An Investigation of the Industrial Ecology of Business Start-up Survival

By

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A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of City and Regional Planning.

Chapel Hill

2006

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ABSTRACT

HENRY RENSKI: An Investigation of the Industrial Ecology of Business Start-up Survival

(Under the Direction of Edward Feser)

This study examines the influence of external economies on the survival and longevity of new independent businesses in the continental U.S. It hypothesizes that new firms with access to the sources of specialized inputs, labor, product markets and knowledge spillovers will outlive those in areas of relative isolation. The size of the region and the diversity of its industrial base are also considered as possible sources of beneficial external economies.

The findings show that while external economies have a statistically significant influence on new firm survival, the effects are typically very modest. The most consistently significant effects are found for localization, which lowers the risk of new firm failure in five of the nine detailed study industries examined: farm and garden machinery, metalworking machinery, motor vehicle parts, advertising and computer and data programming services. After controlling for other sources of external economies, the size of the region is insignificant for most industries. By contrast, regional industrial diversity reduces hazard rates for new firms in drugs, advertising, computer and data processing, and research and testing services.

Measures representing the specific sources of localization are statistically significant in fewer industries than the broadly defined measures of localization, but when significant they often have a stronger influence on new firm longevity. Among the specific sources of

localization, proximity to specialized input suppliers is the most consistently significant, reducing hazard rates for new firms in metalworking machinery, advertising, and computer and data processing services. Proximity to intermediate product markets is only significantly beneficial in the professional services sector. Labor pooling is either insignificant or found to increase new firm hazard rates, but only after the other sources of localization are controlled. Industry knowledge spillovers significantly reduce hazard rates for new firms in the drugs and motor vehicle parts industry, but the accuracy of the variable may be sensitive to industry-specific differences in the economic value of patenting.

This study also investigates whether and how the size of the establishment influences new firms' ability to benefit from their external environment. The evidence suggests that smaller businesses are the most common beneficiaries of external economies, but not in all cases. There are several examples, most commonly for urbanization, where external economies increase the failure rates of larger plants while having little effect on smaller ones. There are also several industries where an increase in external economies produces a relative reduction in hazard rates for medium sized plants, but have little effect on smaller plants.

Overall the research implies that entrepreneurial development strategies are likely to be more effective if designed to capitalize upon a region's existing strengths and assets. The beneficial influence of localization and diversity are often strongest when estimated at larger spatial scales, i.e. those approximating the size of commuting sheds and labor market areas. That provides some conditional support for rural development strategies aimed at strengthening ties to nearby metropolitan areas.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank my academic advisor, mentor and friend, Edward Feser. Ed originally convinced me to pursue my PhD, helped shape my ideas, provided detailed comments on all my work, and miraculously kept me funded for the duration of my doctoral studies. Without his support I doubt I would have come this far. I would also like to thank the rest of my dissertation committee for taking the time to review and comment on my work. I am particular indebted to Harvey Goldstein for the many hours he spent helping me develop as a scholar. Jun Koo, Josh Drucker, and attendees of recent meetings of the Regional Science Association International and the Southern Regional Science Association also deserve credit for their constructive suggestions. Jun deserves special credit for being my study partner during my early years as a doctoral student. I wish to thank the Bureau of Labor Statistics for granting me access to their records. I am especially grateful to Amy Knaup for shepherding me through the federal bureaucracy.

Finally, I would thank my family for their years of support and dedication. My sister, Marcy, deserves particular credit for her encouragement during the difficult first years of my doctoral studies. Most of all I would like to thank my wife, for supporting me throughout my studies and her patience during the many weeks that my research kept us apart.

This research was funded in part by the Ewing Marion Kauffman Foundation and the National Science Foundation, Geography and Regional Science program. Part of the research was conducted while the author was a research associate at the Bureau of Labor Statistics. The contents of this publication are solely the responsibility of Henry Renski.

I dedicate this dissertation to my father, Charlie H. Renski, who has taught me the value of hard work and perseverance even in the most difficult of times.

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CHAPTER I

INTRODUCTION

1.1 The Role of New Firms in Regional Economic Development

Recent years mark a sea change in our understanding of the role of small and new firms in national and regional development. For much of the 20th century it was widely believed that large firms played the dominant role in regional economic development. Large firms pay higher wages and offer greater job stability than small firms (Galbraith 1956; Brown *et al.* 1990). Large employers also invest more in R&D and produce more patents than small firms (Galbraith 1956; Acs and Audretsch 1990). The historical emphasis on size is similarly reflected in state and local economic development policy as evidenced by the widespread offering of direct and indirect fiscal incentives to recruit and retain large manufacturing branch plants (Hanson 1993; Peters and Fisher 2004). But with increasing numbers of branch plants opting for low cost off-shore locations, policy makers are looking inward for new strategies to stimulate job growth and long run economic prosperity (Eisinger 1995).

Entrepreneurial development strategies offer a possible alternative. New firms are a key source of jobs and employment growth. Roughly 26 percent of the jobs added to the economy between 1991 and 1996 came from establishment births, compared to approximately 17 percent attributed to the expansion of existing firms (Acs and Armington 2004). In fact, much of the job generation previously attributed to small firms (Birch 1987) is more accurately attributed to new firms, the vast majority of which happen to be small (Haltiwanger and Krizan 1999).

In addition to their direct contributions in jobs and wage income, new firms also play an important part in dynamic processes of technological evolution. In the long-run, the dynamic function of new firms may be much more important than the short term benefits of direct job creation (Fritsch and Mueller 2004). This is because many new firms are entrepreneurial business endeavors. They take existing intellectual, social, human, and financial resources, and reorganize them in pursuit of market opportunities (Baumol 1993). Large firms may spend more on R&D, but small firms yield more novel products and services per worker than large firms (Acs and Audretsch 1987, 1988, 1989, 1990). By connecting new ideas with markets, entrepreneurs provide a medium for translating new knowledge into economic growth (Audretsch 1995a; Geroski 1995; Audretsch and Keilbach 2004) and are a central mechanism through which regional economies adapt to exogenous technological change (Malecki 1994). Entrepreneurs also initiate technological change by continually pushing the bounds of the technological frontier and challenging existing competitors to stay sharp (Audretsch 1995a; Geroski 1995).

Empirical evidence supports the link between entrepreneurship and development. A recent report by Advanced Research Technologies (2005) produced on behalf of the U.S. Small Business Administration documents the close association between regional entry rates and innovation, income and employment growth. Using a modified regional production function framework, Audretsch and Keilbach (2004) find that a region's stock of new firms is a highly significant determinant of productivity in German regions. Acs and Armington (2004) find positive returns to entrepreneurship in a model of U.S. labor market area employment growth. Contrary evidence is provided by Fritsch (1997) who argues that much regional variation in entry is not due to regional climate but industry-specific variation combined with regional variation in industry mix. After adjusting for intra-industry variation, he finds little association between regional birth rates and employment change in West Germany. In more recent work, Fritsch and Mueller (2004) find the relationship between entry and regional growth evolves over time, and may be negative in the short run but positive when measured over a longer period.

Given the strong ties between entrepreneurship, innovation, and economic growth it is imperative for economists and policy makers to understand the conditions that nurture and sustain new business activity. External economies of localization and urbanization stand out as likely contributors to a favorable entrepreneurial climate. In brief, external economies provide a theoretical rationale for how small businesses are able to compete successfully in an economy dominated by larger and more established enterprises (Marshall 1920 [1890]; Young 1928). Cities have long been viewed as "incubators" for new firms and emerging industries, namely by affording larger markets for niche production (Vernon 1960; Leone and Struyk 1976; Norton and Rees 1979). But an increase in the extent of the market also increases opportunities for specialization in intermediate inputs and skilled labor markets (Marshall 1920 [1890]; Stigler 1951; Malecki 1990; Krugman 1991). By specializing in core competencies and looking to the market for peripheral inputs and services, closely settled small plants may be able to produce at comparable efficiencies as larger competitors (Marshall 1920 [1890]; Carlsson 1996; Oughton and Whittam 1997; Sweeney and Feser 1998; Feser 2001a). It is also widely believed spatial proximity aids the transmission of tacit knowledge (Breschi and Lissoni 2001; Howells 2002). Knowledge spillovers are believed to be particularly important to the formation and successful commercialization of innovation by entrepreneurial firms (Nelson and Winter 1982; Winter 1984; Audretsch 1991; Audretsch 1995a). New firms also rely heavily on external information networks to help reduce the inherent ambiguity of new business ventures (Minniti 2005).

The most common indicator of a region's entrepreneurial climate is its capacity to generate new business. Several studies have found a positive association between regional rates of new firm formation and both city-size and local industrial specialization (Audretsch and Fritsch 1994; Keeble and Walker 1994; Johnson and Parker 1996; Armington and Acs 2002). As important as they may be, entry rates only measure a single dimension of entrepreneurial climate. They reveal little about how the local economic environment may influence the performance of new business ventures in the years following birth. Lack of secondary plant-level data limits the options available to researchers. Production function analysis is the most common framework for measuring the influence of external economies, but practical problems limit its applicability to the study of entrepreneurial firms. Small firms are underrepresented in the *Annual Survey of Manufacturing* (ASM), the primary source of establishment capital and output data in the U.S. Because most new firms are small, their systematic under-representation will likely result in sample selectivity bias. Furthermore, the coverage of the ASM is limited to manufacturing and as a consequence we know little about the influence of external economies in other sectors. The *Economic Census* (EC) covers a larger sample, but infrequent tracking may lead to biased inference from the many new businesses failing between census years.

This study uses survival and establishment longevity to measure the post-entry performance of new independent businesses in the continental U.S. While novel to the study of external economies, survival analysis is common to the empirical industrial organization literature where it is used to measure the influence of market structure on business performance (Audretsch 1995a; Audretsch and Mahmood 1995; Doms *et al.* 1995; Mata *et al.* 1995; Agarwal 1998,Mata, 1995 #817; Agarwal and Audretsch 2001). Survival also has appeal as a gauge for local entrepreneurial policy. It is well established that most new firms fail within the first few years (Evans 1987; Dunne and Samuelson 1988; Dunne *et al.* 1989; Evans and Siegfried 1992), with recent estimates suggesting failure rates of over 50 percent within five years of birth (Acs *et al.* 1999; Knaup 2005). The high likelihood of failure limits the attractiveness of entrepreneurial policy in the eyes of regional development policy makers (Ettlinger 1994). Fritsch and Mueller (2004) argue that, from a global perspective, the high failure rates of new firms do not diminish long-run importance of entry because the mere threat of competition pressures incumbents to innovate. This argument has less merit at the state and local levels where competitors are more likely to be located outside the region, and "first-mover" benefits from the commercialization of new technologies rely on spatial proximity. In sum, the regional benefits of entrepreneurship are more closely tied to the success and failure of particular firms, and thus firm survival is an important facet of the local entrepreneurial climate.

Few studies look at regional variation in survival, and even fewer try to explain it within a multivariate framework. Among the few studies that do cast survival in an ecological context, the evidence is mixed. In a study of Greek entry and survival, Fotopolous and Louri (2000) found that location within greater Athens positively affected survival, with the strongest effects for small firms. Tödtling and Wazenbock (2003) find broad spatial variation in Austrian survival rates, but no evidence that those differences are explained by categorical regional classifications such as the Vienna region, tertiary centers, industrial areas, etc.. Using ES-202 data for three U.S. states, Buss and Lin (1990) find no evidence that survival rates are lower in rural areas compared to metropolitan areas, suggesting that urbanization economies are not relevant to establishment survival.

1.2 Aims of the Study

This study makes several contributions to the empirical literature on external economies and entrepreneurial development. It has a much broader scope than previous studies of spatial variation in survival and is the first to test explicit indicators of the sources of external economies. A second contribution is inquiry into the role of external economies in business and professional services industries. Industries outside of manufacturing are rarely addressed in the empirical studies of external economies. Lastly, disaggregate data on new firm location allows me to model the influence of external economies at a variety of distances, providing evidence of how external economies attenuate over geographic space.

I focus on the post-entry performance of new independent (single-unit) plants in the continental U.S. The industrial organization literature commonly refers to new independent establishments as new firms, because they are both new establishments and new business enterprises. While the opening of a new plant by an existing establishment is likely to represent expansion of existing activity at a new location, the birth of independent firms represent new economic activity and provide a approximation to the concept of innovative entrepreneurship (Acs and Armington 2004). Branch plants and subsidiaries of multi-unit firms also have different post-entry dynamics (Dunne *et al.* 1989; Audretsch 1995a;

Audretsch and Mahmood 1995) and are less sensitive to their local surroundings (Feser 2001a; Henderson 2003).

This study uses establishment longevity data from the Bureau of Labor Statistics' *Longitudinal Database* (LDB) to measure the post-entry performance of new firms. The LDB is a virtual census of private-sector business activity in the United States, covering all establishments subject to state unemployment insurance (UI) reporting requirements. With the aid of unique establishment identifiers in the LDB, I identify new firms born in 1994 and 1995 and track each from its birth until it either exits the market or survives beyond seven full years. To account for industrial heterogeneity, I focus on a representative set of manufacturing and business and professional service industries, most defined by three digit Standard Industrial Classification (SIC) industries. Proxy measures for different types of external economies and control variables are calculated from numerous secondary data sources for the territory surrounding each new firm.

I use a discrete event duration model to estimate the influence of external economies on the new firm hazard rate –the instantaneous probability that a plant fails at a given time provided that the plant has survived to the start of the interval. The discrete form is both more appropriate and more flexible than more common continuous time duration models. It easily accommodates time-varying covariates, permits direct estimation of the baseline hazard function, and allows the influence of independent variable to change over time. I estimate separate models for each study industry with independent variables measured at several different spatial scales.

1.3 Organization of the Dissertation

Chapter Two reviews the pertinent literature on external economies and agglomeration theory. In Chapter Three, I introduce a conceptual framework to clarify the relationship between external economies and new firm survival. The framework connects traditional agglomeration theory with recent work in the industrial organization on structural barriers to new firm survival. Chapter Four introduces the Bureau of Labor Statistic's *Longitudinal Database* (LDB) describing the procedures used to identify and track new firms over time and determine their approximate physical locations. Chapter Four also conducts a descriptive analysis of new firms in my sample, reporting their entry and survival rates, geographic distribution, size and growth. Chapter Five presents describes the measurement of the explanatory variables. The bulk of the empirical analysis is presented in Chapters Six and Seven. In Chapter Six, I estimate the influence of own-industry specialization and regional size on new firm survival and longevity using bivariate life table analysis and multivariate discrete event duration models. Chapter Seven applies these same analytical methods to more specific detailed indicators of the local organization of industry, such as industrial diversity, specialized input suppliers, intermediate goods markets, labor pools and industry knowledge spillovers. The final chapter summarizes the main findings of the study, discusses its implications for research and policy and identifies areas for future research.

CHAPTER II

EXTERNAL ECONOMIES AND FIRM PERFORMANCE

2.1 Introduction

This study builds upon the large body of research known collectively as agglomeration theory. The theoretical significance of agglomeration economies to the understanding of regional development cannot be overstated and spans many sub-disciplines within economics. Agglomeration economies are the basis for modern theories of city formation (Henderson 1986; Duranton and Puga 2000; Fugita and Thisse 2002), national and regional economic growth (Romer 1986, 1990; Lucas 1988), technological change (Vernon 1960), and national competitive advantage (Porter 1990). While some of these forces are natural or infrastructure-driven, in the sense that activity congregates around natural resources or transportation nodes, economists are typically more interested in advantages arising from the concentration of economic activity itself (Ellison and Glaeser 1999).

Agglomeration theory has exercised a considerable influence on regional economic policy as well. Agglomeration economies provide one of the few efficiency-based justifications for place-based development strategies (Bolton 1992). The growth center strategies of the late 1950's and 1960's and agglomeration theory share a common emphasis on inter-industry linkages between firms located in geographic proximity (Hirschman 1958). A more modern manifestation of applied agglomeration theory is industrial cluster analysis. Popularized by Michael Porter (1990), industry clusters provide a framework for both understanding and strategically mobilizing economic development resources to capitalize on positive economic synergies within spatial congregations of economically linked firms, labor, institutions, information networks and other regional assets (Feser 1998b).

This chapter reviews the theoretical and empirical research on agglomeration as a foundation for the empirical investigations in the chapters to follow. The literature on agglomeration is both broad and deep, and as such it is nearly impossible to provide a comprehensive review of this work. For the sake of brevity and relevance, I focus on theory pertaining to the sources of external economies and how they influence plant-level production decisions, largely ignoring the large body of theory discussing the implications of agglomeration on urban form, growth and long-term technological change.[1]

2.2 The Origins of Agglomeration Theory

The key breakthrough marking the origin of modern agglomeration theory was the realization that the concentration of industry in space is rooted in the same primal economic forces that lead to the consolidation of production within a single plant; that is, opportunities to exploit economies of scale in production (Marshall 1920 [1890]; Weber 1929 [1909]). The textbook picture of scale economies is of average cost curves declining with marginal increases in output to the point where congestion diseconomies set in and further gains from size are exhausted. Increasing returns are possible through a more efficient division of labor within the firm, the finer specialization of activity that becomes increasingly feasible as the plant expands its scale of operation. Scale also enables the use of indivisible capital

[1] For a review of recent applications of agglomeration theory in the field of urban economic modeling see Duranton and Puga (2004). For a synthesis of the empirical work see Rosenthal and Strange (2004) and Hanson (2001).

equipment that must operate at a minimal level of output in order to achieve optimal efficiency.

A similar principle applies to the spatial organization of industry, where an increase in the size of the market allows for greater specialization among proximate firms and workers (Young 1928). As with indivisible physical capital, the spatial concentration of activity also enables the efficient provision of common goods, such as infrastructure or cultural amenities. The parallels between internal and external economies also suggest that external resources can partially substitute for internal provision (Weber 1929 [1909]; McCann 1995; Parr 2002a, 2002b).

2.2.1 Alfred Marshall: Industrial Districts and the Sources of Localization

Alfred Marshall (1920 [1890]) is generally accredited as first to recognize the benefits of co-location as economies of scale external to the firm. Marshall describes two types of scale economies, those pertaining to use of specialized resources within the plant, and those that "depend chiefly on the aggregate volume of production in the whole civilized world (p. 266)." Marshall focuses on a special case of the latter, those drawing from the "aggregate volume of production of the kind in the neighborhood" or localized external economies. Thus external economies are not necessarily tied to particular locations but include spatially ubiquitous forces such as "the growth of knowledge and progress of the arts (p. 265)." Several years later, E.A.G. Robinson (1958) clarified the distinction between universal and localized external economies by labeling them as mobile and immobile, that latter of which are spatially bound.

Although external economies influence firms of all sizes, Marshall is most interested in the importance of immobile external economies to small firm competitiveness (Bellandi 1989). Marshall develops the concept of external economies to reconcile the theoretical paradox between the existence of competitive markets and small firms in a world of widespread increasing returns in production (Young 1928). To illustrate, Marshall provides detailed accounts of 'industrial districts' where concentrations of small firms in related industries are able to capitalize on the advantages of scale economies typically restricted to large firms. He describes the organization of production in industrial districts as akin to a "factory without walls" to illustrate the similarity between external and internal scale economies.

Marshall identifies three specific sources of localized external economies in areas where industry is concentrated: labor pooling, access to specialized input suppliers and knowledge spillovers. Specialized labor pools form through the co-location of employers with complementary labor needs. Access to a larger pool of specialized labor is beneficial because it increases the likelihood of a superior match between employer needs and employee skills, resulting in increased efficiency while reducing job training and search costs (Helsley and Strange 1990; Kim 1990; Fugita and Thisse 2002). Krugman (1991) also suggests that the constant market for skill in thick labor markets allows employers to hire and release workers with greater ease, buffering sudden shifts in demand.

The scale benefits of access to specialized input suppliers are roughly analogous to labor pooling economies. A larger input market offers greater opportunities for specialization and a more optimal division of labor between firms (Marshall, 1920; Stigler, 1951; Abdel-Rahman and Fujita, 1990). Marshall associates such benefits with indivisibilities in the operation of highly specialized and typically expensive machinery. While the purchase and efficient utilization of such equipment may not be feasible for a solitary small producer, the concentration of many similar producers encourages the local growth of subsidiary industries that can operate specialized equipment at more efficient levels. Hence internal production is replaced by a market transaction, and may result in savings if the firm can purchase the intermediate input or producer service at lower cost than if it were to produce the good itself. Because larger firms are more capable of efficiently internalizing subsidiary functions, the opportunity to externalize auxiliary functions are presumably of greatest importance to small independent producers who lack the capacity and expertise to provide such functions in-house.

Knowledge spillovers are the third and most empirically elusive of Marshall's triad (Krugman 1991), yet they have received the most attention in the recent literature. A knowledge spillover is a heightened exchange of information between firms, workers and institutions. It has economic value when this exchange results in new innovations or increased rates of technological progression. The allure of the knowledge spillover concept comes from the hypothesized relationship between knowledge, innovation, technological change and economic growth, leading some authors to refer to knowledge spillovers as a "dynamic" source of agglomeration (Glaeser *et al.* 1992).

Marshall does not describe exactly how proximity generates knowledge, but we might assume that it was originally envisioned as analogous to Adam Smith's (1976 [1776]) contention that the division of labor leads to new inventions as specialized workmen discover better methods of production. In the external case, this natural process of discovery is amplified through the exchange of information across workers living and working in close proximity. Proximity may also facilitate knowledge spillovers as competitors benefit by imitating the successes of competitors and avoiding their mistakes (Malmberg and Maskell 1997; Maskell 2001). Marshall also suggests that the local cultural milieu plays a key role in facilitating the exchange of information and localized learning. Over time, industrial specializations become embedded in the local social fabric, resulting in a community where local workers, their families, and others share in a common understanding of trade practices and specialized knowledge. This environment facilitates the transmission of knowledge between contemporaries and provides fertile ground for the development of new ideas and innovations. According to Marshall:

> Good work is rightly appreciated; inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed: if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas (p.271).

Marshall's belief that shared culture provides the medium for knowledge transfer and innovation was long ignored by mainstream economists, but has re-emerged in investigations of new industrial districts (Piore and Sabel 1984; Bellandi 1989; Saxenian 1991, 1994; Harrison 1992, 1994).

Marshall's is not the only view of environmental influences on knowledge spillovers. Jane Jacobs (1969) offers an alternative view which has received considerable attention in recent empirical and theoretical work in urban economics. Jacobs argues that cities play an important role in technological growth because new ideas and innovations result from the exchange of diverse ideas facilitated by proximity. On the one hand, diversity-based spillovers may be viewed as an additional dimension of traditional urbanization economies, because of the close association between city size and industrial and social diversity

(Duranton and Puga 2000). Yet, diversity spillovers are conceptually distinct from the gains from infrastructure and the other indivisibilities usually associated with urbanization. Jacobs' views also differs from those of Chinitz (1961), who considers industrial diversity as indicative of a favorable institutional climate for entrepreneurs, and Vernon (1960) who's product life-cycle theory emphasizes the demand-side benefits of diversity, such as providing concentrated markets to support niche production.

Empirical studies of spillovers often take an either/or tone between specialization and diversity, but the two need not be mutually exclusive (Glaeser *et al.* 1992; Henderson *et al.* 1995a; Feldman and Audretsch 1999). Specialized industry districts often coexist side by side or within more diverse regional economies (Duranton and Puga 2000). Furthermore, different sources of knowledge spillovers likely spur different types of innovation. In an early commentary, Young (1928) describes two interrelated sources of economic progress: (1) exogenous progress inspired by more radical breakthroughs and scientific discoveries, and (2) endogenous progress from increasing returns, whereby expansion of the market permits a finer division of labor, which in turn signals the developments of new production methods and products. At the risk of over-simplification, it is reasonable to expect that diversity is a more likely source of exogenous innovations that give rise to the development of entirely new products and industries, as predicted by product life-cycle theory. Endogenous technological change may be more instrumental in the development of incremental innovations, such as refinements of existing production processes or the gradual improvement of existing product lines. It is the latter type of innovation that is more likely developed in areas of industrial specialization. Unfortunately, the available secondary data is not specific enough to separate the distinct sources of innovation.

