm formation. In addition, the distance band dummy variables are fixed, and alternative distance bands are worth testing. Also, the statistical approach adopted in this study inevitably relies on a set of assumptions that simplify the complex economic behaviors in reality.

An unanswered question is whether these results are transferable to other regions. Why were new firms and development associated with transit access in Hudson County? Would a similar result be likely in Omaha, Nebraska or any other city without the agglomeration of activities in Hudson County? Noland et al. (2014) found distinct differences between Portland, Oregon and Dallas, Texas in the impact of transit on new firm formation, with Portland being more successful, perhaps due to better planning. Similarly, Deboosere et al. (2018) found that access to jobs through land use or transport changes can shorten commute times. The increase in access to jobs and/or employees is associated with commercial and industrial development in Greater Toronto and Hamilton, Canada. Future work could explore how land use planning and/or investment in transport infrastructure, can affect access to jobs and labor and thus generate urban development.

Future studies could control for the impact of planning and zoning regulations, and land use planning, perhaps through the analysis of land use characteristics, as these can influence whether development will occur near transit stations. How do relative transportation costs affect firm formation? That is, if car travel is easy, why would transit matter? Comparisons with other regions that invest in new transit systems would provide greater context to understand these issues.

Most existing studies focus on rail transit service, while the influence of other public transit modes has been ignored. Therefore, it is possible to gain better knowledge by exploring the association between improved accessibility generated by other transit modes (bus rapid transit, or shared mobility) and firm births and survival.

Additional qualitative analysis with entrepreneurs in transit station areas can gain a better understanding of entrepreneurs' perceptions and experience of how location

decisions are made. Case studies with a specific industry (for example, retail businesses or Professional service industries) can provide detailed information of the relationship between access to transit services and the dynamics of establishments as well.

# Appendices

## Appendix A: Interview Questions

Planners/Public officers:

1. How long have you worked at your organization?

2. Could you describe the role that you play in your organization and in the process of encouraging business creation in general?

3. What programs does your organization participate in to encourage business creation and how well have these programs worked? (note: sub-questions to probe the subject to explain more about the program)

    3.a- who is involved in these programs? (State, County, City government? NGO?Private companies?)

    3.b-the program began in which year?

4. What are the funding sources for these programs?

    4.a-State, County, City government? NGO? Private companies?

5. Has your organization/program tried to encourage startups to locate near any Hudson Bergen Light Rail stations? (-which sector?)

    (note: sub-questions to probe the subject to explain more about the program)

    5.a. could you describe your impression about this process?

    5.b. who is involved (city government, NPOs, private companies?)

    5.c, if none

    -. In your perceptions, have you seen any clusters of new businesses in some particular areas that are near a Hudson Bergen Light Rail station?

6. Do you think changes in the Hudson Bergen Light Rail station areas, like the pedestrian features, or access to the station would affect the creation of new establishment or businesses in the area? Or maybe attract businesses to relocate near a light rail station?

7. In your opinion, what are the benefits of creating a new firm or business in this area and how do you encourage startups? -like the proximity to New York City

8. In your perception, what are the difficulties that discourage startups in this area? -like raising property values (office rents), zoning laws, parking requirements?

9. Do you know if any particular city in the County aggressively uses public funding (-providing tax incentives) or supports to attract startups?

10. Do you know how light rail station sites were selected during the planning & construction process?

11. Are there any issues that you would like to bring up or think would be valuable for us to consider as we move forward in our research? Please elaborate.

12. Do you know any business owners or professionals that are familiar with the area that I should speak to for more information?

Developers/Entrepreneurs:

1. How long have you worked at your organization?
2. How many non-residential development projects has your company been involved within Hudson County? Where are these projects?
3. Could you explain why your organization decided to invest in these areas? (What are the crucial factors involved in selecting locations for your projects?)
4. Particularly, do you think transportation, or access to transit services, in general, is important to decide whether to invest in or avoid a particular site? Why?

    4.a How about the access to the Hudson Bergen Light Rail? Has your company tried to invest in any sites near a light rail station? Why? (if invested in a commercial development project near light rail station)

    4.b Can you tell me a bit more about this project? (any funding assistance from the County/city? or any obstacles from zoning laws?)
5. In your perception, do you think the HBLR/PATH influences the number and location of commercial development projects in Hudson County? (or is there more demand for office and commercial space near a light rail/PATH station?
6. In your opinion, what are the constrains that limit your interests for mix-use or commercial property investments?
7. Are there any issues that you would like to bring up or think would be valuable for us to consider as we move forward in this research? Please elaborate.
8. Do you know any local developers or professionals that are familiar with the area that I can contact and interview?

9. When and where did you create your firm or business?

    9.a Why did you decide to start your business to Hudson County? Please elaborate.

10. Could you tell me why you decided to locate your business here, and what factors were important when you made that decision?
11. Have you received any assistance from the state, county or municipality to start your business (such as tax incentives, zoning/planning variances for parking requirements, use variances, and so forth)?
12. In your perception, do you think easy access to the Hudson Bergen Light Rail/PATH benefits your business? (getting more customers, employees can have more commute options, etc.)

    (-have you noticed any concentration of businesses/firms in neighborhoods close to a train station in the past two decades?)

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