2.2.2 Urbanization and Localization, Weber and Hoover

The work of Alfred Weber (1929, [1909]) has also been instrumental in shaping our understanding of the forces of agglomeration. Weber cites three primary determinants of location choice: transport costs, labor costs and the 'cheapening' of production costs that result from geographic concentration of business. He refers to the latter as "forces of social agglomeration (p. 128)." According to Weber, transport and labor costs largely determine the interregional distribution of economic activity while the forces of social agglomeration influence intra-metropolitan location choice, coinciding with early models of urban spatial structure (Alonso 1960; von Thünen 1966 [1826]). In contrast to Weber, most theorists view agglomeration economies as a prime determinant of both intra- and interregional location choice (Henderson 1974).

Weber identifies two levels of social agglomeration: internal economies of scale that lead to the concentration within an individual plant, and economies resulting from the close proximity of multiple plants. He sees internal and external economies as similar in their implications for location choice and makes no real distinction between the two. Weber does make an important distinction between forces of agglomeration and deglomeration, the latter being diseconomies generated by the crowding of activity. Weber sees the concentration of related firms as the key source of positive economies, while deglomerative pressures generally come from the total level of activity in the region, primarily in the form of higher land rents.[2] Weber does recognize possible benefits to overall size, calling attention to the more efficient provision of infrastructure (such as gas, water mains, streets, etc.) that reduce

[2] Weber's view that diseconomies stem largely on the overall size of cities is a common assumption of many theoretical models in urban economics. For example, Henderson (1974) relies on this assumption to explain the size distribution of cities.

‘general overhead costs’, but he does not specify how this differs from industry-specific agglomeration forces.

Weber does not provide a detailed description of the specific sources of external economies, choosing to focus on the implications of the countervailing forces of agglomeration and deglomeration on costs, and thus location choice. Identifying the specific sources of agglomeration, he states, is best left as an empirical matter. He does mention agglomerative benefits to “technical equipment and labor” which parallels Marshall’s description of specialized machinery and labor pooling economies. Weber explains that single plants may not have the requisite demand to warrant highly specialized equipment, repair facilities, and labor, thus social agglomerations form as ‘auxillary’ industries rise up to serve the needs of local producers. Together these auxiliaries and the plants they serve constitute a “technical whole” which functions best when the mutually dependent parts are concentrated and “in touch” with one another (p. 129).

Edgar Hoover (1937) provides an important extension of Weber’s ideas. Hoover takes issue with Weber’s reduction of the forces of agglomeration and deglomeration into a unitary index, which, he claims, obscures important distinctions in how the different types of agglomeration economies and diseconomies lead to different location choices (Hoover 1937). Building on a typology developed by Ohlin (1933), Hoover makes a distinction between internal economies of scale, economies that exist between plants in the same industry at a single location (localization), and advantages shared broadly across all industries at a single location (urbanization). In contrast to Weber, Hoover argues that localization and urbanization are both potential sources of beneficial economies as well as diseconomies. He specifically mentions industry-specific diseconomies generated through the congestion or exhaustion of natural resources used as raw materials, as well as higher labor costs associated with the rise of labor unions in specialized areas.

Hoover's dichotomy between urbanization and localization economies still serves as the dominant conceptual foundation for many theoretical and empirical studies. Its appeal lies in both its ease of application in empirical studies and its clear association with the observable spatial organization of industry which can be roughly divided into a dichotomous spatial economy of small and highly specialized cities (driven by localization economies) and larger more diverse places (driven by urbanization economies) (Duranton and Puga 2004).

2.3 The Role of Proximity in the Organization of Production

2.3.1 The Relationship between Internal and External Modes of Production

The decades following Weber saw relatively little advancement in agglomeration theory beyond refinements to location-cost framework. The fundamental limitation of location-cost framework is that it focuses almost exclusively on size and offers no basis for understanding how the external environment conditions the organization of production within the firm. Size alone is insufficient because scale only offers expanded *opportunities* for specialization, but does not guarantee them. As skillfully argued by Gold (1981) increasing returns cannot derive purely from "doing more of the same" but must coincide with a superior organization of production. A similar logic also holds in the external case (McCann 1995; Feser 1998a). As argued by Goldstein and Gronberg (1984), "it is not simply the scale of activity in the area that is important… but the improvement in production efficiencies from placing related activities nearby (p. 92)." Thus, in order to properly identify the benefits of external economies it is imperative to understand how the spatial organization of industry creates opportunities for new modes of production within the individual plant, and vice-versa.

The work of Stigler (1951) is among the first to cast agglomeration as a theory of industrial organization. The purpose of Stigler's study is to examine "[the] relationship between the functional structure of an industry and its geographic structure (p. 192)." Drawing heavily from Coase's (1937 [2002]) theory of the firm, Stigler motivates his work as an elaboration of Smith's (1976 [1776]) dictum that the division of labor is limited by the extent of the market and Young's (1928) thesis that market expansion encourages technological progress. Stigler redefines the role of the firm from transforming inputs into output to coordinating a series of distinct production processes. Each process has its own average cost curve and is subject to increasing, constant or decreasing returns at different volumes. In isolation the firm has no option but to internalize subsidiary processes, often at less than efficient scales. The expansion of the industry enables the formation of specialist firms, which encourages outsourcing and reduces the overall level of vertical integration within the firm. Stigler notes that localization offers a clear alternative to the vertically integrated firm. He states that firms in spatially concentrated industries typically have smaller plants, and that plants tend to be smaller in areas where industry is specialized. Recent work by Holmes (1999) provides strong evidence to support Stigler's hypothesis.

Richardson (1972) expands Stigler's model to cover both vertical and horizontal dimensions of production. He makes a key distinction between similar and complementary activities. *Complementary* activities include the intermediate inputs and services required for the production of a single product, i.e. the vertical dimension of production described by Stigler. Richardson argues that firms tend to specialize in activities that require *similar* capabilities, such as knowledge, experience and skill. Such technological similarities provide the basis for the horizontal integration of production across different product lines. Panzar and Willig (1981) formalize Richardson's concepts into a model of multi-good production based on economies of scope. In this model, the firm engages in joint production to capitalize on existence of shareable inputs, allowing the firm to produce two or more outputs at a lower cost than if each were produced separately.

While Richardson (1972) defines 'similar' capabilities to explain a firm's the joint-production of multiple goods, a similar logic applies to economies of scope from the spatial division of labor. Goldstein and Gronberg (1984) develop a spatial counterpart to the Panzar and Willig model, where regionally shared inputs such as warehouses, machine shops, storage facilities, training centers and publicly provided infrastructure explain the existence of multi-product regions. While Goldstein and Gronberg and Parr (Parr 2002a; Parr 2002b; Parr 2004) associate external scope economies with urbanization, they also recognize the existence of quasi-public inputs shared by firms in related industries. For example, knowledge has local public goods characteristics and may lead to the co-location of innovative firms sharing a common scientific base (Feldman and Audretsch 1999; Koo 2005a).[3]

Recent organizational theories of agglomeration emphasize the role of transactions costs in a firm's choice between the internal and external division of labor and the geographic co-location of firms with key intermediate goods providers. The production of any commodity involves a sequence of transactions or a technical division of labor across multiple stages. At each stage the firm chooses between integration, whereby separate tasks are coordinated by

[3] Parr (2002a; 2002b; 2004) uses the term "external economies of complexity" to distinguish scope (and scale) economies where production is integrated across different stages, which may also have internal and external dimensions.

managerial authority, or market transaction, with inputs and services purchased from external providers based largely on price signals. According to Williamson (1975; 1981), the choice between vertical integration and market exchange can be understood as a desire to minimize transactions costs. While integration allows greater control over the supply of auxiliary inputs, the firm is bounded by its limited capacity to assimilate information and coordinate activity. The market, on the other hand, frees firms to specialize on core competencies, but increases external transactions costs, which may be particularly high when product markets are uncertain and production requires a high degree of coordination between different phases of production.

Hybrid models of coordination, such as contractual arrangements between independent competitors or trade partners or informal arrangements such as business networks, offer a middle ground between arms length market transactions and full integration (Richardson 1972; Scott 1986, 1988; Oughton and Whittam 1997). Cooperative arrangements are more easily monitored and coordinated when partners are located in close geographic proximity. Proximity reduces external transactions costs while simultaneously allowing firms to benefit from the advantages of specialization (Stigler 1951; Scott 1986, 1988). The geographic alternative is particularly attractive to firms seeking to externalize risk in highly volatile markets and where short product cycles and continual pressures for innovation require more intimate relationships between producers and their key suppliers (Scott 1986, 1988).

2.3.2 Institutional and Cultural Influences: The 'Embedded' Nature of Economic Relations

The key element distinguishing the New Industrial Districts (NID) literature from other theories of agglomeration is its emphasis on the embedded nature of economic transactions

(Harrison 1992). The NID literature holds that conventional agglomeration theory is abstracted from the individual circumstances of particular places. It implicitly accepts the universality of economic forces and promotes agglomeration as a quantitative, but not necessarily qualitative, phenomenon. Presumably, if the industrial composition of one location could be replicated in another, firms in the new location would realize identical benefits. Building on Granovetter's (1985) arguments of the over- and under-socialization of human activity, the NID approach holds that the ability of a firm to capitalize on external resources is influenced by historically contingent cultural and sociological factors. Therefore, external economies are inherently qualitative and place-based and should not be divorced from the historical and cultural forces of which they are a part.

The arguments of Benjamin Chinitz (1961) serve as an early predecessor of the modern NID literature, although not commonly recognized as such (Feser 1998a). Chinitz does not argue against the universality of external economies but rather calls on economists to broaden their perspective. In contrast to the pure cost-minimization approach favored by most economists, Chinitz argues that the ability of local firms to benefit from agglomeration has much more to do with the composition of the local economy than its size. He stresses the interrelationship between the structure of local industry and supporting institutions, both of which play critical roles in shaping the entrepreneurial climate. He uses the cases of Pittsburgh and New York City to illustrate. He ascribes the persistently sluggish growth of Pittsburgh to its historical specialization in just a few industries. Monopolistically organized economies such as Pittsburgh inadvertently suppress the development of new industries because local institutions are only capable of supporting the dominant sector(s). In contrast, diverse and competitively organized places, such as New York City, remain dynamic because they provide a fertile environment for the creation of new firms and the development of emerging industries.

The modern NID literature builds on arguments in Piori and Sabel's *The Second Industrial Divide* (1984). Piori and Sabel describe an emerging paradigm shift in the competitive nature of industry favoring flexibly-organized production strategies over mass production or 'Fordist' regimes. The emerging post-industrial paradigm is characterized by the vertical disintegration of the large firms, greater use of flexible production technologies, and a growing importance of localized external economies relative to internal economies (Sabel 1989, Storper 1992). Drawing inspiration from Marshall (1920 [1890]), Priori and Sabel illustrate this emerging form of production with examples of dynamic networks of small firms in tightly packed Italian industrial districts. The firms in these districts act both as atomistic competitors but also as part of a collective whose internal transactions are governed by inter-personal relations and trust (Sabel 1989). The NID model has been extended to explain other emerging regional industrial complexes, most prominently the software industry in Silicon Valley (Saxenian 1991, 1994).

The NID model has been subject to much criticism and debate. With evidence based largely on case studies it is difficult to generalize beyond particular locations and therefore assess the validity of this model as a strategy for regional development. Amin and Robins (1990) argue that rise of successful industrial districts is largely the product of heterogeneous circumstances that defy broad application. They also believe such regionalizing tendencies as rather weak in the face of growing global integration (see also Harrison 1994). Many question the extent of the NID form of development, at least in its pure Italianite expression as flexible networks of small independent producers. Markusen (Markusen) shows that most of fast-growing regions in the US are places where linkages to large firms are important. Likewise, Scott (1992) stresses the development of regionalized production networks through collaborative linkages with large anchors. Even Silicon Valley's famed networks of independent, yet interdependent, semiconductor and software firms have a strong historical dependency on Department of Defense R&D, the aerospace complex in southern California, and internally dominant firms such as Hewlett-Packard (Harrison 1994). Harrison (1994) questions whether flexible specialization actually favors small-firm production, arguing that large-businesses have effectively responded to changing times through downsizing, reorganization and the adoption of more flexible production arrangements. He notes that by the 1980's, many of Third Italy's most successful independent producers had either been consolidated into holding concerns or had grown into hierarchical multinationals themselves. The recent weak performance of several prominent industrial districts has further diminished the popularity of the NID model, most notably the burst of the technology stock bubble that financed much of the venture capital industry and subsequently put thousands of Silicon Valley technicians out of work (Gittell and Sohl 2005).

While the NID model as a whole has some serious shortcomings as a long-term development strategy, some of its key elements have made a lasting contribution to the understanding of economic relations and local development policy. This is most prevalent in industry cluster approaches to economic development planning, which integrate the NID model's emphasis on local institutions and networks, with Marshallian perspectives on cross-industry externalities, buyer-supplier transactions and local spillovers as a source of regional innovation (Feser 1998a). But perhaps the most important legacy of the NID model is the recognition that economic strategies must be cognizant of local history, politics and culture to be most effective.

2.4 Empirical Studies of External Economies

My review of agglomeration theory shows a steady progression from a narrow view of external economies as pure scale benefits dictated by the size of a region or industry, to a richer perspective where internal and external economies are viewed as alternative modes for the organization of production. Empirical research on the topic has not kept up with theoretical developments (David 1999). With the location-cost perspective of Weber and Hoover as the guiding theoretical paradigm, early empirical work was largely focused on measuring productivity advantages associated with size. The progression of empirical research has also been hindered by the lack of appropriate data. Because empiricists have been stuck trying to develop second-best econometric specifications to account for poor data, research has barely progressed beyond the simple identification of agglomeration effects.

In the mid-1990's, empirical work on agglomeration shifted from aggregate production function analysis of localization and urbanization, to more detailed analysis of spatial variations in establishment productivity, employment and income growth, industrial concentration, innovation, and new firm formation.[4] What made this possible was the availability of new data sources and an emerging body of theory stressing the role of agglomeration as a dynamic force of technological change (Lucas 1988, 1993; Romer 1990).

[4] There is also a sizable literature that uses case studies and comparative analysis to understand the role of externalities and institutions within the context of specific regions. While these studies are often insightful, I focus on econometric studies because their particular relevance to my study.

2.4.1 Analysis of Productivity and Labor Demand

2.4.1.1 Localization and Urbanization

Productivity is the most common, and arguably most direct, outcome measure used in empirical studies of agglomeration. A standard production function associates the level of plant output to factor inputs (i.e. input, labor, capital, land, etc.), with external economies typically introduced as an exogenous technological shift parameter.[5] Most productivity studies follow Hoover's localization-urbanization framework, presumably due to its simplicity and its clear association with observable features of the spatial organization of industry.

Production functions were first used in the 1970's to test for productivity advantages of large cities. These studies frequently find considerable returns to regional population and/or employment size, although the reliability of these studies has been heavily scrutinized (Carlino 1978, 1979; Moomaw 1981, 1983). Shefer (1973) analyzes a group of 20 industries across US MSAs, concluding that on average a doubling of city size would increase productivity from 14 to 27 percent. Using a smaller number of industries, but a more sophisticated empirical formulation, Sveikauskas (1975) found that a doubling city size increased Hick's neutral productivity by 6 to 7 percent. Segal (1976) estimates capital stocks by the perpetual inventory method, finding Hick's neutral productivity to be 8 percent higher for metros of about 2 million or more in population as compared to medium-sized metropolitan areas. Using state-level data, Beeson (1987) finds higher productivity for states

[5] Feser (2001b) points out that the common assumption of Hick's neutrality denies the potential substitutability between external and internal resources. He uses a translog production function to test for factor augmenting forms of external economies, but finds only weak support for this specification over Hick's neutrality.

with a higher population share in SMSA's, but lesser productivity for states home to the largest SMSA's.

A related literature looks at the whether technological changes over the 1960's and 70's reduced the returns to city size and contributed to the decline of large cities in the U.S. Carlino (1985) finds that manufacturing loss generally precedes population out-migration and jobs losses in other industries. In a more direct test, Moomaw (1985) finds that returns to city size declined over the 1960's and 1970's for up to eight two-digit manufacturing sectors, which, when combined, represent over a third of metropolitan manufacturing employment. Using a dynamic growth accounting framework, Fogarty and Garafolo (1988) find that the rate of technological change is higher in large cities, suggesting dynamic benefits to urbanization. They also find that productivity growth has declined as the density gradient of cities has flattened over time.

Some argue that city size is a poor proxy for urbanization and that likely captures both positive economies and congestion diseconomies (Carlino 1978, 1979; Ciccone and Hall 1996). Fogarty and Garafolo (1988) address this deficiency using spatial density variables in addition to population size to measure urbanization. They find that both density and city size are associated with higher returns to regional productivity growth, but non-linearities suggest limits to city size for manufacturing. Ciccone and Hall (1996) find that states with higher average employment density of its counties tend to be more productive. Slightly smaller effects were found in a similar study of European *NUTS 3* regions (Ciccone 2002).

By the 1980's, research interest shifted from a unitary interest in city size to detecting the relative importance of urbanization versus localization economies. Carlino (1978, 1979) and Nakumura (1985) argue that returns to city size are likely to be overestimated by the omission of measures for localization economies, which may be much more representative of the types of indivisibilities that drive manufacturing agglomeration. After controlling for localization, studies often find net urbanization diseconomies depending upon the particular industry (Carlino 1978, 1979; Henderson 1986; Moomaw 1988; Feser 2001b). Most studies find at least some significant returns for both urbanization and localization economies in different industries (Carlino 1978, 1979; Nakamura 1985; Moomaw 1988). There are some notable exceptions. In an analysis of regional manufacturing productivity variation in the US and Brazil, Henderson (1986) finds only significant localization benefits. To the contrary, Svietikauskas *et al.* (1988) suggest that the estimated gains to localization may actually be measuring pecuniary benefits related to reduced transportation costs and not necessarily technological externalities. In a study of the food processing industry, they find that productivity benefits to localization disappear once a control for proximity to natural resources is introduced.

Aggregate production function analysis suffers from several shortcomings, most notably the lack of adequate information on regional output and capital stocks. A number of methods have been proposed to overcome this deficiency: estimating regional capital stocks by indirect methods (Segal 1976; Fogarty and Garofalo 1988; Sviekauskas 1988); estimating a labor productivity model under the assumption of constant capital to labor ratios across regions (Shefer 1973; Sviekauskas 1975); using indirect proxies for capital (Moomaw 1981, 1985; Henderson 1986); estimating a reduced-form CES labor demand function (Kelley 1977; Moomaw 1988, 1998; Viladecans-Marsal 2004), or estimating state-level production functions that incorporate sub-state proxies for urbanization (Beeson 1987; Ciccone and Hall 1996; Ciccone 2002). Each method has its own limitations (Moomaw 1981, 1983; Feser

2001b). The lack of a consistent methodology makes it very difficult to drawn broad inference from this work.

The empirical literature on agglomeration has made great strides in just the last few years due to the greater use of establishment-level data in applied production function analysis. Establishment records in US Census Bureau's Longitudinal Research Database (LRD) include data on labor, capital, and energy inputs, thus bypassing the need for indirect estimation strategies. Establishment-level data have the additional benefit of overcoming the ecological bias of aggregate analysis, and allow for more specific testing of the attenuation of external economies in geographic space (Rosenthal and Strange 2004).

Two studies measure the influence of localization and urbanization economies with establishment-level data from the LRD. Feser (2001b) examines urbanization and localization in two divergent manufacturing industries, farm & garden machinery (SIC 352) and measuring and controlling devices (SIC 382). He finds that localization effects are significant in the more tech-intensive measuring and controlling devices sector, but less so for the low-tech farm and garden machinery industry where urbanization benefits are more significant. Henderson (2003) exploits the longitudinal dimension of the LDB by estimating a fixed-effect model that controls for idiosyncratic plant characteristics. He finds that localization has strong positive effects on plant productivity in high-tech industries but not in machinery industries where knowledge spillovers are presumably less prevalent. Neither city size nor regional diversity influences productivity in either high-tech or machinery manufacturing. He also finds that single-establishment plants benefit more from external economies than do branch-plants, presumably due to their greater access to internal firm resources and capital intensive production methods.

2.4.1.2 Marshall's External Economies

Although easily measured with available data, Hoover's dichotomous characterization of localization and urbanization economies may obscure the true sources of external economies (Feser 1998a). Strictly interpreted, Hoover's definition of localization implies that same-industry measures (such as employment or establishment counts) adequately capture the mass of externalities related to same-industry knowledge spillovers, labor pools, and access to specialized input suppliers. But standard industry definitions are based on similarity in the primary goods produced by the establishment, and not according to similarities in production technologies, worker skills and intermediate inputs. Furthermore, not all industry definitions are equally homogeneous, and many key transactions occur between firms producing complimentary but dissimilar goods (Stigler 1951; Richardson 1972). Moving to a higher level of industrial aggregation (such as three and two digit SIC) may capture additional inter-industry transactions, but also increases the chances of including unrelated industries. Common proxies for urbanization are equally ill-suited to capture these externalities. Lumping all economic activity into a single category ignores the fact that some industries are more closely related than others in economic space (Perroux 1950; Rosenthal and Strange 2004). In practice, this means that influences commonly associated with broadly defined localization economies (i.e. related industries) may be falsely interpreted as urbanization.

Seeking a deeper understanding of the forces driving spatial agglomeration, a growing number of studies develop explicit proxies for Marshall's sources of localization and include these as explanatory variables in establishment productivity models. Feser (2002) uses LRD data to estimate the influence of Marshallian externalities on plant-level productivity by including distance-weighted measures of access to labor pools, intermediate goods providers, producer services, intermediate markets and disembodied knowledge spillovers.[6] He shows that access to producer services, labor pooling externalities and university-based knowledge spillovers increase productivity for plants in the measuring devices industry. In the low-tech farm and garden machinery industry, only specialized input suppliers are significant.

In related work, Feser (2001a) tests whether that the influence of Marshallian externalities varies by plant size and ownership status. He finds an inverted U relationship between plant size and external economies, contrary to the prevailing wisdom that the smallest plants benefit most from external economies. In measuring and controlling devices the smallest plants (< 31 employees) only benefit from proximity to research universities. But when the small size limit is raised to plants with less than 88 employees, proximity to universities, producer services, and specialized labor pools all become significant. Measuring devices plants larger than 88 employees only derive significant proximity benefits from labor pools. In the farm and garden machinery industry, labor pools, patent rates and producer services are significant for all plants larger than 27 employees, but only producer services remains significant, and in fact become stronger, when the size threshold is raised to 70 employees. Feser also finds that branch plants benefit less from local external economies than do independent establishments.

Rigby and Essletzbichler (2002) also use LRD data to study Marshallian externalities. They estimate labor-productivity models for U.S. two-digit manufacturing industries.[7] The most consistently significant results are for their combined supply-chain/average plant size proxy, but, as a composite measure, it is uncertain whether this variable is picking up internal

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[6] Feser (2002) measures knowledge spillovers with measures of regional patenting rates and university R&D.

[7] The authors do not provide much detail on their disaggregate industry models (4-digit) which they found to be largely insignificant. They ascribe plant-heterogeneity and outliers for the disappointing results.

economies, external economies or industrial composition effects. A favorable metropolitan labor mix is significantly beneficial in five two-digit SICs (food, apparel, fabricated metals, transportation equipment and instruments). Embodied technology spillovers (i.e. regional productivity growth in upstream industries) are positively significant in twelve industries. Metropolitan size is positive and significant in seven industries, mainly those representing the low-end of the technology intensity spectrum.

2.4.2 Knowledge Spillovers and Dynamic Externalities

As the interest in agglomeration has broadened from its beginnings as a determinant of industrial location to a more modern perspective as a driving force of regional competitive advantage and technological change, so too has the scope of empirical analysis. In particular, there is a growing interest in agglomeration as a source of 'dynamic' development outcomes, such as long-run employment growth, innovation, new firm formation and technological progression. Finding motivation in new growth theory, Glaeser *et al.* (1992) associate these dynamic outcomes with technological externalities, particularly knowledge spillovers, which speed the rate technological change and productivity growth.

There is strong evidence that knowledge spillovers are locally contingent and spatially mediated. If knowledge flows are purely mobile, then we would see no association between knowledge inputs and outputs, and local investments in science and technology would provide little direct benefit to regional development (Audretsch and Feldman 1996; Koo 2005b). The spatial concentration of innovative activity suggests otherwise. Building on the knowledge production function framework of Griliches (1979), several studies find a positive association between industrial R&D and innovation (Jaffe 1989; Griliches 1992; Feldman

1994a; Acs *et al.* 2002; Acs and Varga 2002; Koo 2005a). The strongest evidence of industrial knowledge spillovers is provided by Jaffe *et al.* (1993) who track the diffusion of patent citations over both time and space against patterns produced by a sample of non-cited patents. They find patents are five to ten times as likely to cite other patents that originate in the same city. Using a similar approach, Almedia and Kogut (1997) confirm Jaffe *et al.'s* findings of localized spillovers for the specific case of the U.S. semiconductor industry.

Universities are another important source of knowledge spillovers either through indirect technological spillovers from new scientific discovery, industry-university collaborations, entrepreneurial activity by faculty or the elevated human capital of students who embody new technical knowledge (Goldstein *et al.* 1995; Drucker and Goldstein forthcoming). University research expenditures have also been linked to higher regional innovation rates in high-tech industries (Jaffe 1989; Acs *et al.* 1992, 1994; Audretsch and Feldman 1996; Anselin *et al.* 1997, 2000; Acs *et al.* 2002). In most models, University R&D has less impact on regional innovation than a comparable amount of private R&D, but a larger spatial range, presumably due to the higher spatially mobility of basic research (Anselin *et al.* 1997, 2000; Acs *et al.* 2002; Fischer and Varga 2003). Applied research may have more direct and localized benefits. Adams (2002) finds that spillovers from academic research are generally more localized than industry spillovers, except for a handful of top institutions, where a focus on basic science produces highly mobile knowledge. There is also evidence that University R&D spillovers are highest in cities with concentrated high-tech employment, suggesting that a 'critical mass' of related private-sector activity is necessary to absorb the benefits of University research (Varga 2000). But a critical mass in knowledge intensive industry does not universally favor large cities as receptacles of University Spillovers. Goldstein and

Drucker (2006) find that medium-sized metropolitan areas benefit most from University R&D while technological development initiatives and the education of graduate students in science and technology fields favors small metros. University policies that encourage the commercialization of technology and build networks with local business may also help transmit University research into local economic activity (Goldstein *et al.* 1995; Feldman 2001, 1994b; Goldstein and Renault 2004).

A related issue is whether a region's industry mix influences the generation and transfer of new knowledge. Recent work in this area recasts the traditional localization-urbanization framework in terms of alternate theories of knowledge spillovers, namely MAR (Marshall-Arrow-Romer) spillovers associated with industrial specialization and "Jane Jacobs" spillovers related to regional diversity. These studies adopt a variety of outcome measures, such as employment change (Glaeser *et al.* 1992; Henderson *et al.* 1995; Henderson 1997), product innovation (Feldman and Audretsch 1999), localized patent citations (Koo, 2005a) productivity growth (de Lucio *et al.* 2002), industrial concentration (Maurel and Sedillot 1999; Dumais *et al.* 2002), and industrial modernization (Harrison *et al.* 1996). The evidence from these studies is mixed. Glaeser *et al.* (1992b) find that industrial diversity, but not specialization, leads to employment growth among larger MSA's. Henderson *et al.* (1995) find that diversity only matters in emerging industries, while specialization is significant in both emerging and mature industries. Harrison *et al.* (1996) find that urbanization is more important than localization in encouraging the adoption of programmable automation after controlling for plant-specific characteristics such as size. Feldman and Audretsch (1999) find that spillovers flow neither from pure diversity or specialization but between industries sharing a common science base. After controlling for possible endogeneity between agglomeration, technological change and spillovers, Koo (2005a) finds diversity, specialization, and cluster-based specialization (ie. employment in industries sharing the same knowledge base) all to be positively associated with local innovation. He also finds that diversity and specialization decline in importance as the industry's knowledge intensity increases, while cluster-based specialization increases with knowledge-intensity.

2.4.3 New Firm Formation

As mentioned in the introductory chapter there is mounting evidence that a region's capacity to stimulate the new business formation is a dynamic outcome of agglomeration (Acs and Armington 2002; Audretsch and Keilbach 2004; Advanced Research Technologies 2005). Several studies find positive associations between population/employment density and entry (Audretsch and Fritsch 1994; Keeble and Walker 1994; Johnson and Parker 1996). These results may be partly driven by the location preferences of service and retail establishments that make up the lion's share of new firms. Examining entry in U.S. labor market areas, Reynolds (1994) finds a positive effect of density on business services births but a negative effect on manufacturing births.

Evidence linking industrial specialization to entry is slightly more contentious, although still generally favorable. Armington and Acs (2002) find that same-industry establishment density is a highly significant determinant of entry rates in U.S. Labor Market Areas. Rosenthal and Strange (2003) model the effects of same-industry and total industry employment on new establishment density at successively larger distances, finding consistently significant effects only for localization. Focusing on high-tech plant entry in U.S. counties, Woodward *et al.* (2004) find significant positive effects for both urbanization and localization, as well as for distance-weighted University R&D. The evidence provided by Reynolds (1994) and Rocha and Sternberg (2005) is more tempered. Reynolds (1994) finds that industrial specialization has a positive impact on manufacturing entry in rural areas and has no effect on the entry of business services. Using a combination of secondary data and expert surveys, Rocha and Sternberg (2005) find that industrial specialization leads to higher levels of entrepreneurship only when combined with network externalities. These findings are supportive of Chinitz (1961), Saxanian (1994), Minniti (2005) and adherents to the New Industry Districts (NID) school who contend that external economies are conditional on the institutional and social environment.

Dumais *et al.* (1997) estimate the influence of Marshallian externalities on employment change. Using data on manufacturing establishments from the Census Bureau's *Longitudinal Research Database* (LRD), the authors decompose state and metropolitan employment change into the portion attributable to new independent establishment (new-firm births), new establishments owned by existing firms (old-firm births), expansions and closures. For metropolitan areas, the authors find that labor pooling and knowledge spillovers both have positive effects on new and old firm births, and are stronger in more technology-intensive manufacturing sectors. Access to suppliers has positive effects only on old firm births at the metropolitan level, but grows in importance at the state level for both new and old firm births. Labor pooling and knowledge spillovers are found to have significant and positive effects on the employment loss associated with closures, contrary to general expectations. They explain that the labor pooling effect may are not inconsistent with theory because an isolated firm may be more capable of reducing wages in the event of a negative shock in comparison to firms in deep labor markets with less wage flexibility.

2.4.4 Geographic Concentration

Researchers have also sought evidence of localization economies by examining the geographic concentration of industry. The earliest work of this type sought to determine whether industries with stronger functional linkages, typically as determined by input-output flows, also have stronger tendencies toward co-location (Streit 1969; Bergsman *et al.* 1972; Lever 1972; Gilmour 1974; Bergsman *et al.* 1975; Czamanski and Ablas 1979). This work is a direct antecedent of contemporary studies of geographic concentration in industry clusters (Feser *et al.* 2005). In its entirety, these studies find moderate evidence of an association between economic linkage and spatial co-location, but fail to identify whether it is spatial externalities, transportation costs or the first-order spatial concentration of human activity that is driving these associations.

More recent studies make greater effort to measure within-industry geographic concentration beyond the level expected by either random chance or the overall distribution of human activity. One common approach is to calculate a global index of industrial concentration that accounts for "dartboard" concentration, such as the Ellison-Glaeser (1997) statistic, and then infer the importance of different agglomeration forces by comparing industries that are most and least concentrated (Krugman 1991; Ellison and Glaeser 1997; Maurel and Sedillot 1999; Devereux *et al.* 2004). Others regress a global concentration index on industry-level characteristics to identify specific sources of concentration (Ellison and Glaeser 1999; Kim 1999; Rosenthal and Strange 2001; Dumais *et al.* 2002). Rosenthal and Strange (2001) use this method to study the influence of Marshallian external economies on geographic concentration at three different spatial scales: zip codes, counties, and states. They find that industry characteristics associated with knowledge spillovers are more relevant to concentration at small scales, specialized inputs and suppliers more relevant at the largest scale, and labor pooling to be relevant at each scale. Dumais *et al.* (2002) use a global index to identify the contribution of establishment births, contractions, expansions, and failures to state-level industrial concentration over a twenty-five year time span. Entry and expansions are found to have a deconcentrating effect, while firm exits increase industrial concentration. Over time these two forces are roughly in balance, resulting in a general persistence of regional specialization patterns. The authors suggest that the dynamic spillovers that lead to new firm formation are stronger in areas of higher industrial diversity. A second possibility, not mentioned by the authors, is that specialization enables firm competitiveness, enabling them to survive while more isolated firms fail.

An alternative approach combines measures of local concentration with a quasi-experimental research design to compare the location patterns of economically-linked establishments against a control group of unrelated establishments (Diggle and Chetwynd 1991). This technique permits estimation of geographic concentration at a variety of distances and is less prone to spatial aggregation bias {Sweeney and Feser, 2004}. The method was first applied to study of industrial co-location by Sweeney and Feser (1998) to study the influence of plant size and ownership on localization.[8] They find that medium sized manufacturing plants are more concentrated than manufacturing plants in general, suggesting that the smallest plants may not have the resources or volume of production to truly benefit from proximity to other manufacturers. They also find that independent establishments are more concentrated than branch plants. In later work, Feser and Sweeney (2000, 2002) use this method to study the concentration of establishments in common value-

[8] This approach has also been used to study localization in France (Marcon and Puech 2003) and the UK (Duranton and Overman 2004).

chains. They find that many value-chains are significantly concentrated, particularly those that are more technologically-intensive or have stronger supply-chain linkages. But they also find some value-chains with insignificant or dispersed patterns. In other words, economic linkages do not necessary imply spatial proximity; technological and other industry-specific conditions also play an important role.

2.5 Empirical Summary

Although the bulk of the evidence suggests significant external economies in many industries, it is far from unequivocal. A strict localization vs. urbanization dichotomy is too narrow a simplification, but there does seem to be some evidence of a trade-off between the two, driven presumably by a balancing of agglomeration economies and diseconomies. It appears that urbanization economies are more widespread, but relatively weaker in industries where localization economies are significant. In other words, fewer industries may benefit from localization, but for those that do, these effects give higher returns than urbanization economies. Among Marshall's (1920 [1890]) sources of external economies, labor pooling appears to be the most dominant, although positive evidence of each type has been found depending on the industry and spatial scale. Localized knowledge spillovers appears to require a close proximity while supply-chain and labor-pooling externalities are far-reaching, frequently spanning far beyond the borders of a single regional labor market (Rosenthal and Strange 2001; Feser 2002).

Industry-specific conditions apparently play a very important role in mediating the influence of external economies. This is evident from the sizable variation in the measured influence of external economies in different industries. At present, the literature only hints at the types of structural conditions that might determine these relationships. Carlino (1978, 1979) concludes that localization economies are less relevant in industries where internal economies are stronger. Nakumura (1985) and Moomaw (1988) find that urbanization is more important in “light” industries such as apparel, food products, and printing, while localization may be more important in heavy durable product industries. Feser (2001b) and Henderson (2003) find that localization is more important in technology intensive industries where the ability to incorporate new knowledge is of greater importance.

There is some evidence that firm/establishment conditions are also important mediators of external economies. The trade off between internal and external economies has long been viewed as a key explanation for the existence of small firms (Marshall 1920 [1890]; Young 1928; Pratten 1991). While generally supportive, empirical work suggests that medium-size firms are more likely to benefits of localization than either large or extremely small establishments (Sweeney and Feser 1998; Feser 2001a). There is also consistent evidence that independent plants are more likely to enjoy benefit from local external economies than manufacturing branch plants (Sweeney and Feser 1998; Feser 2001a; Henderson 2003). Many branch plants are organized to maximize the full-extent of internal economies, have access to resources internal to the firm, and are likely to buy inputs locally.

Finally, there is accumulating evidence favoring the Chinitz (1961) hypothesis that industrial dominance, i.e., whether a region is dominated by large or small firms, is important to long-run economic development. Feser (2002) finds that measuring and controlling device establishments are less productive in regions dominated by a small number of large manufacturers, but has no effect on farm and garden machinery plant productivity. Citing Porter (1990) and Jacobs (1969), Glaeser *et al.* (1992b) use relative plant size to measure local competition and find it to be highly a significantly determinant of regional employment growth. New firm formation is also consistently higher in regions with either a higher share of small establishments (Keeble and Walker 1994; Reynolds 1994; Fotopoulos and Spence 1999) or a smaller average plant size (Audretsch and Fritsch 1994; Sutaria 2001; Armington and Acs 2002; Sutaria and Hicks 2004). It is uncertain whether the region's firm size distribution acts as a direct influence on firm behavior, or whether its acts as a mediating force that limits or enhances the ability of establishments to access external economies.

CHAPTER III

LINKING EXTERNAL ECONOMIES TO NEW FIRM SURVIVAL

3.1 Introduction

Chapter Two identified several avenues through which external economies might influence firm-level production decisions and performance. Localized external economies can be reduced to three basic sources: (1) thick markets for specialized inputs, such as skilled labor, intermediate goods suppliers, and producer services; (2) indivisible public goods, such as infrastructure; and (3) knowledge spillovers, whether originating in the confluence of similar or diverse ideas. Thick markets preclude the necessity for vertical integration, allowing firms to focus on core specialization while simultaneously taking advantage of the specialization of others and reducing transaction costs (Stigler 1951; Richardson 1972; Goldstein and Gronberg 1984; Scott 1986). Indivisibilities in public infrastructure similarly reduce the costs of production, although a single firm rarely has the option of providing these goods themselves. Proximity also facilitates the formal and informal exchange of tacit knowledge and promotes successful innovation (Jaffe *et al.* 1993; Feldman and Audretsch 1999), the adoption of new production technologies (Gabe 2005) and faster rates of regional technological change (Koo, 2005a).

In this chapter I describe how external economies influence of the survival of new firms. I begin with a discussion of possible influences on new firm survival. I then build a conceptual model that maps the influence of the spatial organization of industry on new firm survival. This conceptual model provides a framework for the derivation of an empirical event duration model where external economies reduce the new firm hazard rate, or the instantaneous probability of failure. I end the chapter with a discussion of two key validity threats to my research design: unobserved heterogeneity and endogeneity bias.

3.2 Barriers to Survival

Figure 3.1
Key Determinants of New Firm Survival

The survival of any new firm is contingent on three overlapping sets of attributes (see Figure 3.1). Many influential attributes are idiosyncratic to the individual business. Characteristics of the founder or business owner such as education, prior experience and age are common predictors of business survival (Bates 1990; Brüderl *et al.* 1992; Headd 2003). Organizational attributes such as human capital of workers, access to start-up and expansion capital and business strategies are also critical elements of success (Hannan and Freeman 1977; Brüderl *et al.* 1992). Specific measures of owner and organizational attributes are rarely available in secondary datasets used for survival analysis. Ownership status and plant employment are commonly used to proxy for the potential availability of plant and firm-specific resources.

Studies of industrial organization focus on the role of industry-level attributes in determining market concentration. Traditional microeconomic theory views entry as a response to excessive profits, which, in the long run, helps balance supply and demand and restores competitive equilibrium. But not all markets are competitive and above normal profit levels often persist without stimulating a noticeable increase in entry. To resolve this paradox, Bain (1956) introduced the concept of barriers to entry –structural characteristics of markets that prohibit free entry –to explain persistent differences in entry rates and profit levels across industries. Bain identified several types of entry barriers, most notably: the minimum efficient scale (MES) of operation necessary for competitive production in a market, deliberate actions taken by incumbents to keep out potential competitors, and growing market demand or high profit margins that may encourage entry without fear of reciprocity.

Entry barriers may provide an appealing explanation for persistent market concentration but empirical evidence of their existence is rather weak. Recent work is marked by a noticeable shift from barriers to entry to barriers to survival to explain market concentration. Entry is widespread in most industries, even in those with presumably high entry barriers, but few firms survive their first years of existence (Geroski 1995). Roughly 50 percent of all new manufacturing plants fail within the first 5 years, and roughly than 20 percent survive beyond ten years (Dunne *et al.* 1989; Mata and Portugal 1994; Knaup 2005).[9] Failure rates

[9] Using Dun and Bradstreet records, Audretsch and Mahmood (1994) find slightly higher survival probabilities for manufacturing plants born in the mid 70's. They estimate a four year survival rate of approximately 63

are typically higher in business and professional service establishments (Knaup 2005) and among independent entrants (Dunne *et al.* 1989; Audretsch 1995a; Audretsch and Mahmood 1995). Furthermore, variation in survival rates across industries is considerably higher than industry variation in entry, suggesting that survival may be more sensitive to industry-specific conditions (Audretsch 1991; Mata and Portugal 1994; Wagner 1994; Audretsch and Mata 1995; Mata *et al.* 1995).

The efficiency and resource of disadvantages of small firms is one possible explanation for the high mortality of entrants (Audretsch 1991; Audretsch 1995a; Audretsch and Mahmood 1995). Size is a common indicator of internal scale economies, access to financial capital and sunk costs in non-transferable assets that dissuade exit (Caves and Porter 1976). Most start-ups are small, but those "born" larger are much more likely to survive (Evans 1987; Dunne and Samuelson 1988; Dunne *et al.* 1989; Audretsch 1991, 1995b; Brüderl *et al.* 1992; Dunne and Hughes 1994; Mata and Portugal 1994; Wagner 1994; Audretsch and Mahmood 1995; Doms *et al.* 1995; Mata *et al.* 1995). The positive size/survival relationship is particularly strong in industries characterized by a high MES of production (Audretsch 1991, 1995b; Mahmood 1992; Audretsch and Mahmood 1995). In high MES industries the efficiency advantages of large-scale production makes competition against large incumbents inherently difficult for small start-ups while larger start-ups face less of a barrier to survival. The significance of MES on survival diminishes as the firm ages (Audretsch 1995b) or grows (Mata *et al.* 1995).

Focus on scale as a determinant of survival implies direct market competition between entrants and incumbents. But many, if not most, new firms do not compete directly against

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percent, and a ten year survival rate of 31 percent. The estimates of Baldwin and Gorecki (1991) are even higher, with a ten year survival rate of 50 percent for Canadian manufacturers.

incumbents. Instead, they enter into niche markets where they are sheltered from the harsh rigors of direct price competition (Caves and Porter 1977, Agarwal and Audretsch, 2001; Porter 1979, 1980). The industrial aggregation in secondary data makes it difficult to distinguish niche competitors, but there is some evidence that entry rates are higher in emerging markets where a dominant design and standardized production methods have not yet been developed (Gort and Klepper 1982; Agarwal 1996, 1997). Other studies find a positive association between industry entry and innovation rates (Geroski 1989; Acs and Audretsch 1990). So while large producers make standardized goods for broad markets and compete against other large producers, entrepreneurial firms develop customized goods for specific market segments and compete through innovation, not price. In the absence of direct price competition scale deficiencies with incumbents should pose less a direct threat to survival.

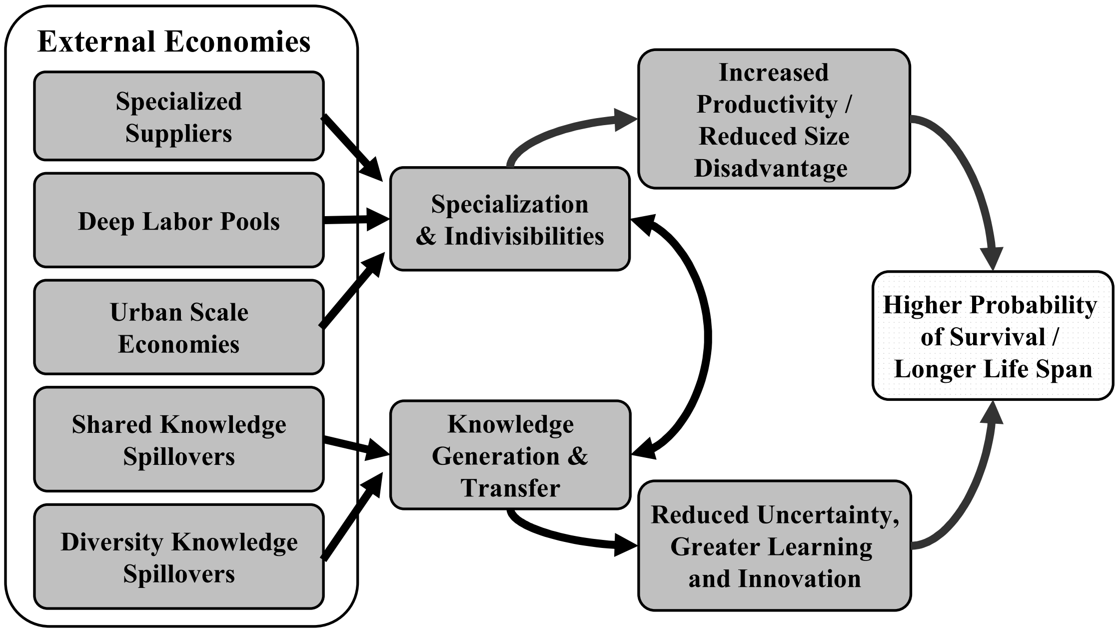
An alternative perspective relates high mortality to information asymmetries, uncertainty, and evolutionary learning. New businesses are born into an environment of uncertainty, a situation exacerbated by the entrepreneur's inexperience. A new business may lack managerial experience, knowledge of market demand and competition, or even how to successfully market a new product. Over time, less viable firms fail while those that survive gain more experience and increase their likelihood of success (Jovanovic 1982; Baldwin and Rafiquzzaman 1995; Ericson and Pakes 1995; Pakes and Ericson 1998). In support of this view, many studies find a strong positive relationship between age and survival (Evans 1987; Dunne *et al.* 1989; Audretsch 1991, 1995b). There is also a direct link between uncertainty, innovation and market turbulence. Firms in highly innovative, and presumably more uncertain, markets also face a higher likelihood of failure at start-up than those in mature industries (Mahmood 1992; Audretsch 1995b; Agarwal and Gort 1996; Mata and Portugal 1999). But those firms that manage to survive past the first few years in an innovative market have a greater continued likelihood of survival than those in mature industries (Audretsch 1995b).

In addition to establishment and industry characteristics, regional attributes also influence the survival prospects of new businesses. Many of the typical elements of the entrepreneurial climate may fall into this category: such as regional variations in the costs of factor inputs, tax rates, institutions and government indirect support of government initiatives. Of particular interest to this study is whether external economies influence the survival prospects of new firms.

3.3 External Economies and Survival: Conceptual Framework

Combining agglomeration theory with structural barriers to survival reveals two paths whereby external economies may influence the survival of individual firms (see Figure 3.2). The first path assumes direct competition between new firms and incumbents. On this path, localized external economies of scale and scope compensate for the scale disadvantages that act as a barrier to new firm survival. The result is higher productivity relative to similar new firms lacking access to external economies. Because the relevance of scale barriers and direct competition varies by industry, so does the influence of external scale economies. Establishment size is also likely play a key mediating role in the relationship between external and internal economies.

Figure 3.2
Influence of External Economies on New Firm Survival



A second path by which external economies influence new firm survival is through localized knowledge spillovers, either of the Marshallian or Jacobs varieties. Knowledge spillovers allow new firms to learn about market conditions, new innovations and technologies, and learn from the mistakes and successes of others sooner than if they had been born in areas of relative isolation (Maskell 2001). The business survival literature similarly emphasizes that external knowledge and learning are key to long-run business survival, primarily by reducing the uncertainty that poses a major liability for new business (Minniti 2005). Thus proximity to external sources of relevant knowledge is expected to increase the chances of survival, relative to plants lacking such resources.

The importance of knowledge and learning is likely to vary across industries depending upon the underlying source of knowledge that leads to successful innovation (Nelson and Winter 1982). In some industries, new innovations come mainly from large incumbents who invest more in R&D (Acs and Audretsch 1990). This is often the case in mature markets where innovation involves marginal product or process refinements. Novel innovations, on the other hand, are often inspired by external sources of knowledge. In this context start-ups may have the innovative edge because of their superior ability to assimilate external ideas. Winter (1984) describes these as entrepreneurial and routinized technological regimes, the latter reflecting the institutionalization of technological change within large R&D labs. The empirical work of Audretsch (1991; 1995b), Audretsch and Mahmood (1995), and Audretsch *et al*. (2000) provides some support that such technological regimes are relevant to the long-run survival of firms.

Before continuing, it is worth emphasizing that the two paths illustrated in Figure 3.2 are not mutually exclusive or rival hypotheses. It is likely that both paths are relevant and act simultaneously to influence the survival of a single firm. Furthermore, it is exceedingly difficult to empirically distinguish the individual sources of localization with existing secondary data. Theory based indicators of the sources of localization will be closely correlated in space. Deep labor pools form in locations where there are numerous employers in the same supply chain, and Marshallian knowledge spillovers flow most freely between similar firms and workers. Economies of diversity and urbanization are also bound to be closely related, relating to different advantages to production in large cities (Duranton and Puga 2000). Distinguishing these constructs requires highly detailed industry and occupational data, weighted by the potential transactions between firms and workers in different industries and occupations. Reliable estimation also requires highly detailed data on the physical location of establishments, to help ensure sufficient spatial variation in the independent variables.

3.4 A Model of New Firm Survival

My primary hypothesis is that proximity to the key sources of external economies will increase the likelihood of start-up survival, controlling for other relevant establishment and regional characteristics. The probability that a new firm survives beyond some point in time (t) can be defined as

$$S_{it} = \Pr(T_i \geq t), \tag{3.1}$$

where T_i is a random variable denoting the uncensored time of failure for a new firm. Most empirical work models the firm's hazard rate, its instantaneous risk of failure at time t given that it has not already exited the market. Following Allison (1982) and Kiefer (1988) the hazard rate (λ_{it}) can be defined as

$$\lambda_{it} = \lim_{\Delta t \to 0} \Pr(t \leq T_i < t + \Delta t \mid T_i \geq t) / \Delta t, \tag{3.2}$$

To express the hazard rate as a function of explanatory variables, it is common practice to assume a constant hazard between individuals at each interval, or

$$\lambda_{it} = \alpha(t) \bullet \exp(\mathbf{E}_i \boldsymbol{\beta} + \mathbf{I}_i \boldsymbol{\delta} + \mathbf{R}_i \boldsymbol{\gamma}). \tag{3.3}$$

where $\alpha(t)$ represents the baseline hazard function, and **β, δ** and **λ** are parameter vectors measuring the marginal influence of a unit change in the establishment (**E**), industry (**I**), and regional (**R**) attributes on the hazard rate. [10] Taking logs to linearize the proportionate hazard in the explanatory variables, gives

$$\log \lambda_{it} = \alpha(t) + \mathbf{E}_i \boldsymbol{\beta} + \mathbf{I}_i \boldsymbol{\delta} + \mathbf{R}_i \boldsymbol{\gamma}. \tag{3.4}$$

[10] Several common models are formed by assuming a specific form for the baseline hazard. If one assumes that T_i follows an exponential distribution then $\alpha(t) = \alpha$, corresponding to a constant baseline hazard. Other popular distributional assumptions for T_i are the Weibull ($\alpha(t) = \alpha + \alpha_1 \ln t$) and Gompertz ($\alpha(t) = \alpha + \alpha_1 t$). In cases where the form of the baseline hazard is unknown, but of little interest in and of itself, $\alpha(t)$ can be omitted and estimated using the partial likelihood methods originally proposed by Cox (1972).

The model presented above assumes that events (T_i) occur in continuous time. In practice the timing of events is often measured in discrete units, such as months or years. This results in many tied events, necessitating the use of computationally intensive estimation procedures. A more efficient alternative is to use a specification that specifically accounts for discrete measurement in the timing of events (Allison 1995). A discrete time analog to (3.2) can be written as the conditional probability that an event (T_i) occurs at time t, given that it has not already occurred:

$$\lambda_{it} = \Pr\left[T_i = t \mid T_i \geq t\right]. \tag{3.5}$$

If one assumes that the underlying distribution of event times are continuous, but measured coarsely, the corresponding proportional hazard function is (Prentice and Gloeckler 1978; Allison 1982):

$$\lambda_{it} = 1 - \exp\left[-\exp\left(\alpha(t) + \mathbf{E}_i\boldsymbol{\beta} + \mathbf{I}_i\boldsymbol{\delta} + \mathbf{R}_i\boldsymbol{\gamma}\right)\right], \tag{3.6}$$

which can rewritten in the complimentary log-log form as

$$\log\left[-\log\left(1 - \lambda_{it}\right)\right] = \alpha(t) + \mathbf{E}_i\boldsymbol{\beta} + \mathbf{I}_i\boldsymbol{\delta} + \mathbf{R}_i\boldsymbol{\gamma}\,. \tag{3.7}$$

The unknown parameters can be estimated through maximum likelihood, which is more computationally efficient than continuous time partial likelihood estimation.

Determining the corresponding likelihood function to (3.5) requires making a distinction between censored and uncensored observations. The probability that an *uncensored* firm i will experiences an event in period t can be written as a product of the conditional probabilities that the event occurred in, but not prior to, period t. This is written

$$\Pr\left(T_i = t_i\right) = \Pr\left[T_i = t_i \middle| T_i \geq t_i\right]\Pr\left[T_i \neq t_i - 1 \middle| T_i \geq t_i - 1\right]..\Pr\left[T_i \neq 2 \middle| T_i \geq 2\right]\Pr\left[T_i \neq 1 \middle| T_i \geq 1\right], \tag{3.8}$$

or in condensed form as

$$\Pr(T_i = t) = \lambda_{it} \prod_{j=1}^{t-1} (1 - \lambda_{ij}). \quad (3.9)$$

The probability that a *censored* firm fails after period *t* is similarly developed as a product of conditional probabilities

$$\begin{aligned}\Pr(T_i > t_i) = \Pr[T_i \neq t_i | T_i \geq t_i] \Pr[T_i \neq t_i - 1 | T_i \geq t_i - 1] .. \\ \Pr[T_i \neq 2 | T_i \geq 2] \Pr[T_i \neq 1 | T_i \geq 1]\end{aligned}, \quad (3.10)$$

or:

$$\Pr(T_i > t) = \prod_{j=1}^{t} (1 - \lambda_{ij}). \quad (3.11)$$

Following Allison (1982) the likelihood function is

$$L = \prod_{i=1}^{n} [\Pr(T_i = t_i)]^{\delta_i} [\Pr(T_i > t_i)]^{1-\delta_i}, \quad (3.12)$$

where δ_i is a binary variable distinguishing censored and uncensored individuals. Making substitutions and taking logarithms yields the log-likelihood function

$$\log L = \sum_{i=1}^{n} \delta_i \log \left\{ \lambda_{it_i} \big/ 1 - \lambda_{it_i} \right\} + \sum_{i=1}^{n} \sum_{j=1}^{t_i} \log(1 - \lambda_{ij}). \quad (3.13)$$

Reconstructing the dataset so that each discrete time unit for each individual establishment is a separate observation with a binary dependent variable (y_{it}) indicating exit during interval *t*, (3.13) can be rewritten:

$$\log L = \sum_{i=1}^{n} \sum_{j=1}^{t_i} y_{it} \log \left\{ \lambda_{ij} \big/ 1 - \lambda_{ij} \right\} + \sum_{i=1}^{n} \sum_{j=1}^{t_i} \log(1 - \lambda_{ij}) \quad (3.14)$$

and estimated using standard procedures designed for the analysis of dichotomous data (Allison 1982; Singer and Willett 1993). The establishment-event dataset structure is preferable because it can easily accommodate both time-varying and time-constant independent variables, and also allows for empirical estimation of the baseline hazard without assuming a restrictive functional form. Allison (1982) recommends specifying $\alpha(t)$ with a series of dummy variables, one for each time period, to fully accommodate temporal variations in the baseline hazard. Other possibilities include modeling $\alpha(t)$ as a time-invariant constant ($\alpha(t) = \alpha$), as a linear function of time ($\alpha(t) = \alpha t$), or as quadratic expression to capture curvature in the baseline hazard (i.e. $\alpha(t) = \alpha t + \alpha t^2$).

3.5 Empirical Validity Threats

There are two potential threats to the model laid out above, unobserved heterogeneity and endogeneity.

3.5.1 Unobserved Heterogeneity

Unobserved heterogeneity occurs when the omission of a relevant variable results in the selective attrition of cases with a higher propensity of failure. The outcome is a downward bias in estimated hazard rates (Heckman and Singer 1984; Trussell and Richards 1985). Bias is possible even if unobserved variables are uncorrelated with included variables, although the degree of bias is likely to be small in this situation (Trussell and Richards 1985). There is no consensus on how to best to deal with unobserved heterogeneity. Since the problem is a particular form of omitted variable bias it is important to test the influence of potentially relevant control variables on the estimates of other key regressors, even when the former are statistically insignificant. A second common alternative is to incorporate a random mixing distribution into the estimating equation. This alternative may cause more problems than it solves because parameter estimates then become conditional on the chosen distribution (Heckman and Singer 1984).

I address the unobserved heterogeneity issue by testing whether my results are robust to alternative model specifications. I test a wide range of potential confounding factors, carefully noting changes in parameter estimates and significance levels. Theory provides some guidance for identifying relevant spatial variables that may influence establishment location choice and productivity, but there are no past studies testing whether these factors are also influential to plant survival. I report restricted and full versions of the estimated models, the former including only the key external economy variables and the latter including the full set of spatial controls. As a secondary check, I compare my final results against a mixed model that allow for plant-specific random effects. A mixed complementary log-log model is defined as

$$\log[-\log(1-\lambda_{it})] = \alpha(t) + \boldsymbol{\beta}'\mathbf{E}_i + \boldsymbol{\delta}'\mathbf{I}_i + \boldsymbol{\gamma}'\mathbf{R}_i + \varepsilon_i, \tag{3.15}$$

with $\varepsilon_i \sim N(0,\sigma^2)$. I find that the random term makes little difference on the values of the key parameters in most specifications, suggesting little problem with heterogeneity shrinkage.[11]

3.5.2 Endogeneity

There has been much talk in recent work of the potential threat of endogeneity bias in empirical studies of external economies (Hanson 2001; Henderson 2003; Rosenthal and Strange 2004; Koo and Lall 2005). Simultaneity in spatially aggregated data is one potential source of endogeneity. When the region is the unit of measurement, common outcome measures such as productivity or employment growth are likely to have contemporaneous feedback with indicators of the region's industrial composition. Establishment-level analysis is less prone to simultaneity bias. Except in the case of very small regions with particularly

[11] The results of random effects models are available upon request.

large plants, a single establishment typically has a very small influence on the overall composition of the region's economy. Focusing on start-ups further insulates against simultaneity bias, because most start-ups are small and must take the local economic environment as given at birth (Rosenthal and Strange 2004). As a further precaution, I measure all independent variables either prior to or in the same year as the new firm's entry date.

Endogeneity may also result from selectivity in location choice. Under assumptions of perfect information, a profit maximizing firm will locate where it will be most productive. But if there are information asymmetries, then firms with better information will choose better locations, possibly based upon the availability of external economies. It is reasonable to expect that plants that make better location choices will also be more competitive in other ways, and thus have an inherent survival advantage that is correlated with, but not the direct result of, certain locational attributes. Unless the location choice issue is accounted for, some of the benefits attributed to the region's economic composition may actually result from the attraction of more productive firms to areas with stronger external economies. In other words, the perceived benefits of agglomeration act as a signal. They help attract more productive firms, but are not the actual source of beneficial outcomes.

Only a few studies have attempted to deal with plant selectivity. Koo and Lall (2005) conceptualize the selectivity problem as one of estimation on an incidentally truncated sample. They address the problem with Heckman's (1979) two-stage estimator, modeling the firm's location choice in the first stage, and controlling for the selection probability in a second stage production function. Henderson (2003) addresses selectivity by testing both instrumental variables (IV) and plant-specific and MSA-specific fixed effect models. He finds that the fixed-effects approach is superior to IV estimation. The downside to a fixed effect model is that it requires multiple observations for each plant, thereby excluding all cases that survive only short periods. Whereas location selectivity is, at best, a hypothetical source of bias, creaming the dataset of its weakest members will almost definitely lead to biased inference if the role of external economies varies over the plant's life cycle.

The validity threat from location choice selectivity is less applicable to new firms. Profit maximization may adequately represent the location choice process for large branch plants, headquarters, and R&D facilities, but not for small independent entrants. New firms enter a market characterized by great uncertainty, and only through experience do they learn of their true competitive efficiency (Jovanovic 1982). They frequently lack the necessary information to make optimal location choices and are constrained by limited financial resources. For either personal reasons or to minimize search costs and uncertainty, entrepreneurs overwhelmingly choose to locate near their existing residence (Figueiredo *et al.* 2002; Meester 2004). A strong case can be made that for new firms the inter-regional location decisions is exogenous, since few take available external economies of other regions directly into account. When new firms do evaluate sites based on access to external resources, it is likely to be between candidate locations within the same region. Models estimated at larger spatial scales should not be seriously affected, and can provide a check against bias for similar models estimated at smaller scales.

CHAPTER IV

INDENTIFYING & TRACKING NEW FIRMS

4.1 Introduction

Estimating an ecological model of new plant survival requires a database that allows one to identify new firm births, track individual plants over time, distinguish survivors from those that fail, and link establishments to measures of the local economic environment taken from other data sources. In this chapter, I describe the development of a novel database of new firm entry and longevity that is built from confidential establishment-level records. I begin by describing the primary source for identifying new firms, the U.S. BLS' Longitudinal Database (LDB), and the procedures used to link individual records across successive periods. I then describe the geocoding process whereby the approximate physical location of each establishment is identified by linking its zip code to latitude and longitude coordinates and test for spatial sampling bias by comparing address matching rates for establishments partitioned by several key criteria. The chapter concludes with a descriptive analysis of new firm entrants in each of the study industries that summarizes: the number and rate of new firm entry across several industries; survival and failure rates as compared to estimates from earlier studies; the geographic distribution of new firm entry and its key influences; and the size and growth of entrants in comparison to incumbent establishments.

My descriptive analysis identifies several important characteristics of new firms that may help explain the relationship between the local industrial environment and their survival.

Both the intra and interregional distribution of new firms largely mirrors that of existing industry. This suggests that new firms either seek out similar locations as their predecessors or that they are direct or indirect spin-offs from existing firms. I also found that most new firms are small and live for a very short time. At such a small size, it is doubtful that most new firms can effectively compete on price with larger incumbents and may explain their high rates of mortality. However, the eventual survivors converge toward a long-run average size much smaller than incumbents, suggesting that new firms compete in fundamentally different markets than incumbents, possible on the basis of quality, service, innovation or product customization.

4.2 The Longitudinal Database (LDB)

My sample of independent start-ups is pulled from the Bureau of Labor Statistics' (BLS) *Longitudinal Database* (LDB). The LDB is the micro-level counterpart to the Covered Wages and Employment (CEW) series, commonly known as the ES-202. The CEW is a near census of private-sector business activity in the United States, covering approximately 98 percent of all employment on non-farm payrolls.[12] Only sole-proprietorships are excluded. The LDB is also the only national register of business activity updated on a quarterly basis. Its high frequency of observation is particularly valuable for longitudinal studies, permitting greater precision in measuring the timing of events.

The CEW program is administered as a partnership between the federal BLS and State Employment Security Agencies (SESAs). SESAs collect establishment-level data as part of their unemployment insurance reporting requirements. The federal BLS compiles the data

[12] The LDB also serves as a primary source for the Census Bureau's Statistical Survey Establishment List (SSEL). The SSEL provides the sampling frame for other economic surveys including the *Annual Survey of Manufacturing*, *County Business Patterns*, and Economic Census series.

from the individual states, provides additional checks for quality and accuracy, and develops employment and wage estimates at the national, state and county levels. Beginning in the late 1980's the BLS undertook a major effort improve the consistency of the data collected across the individual states. As a result, the overall quality of the micro-data has improved dramatically since the early 1990's.

The micro-files of the CEW have recently been made available to outside researchers, but with several caveats. First, all research must be conducted on-site at the BLS offices in Washington DC. Second, the researcher must adhere to the BLS rules for non-disclosure in order to maintain the confidentiality of individual respondents. Third, and of greatest relevance to my study, the individual SESAs retain final authority over the use of their data by non-governmental personnel. While the majority of states have a blanket agreement with the BLS to allow approved researchers to use their state's data, several require the researcher to obtain explicit permission from the SESA. Of those non-blanket states, I was denied access to the records for New York, Massachusetts, Michigan and Wyoming. The absence of these four states is unfortunate because it reduces the sample size, the degree of geographic variation in independent variables, and may limit the external validity of the findings. Yet even without these states, my analysis still covers a very large sample of business activity in the continental U.S., dwarfing previous studies of the spatial variation in business survival (Buss and Lin 1990; Fotopoulos and Louri 2000; Tödtling and Wansenböck 2003).

4.3 Identifying New Firms, Births and Exits

I focus on independent establishments born in 1994 and 1995, tracking each until it either exits the market (fails) or survives beyond seven full years.[13] When a new establishment first files with their respective SESA, it is assigned a unique identifier, marking its "birth" in the LDB. Following BLS protocol, I use this identifier to track each establishment across successive quarters.[14] I measure the establishment's date of birth by the first quarter it registers positive employment. This is a more accurate measure of the establishment's start date than its registration date (i.e., date of initial liability) because some establishments file long before they actually begin operations. In a small number of cases, the establishment never hires employees. Such establishments are not included in my sample. For additional assurance that each establishment is a novel birth, and was not temporarily removed from the database at some time prior to the study period, I scanned the LDB records back to 1992 to verify that the establishment unique identifier did not previously exist.

An establishment's date of closure (DOC) is measured by the final quarter and year in which the establishment registers positive employment prior to its removal from the LDB database. When an establishment discontinues operations its identification number (ID) is removed from the LDB. In most cases the discontinuation of the LDB ID number coincides with the establishment's DOC, but some accounts remain in the system even after the establishment closes. The establishment may have neglected to report a cessation of activity resulting in a lag between closure and its removal from the system. In some cases, dormant employers deliberately keep their accounts active in hopes of resuming activity at some

[13] Because the earliest years of the LDB are known to have significant reporting errors they were deliberately avoided (Feser and Sweeney, forthcoming).

[14] Information on the BLS establishment matching procedure is reported in Robertson *et al.* (1997), Pivetz and Change (1998) and Pivetz *et al.* (2001).

future date. To distinguish true closures from dormant ones, all establishments remaining in the database at the end of the study period were tracked for an additional two years –until the 4th quarter of 2003, the most recent period available at the time of the study. If the establishment showed no resumption of employment during that time, it was presumed 'dead' and its date of closure was rolled back to its last quarter of positive employment.[15]

It is a relatively simple matter to separate independent from multi-unit establishments in the LDB. The database contains an indicator variable (MEEI) indicating whether a firm is independent or part of a multi-establishment enterprise. Establishments operating under common ownership also share an Employer Identification Number (EIN), which I use as an additional to test of establishment independence. I also eliminate establishments whose size at birth is 250 employees or larger. The 250 employee cut-off is not wholly arbitrary. Inspection of the individual records suggests that most establishments above that threshold are either not new or not independent, but probably miscoded. In any case, only a handful of establishments were eliminated for being too large. While all establishments must be independent at birth, I do allow establishments that change ownership status and/or physical location to remain in the database. If the plant's physical address changes, so does the location at which I measure the proximity-based indicators. The same holds true for changes in the establishment's reported industry.

The LDB also includes predecessor and successor ID variables that make it possible to continuously track plants that undergo a change in ownership status. Most ownership changes are one-to-one. The plant may be acquired out by new entity, and may change from

[15] In a small number of instances a new LDB ID number is assigned to a continuing establishment. If births and closures are identified purely on the basis of new and discontinued ID numbers, those continuing firms might be mistakenly identified. Fortunately, the LDB also includes predecessor variable that retains the discontinued ID numbers of continuing establishments that are assigned new LDB numbers.

an independent to one plant within a multi-unit firm, but still continues operations at the same location. A change of status can also take the form of breakouts or consolidations. A breakout occurs when an establishment is formally split into two or more distinct reporting units. Most often a breakout signifies an administrative correction where separate establishments of a multiple unit organization were initially assigned to a single location and then split at a later date.[16] Consolidation occurs when individual plants are combined into a single reporting unit. This is most common for subsidiaries of multi-unit establishments. On a few occasions, two or more independents are consolidated into a single unit, or a born independent is broken into two or more units. Plants experiencing breakouts and consolidations were excluded due to the difficultly of accommodating activity taking place at multiple locations in an establishment-level model.

4.4 Selection of Study Industries

I examine new firm survival in two broad industry sectors: manufacturing (SIC 20 through 39, excluding 21) and business and professional services (SIC 73 and 87).[17] Because analysis on aggregated sectors often fails to adequately represent specific component industries, I repeat my analysis for several narrowly defined study industries: drugs (SIC 283), farm and garden machinery (SICs 3523 and 3524), metalworking machinery (SIC 354), electronic components and accessories (SIC 367), motor vehicle parts (SIC 3714), measuring and controlling devices (SIC 382), advertising (SIC 734), computer and data processing services (SIC 737) and research and testing services (SIC 873).

[16] Prior to 1993, multi-unit firms were allowed to file a single report for establishments located in the same county.

[17] I exclude SIC 21 (Tobacco Products) from manufacturing due to the extremely small number of establishment births in that sector over the study period.

These industries were selected for the following reasons. First, together they represent a range of economic activity, including knowledge-intensive (drugs, electronic components, measuring and controlling devices, computer and data processing services), capital-intensive (farm and garden machinery, motor vehicle parts, metal working machinery), and business services sectors (advertising). Several industries, such as drugs and farm and garden machinery, generally produce goods for end-users, while others, such as motor vehicle parts, electronic components and metalworking machinery, are primarily intermediate goods providers. I did not consider industries that are heavily resource dependent. For resource dependent industries the coincidence of geographic concentration and low production costs is more likely to reflect access to spatially fixed raw materials and transportation infrastructure rather than business spillovers (Ellison and Glaeser 1999).

Second, to ensure a sufficient sample size for the estimation of multivariate models, I only considered industries with more than 200 new firms in the two cohort years (1994 and 1995) combined.

Third, I exclude industries where new firms are heavily concentrated in a single or small number of regions. Efficient estimation of external economies requires sufficient spatial variation in the location of entrants. If an industry's establishments are clustered in a handful of locations, location-based independent variables will have limited variability and will be highly correlated with one another.[18] The geographic distribution of new firms is discussed in section 4.6.3.

[18] This is a particularly problematic for variables measuring different dimensions of localization (labor pooling, input-suppliers, MAR knowledge spillovers) which tend to occupy common geographic space.

4.5 Geocoding and Spatial Sample Selectivity Bias

The study uses zip codes as the primary spatial unit of analysis. While most records in the LDB include physical street address information, geo-coding individual street addresses is fraught with error and greatly reduces the total sample size because many records cannot be confidently matched to a street address. The zip code fields in the LDB are much more complete and less prone to miscoding. Zip codes are also sufficiently disaggregated to allow the researcher to construct more functionally-relevant economic regions. Building up from disaggregated geography helps offset possible bias resulting from the use of large and somewhat arbitrary spatial units such as counties.

Zip codes also have several drawbacks. First, zip codes were not originally developed for data collection and can only be approximated into discrete geographic boundaries. Second, the size of zip code areas can vary greatly between rural and urban areas. Variables will be measured with greater precision in urban areas, creating possible modifiable area unit problem (MAUP). Given the national scope of this study, and the fact that most new firms are located in urban and suburban areas, I expect any MAUP related bias to be minimal. This study is certainty less-prone to MAUP than comparable studies that use larger area units such as counties, metropolitan areas or states.

Each zip code is identified at its geographic centroid coordinates. To increase the likelihood of a correct match, I compiled a database of zip code coordinates from several sources: the 1990 and 2000 versions of the *U.S. Gazetteer*, and two commercial databases that come bundled with the ArcView and Maptitude GIS software. Matching zip codes from each source were cross-referenced to ensure correspondence. The distance between spatial units is measured by great circle arc distances.

In the LDB, establishment zip codes are classified as one of three types: a physical address, a mailing address, or the address of the unit reporting to the SESA (the UI address). Since the LDB only specifies a single address type for each establishment it is likely that many mailing addresses also correspond to physical locations. By definition, independent plants only operate out of a single facility and for these the physical and mailing address are usually one and the same, even if not identified as such. I initially include all matched physical and mailing address zip codes (excluding UI addresses) in the sample and eliminate establishments where the physical location is less certain. As an initial check, I capitalize on the longitudinal nature of the database by checking each plant's zip code across quarters. If the mailing address zip code is also identified as the physical address zip code in any other quarter, it is considered a physical location. Among the remaining mailing addresses, I eliminate establishments from the sample where the geocoded mailing address zip code is outside of the county of the plant's physical location.[19]

Table 4.1
Zip Code Match Rates by Industry

Industry Title	Zip Code Match Rate
Manufacturing	**0.85**
Drugs	0.72
Farm & garden machinery	0.91
Metalworking machinery	0.81
Electronic components & accessories	0.83
Motor vehicle parts & accessories	0.85
Measuring & controlling devices	0.84
Business & professional services	**0.76**
Advertising	0.75
Computer & data processing services	0.71
Research & testing services	0.72

Source: US BLS Longitudinal Database (LDB)

The geocoding process may produce sampling bias if the probability of a successful match varies non-randomly according to structural characteristics of establishments and industries. In other words, the selectivity of the address matching process generates a non-random "sample of convenience" that may skew measured outcomes (Feser and Sweeney

[19] The LDB contains a separate variable listing the FIPS code of the county of the plant's physical location.

forthcoming). Match rates tend to vary by industry, possibly due to industry- or state-specific differences in data collection procedures and stringency, or the interaction between establishment and industry characteristics such as location preferences or size. Table 4.1 shows that the share of establishments successfully matched to zip code centroids is much higher in manufacturing (85 percent) than in business and professional services (76 percent). There is also moderate heterogeneity across the study industries, with the highest match rates in farm and garden machinery (91 percent), and the lowest match rates for computers and data processing services (71 percent), drugs (72 percent), and research and testing services (72 percent). Overall, the match rates of the study industries are fairly close to their sector averages.

Table 4.2
Zip Code Match Rates - Structural Characteristics

	Manufacturing			Professional Services		
	Total	**Matching**	**Match Rate**	**Total**	**Matching**	**Match Rate**
Cohort (year of birth)						
1994	27,872	23,740	0.85	84,905	64,034	0.75
1995	27,088	22,809	0.84	95,315	73,513	0.77
County Population Growth						
Lowest Quartile	5,566	4,794	0.86	15,482	12,290	0.79
2nd Quartile	13,986	12,495	0.89	38,226	32,609	0.85
3rd Quartile	15,298	13,464	0.88	50,111	41,375	0.83
Highest Quartile	17,490	15,479	0.89	59,478	49,602	0.83
County Population Density						
Lowest Quartile	1,876	1,698	0.91	2,471	2,159	0.87
2nd Quartile	4,202	3,849	0.92	4,756	4,171	0.88
3rd Quartile	7,232	6,486	0.90	11,830	10,430	0.88
Highest Quartile	39,030	34,199	0.88	144,240	119,116	0.83
Establishment Size (@ Birth)						
< 10 Employees	46,786	39,611	0.85	167,879	128,517	0.77
10 - 100 Employees	7,638	6,528	0.85	11,707	8,575	0.73
> 100 Employees	536	410	0.76	634	455	0.72

Source: US BLS Longitudinal Database (LDB)

Also of great concern are systematic variations in match rates that may be related to key independent variables. In a recent paper, Feser and Sweeney (forthcoming) find that *street address* match rates are higher in more densely settled areas, areas with faster population growth, and for smaller establishments. All three characteristics could conceivably be related to external economies and therefore produce a biased sample. Table 4.2 reports the zip code match rates across the two separate birth cohorts and by quantile based on county population density, county growth rate and establishment size. There is very little difference in the match rates of plants born in different years. Similar to Feser and Sweeney (forthcoming), I find a tendency for establishments in slow growing counties to be under represented in the geo-matched sample, but the differences are small. There is a notable tendency for the largest establishments (> 100) to be underrepresented in both manufacturing and services, but since there only a few independent firms are born with more than 100 employees, this bias only affects a small portion of the overall population. Contrary to Feser and Sweeney (forthcoming), I find a mild tendency for more densely settled counties to have lower match rates for business and professional service establishments. This is most likely because the Feser and Sweeney results include multi-unit establishments, which may be more difficult to geocode. In sum, while there are differences in match rates by sector and location, none are very large.

4.6 Sample Properties

4.6.1 New Firm Entry by Industry

After dropping potentially erroneous observations and establishments that could not be accurately matched to a physical location, the study sample includes 46,549 new manufacturing firms and 137,547 new firms in business and professional services for the 1994 and 1995 period (see Table 4.3). This represents 6.5 percent of all manufacturing establishments and 10.6 percent of all advanced services establishments in the target states.

Table 4.3
New Firm Entry and Entry Rates

Study Industry	Entrants: Both Cohorts	Entrants: 94 Cohort	Entrants: 95 Cohort	Entry Share*
Manufacturing	**46,549**	**23,740**	**22,809**	**6.5%**
Drugs	206	103	103	6.0%
Farm & garden machinery	278	148	130	7.2%
Metalworking machinery	939	474	465	4.6%
Electronic components & accessories	820	421	399	6.7%
Motor vehicle parts & accessories	471	248	223	7.2%
Measuring & controlling devices	569	288	281	6.3%
Business & professional services	**137,547**	**64,034**	**73,513**	**10.6%**
Advertising	3,859	1,812	2,047	9.3%
Computer & data processing services	20,524	9,025	11,499	12.8%
Research & testing services	3,707	1,811	1,896	8.0%

Source: US BLS Longitudinal Database (LDB)

*Entry share is measured as the number of entrants divided by the total number of establishment, averaged over 1994 and 1995. The total establishment counts cover only the same states as new firm counts.

Births in the manufacturing study industries range from 206 new firms in farm and garden machinery to roughly 1,000 in metalworking machinery. Despite having the most entrants, metalworking machinery has the lowest entry share of the selected industries (4.6%). Among manufacturing-based industries, the highest entry rates are for motor vehicle parts and farm and garden machinery (both 7.2 percent). New firm entry is considerably higher in the business and professional services industries, in both number and as a share of all establishments. Entry in the service industries range from 3,707 (8 percent) in research and testing services to over 20,000 in computer and data processing (12.8 percent). The high entry rate of the computer programming and data processing industry reflects the extraordinary growth of this industry during the 1990's. In every industry, the number of entrants is nearly evenly split between the two cohorts.

4.6.2 Empirical Survival and Hazard Rates

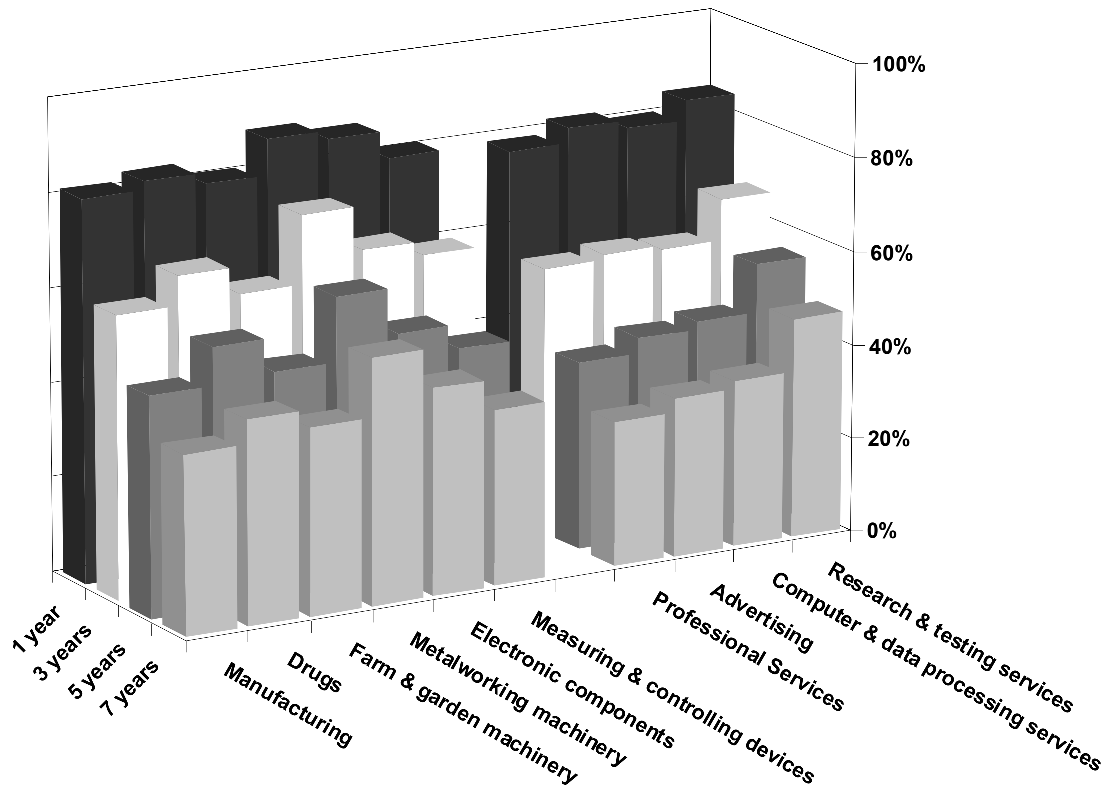
Most new firms are short-lived, with manufacturing plants slightly more likely to survive their early years than professional services. Figure 1 displays survival rates for new firms in each study industry measured after one, three, five, and seven years. Approximately 81 percent of the new firms in manufacturing and business and professional services survive their first year of operation. By the fifth year, less than half of the new firms in manufacturing (47 percent) and business and professional services (40 percent) remain in the market. Only 38 percent of manufacturing plants and 31 percent of business and professional service firms survive beyond the seven year study period.

These survival rates are slightly lower than previous estimates for U.S. establishments, most of which are estimated on independents and subsidiaries combined. Tracking entrants across three U.S. *Census of Manufacturers* cohorts in the 1970's and early 1980's, Dunne *et al.* (1988) estimate an average 5 year survival rate of 48 percent for manufacturing entrants. Knaup (2005) provides more recent estimates for a larger cross-section of industries, based on the US BLS LDB data. For establishments born in 1998, Knaup estimates a one year average survival rate of 84 percent for manufacturing entrants and 82 percent for business and professional services, and three year survival rate of 57 percent for manufacturing and 55 percent for business and professional services.[20] Audretsch (1995a) distinguishes single-unit entrants from subsidiaries in US manufacturing survival rates. Using Dunn and Bradstreet data covering the mid-70's to the mid-80's, he estimates a four year survival rate of 63 percent and an eight year survival rate of 37 percent for single-unit manufacturing establishments. Audretsch (1995a) also reports that single-unit establishments have higher failure rates than subsidiaries and branch plants, consistent with evidence from multivariate models of industry hazard rates (Dunne *et al.* 1989; Audretsch and Mahmood 1995). The higher probability of failure explains the survival rates of new firms found in this study

[20] Knaup's (2005) definitions of manufacturing and business and professional services are based on NAICS industry definitions and therefore differ slightly from my SIC based definitions.

compared to Knaup (2005), Dunne *et al.* (1988), and studies from other industrialized nations (Baldwin and Gorecki 1991; Dunne and Hughes 1994; Mata 1994; Wagner 1994, 1999; Mata *et al.* 1995).

Figure 4.1
New Firm Survival Rates



Source: US BLS Longitudinal Database (LDB) and author's calculations.

Differences in survival rates across industries are explained by structural barriers to survival that derive from the technological requirements and competitive orientation of different markets (Gort and Klepper 1982; Winter 1984; Audretsch 1991; Geroski 1995). My data suggests that industry survival barriers act early in the plant's life cycle (between the end of the first and third year), creating persistent differences in industry survival rates for the duration of the observation period. After one year, survival rates for individual study industries are fairly uniform and close to their respective sector averages. The highest one year survival rates are for metalworking machinery (88 percent), followed by electronic components (86 percent) and research and testing services (84 percent). There is a significant drop in survival rates in all industries between the end of the first and third years, most notably for the computer and data processing services and advertising, both with a 22 percentage point drop in survival rates between the first and third years. The rate of decline in survival begins to subside following the third year, while the relative differences between industries remain stable. By the end of the seventh year, the highest survival rates are for metalworking machinery (52 percent) and research and testing services (47 percent).

Empirical hazard rates are an alternative method for examining the life cycle of establishments that emphasizes temporal influences on survival. The hazard rate describes the instantaneous risk of failure occurring during a discrete time interval. The hazard rate at the midpoint of each interval is measured as

$$h(t_{im}) = \frac{d_i}{w_i\left(n_i - \frac{c_i}{2} - \frac{d_i}{2}\right)}, \tag{4.1}$$

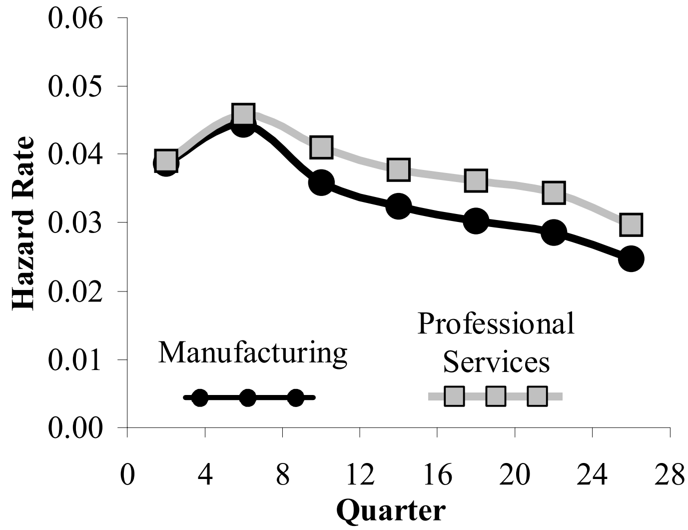
where t_{im} is the midpoint of the ith interval, d_i is the number of events, w_i is the interval width, n_i is the number still at risk at the start of the interval, and c_i is the number of cases censored within the interval.[21] The denominator is an approximation of the total exposure time (the sum of individual exposure times) which is standard for life-table analysis (Allison 1995).

The hazard rates for both manufacturing and professional services decline steadily over the first seven years of life, following a peak in the hazard rate in the second year (see Figure 4.2). Similar patterns in U.S. manufacturing are reported by Mahmood (2000) and Agarwal and Gort (2002), and Wagner (1994) for Germany. Borrowing arguments from the

[21] I use an interval length of four quarters to smooth seasonal fluctuations.

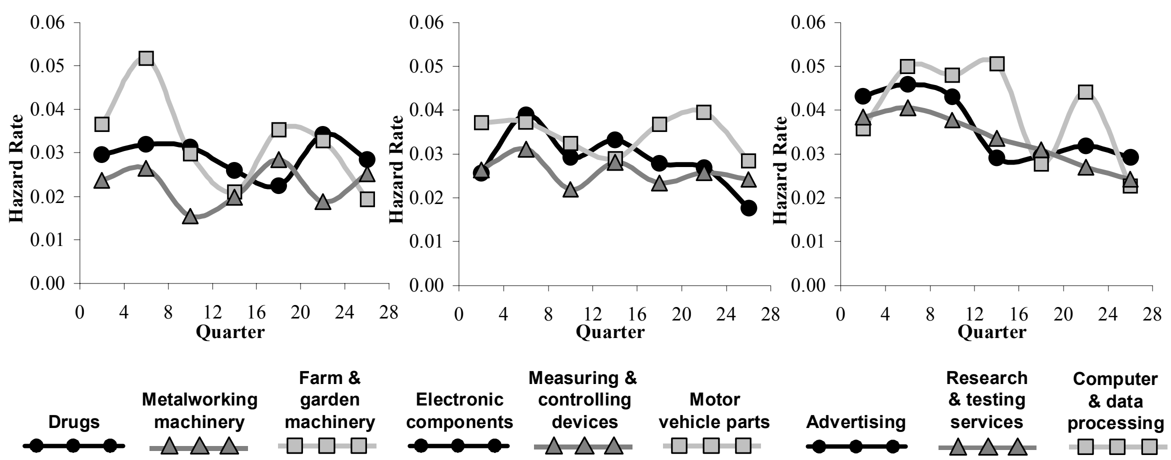
organizational ecology literature, Mahmood (2000) associates the initial rise then decline in hazard rates with the "liability of adolescence." He explains that such patterns may arise if new firms have a limited stock of initial resources they must exhaust before forced to make the exit decision. A second explanation, in the tradition of Jovanavic (1982), is that it takes time for firms to realize their deficient efficiency and decide to exit the market.

Figure 4.2
Empirical Hazard Rates
Manufacturing & Professional Services



Source: US BLS Longitudinal Database (LDB)

Figure 4.3
Empirical Hazard Rates, Study Industries



Source: US BLS Longitudinal Database (LDB)

Hazard rates are a little more erratic when measured for individual study industries, as expected given the smaller number of establishments (see Figure 4.3). Manufacturing study industries can be grouped roughly into two groups, those with declining and those with constant hazard rates. Diminishing hazard rates are visibly apparent in the farm and garden machinery, electronic components, advertising, computer and data processing services and research and testing services. For drugs, metalworking machinery, motor vehicle parts and measuring devices hazards decline slightly over the first seven years at a near constant rate.

4.6.3 The Geographic Distribution of New Firm Formation

The ability of statistical tests to significantly detect spatial influences depends greatly on the spatial distribution of new firms. There may be beneficial external economies in many locations, but if there are no new firms at these same locations these influences may go undetected. Spatial variation in new firm births increases the possible variation in spatial-based independent variables, improving the reliability of statistical estimates and reducing mutlicollinearity among closely related independent variables. Spatial variation across industries is also desirable. Studying differences in the geographic variation of entry provides insight about the relationship between location and performance and helps increase the study's external validity.

Confidentially restrictions limit the precision with which I can present establishment locations. To accommodate disclosure rules and to account for arbitrary jurisdictional boundaries, new firm births are aggregated into counties and spatially smoothed across county boundaries by a linear distance decay function,

$$w_{ij} = \frac{(m - d_{ij})}{m}, \tag{4.2}$$

where d_{ij} is the great circle distance between county centroid pairs and m is the maximum distance for potential geographic spillovers. I set m at 80 kilometers to approximate modern commuting preferences. The resulting maps for the spatial distribution of each industry are included as Appendix B. As a further protection against violations of disclosure, the maps in Appendix B classify entrants in positive standard deviations and not levels. This transformation does not effect the relative ordering of places within each industry.

Table 4.4
Regional Distribution of Entrants by Commute Zones (CZs)

Industry	Number of CZs (of 679)	% Births Top 5 CZs	Top 5 Commute Zones (Largest City)
Manufacturing	661	21.3	Los Angeles, CA; Chicago, IL; Seattle, WA; San Francisco, CA; Newark, NJ
Drugs	85	27.5	Los Angeles, CA; San Francisco, CA; San Diego, CA; Trenton, NJ; Minneapolis, MN
Farm & garden machinery	185	8.3	Chicago, IL; Los Angeles, CA; Minneapolis, MN; Wichita, KS; Sacramento, CA
Metalworking machinery	202	28.4	Los Angeles, CA; Chicago, IL; Cleveland, OH; Erie, PA; Hartford, CT
Electronic components & accessories	154	37.8	San Jose, CA; Los Angeles, CA; San Francisco, CA; San Diego, CA; Dallas, TX
Motor vehicle parts	172	25.8	Los Angeles, CA; Chicago, IL; Trenton, NJ; Minneapolis, MN; Dallas, TX
Measuring & controlling devices	147	27.0	Los Angeles, CA; San Jose, CA; Chicago, IL; Houston, TX; San Francisco, CA
Business & professional services	654	23.0	Los Angeles, CA; Chicago, IL; Washington, DC; Trenton, NJ; Atlanta, GA
Advertising	330	27.1	Los Angeles, CA; Atlanta, GA; Chicago, IL; Trenton, NJ; San Francisco, CA
Computer & data processing services	475	27.1	Trenton, NJ; Los Angeles, CA; Washington, DC; Atlanta, GA; San Francisco, CA
Research & testing services	333	24.2	Los Angeles, CA; Washington, DC; San Francisco, CA; Seattle, WA; San Jose, CA

Source: US BLS Longitudinal Database (LDB)

All selected industries show sufficient spatial variation. New firms in manufacturing and professional services are found in over 600 commute zones (CZs), with study industries ranging from 85 CZs for drugs to over 475 CZs for computer and data processing services (see Table 4.4). Because industries with more entrants tend to cover more ground, a more revealing measure of the geographic concentration is the share of births in the top five commuter zones. The top five commuter zones typically account for 25 percent of the total births, ranging from only 8.3 percent in farm and garden machinery to 38 percent in electronic components.

Large cities play an important role as centers of new firm formation. The largest metropolitan areas, such as Los Angeles, Chicago, San Francisco and Minneapolis top the list in the number of firm births for nearly every industry (see Table 4.4). The close association between population and firm formation extends down the entire urban hierarchy. The bivariate correlation between new firm births and previous year population is above 0.90 in both manufacturing and professional services for counties and above 0.80 for commuter zones (see Table 4.5). Urbanization tendencies are strongest among the three professional services study industries, industries with strong ties to local demand. In manufacturing, motor vehicle parts and metalworking machinery have the highest correlation between population and new firms. Only new firms in the farm and garden machinery industry have a weak association with population choosing instead to locate to their agricultural clientele.

The strong ties between population and firm formation may be remarkable, but they are not unexpected. Export-based theories of regional development suggest that a

Table 4.5
Geographic Correlations of New Firm Births with Population & Same Industry Establishments*

	Counties		Commute Zones	
	Pop	**Estabs****	**Pop**	**Estabs****
Manufacturing	0.92	0.96	0.80	0.84
Drugs	0.67	0.76	0.69	0.74
Farm & garden machinery	0.28	0.38	0.33	0.53
Metalworking machinery	0.74	0.91	0.69	0.68
Electronic components & accessories	0.55	0.95	0.61	0.88
Motor vehicle parts	0.83	0.89	0.74	0.74
Measuring & controlling devices	0.69	0.87	0.70	0.77
Business & professional services	0.93	0.92	0.81	0.85
Advertising	0.90	0.93	0.80	0.72
Computer & data processing services	0.77	0.95	0.71	0.85
Research & testing services	0.80	0.91	0.74	0.80

Source: US BLS Longitudinal Database, BEA County Population Estim
** Population and same-industry establishment are based on 1993 data to avoid double counting new firms.*
*** Counties and commute zones that have no births and no existing establishments are excluded from the calculations.*

certain percentage of a region's industrial base exists to serve local demand. The dominance of large places is also predicted by agent-based theories of entrepreneurial choice. According to this perspective, the stock of potential entrepreneurs is partly determined by the size of the workforce and strong "home-bias" preferences in entrepreneurial location choice (Figueiredo *et al.* 2002; Meester 2004).

The spatial distribution of existing industry is also influential in determining the location of new firms. Dumais *et al.* (2002) report that while regional industrial concentration is highly persistent, employment change due to entry results in slight tendencies toward dispersal. My data reinforces the importance of existing industry as a source of new firm formation. For most industries the association between entry and existing firms is even stronger than the association between entry and population. The county-level correlations between new firm and the previous years establishments are all over +0.80, with the exception of farm and garden machinery and drugs. The spatial association between entrants and incumbents is strongest in electronic components and accessories and computer and data processing services. The commuter zone establishment correlations are either very close to the county level or slightly lower.

There are several possible explanations for the strong geographic association between new and existing plants. It is possible that new firms seek out similar environments as their predecessors. Areas where industry is concentrated are also likely to be areas where external economies and business networks are particularly well developed. A second possibility is that existing industry directly stimulates the formation of new businesses. Many new firms are spin-offs from existing businesses. The spin-off may be direct, as in the form of a large firm downsizing through the outsourcing formerly internal functions (Harrison 1994). Or they may be informal, such as the entrepreneurs start their own business based on experience gained at their previous employer. In either case, the new business is likely to be in a similar industry as the parent, and, because of "home-bias" preferences, likely to start-up in the same region.

Table 4.6
Entrant Location by Urbanity

	New Firms (%)			Incumbents (%)			
Study Group Title	**Rural**	**Sub-urban**	**Central City**	**Rural**	**Sub-urban**	**Central City**	**Pr > χ^2**
Manufacturing	**23.6**	**47.0**	**29.3**	**21.7**	**46.1**	**32.2**	**0.00**
Drugs	9.2	60.7	30.1	9.5	54.2	36.3	0.08
Farm and garden machinery	59.7	29.1	11.2	53.3	32.2	14.5	0.35
Metalworking machinery	20.7	57.1	22.3	15.3	59.4	25.3	0.00
Electronic components and accessories	10.6	54.8	34.6	9.1	55.2	35.8	0.70
Motor vehicle parts and accessories	19.1	49.9	31.0	19.6	45.5	34.9	0.46
Measuring & controlling devices	10.5	58.0	31.5	8.7	58.9	32.4	0.71
Professional Services	**10.4**	**53.5**	**36.1**	**10.1**	**49.9**	**40.0**	**0.00**
Advertising	7.4	49.1	43.6	6.8	43.3	49.9	0.00
Computer and data processing services	5.9	61.7	32.4	4.9	59.3	35.8	0.00
Research and testing services	10.4	51.7	38.0	8.6	48.1	43.3	0.00

Source: US BLS Longitudinal Database

Start-ups in different industries also differ in their intra-regional location preferences. New firms tend to prefer suburban over central cities and rural sites (see Table 4.6).[22] Only the farm and garden machinery industry has a majority of births in rural counties (59.7 percent). Within manufacturing, central city orientation is highest for electronic components and accessories (34.6 percent), motor vehicle parts (31 percent) and drugs (30.1 percent). Professional service entrants have a higher proclivity for urbanity and a noticeably smaller share of rural entrants. Advertising is the most urban (43.6 percent) industry, perhaps reflecting the need for frequent interaction with corporate clients. Agglomeration dependent

[22] Establishments were located in a central city if their zip code centroid falls within the boundaries of central cities as defined in the US Census Bureau year 2000 TIGER files. Because zip codes do not conform to city jurisdictional boundaries, these locations are approximations. Suburban establishments are located in Metropolitan Statistical Areas, but outside of the Central City boundaries. Rural establishments are defined as those located outside of MSAs.

–but otherwise footloose –computer and data processing services is the most suburban (61.7 percent) and the least rural (5.9 percent) of all the study industries.

Table 4.6 also compares the intra-regional location patterns of new firms to incumbents. New firms have similar intra-regional location preferences as existing firms, analogous to what was found in the inter-regional distribution of new firms. A χ^2 test of no difference in the intra-regional location of new and incumbent firms is rejected for both aggregate sectors and for four of the detailed industries. Metalworking entrants favor rural locations noticeably more than incumbents. New firms in advertising, computer and data processing and research and testing services are slightly less likely to locate in center cities and slightly more likely to locate in rural areas compared to incumbents. This contradicts the 'simple' interpretation of the urban incubator hypothesis that small establishments prefer high-density central locations in order to access a larger and more diverse client-base and specialized infrastructure and services (Leone and Struyk 1976).

4.6.4 Establishment Size and Growth

Studies of industrial organization stress the importance of size as an indicator of an establishment's potential for long-term survival. Size represents the establishment's access to critical resources, financial or otherwise, productive efficiencies attainable through internal scale economies (Audretsch and Mahmood 1995; Mata *et al.* 1995; Audretsch *et al.* 1999), the entrepreneur's level of uncertainty in undertaking a new business endeavor (Jovanovic 1982; Pakes and Ericson 1998), and potential 'sunk' costs in non-recoverable assets that discourage exit (Caves and Porter 1976). Starting size also correlates strongly with the adoption of advanced production technologies, which has also been shown to increase the likelihood of new firm survival (Doms *et al.* 1995). Establishment employment size is also an important indicator of an establishment's potential relationship with its external environment, namely its reliance on external resources to compensate for its limited internal production capacity (Sweeney and Feser 1998; Feser 2001a).

Table 4.7
Establishment Size - Average Employment

Industry	New Firms At Birth	New Firms At 8 Years	Incumbent (1994)
Manufacturing (ex. SIC 21)	**7.1**	**18.4**	**45.2**
Drugs	12.4	23.3	132.0
Farm & garden machinery	7.3	12.9	51.1
Metalworking machinery	5.1	11.5	20.2
Electronic components & accessories	11.5	39.9	79.7
Motor vehicle parts & accessories	9.4	41.6	95.4
Measuring & controlling devices	8.7	25.5	54.0
Professional services (SIC 73 & 87)	**3.9**	**12.9**	**14.2**
Advertising	2.9	7.3	9.5
Computer & data processing services	3.0	14.9	13.5
Research & testing services	4.5	16.2	23.3

Source: US BLS Longitudinal Database (LDB)

Most new firms are very small. Keeping in mind that entrants with over 250 employees have been excluded from the sample, the average new manufacturing firm has only 7.1 employees per establishment at birth, roughly 1/6th the size of the average incumbent in 1994 (see Table 4.7). The bulk of new manufacturing firms (70 percent) have fewer than five employees at birth, and less than 1 percent are born with more than 100 employees. For manufacturing as a whole, 43 percent of the establishments have less than five employees, and a considerable number of these are new and young establishments.[23] Similar trends are observed within the specific study industries. At birth, new firms in drugs, electronic components and motor vehicle parts are somewhat larger than the other study industries, but they also face a larger absolute size gap with incumbents. New firms in metalworking machinery face the smallest gap, perhaps explaining their higher survival rates.

[23] I estimate that 11 percent of all manufacturing establishments with <5 employees and 6 percent of establishments with between 5 and 10 employees are new firms (i.e., born in 1994). In professional services, the new firm shares are 14 and 7 percent respectively.

New firms in professional services are considerably smaller than their manufacturing counterparts, but then so are professional service incumbents (see Table 4.7). The average new professional services firm has approximately four employees per establishment, compared to an incumbent average of only 13 employees. New research and testing firms are the slightly larger than the other study industries. The size distribution for new professional services establishments is also more skewed than manufacturing, with roughly 85 percent of new firms having less than five employees and only 0.3 percent larger than 100 employees.

There is a notable tendency for the relative size of new firms to vary systematically with the average incumbent size across industries. Industries where the average incumbent size is large tend to have larger entrants.[24] This suggests that the structural forces that condition incumbent size across industries also affect new enterprises. The drugs industry has the largest new firms (12.4 employees per establishment) and the largest incumbents (132 employees per firm). But new firms in the drugs industry also have the largest size gap with incumbents, suggesting that these firms may have greater difficulty matching scale efficiencies if they were to compete directly against incumbents.[25] Metalworking machinery has the smallest new firms (5.1 employees per establishment), the smallest incumbents (20.2 employees per establishment) and the smallest new firm size deficiency. The average establishment in metalworking machinery devices is only 4 times larger than the average entrant. Among professional services, research and testing has both the largest new firms (4.5 employees per establishment) and the largest incumbents (23.3). New firms in

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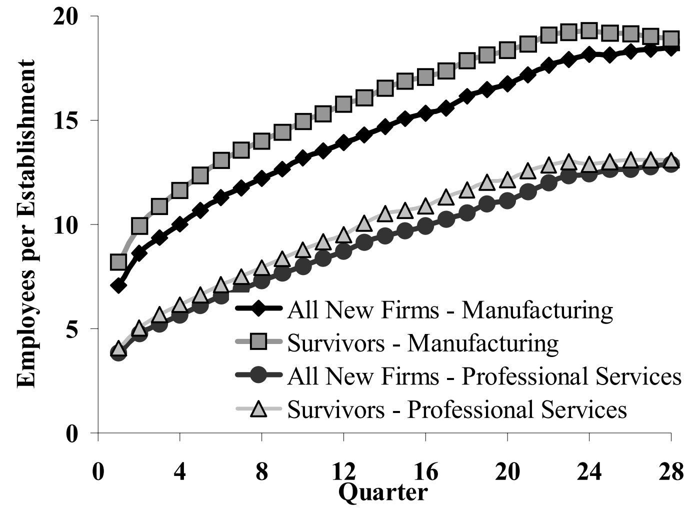
[24] The pairwise correlation coefficient between new firm size at birth and incumbents in 1994 is 0.81 when measured across all manufacturing and professional services sectors.

[25] A large new firm-incumbent size gap may also signify industries where entrants compete on the industry fringe (i.e. niche markets).

advertising have the smallest size gap with incumbents, on average they are only one-third the size of incumbents.

Figure 4.4
New Firm Size by Age



Source: US BLS Longitudinal Database (LDB)

While informative, a firm's size at birth is only a static indicator of its potential relationship to the local environmental context and potential for survival. Mata (1995; 1996) and Wagner (1994) argue that establishment growth, rather than size at birth, is a more appropriate indicator of scale and information advantages. Growth also reflects organizational learning if, in the face of uncertain market prospects, entrepreneurs choose to start small and expand if their market experience is favorable (Jovanovic 1982; Pakes and Ericson 1998).

Measuring the relationship between age and average establishment size must account for selective attrition of small firms (Evans 1987; Dunne *et al.* 1989). If small employers exit the market early, average establishment size increases even if the actual size of the surviving plants remains constant. To account for selective attrition, I measure both the average size of all new firms as well as the average for only entrants that survive the entire study period. The average size of survivors will not be influenced by sample attrition.

Figure 4.4 presents the average entrant size by quarter for the duration of the study period for manufacturing and professional services. Supplemental charts for each study industry are provided in Appendix C. Three patterns stand out. First, the average size of surviving establishments almost always exceeds the overall average size, reflecting higher propensity for exit among smaller firms. The drugs industry is a notable exception where eventual survivors are slightly smaller than non-survivors in the first few years. Second, even after seven full years new manufacturing firms are still much smaller than incumbents (see Table 4.7 for incumbent size in 1994). After seven full years the average manufacturing plant born in 1994 or 1995 has only 18.6 employees, compared to a 1994 incumbent average of 45.2 employees per plant. This suggests that eight years is hardly long enough to establish oneself as a dominant manufacturer in most markets. For professional services, the size gap with incumbents is nearly eliminated by the end of the study period, 13 employees per establishment for new firms compared to 14 for incumbents. In computer and data processing the average size of new firms after seven years is slightly larger than the incumbent size in 1994. Third, there is evidence that new firm employment growth plateaus in the final quarters of the study period. This is expected in services where the average entrant size approaches the incumbent average. But even in manufacturing it appears that survivors approach an equilibrium size considerably smaller than incumbents, suggesting niche market production as opposed to direct competition.

The preceding analysis suggests that new firms, particularly those in manufacturing, face serious scale disadvantages if forced to compete directly against incumbents on a pure efficiency basis. But the existence of a significant size rift between new firms and incumbents throughout the study period suggests that new firms can survive at a sub-optimal level of efficiency for quite some time. Presumably they do so by occupying a strategic niche market where competition might be on the basis on service, quality or innovation (Caves and Porter 1977, Agarwal and Audretsch, 2001; Porter 1979, 1980). For this study, the key implication is that post-entry dynamics of new firms may be very differently than established competitors in the same industry. The results found by this study could be considerably different than similar work conducted on a broader population of firms.

4.7 Summary

In this chapter I describe the development of a database of new firm longevity built from establishment level records of the Bureau of Labor Statistics' Longitudinal Database (LDB). With its high frequency of observation, detailed ownership and address information, industrial coverage and establishment-specific unique identifiers, the LDB is ideal for spatial econometric modeling and duration analysis. But because it has not previously been used for this purpose, preparing this database for scholarly analysis required months of work at the US BLS offices linking individual records, checking the data for errors and consistency, address matching each record, and linking them to other secondary data sources based on physical proximity.

My analysis covers new firm births in the manufacturing and business and professional service sectors, including several specifically defined industries therein. I provide a detailed exploration of the properties of each study industry. Implicit in this descriptive analysis is the question of whether new firms differ from incumbents in ways that may substantively alter their response to external stimuli. Past empirical studies of external economies do not distinguish new firms from incumbents, and it is uncertain whether the findings of these studies are applicable to new firms.

The descriptive analysis reveals both similarities and differences between new firms and incumbents in several key attributes. New firms face a high probability of failure in their youth, suggesting that the new firms face serious information asymmetries leading to misinterpretation of their actual market potential. New firms in manufacturing are much smaller than incumbents, and thus may be more dependent upon external resources to compensate for deficient internal scale and scope resources. They also seem to approach an equilibrium size far below incumbents, suggesting that new-firms compete in different markets and may not respond in a manner predicted by studies based on a full sample of establishments. New firms in professional services face less of a size barrier at birth, and are virtually indistinguishable from incumbents after seven years.

The inter- and intra-regional location choices of new firms closely mirror the preferences of their predecessors. It may be that the place-based positive feedback mechanisms that reinforce and sustain existing regional industrial specialization also influence the start-up and location decisions of new firms. A second possibility, one that I find particularly compelling, is that many new firms are spin-offs from existing firms. Many entrepreneurs found their new enterprises to capitalize both upon industry- and place-specific knowledge, thus reinforcing existing spatial patterns. Unfortunately, I cannot differentiate these two processes with currently accessible data. I hope to investigate these issues in greater detail in future research.

CHAPTER V

MEASURMENT OF INDEPENDENT VARIABLES

5.1 Introduction

In Chapter Three, I introduced a model where the probability of a new firm's survival is described as a function of establishment, industry, and regional attributes. Past research provides detailed coverage of establishment and industry characteristics that influence the likelihood of survival, but the regional dimension of new firm survival remains virtually unexplored. In this chapter, I discuss the measurement of the independent variables that help explain new firm survival in a spatial context.

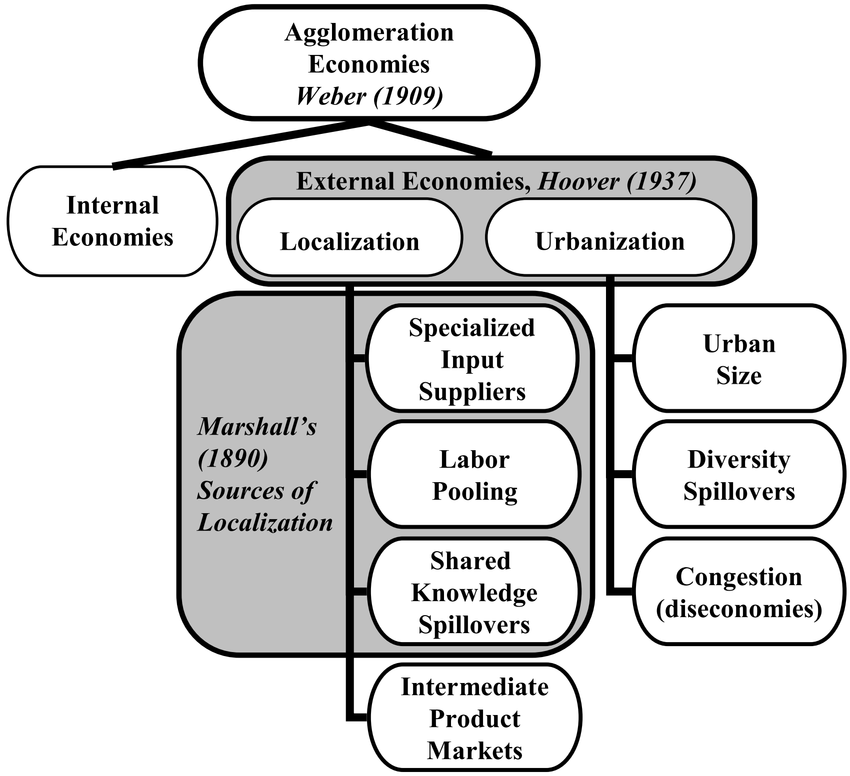
The chapter opens by presenting a hierarchical typology of external economies built on underlying conceptual similarities in both the localization/urbanization and Marshallian traditions. This typology provides an organizational framework for the empirical analysis to follow. Building on this typology, I develop explicit measures for each of the primary sources of external economies. I construct these variables by bringing together data from numerous secondary data sources: *Zip Code Business Patterns*, the *1990 U.S. Census of Population*, the *Occupational Employment Survey (OES)* of the Bureau of Labor Statistics, the *1992 U.S. Benchmark Input-Output Accounts*, the National Science Foundation *CASPAR* database, the *Integrated Postsecondary Education System (IPEDS)*, as well as the LDB itself. Capitalizing on increased geographic precision in secondary economic and demographic data, I measure the regional environment of each plant using distance based methods. I also include measures to represent key establishment characteristics that may interact with or mediate the relationship between a firm and its industrial environment, such as the establishment's size and age. The chapter concludes with discussion of the pairwise correlations among key independent variables. This analysis helps confirm the construct validity of the empirical measures, and highlights instances where a lack of unique variation may present problems for multivariate analysis.

5.2 A Typology of Agglomeration Economies

Despite a rich history dating back over 100 years, progress in agglomeration theory is still mired by persistent confusion and ambiguity over core theoretical constructs and their proper measurement (Feser 1998a; Parr 2002a). Much of the ambiguity and confusion originates in the early divergence and separate development of two approaches to the empirical study of agglomeration: Hoover's (1937) localization-urbanization dichotomy and Marshall's (1920 [1890]) sources of external economies. This confusion is further provoked by contemporary disagreement over the proper usage of common terms such as agglomeration, external economies and spillovers.

Figure 5.1 clarifies key concepts and terminology and provides a guide to my empirical inquiry, by presenting a typology of agglomeration economies that combines both Hoover's and Marshall's perspectives. Both frameworks are rooted in the common concept that geographic agglomeration is a product of increasing returns to scale. The frameworks differ in their degree of specificity. The concept of agglomeration economies is at the top of the hierarchy, encompassing nearly all economic forces that may result in the spatial concentration of human activity. According to Weber (1929 [1909]) the social forces of agglomeration may take the form of either internal or external economies of scale, the former realized in the concentration of production within a single plant while latter results in the concentration of production across multiple plants in relative proximity to one another. Building on Weber's

Figure 5.1
Typology of Agglomeration



ideas, Hoover (1937) delineates two types of spatial external economies: localization and urbanization, respectively pertaining to industry-specific and region-wide economies. Marshall (1920 [1890]) describes the specific sources of the benefits of industrial localization: specialized input suppliers, labor pooling and knowledge spillovers between firms sharing a common technological foundation. Because a business may also benefit from proximity to thick product markets, I add intermediate goods suppliers to the list of the possible sources of localization.

Urbanization economies can similarly be divided into several components. Economies of urban size represent the myriad of economic goods requiring a minimum level of human activity for efficient provision, such as infrastructure, urban amenities, and access to final markets for consumer goods. The extent of beneficial urbanization economies is limited by offsetting congestion diseconomies from increased traffic, pollution, and higher land rents. Beyond assets and liabilities rooted in the concentration of human activity are potential benefits related to the industrial and social composition of cities relative to smaller places. Of greatest significance are potential knowledge spillovers derived from the exchange of diverse ideas that may lead to beneficial innovation and ideas (Jacobs 1969; Glaeser *et al.* 1992; Henderson *et al.* 1995). In theory, industrial and cultural diversity is not a purely urban phenomenon, but city size and diversity do have a close practical association. Generic measures of regional size are likely to capture diversity benefits unless the latter are explicitly controlled.

I estimate two distinct sets of empirical models summarized in the framework. The first uses broadly defined proxies for localization and urbanization. The second, referred to as the Marshallian model, uses specific indicators for the individual sources of localization and urbanization economies: input suppliers, knowledge spillovers, labor pooling, intermediate goods markets, urban size/congestion and diversity spillovers. While it is generally preferred to use the most specific measures available, estimation using the aggregate definitions has several advantages. The bulk of the empirical literature still follows the localization-urbanization framework, and estimation of such models allows me to situate my results within this large body of work. Second, the specific sources of localization are closely related to one another, making it difficult to disentangle their separate influences. An aggregate measure of localization may reveal overall influences that are not apparent when effects are divided between multiple components.

5.3 Measuring External Economies

Both Feser (1998a) and Rosenthal and Strange (2004) identify two key dimensions that should be addressed in the empirical measurement of external economies: economic distance and geographic distance.[26] Economic distance accounts for possible linkages or economic transactions between independent businesses. It may be defined according to any number of possible inter-industry relations, including similarity in product markets, buyer-supplier links, shared labor needs, or common technological foundations. These linkages may be direct, as in the case of contractual purchasing or cooperative information sharing and research, or they may be indirect, such as productivity gains from a preferable division of labor or learning from the passive observation of the success and failures of competitors.

Economic linkages between industries can be represented by either dichotomous or continuous weights. Empirical work following Hoover's localization/urbanization framework implicitly adopt a dichotomous notion of economic distance, whereby beneficial linkages spread only between firms in the same industry (localization), or spread to all proximate firms regardless of industry (urbanization). Recent work in the Marshallian tradition views economic distance along a continuum, using weighting schemes to account for the proximity of firms in different industries (Dumais *et al.* 1997; Feser 2001a, 2002; Rigby and Essletzbichler 2002; Koo 2005a).

Geographic distance relates to the attenuation of agglomeration benefits over space. Many studies implicitly follow a 'spatial club goods' approach by assuming that external economies are stationary within jurisdictional boundaries and irrelevant beyond (Rosenthal

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[26] Rosenthal and Strange (2004) also include a temporal dimension to capture how externality-generating activity in one period influences the productivity of others in successive periods. I do not account for temporal effects in this study. In practice, it is difficult to adequately account for temporal or lagged effects given the relatively short durations of economic data using consistent industry definitions and the gradual nature of regional economic evolution.

and Strange 2004). When based on highly aggregated spatial units this approach is particularly susceptible to MAUP related bias, and may alternately over- or under-identify proximity effects when the economic relations between do not match spatial units. Recent studies using disaggregate data overcome this problem by modeling externalities according to a declining distance gradient (Aji 1995; Feser 2001a, 2001b, 2002). To apply the distance decay method the analyst must specify both the maximum spatial range of proximity effects as well as the shape of the decay gradient within this range. The primary limitation of this approach is that there is no a priori basis for preferring one decay gradient over another, and estimates of proximity effects are likely to be contingent upon the choice of distance based weights.

Estimating the model at a variety of spatial scales provides an alternative method for identifying the spatial extent of external economies when the shape of the decay gradient is unknown. This is done by measuring the economic activity surrounding each new firm within four distance bands (20 km, 40 km, 80 km and 160 km), and estimating separate models at each distance.[27] Economic activity within each distance band space is treated dichotomously, with geographic weight of one inside each band and zero beyond its borders. In other words, one set of models are estimated with external economies variables measured at 20 km, a second set at 40 km, and so on. Modeled as spatial club goods, this approach presumes that the spatial gradient is flat within each band and does not provide direct estimates of the shape of the gradient. But unlike past studies based on aggregate spatial

[27] This approach is a modification of Rosenthal and Strange (2003) method where economic activity is measured *between* successive bands and jointly estimated in a single regression.

units, iterative estimation provides additional insight into how proximity effects vary when estimated at different spatial scales and provides some leverage over MAUP related bias.[28]

The third element required for empirical measurement is a suitable measure of the source of each business externality. External economies cannot be observed directly. Their possible influence can only be approximated by indirect means. Industry employment is the most common indicator used in applied agglomeration studies, although in some cases alternative measures such as establishment counts, occupational employment, R&D expenditures, or patent counts may offer a closer approximation to the underlying theoretical construct.

Based on these three components (economic distance, geographic distance and the externality source measure) I define a generic measure of potential external economies as:

$$A_{i,k} = \sum_{j} \left(ED_{ij} \bullet I_{j,k} \right) \tag{5.1}$$

where the agglomeration potential (A) for firm i located within distance k, is calculated as the amount of proximate economic activity (I) in industry j, weighed by the economic distance

[28] Multilevel models provide a further alternative for separating the influence of plant-specific and regional (contextual) influences on plant-level outcomes, such as survival. Multilevel models account for unmeasured dependency among geographically clustered observations and spatial heterogeneity by separating plant and regional influences into fixed and random components (Jones and Duncan 1996; Duncan and Jones 2000). Originally developed for continuous dependent variables, multilevel models have recently been extended to binary outcomes and survival data through a generalized linear modeling framework (Guo and Rodriguez 1992; Guo and Hongxin 2000). The primary limitation of this method is that it requires a priori specification of discrete and mutually exclusive spatial jurisdictions (Fotheringham and Brunsdon 1999). This restriction is not appropriate when observed regional boundaries do not match the geography of economic processes or when economic relations are continuous in space. In this sense, multilevel models share the same weaknesses of other spatial club goods approaches; they assume that spillovers exert equal force on plants in the same region, regardless of the spatial arrangement of plants therein, and that spillovers stop at regional boundaries. This is at odds with the bulk of agglomeration theory which views external economies as distance-dependent and centered on each establishment. The recent development of cross-classified models takes a step toward eliminating the restriction of exclusivity (Goldstein 1994; 2003). Unfortunately, the computational intensity of this procedure increases exponentially with the number of possible shared regional associations, eliminating it as a realistic candidate for this study.

(ED) between industries *i* and *j*.[29] The weighted economic activity is then summed across all *j* industries, within distance band *k*.

A final consideration in defining an appropriate proxy is whether agglomeration potential should be measured on an absolute or relative scale. Studies following in the localization/urbanization tradition focus on size (scale) as the critical dimension of external economies, and favor absolute measures, such as total employment. But as argued in Chapter Two, the evolution of the conceptual literature in the latter 20th century emphasizes external economies emanating from a favorable industrial composition or economies of scope (Chinitz 1961; Goldstein and Gronberg 1984; Parr 2002a, 2002b). Thus the ability of firm to access beneficial externalities is conditional on both the total level of activity in the region as well as the density of activity in relevant economic sectors.

There are also practical considerations involved in the choice between absolute and relative indicators. Absolute indicators are fairly insensitive to a regional variation in industrial composition. Even when limited to a single industry, absolute measures tend to be dominated by the very largest cities. In such instances size may not necessarily indicate beneficial spillovers if the local industry exists to serve the local population. Furthermore, absolute indicators of the sources of localization tend to be highly correlated with both the total size of the region and each other, confounding interpretation of regression coefficients in a multivariate setting.

Modern work on industrial clustering favors relative indicators to detect areas of potential agglomeration benefits (Bergman and Feser 1999; Feser *et al.* 2005). Scaling industrial activity by the size of the region helps detect places where an excess of industrial activity

[29] I use the term agglomeration potential in recognition that external economies cannot be measured directly, but can only be estimated by potential economies based on the pre-existing industrial composition of the region (Richardson 1974).

may be the result of regionally stationary economic advantages. Location quotients are a commonly used share-based indicator because they are easy to calculate and have a straightforward interpretation as the region's degree of industrial specialization relative to a reference area, usually the nation.[30] The primary drawback to location quotients is that they exaggerate potential external economies in very small places. When the industrial base is very small, even one or two businesses in an industry may produce a high location quotient. It is doubtful that such places have the critical mass necessary for economic spillovers.

This study uses location quotient based measures of regional industrial specialization to account for the size and scope dimensions of localization economies and its individual components measures, such as input suppliers, intermediate goods markets, labor pooling, and knowledge spillover.[31] The specialization index (*SI*) for industry *i* in region *k* is written:

$$SI_{i,k} = \frac{A_{i,k} \Big/ \sum_i A_{i,k}}{A_{i,US} \Big/ \sum_i A_{i,US}}, \tag{5.2}$$

where A_i is the agglomeration potential measure defined in 5.1, measured both for the region (*k*) and the nation as a whole (*US*). The index is simply the weighted share of regional industry activity, divided by corresponding national share. The specialization index is defined within the interval $[0,\infty)$, and takes the value of one when the nation and region are in proportion. To offset the potential bias from small areas, I exclude establishments with

[30] Recent studies adopting location quotients to represent external economies include Feser (2002), Rigby and Essletzbichler (2002) and Koo (2005a).

[31] I also tested an alternative method for measuring regional specialization that is less subject to the small area bias. Specialization is measured with the residuals from a regression of total regional activity on industry-specific regional activity (Feser *et al.* 2005). This approach was abandoned because of high multicollinearity between the separate sources of Marshallian externalities, and concerns that residuals overly penalize large places with below average industry activity. In models where multicollinearity is less of an issue, the location quotient and residual-based methods were found to produce largely similar results.

regional location quotients greater than 25. This cut-off only applies to a small number of establishments in any industry, mainly those measured at smaller spatial scales by own industry employment (see Appendix D). The excluded establishments are also located in places for smaller than industry averages (see Appendix D and Table 5.1).

5.3.1 Urbanization (URB)

Urbanization economies represent the availability of infrastructure, access to local markets, urban amenities, and other goods requiring a minimum level of human activity for efficient provision. Urbanization may also capture congestion diseconomies, such as traffic, pollution, and higher land rents (Carlino 1978; 1979). I measure urbanization economies by total private-sector employment within each *k* distance band (in 10,000's), using zip code employment totals from the *1994 Zip Code Business Patterns* database. In terms of agglomeration potential (equation 5.1), urbanization is calculated

$$URB_k = \sum_i Emp_{i,k} \tag{5.3}$$

where all industries are weighted equally (i.e. ED_{ij}=1). With distance fixed, variation in the level of employment also accounts for employment density, which Ciccone and Hall (1996) argue is a superior proxy of agglomeration.[32]

I include a regional size variable in both the aggregate (localization) and disaggregate (Marshallian) models. The coefficients may have either a negative or positive influence on plant failure, depending on whether net agglomeration economies or diseconomies prevail. In the localization model, the net effect of region size is unclear and will depend greatly on the specific industry examined. Controlling for industrial diversity will likely reduce the

[32] Employment density and population were tested as alternative proxies for urbanization and found to produce largely similar results as regional employment.

benefits associated with regional size and increase the chances that the net diseconomies prevail in the Marshallian models.

The level of regional employment has to increase as the region surrounding each plant expands (see Table 5.1). On average, there are approximately 36,000 employees within 20 km of each manufacturing entrant. Professional services entrants prefer areas of higher density, with approximately 41,000 employees within 20 km. The most rural industry, farm and garden machinery, has less than 1,000 employees within 20 km, while the most urban, advertising, has over 45,000. At 160 km, computer and data processing services is the most densely located, followed by metalworking machinery and electronic components. At this distance, the urbanization variable increasingly captures the inter-metropolitan spatial distribution of activity, favoring industries concentrated in the Northeast, Great Lakes region and California coast where large metros abut one another.

Table 5.1
Descriptive Statistics, Urbanization Economies*

		20 km			40 km			80 km			160 km		
	N	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**
Manufacturing	46,549	0.36	0.14	0.52	0.81	0.37	1.06	1.46	0.82	1.66	2.71	1.85	2.45
Drugs	206	0.39	0.23	0.48	0.91	0.56	1.07	1.61	0.96	1.73	3.18	2.18	2.75
Farm & garden machinery	278	0.09	0.01	0.22	0.23	0.04	0.47	0.51	0.18	0.83	1.46	0.88	1.67
Metalworking machinery	939	0.30	0.12	0.43	0.76	0.39	0.98	1.51	1.01	1.50	3.29	2.64	2.43
Electronic components	820	0.41	0.31	0.37	0.92	0.78	0.82	1.85	1.45	1.50	3.28	3.16	2.35
Motor vehicle parts	471	0.33	0.14	0.44	0.79	0.37	1.02	1.49	0.81	1.68	2.74	1.86	2.38
Measuring devices	569	0.34	0.23	0.33	0.81	0.61	0.81	1.56	1.11	1.43	2.99	2.23	2.41
Professional services	137,547	0.41	0.28	0.44	0.90	0.65	0.96	1.65	1.05	1.63	2.98	2.17	2.59
Advertising	3,859	0.45	0.34	0.45	0.96	0.70	0.98	1.71	1.07	1.71	3.05	2.19	2.71
Computer & data processing	20,524	0.45	0.34	0.44	1.04	0.86	0.97	1.94	1.39	1.76	3.37	2.37	2.85
Research & testing	3,707	0.40	0.29	0.42	0.87	0.68	0.88	1.64	1.07	1.62	2.99	2.07	2.67

**Measured in 10,000's workers.*

5.3.2 Localization (LOC)

In the original framework of Weber (1929 [1909]) and Hoover (1937), localization plays the role of a summary indicator of the numerous benefits that brings about the geographic concentration of industry. Because most industries exhibit some degree of second-order spatial concentration, I expect localization to have a negative effect on the new firm's hazard of failure, although its relative importance will also vary by industry. In some cases, local competition against similar firms may override weak localization benefits, resulting in a positive coefficient.

Localization economies are measured as the share of same-industry establishments within each distance band (*k*) relative to the national share (equation 5.2). In the terms of equations 5.1 and 5.2, I use establishment counts for the externality measure (I_j) and binary economic weights to identify same industry establishments (i.e. $ED_{ij} = 1$ if $j=i$, $ED_{ij} = 0$ if $j \neq i$). Establishment counts are based on three digit SIC industries taken from the *1994 Zip Code Business Patterns*. I use establishment counts to emphasize potential opportunities for a spatial division of labor between related businesses, most closely associated with a large variety of specialized input suppliers. Establishment counts may also help identify regions with strong small firm networks because it is based on the number, and not the size, of similar plants in a location. The main alternative, employment, gives greater weight to large businesses and may provide a better proxy for externalities originating in workers, such as labor pooling, or market spillovers.[33] In practice, establishment and employment based specialization measures are too highly correlation to include in the same model. Since the

[33] Models estimated with employment-based specialization were generally weaker than models using establishment level specialization. This suggests that input suppliers and small firm networks may be the dominant form of localized externalities for new firms, a result supported by estimation of the Marshallian models in the next chapter.

three primary sources of Marshallian localization are also closely related, I expect my establishment-based measure of industrial specialization to represent benefits stemming from all the sources of localization, and not just input suppliers.

Table 5.2
Descriptive Statistics, Localization Economies

		20 km			40 km			80 km			160 km		
	N	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**
Manufacturing	46,549	2.64	1.29	3.92	2.31	1.24	3.28	2.03	1.19	2.78	1.69	1.13	1.88
Drugs	206	1.93	1.44	1.84	1.53	1.34	1.15	1.33	1.35	0.81	1.17	1.20	0.46
Farm & garden machinery	278	4.86	2.20	6.28	4.70	2.72	5.14	3.73	2.49	4.17	2.85	1.69	2.84
Metalworking machinery	939	2.31	1.55	2.23	2.13	1.51	2.28	1.72	1.16	1.39	1.50	1.11	0.99
Electronic components	820	3.44	1.69	4.20	2.70	1.60	2.84	1.85	1.61	1.33	1.57	1.37	0.89
Motor vehicle parts	471	1.57	0.94	2.33	1.42	1.02	1.60	1.24	1.10	0.96	1.14	1.08	0.53
Measuring devices	569	1.87	1.39	1.74	1.58	1.25	1.22	1.33	1.20	0.78	1.17	1.13	0.56
Professional services	137,547	1.28	1.17	0.71	1.20	1.13	0.53	1.13	1.08	0.43	1.06	1.06	0.31
Advertising	3,859	1.31	1.27	0.63	1.18	1.15	0.47	1.09	1.05	0.38	1.01	0.96	0.31
Computer & data processing	20,524	1.65	1.48	0.98	1.49	1.36	0.75	1.34	1.28	0.59	1.18	1.19	0.41
Research & testing	3,707	1.52	1.23	1.13	1.36	1.16	0.80	1.24	1.11	0.61	1.12	1.09	0.46

As the size of the study region expands, the local share of industry increasingly mirrors the national share, as evidenced by the convergence of average location quotients to one (see Table 5.2). Because location quotients have a lower but no upper bound, the median is the preferred measure of central tendency. The median location quotient exceeds one in nearly all cases coinciding with previous findings that new firm's prefer locations where existing industry is already concentrated (see Table 4.3). Motor vehicle parts (at 20 km) and advertising (at 160 km) are the only cases with median location quotients below one.[34] In general, new establishments in manufacturing are more likely to locate in areas of higher own-industry concentration than professional services. Farm and garden machinery has the highest median at all distances, followed by electronic components. The high scores of farm

[34] The average location quotients for motor vehicle parts may be downwardly biased because Michigan is not represented in the new firm database. If included these new firms would likely bring up the reported averages.

and garden machinery reflect its preference for rural locations. The high location quotients in electronic components coincide with the strong geographic associations between new and existing firms in that industry (see Table 4.3).

5.3.3 Industrial Diversity (DIV)

In addition to urbanization economies derived from the size of the local economy, I also include a separate measure to account for variation in a region's industrial diversity. This measure is intended to capture potential Jacobs-type knowledge spillovers (Henderson *et al.* 1995; Feldman and Audretsch 1999), although it may also represent benefits for new firms operating in competitively organized regions (Chinitz 1961; Carlino 1980; Porter 1990), or advantages pertaining to access to a more diversified clientele. Following Duranton and Puga (2000), I measure industrial diversity with a relative index that measures how far local industry mix matches, or deviates from, the national industrial profile.[35] I calculate the region's industrial diversity as the absolute difference between the local share of local employment in each industry and the national share, summed across all industries (i) in each distance band (k), or

$$RDI_k = \frac{1}{\sum_i \left| Emp_{i,k} \Big/ \sum_i Emp_{i,k} - Emp_{i,US} \Big/ \sum_i Emp_{i,US} \right|} . \quad (5.4)$$

I use the inverse of the summed absolute differences so that a higher index value corresponds to a more diversified regional economy. The index is based on three digit SIC industry employment data from the *1994 Zip Code Business Patterns*. Because the *Zip Code Business*

[35] While I prefer the relative diversity index on conceptual grounds, I also tested models using an absolute (herfidahl) diversity index. The latter was found to be highly correlated with regional employment.

Patterns only reports employment size class by industry, I estimate industry employment by multiplying the establishment counts by the mid-point of each employment size interval and adjusting the employment of the largest size class so that the sum across classes matched the total employment for each zip code. To the extent that new firms benefit from proximity to a wide variety of industrial activity, I expect this variable to have a negative effect on the likelihood of plant failure after controlling for regional size and industrial specialization.

Similar to urbanization, the diversity index increases as the surrounding region expands (Table 5.3). The index is generally centered at 1.8 at 20 km and at 2.9 at 160 km, with manufacturing plants typically located in less diverse areas than professional services at small scales. At the largest scales there is less distinction in regional industrial diversity between the manufacturing and professional services.

Table 5.3
Descriptive Statistics, Regional Industrial Diversity

		20 km			**40 km**			**80 km**			**160 km**		
	N	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**
Manufacturing	46,549	1.68	1.73	0.55	2.03	2.12	0.60	2.40	2.44	0.58	2.82	2.84	0.53
Drugs	206	1.84	1.85	0.46	2.20	2.24	0.47	2.47	2.49	0.50	2.89	2.87	0.47
Farm & garden machinery	278	1.27	1.09	0.52	1.62	1.45	0.60	2.02	1.94	0.62	2.61	2.62	0.65
Metalworking machinery	939	1.71	1.74	0.50	2.13	2.19	0.55	2.58	2.72	0.52	3.05	3.12	0.49
Electronic components	820	1.80	1.84	0.45	2.16	2.19	0.49	2.54	2.51	0.46	2.91	2.92	0.40
Motor vehicle parts	471	1.76	1.84	0.53	2.10	2.20	0.58	2.47	2.52	0.54	2.90	2.97	0.51
Measuring devices	569	1.80	1.84	0.44	2.18	2.21	0.48	2.52	2.51	0.49	2.89	2.89	0.49
Professional services	137,547	1.84	1.88	0.46	2.18	2.26	0.51	2.50	2.51	0.52	2.87	2.89	0.50
Advertising	3,859	1.93	1.97	0.44	2.26	2.34	0.48	2.54	2.55	0.50	2.89	2.89	0.48
Computer & data processing	20,524	1.88	1.90	0.41	2.24	2.30	0.45	2.55	2.53	0.46	2.93	2.91	0.43
Research & testing	3,707	1.83	1.84	0.47	2.17	2.22	0.50	2.47	2.46	0.50	2.84	2.82	0.47

5.3.4 Specialized Input Suppliers (INPUTS)

Access to potential specialized intermediate goods and service providers is the first of the Marshall's (1920 [1890]) three theorized sources of localized external economies. This variable represents the productivity advantages associated with a greater spatial division of labor and reduced transactions costs when new firms are located near their key suppliers.

The specialized input suppliers variable accounts for both within- and cross-industry spillovers between firms in related industries. Most studies use data on inter-industry trade from the *Benchmark Input-Output Accounts of the United States* (*IO*) to measure the economic distance between purchasing and supplier industries. Feser (2001b, 2002) applies *IO* based weights to local industry employment of intermediate goods and producer services suppliers, Dumais *et al.* (1997) uses similar percentages to weigh the share of local industry employment, and Rigby and Essletzbichler (2002) and Koo (2005a) use IO weighted location quotients. I define the economic distance (ED_{ij}) between each industry (i) and its input supplier industries (j) as the percentage of industry *i's* total intermediate goods and service purchases made from industry j, or

$$ED_{ij} = \frac{Purchases_{ij}}{\sum_j Purchases_{ij}}. \tag{5.5}$$

Industry purchasing shares are based on national estimates from the make and use tables of the *1992 Benchmark Input-Output (IO) Accounts*. The *IO Accounts* list the dollar volume of national sales and purchases of 478 commodities by 491 industries.[36] To estimate the sales between industries, the make (**M**) and use (**U**) tables are combined to form a 491x 491 transactions matrix (**T**);

$$\mathbf{T} = \mathbf{M} \bullet \left(\mathrm{diag}\left(\mathbf{O_c}\right)\right)^{-1} \bullet \mathbf{U} \tag{5.6}$$

where $\mathbf{O_c}$ is a vector of total commodity output. The rows of **T** list the industries selling goods and services while the columns list purchasing intermediate goods and industries.

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[36] Government services, non-produced commodities, and other commodities not produced by private industry sectors were eliminated to ensure conformability between the make and use matrices.

I use establishment counts from the *1994 Zip Code Business Patterns* as the externality measure ($I_{j,k}$), which are aggregated from four digit SIC codes into IO industry classes. I use establishments, as opposed to employment, under the assumption that a larger concentration of supplier firms more accurately represents the potential opportunities for outsourcing and specialization. To limit attention to the most important trade partners, I only include the top twenty input suppliers for each industry in the calculations.

The median location quotients for input suppliers are slightly higher than one, with the greatest variation at smaller spatial scales (see Table 5.4). Similar to localization, average input supplier location quotients above one indicate higher entry where input suppliers are specialized. The scores for the specialized input suppliers are closer to national shares and have less variation than the corresponding scores for localization. This may be because the input supplier measure is spread over more industries, and thus has a slightly more uniform spatial distribution than the localization measure.

Table 5.4
Descriptive Statistics, Specialized Input Suppliers

		20 km			40 km			80 km			160 km		
	N	Mean	Median	StdDev	Mean	Median	StdDev	Mean	Median	StdDev	Mean	Median	StdDev
Manufacturing	46,549	1.61	1.05	2.14	1.51	1.04	2.02	1.34	1.03	1.39	1.20	1.02	0.75
Drugs	206	1.04	1.06	0.18	1.03	1.03	0.14	1.00	1.01	0.13	0.99	1.02	0.10
Farm & garden machinery	278	1.60	1.32	1.31	1.36	1.30	0.52	1.21	1.16	0.33	1.13	1.11	0.25
Metalworking machinery	939	1.33	1.19	0.73	1.20	1.12	0.46	1.12	1.07	0.31	1.07	1.06	0.26
Electronic components	820	1.38	1.16	0.76	1.26	1.12	0.53	1.14	1.09	0.31	1.08	1.04	0.25
Motor vehicle parts	471	1.17	1.04	0.54	1.13	1.02	0.40	1.08	1.04	0.31	1.07	1.04	0.24
Measuring devices	569	1.31	1.11	0.73	1.25	1.11	0.58	1.16	1.08	0.41	1.11	1.04	0.35
Professional services	137,547	1.13	1.09	0.36	1.09	1.07	0.30	1.06	1.05	0.24	1.01	1.04	0.17
Advertising	3,859	1.13	1.15	0.28	1.08	1.11	0.23	1.04	1.06	0.20	1.00	1.06	0.16
Computer & data processing	20,524	1.35	1.27	0.52	1.27	1.21	0.41	1.18	1.18	0.33	1.09	1.11	0.23
Research & testing	3,707	1.17	1.14	0.38	1.12	1.11	0.32	1.08	1.07	0.26	1.03	1.07	0.19

5.3.5 Intermediate Goods Markets (MARKETS)

From Smith (1976 [1776]) onward, an expansion of the market has been understood to create the opportunities for a finer division of labor both within and external to the firm. Similarly, urban incubator theories argue that the larger markets found in urban areas help support niche producers operating in the early stages of the product life cycle (Vernon 1960; Leone and Struyk 1976). Recent work on flexible production regimes emphasize the growing intimacy of interaction between large producers and first and second tier suppliers, and the role physical proximity plays in minimizing transactions costs between a firm and its major corporate client(s).

Urbanization accounts for the size of the local market for consumer goods and services, but is too broad to adequately represent specialized markets for intermediate goods and services. Studies of Marshallian externalities include a separate variable for this purpose (Feser 2001a; Feser 2002; Rigby and Essletzbichler 2002; Koo 2005a). I measure proximity to intermediate product markets similarly to the specialized input supplier variable, but with several key differences. The economic distance weights are calculated as industry *i*'s sales to industry *j* as a share of industry *i*'s total (intermediate and final) sales, based on inter-industry sales from the transactions matrix derived from the *1992 U.S. Benchmark Input-Output Accounts*, or

$$ED_{ij} = \frac{Sales_{ij}}{\sum_j Sales_{ij}}. \tag{5.7}$$

The size of the local intermediate goods market for industry *i* is represented by the combined weighted *employment* of potential industrial clients *j*, measured as a share of the total weighted employment of all industries in the region. Employment is the appropriate externality measure ($I_{j,k}$) for intermediate goods markets because local demand depends more on the total size of the potential client base than its distribution across establishment. Industrial employment by zip code is estimated from the *1994 Zip Code Business Patterns* database following the estimation strategy described in the section on industrial diversity. Similar to the specialized input suppliers variable, I only include the top twenty goods purchasing industries in the calculations.

In several industries the median location quotient for intermediate goods markets is below one (see Table 5.5). In particular, new firms in motor vehicle parts and drugs form where intermediate goods suppliers are less specialized than the nation. New firms in electronic components, metalworking machinery, computer and data processing services, and farm and garden machinery (except at 20 km), generally prefer locations of higher intermediate goods supplier concentration.

Table 5.5
Descriptive Statistics, Intermediate Goods Markets

		20 km			**40 km**			**80 km**			**160 km**		
	N	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**
Manufacturing	46,549	1.79	0.99	2.86	1.69	1.00	2.61	1.68	1.00	2.64	1.47	1.00	1.89
Drugs	206	0.95	0.85	0.52	0.96	0.90	0.33	0.95	0.92	0.25	0.93	0.88	0.17
Farm & garden machinery	278	3.33	0.97	5.04	3.24	1.47	4.55	2.73	1.48	3.44	2.47	1.26	2.88
Metalworking machinery	939	1.85	1.29	1.95	1.59	1.16	1.30	1.40	1.13	0.90	1.26	1.06	0.65
Electronic components	820	2.06	1.46	1.82	1.82	1.35	1.40	1.48	1.29	0.79	1.33	1.28	0.56
Motor vehicle parts	471	1.17	0.52	2.01	1.16	0.65	1.38	1.12	0.73	1.01	1.06	0.86	0.70
Measuring devices	569	1.43	0.98	1.63	1.29	1.02	1.15	1.15	0.99	0.82	1.05	0.98	0.42
Professional services	137,547	1.04	1.02	0.34	1.03	1.00	0.26	1.02	0.99	0.21	1.01	0.99	0.16
Advertising	3,859	1.08	1.09	0.27	1.05	1.07	0.21	1.03	1.04	0.18	1.01	1.00	0.15
Computer & data processing	20,524	1.13	1.11	0.32	1.11	1.08	0.24	1.09	1.05	0.20	1.05	1.03	0.16
Research & testing	3,707	1.07	1.02	0.36	1.05	1.01	0.26	1.04	1.02	0.21	1.02	1.01	0.17

5.3.6 Labor Pooling (LABOR)

The concept of labor pooling implies economic benefits from a local abundance of workers of needed specialized skills. There are several different methods used to develop proxies for labor pooling economies. Dumais *et al.* (1997) and Rigby and Essletzbichler (2002) measure how closely the region's occupational profile matches or deviates from the national distribution. As a pure composition measure, this indicator does not directly account for the relative size of the potential labor pool or whether the region has an abundance or deficiency of highly skilled occupations whose relative scarcity heavily influence the location decisions of hi-tech firms (Schmenner 1982; Blair and Premus 1987). Feser (2001a; 2002) follows a different approach. He first groups industries based on similarity in national staffing patterns and then measures the relative concentration of regional employment in occupation based industry clusters. This approach is more likely to capture the depth of the potential labor pool, although more direct measures of labor pooling can be developed from data on the occupational profile of the residential labor force.

My labor pooling measure accounts for both the composition resident work force and the relative specialization of these workers to each industry. I use data on national industry staffing patterns from the *Occupational Employment Survey* (OES) of the U.S. Bureau of Labor Statistic to define the economic distance between occupations and industries.[37] The OES offers two possible alternatives to define economic distance weights. The first is the percentage of the industry's employment filled by workers in different occupational categories (industry share). The second is the percentage of the occupation's employment

[37] In an alternative specification, I substitute the occupation share weights with estimates of each occupation's knowledge intensity using data from the *O*NET 5.1* database developed by the U.S. Department of Labor. While both methods produce largely similar results, the occupation share method was slightly better at distinguishing specialized occupations.

found in each industry (occupation share). A case could be made for the either measure as an indicator of the occupation's importance to the industry. Industry share equates the importance of each occupation by its relative size –the share of the industry's workforce made up of each occupation. One the other hand, some occupations may comprise a sizable share of the employment in an industry, but require very general skills that are readily available. Occupation share measures how specific an occupation is to a particular industry, and may provide a better indicator of specialized, and relatively scarce, labor. Respecting both dimensions, I estimate the economic distance between industries *i* and occupation *j* (ED_{ij}) by multiplying occupational employment share by the industry employment share.

$$ED_{ij} = \frac{Emp_{ij} \Big/ \sum_j Emp_{ij} \bullet Emp_{ij} \Big/ \sum_i Emp_{ij}}{\sum_j \left(Emp_{ij} \Big/ \sum_j Emp_{ij} \bullet Emp_{ij} \Big/ \sum_i Emp_{ij} \right)}. \qquad (5.8)$$

Dividing by the sum across occupations rescales the indicator so that the weight of each occupation reflects its relative importance to the particular industry (*i*). I limit the occupation set for each industry to the most relevant 15 occupations.

I measure the size of the candidate labor pool ($I_{j,k}$) based the occupational profile of the residential employment using data from the *1990 U.S. Census of Population*.[38] The *Census* reports the number of workers in 90 occupational classes down to census tracts, which I aggregate to distance bands surrounding each plant (*k*). Occupational employment is measured at the place of residence, and not at place of work. Residence based measures are more appropriate than work based measures under the assumption that the spatial extent of a

[38] The U.S. Census only records the occupations for those who are currently employed at the time of the census and may undercount the true pool of available workers with relevant skills.

labor pool is determined by the commuting preferences of workers, and not by the distance of one worksite to another. Place of residence and place of business labor force estimates will differ primarily at intra-metropolitan scales where residential and business location patterns diverge.

Table 5.6
Descriptive Statistics, Labor Pooling

		20 km			40 km			80 km			160 km		
	N	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**
Manufacturing	46,549	1.58	1.10	2.18	1.55	1.12	2.05	1.46	1.12	1.63	1.33	1.11	1.09
Drugs	206	1.18	1.17	0.35	1.18	1.11	0.37	1.17	1.10	0.44	1.15	1.11	0.33
Farm & garden machinery	278	1.14	1.04	0.59	1.11	1.04	0.46	1.10	1.03	0.46	1.08	1.05	0.43
Metalworking machinery	939	1.41	1.26	0.65	1.38	1.20	0.60	1.38	1.18	0.71	1.37	1.22	0.66
Electronic components	820	1.27	1.15	0.46	1.25	1.17	0.45	1.23	1.18	0.61	1.18	1.10	0.43
Motor vehicle parts	471	1.13	1.01	0.59	1.16	1.05	0.50	1.18	1.12	0.49	1.16	1.09	0.42
Measuring devices	569	1.19	1.14	0.44	1.18	1.12	0.47	1.22	1.12	0.72	1.17	1.12	0.45
Professional services	137,547	1.26	1.17	0.54	1.26	1.16	0.60	1.27	1.12	0.71	1.19	1.09	0.51
Advertising	3,859	1.33	1.26	0.58	1.31	1.22	0.73	1.29	1.16	0.76	1.20	1.12	0.55
Computer & data processing	20,524	1.55	1.45	0.68	1.52	1.38	0.71	1.52	1.31	0.91	1.34	1.16	0.59
Research & testing	3,707	1.37	1.26	0.65	1.34	1.25	0.54	1.33	1.18	0.64	1.25	1.09	0.50

Average measures of labor pooling are consistently greater than one, indicating new firm formation in areas of higher occupational specialization (Table 5.6). The professional services industries generally have higher average location quotients than manufacturing at small spatial scales, possibly because of the greater separation of manufacturing and residential land-uses. Labor pooling location quotients are fairly consistent across spatial scales, with median labor pooling scores exhibiting less variation at smaller spatial scales than found for the localization proxy. It is unlikely that occupation plays an important role in the spatial segmentation of the residential population, resulting in a more uniform spatial distribution than observed for industry based employment. Local spatial concentration will also be influenced by degree of aggregation of census occupation groups relative to industry groups.

5.3.7 Industrial Knowledge Spillovers (KNOW)

Knowledge spillovers are believed to be of particular importance for small and new firms, who are, presumably, more reliant on external sources of knowledge. Acs and Audretsch (1990) suggests a strong association between small firms and regional innovation. External knowledge and spillovers help reconcile high innovation rates of small firms with their low R&D expenditures (Acs *et al.* 1994; Audretsch and Vivarelli 1996). Small firms appear particularly adept at innovating in industries where the source of knowledge comes from outside the industry (Nelson and Winter 1982), such as those in the early stages of a product's life cycle (Vernon 1960; Norton and Rees 1979).

Researchers take several different paths to measuring the sources of knowledge spillovers. Griliches (1992) describes two general avenues for the transmission of new knowledge: "embodied" spillovers where knowledge is transmitted through the adoption of new equipment and technology, and "disembodied" spillovers that are closer in concept to pure knowledge spillovers (Romer 1986, 1990; Lucas 1988). Acknowledging the difficulty in measuring disembodied spillovers, Rigby and Essletzbichler (2002) proxy embodied technological spillovers based on productivity growth in upstream industries. Feser (2001a, 2002) uses county patent data to indicate regional environments where disembodied knowledge spillover are likely. Dumais *et al.* (1997) develop two measures of disembodied spillovers: one based on Scherer's (1982) technology flow matrix, the other based on an analysis of cross-industry plant co-ownership patterns using micro records from the Longitudinal Research Database (LRD).

I follow Koo (2005a, 2005b) by using the geographic distribution of patents weighted by a technology flow matrix to identify areas where disembodied knowledge spillovers may be most prevalent. The limitations of patents as a proxy for the geographic distribution of knowledge spillover are well known (Griliches 1979, 1990; Acs *et al.* 2002). Not all inventions are patented, and patents do not indicate the economic value of an invention. Furthermore, the propensity to patent varies greatly across industries and patents categories do not always match to industry categories with equal relevance. This means that patent counts may be a good proxy for knowledge spillover in some industries, but not others. Despite these many flaws, and lacking any better alternatives, I include patent-based measures in my study but interpret them cautiously.[39]

Industry utility patent counts are taken from an electronic database maintained by the U.S. Patents and Trademark Office (USPTO). I include all patents with an application date within five years prior to plant's initial date of entry, locating each by the community (city, town, etc..) of residence of each named author. Patents with multiple authors living in different communities are split and given equal weight at each location.

Recognizing that cross-industry spillovers are predominantly transmitted between establishments with a common technological foundation (Feldman and Audretsch 1999), I use the inter-industry technology flow matrix developed by Koo (2005b) as the basis of

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[39] I test two alternate specifications for the disembodied knowledge spillovers. The first weighs industry employment by similarity in the commodities produced between industry pairs, as determined from the Make table of the IO Accounts. This variable is based the assumption that industries producing similar goods have similar technological foundations (Panzar and Willig 1981) The second measure applied cross-industry patent citation weights to industry employment instead of patents. Both measures were highly correlated with the other indicators of external economies.

economic distance weights between industries (ED_{ij}). Koo's technology flow matrix is based on an analysis of industrial patent citation patterns across industries, roughly equivalent to the share of patents citations in industry *i* that originate in industry *j*. To focus on the most relevant industries I only include the top five cited *j* industries. The USPTO industry classes for business and professional service industries are highly aggregated, and as a result industrial knowledge spillovers are only calculated for manufacturing industries.

The average index scores for knowledge spillovers are noticeably lower than the other location quotient based measures of localization at smaller scales (Table 5.7). This suggests that the spatial association between new firms and patents is not as close as the association between new firms and existing industry or specialized workers.[40] The association is highest for electronic components and weakest for motor vehicle parts. As with several other measures, the patent based location quotients converge to the national share as the spatial scale expands.

Table 5.7
Descriptive Statistics, Industrial Knowledge Spillovers

		20 km			40 km			80 km			160 km		
	N	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**	**Mean**	**Median**	**StdDev**
Manufacturing	46,549	1.10	0.79	1.46	1.06	0.90	1.14	1.05	0.97	0.83	1.01	0.97	0.54
Drugs	206	1.63	0.77	1.87	1.41	0.94	1.31	1.27	0.93	0.98	1.09	1.08	0.60
Farm & garden machinery	278	1.60	0.85	2.56	1.44	0.96	2.03	1.22	0.99	1.23	1.10	1.02	0.46
Metalworking machinery	939	1.24	0.98	1.20	1.11	1.07	0.72	1.07	1.09	0.52	1.03	1.06	0.39
Electronic components	820	3.19	1.21	4.20	2.82	1.27	3.53	2.13	1.15	2.14	1.77	1.19	1.43
Motor vehicle parts	471	0.93	0.68	1.16	0.93	0.73	0.95	0.88	0.77	0.57	0.87	0.87	0.47
Measuring devices	569	1.78	1.07	2.24	1.66	1.04	1.94	1.39	1.05	1.17	1.22	1.00	0.83

[40] The divergent spatial association between new firms and patents may also relate to the relatively high aggregation of USPTO industry classes.

5.4 Additional Controls

5.4.1 Establishment Age

In an event duration model, the influence of a establishment's age on its continued survival is represented by the shape of the baseline hazard function $\alpha(t)$. Unlike more common continuous time hazard models, the discrete complementary log-log specification imposes no prior restrictions on the shape of $\alpha(t)$. Allison (1995) recommends specifying $\alpha(t)$ with a series of dummy variables, one for each interval. The resulting coefficient estimates describe the instantaneous risk of failure at each time period after controlling for other included covariates. While Allison's approach captures the full temporal variation in the baseline hazard, it uses many degrees of freedom and is only appropriate for large datasets with relatively few time intervals.

A more parsimonious specification is attained by imposing restrictions on the shape of the baseline hazard. Lacking any theoretical basis for identifying the baseline hazard, I determine $\alpha(t)$ empirically by sequentially testing higher orders of polynomials as a function of time (t). I begin with a linear baseline hazard ($\alpha(t)=a_1t$) and then re-estimate each model by adding squared ($\alpha(t)=a_1t+a_2t^2$), cubic ($\alpha(t)=a_1t+a_2t^2+ a_3t^3$), and quadric ($\alpha(t)=a_1t+a_2t^2+ a_3t^3+ a_4t^4$) representations of t. I use likelihood ratio tests to determine whether higher order polynomials are a significant improvement over more parsimonious specifications.

5.4.2 Establishment Size (SIZE)

Establishment size represents the plant's ability to benefit from internal scale economies, access to other critical financial or information resources, and the volume of sunk costs in non-recoverable fixed assets that may deter early exit (Caves and Porter 1976; Eaton and

Lipsey 1980; Rosenbaum and Lamort 1992). Establishment size is expected to reduce the plant's likelihood of failure, as consistently found in past research (Dunne and Hughes 1994; Mata and Portugal 1994; Wagner 1994; Audretsch 1995b; Audretsch and Mahmood 1995; Doms *et al.* 1995; Mata *et al.* 1995).

There is some debate over how plant size should be measured. Audretsch (1995a) and Audretsch and Mahmood (1995) use employment at birth to represent the plant's scale economies and access to other resources. Mata *et al.* (1995) argue that current employment better captures the dynamic influence of the plant's growth on its risk of failure. However, current size may overstate the causal association between size and hazard rates. An examination of establishment records in the LDB reveals that establishments often shed workers prior to exit. Measured by current size, the statistical model may falsely associate the plant's failure to its smaller size during the last period of its operation, when then true cause of failure was not the plant's deficient internal resources but some unmeasured factor, such as declining demand, that led to both the plant's downsizing as well as its ultimate failure. In this common situation, small plant size is a symptom of a failing business rather its cause.

Table 5.8
Descriptive Statistics, Establishment Size*

	N	Mean	Median	StdDev
Manufacturing	46,549	18.0	6.0	48.4
Drugs	206	25.6	10.0	42.8
Farm & garden machinery	278	13.8	6.0	23.7
Metalworking machinery	939	12.6	6.0	26.5
Electronic components	820	39.3	11.0	93.9
Motor vehicle parts	471	31.1	7.0	77.6
Measuring devices	569	18.3	6.0	39.2
Professional services	137,547	13.0	3.0	76.8
Advertising	3,859	7.5	3.0	19.7
Computer & data processing	20,524	12.6	3.0	62.6
Research & testing	3,707	13.4	4.0	38.2

**Measured as the plant's largest employment during its first seven years.*

I use the maximum employment of the plant over during its first seven years to represent its potential internal scale economies, ability to utilize advanced production technologies, and access to information and financial resources. Unlike current size, this measure should not overstate the hazard associated with small plant size. In practice, the alternate use of current versus maximum size made little difference on the coefficient estimates of the external economy variables.

Table 5.8 describes the average maximum plant size for new firms in each industry. The average maximum size of each plant is typically much larger than the average plant size when measured at birth, although still much smaller than the average size of incumbents (see Table 4.7). The distribution of average plants sizes across industries is consistent with previous findings. The largest new firms are in electronic components, motor vehicle parts, and drugs, while advertising and computer and data processing services are the smallest.

5.4.3 University Strength (UNIV)

Research universities are another commonly postulated source of knowledge spillovers (Jaffe 1989; Acs *et al.* 1992; Beeson and Montgomery 1993; Anselin *et al.* 1997). They are believed to have a particularly strong influence on entrepreneurial innovation in small firms (Acs *et al.* 1994). Feldman (1994b) argues that the ability of a region to translate academic knowledge into marketable goods and services is critically dependent on local availability of entrepreneurs and supporting institutions. Knowledge generated at universities, either through research or teaching, also stimulates localized entry in high-tech industries (Bania *et al.* 1993; Kirchoff *et al.* 2002; Woodward *et al.* 2004). It is reasonable to expect that new firms in proximity to academic institutions also have a survival advantage due to their ability to access cutting-edge research, highly-skilled workers, and the many university-based programs that support innovative businesses.

For manufacturing, I measure university strength by the region's share of national university R&D expenditures in academic disciplines sharing a common technology foundation with the industry of each new firm (Feldman and Audretsch 1999). This is measured as,

$$UNIV_{i,k} = \sum_j ED_{ij} \frac{RD_{j,k}}{RD_{j,US}}, \tag{5.9}$$

where economic distance (ED_{ij}) is a binary indicator equal to one if academic discipline j is closely related to industry i. The industry-academic concordance is based on responses to the 1994 Carnegie Mellon Survey on industrial R&D as reported in Cohen, *et al.* (2002). The survey asks a sample of R&D lab managers to rank the importance of public research in ten academic fields to their firm's research. The results are reported by broad manufacturing industries, generally at the two or three digit SIC level. I identify relevant disciplines as those where over 35 percent of respondents identified the field as "moderately" or "very" important. I then calculate the regional university activity ($U_{i,j}$) by matching the industry of each new firm to University R&D expenditures in relevant discipline as reported in the National Science Foundation's WebCaspar database. University R&D expenditures were averaged for the three years preceding each plant's date of entry. The locations of academic institutions, measured at zip code centroids, are taken from the Integrated Postsecondary Education System (IPEDS) database; an annual compendium of enrollment and degree completions for all educational institutions that administer federal financial aid in the U.S..

The Carnegie survey does not cover service-based industries and it is presumed that these firms are less likely to directly benefit from academic research (Goldstein and Drucker, 2005). Firms in business and professional services may be more influenced by a larger pool of university trained workers. For business and professional services industries I identified the most relevant disciplines by reviewing *Classification of Instructional Program (CIP)* definitions and calculating university activity based on academic completions in these fields as reported in the *IPEDS* completion survey. The number of local completions in relevant fields is standardized by the total stock in the nation:

$$UNIV_{i,k} = \sum_j ED_{ij} \frac{Completions_{j,k}}{Completions_{j,US}}, \tag{5.10}$$

where economic distance (ED_{ij}) is a binary (0,1) weight used to identify relevant academic disciplines (*j*) for each industry (*i*). To restrict analysis to prominent academic institutions, I only include completions for institutions ranked as doctoral or research institutions by the 1994 Carnegie Classification system. The relevant disciplines for the study industries are listed in Appendix E.

5.4.4 Large Plant Dominance (LG SHARE)

The core of the Chinitz (1961) hypothesis is that the organization of the local economic environment plays a key role in determining a region's development trajectory. He argues that regions dominated by a small number of large firms may hinder new business because such places often lack the supportive institutions and financial mechanisms that aid small business development. Entrepreneurs in such places may also face negative cultural barriers that often subjugate small business owners to second class citizen status. Along similar lines, Mason (1991) argues that the local organization of industry influences entrepreneurship through both supply and demand factors. The supply of potential entrepreneurs is curtailed in regions dominated by large branch plants because the task specialization of branch plant production does not provide workers with the opportunity to gain experience in the range of technical and managerial skills necessary for small business success (O'Farrell and Hitchens

1988). Subsidiaries and branch operations of large firms are also less likely to source inputs from local providers, resulting in fewer market opportunities for new businesses (Chinitz 1961; Mason 1991).

Direct indicators of industrial dominance, such as credit availability, small business support services, and cultural bias, are difficult to measure with available secondary data. Empirical studies of new firm formation commonly use average firm size (Audretsch and Fritsch 1994; Sutaria 2001; Armington and Acs 2002; Sutaria and Hicks 2004) or the share of employment in small firms (Reynolds 1994, Keeble, 1994 #1138; Fotopoulos and Spence 1999) to identify regions where the environment may be more hospitable to small firms. Feser (2002) uses a more explicit measure of regional dominance, the concentration of the regional sales in the top four employers, in his study of manufacturing productivity. I take a similar approach, calculating industrial dominance as the share of the region's employment in its four largest establishments based on micro data in the LDB. Because my measure is based on large establishments, and not firms, this measure may understate industrial dominance in regions where a single entity owns several large facilities.

5.4.5 Regional Educational Attainment (BACH)

I include the share of the region's adult labor force (24+ years old) with a bachelor's degree of higher to represent the region's stock of general human capital. This is calculated from the *1990 U.S. Census of Population* based on census tract geography. Regional educational attainment controls for higher knowledge and skill of the residential labor force that is not specific to a particular industry, but still beneficial. It is plausible that new establishments have less need for specialized workers, because new firms are smaller and lack the strict task specialization associated with large branch plants. Yet a new firm may still benefit from having access to higher population of educated workers, particularly if higher education makes workers more capable of performing a variety of tasks quickly and without need for additional formal training.

5.4.6 Population Growth (POPGR)

The final control is region's growth rate, measured as the percentage change in the residential population between the 1990 and 2000 *U.S. Census of Population*.[41] Population growth is common in studies of regional firm formation where it is used to represent expansion in local demand that induces market entry (Audretsch and Fritsch 1994; Keeble and Walker 1994; Reynolds 1994; Johnson and Parker 1996; Armington and Acs 2002). Similarly, expansion in local demand may also reduce short run competitive pressures on new firms following their birth. An expanding population base signifies growing market opportunities for the many new firms that exist to serve the local population, and may provide the business with some shelter from intense price or quality based competition. In a stagnant, or declining, region a local-serving new business must pull customers from existing competitors.

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[41] Population within each distance band is aggregated from census block groups. Aggregating from highly disaggregate block groups helps reduce error associated with changes in Census geography between 1990 and 2000.

Table 5.9
Maufacturing and Professional Services
Bivariate Correlations, Measured at 20 km* and 160 km**

	SIZE	URB	LOC	INPUTS	MARKETS	DIV	LP	KNOW	UNIV	LG SHARE	BACH	POPGR
Manufacturing												
SIZE		0.04	0.01	-0.02	0.00	0.02	-0.02	0.00	0.02	-0.03	-0.01	-0.01
URB	0.03		-0.05	-0.08	-0.08	0.49	-0.04	-0.01	0.62	-0.41	0.30	-0.14
LOC	0.01	-0.01		0.36	0.50	-0.17	0.27	0.02	-0.03	0.12	-0.15	-0.02
INPUTS	-0.01	-0.13	0.72		0.41	-0.29	0.65	0.01	-0.05	0.29	-0.25	-0.06
MARKETS	0.00	-0.11	0.46	0.50		-0.20	0.35	0.00	-0.05	0.17	-0.17	-0.03
DIV	0.03	0.49	-0.14	-0.22	-0.15		-0.26	-0.01	0.32	-0.70	0.49	-0.12
LP	-0.02	0.00	0.59	0.68	0.47	-0.11		0.01	-0.04	0.24	-0.21	-0.07
KNOW	0.05	0.26	0.06	-0.03	-0.02	0.20	-0.01		0.00	0.01	0.00	0.00
UNIV	0.01	0.77	-0.08	-0.15	-0.10	0.44	0.00	0.22		-0.23	0.24	-0.13
LG SHARE	-0.02	-0.38	0.06	0.08	0.06	-0.59	-0.05	-0.20	-0.37		-0.50	0.02
BACH	0.01	0.48	-0.11	-0.24	-0.17	0.39	-0.12	0.49	0.46	-0.30		0.10
POPGR	0.00	-0.29	-0.11	-0.17	-0.09	-0.25	-0.16	-0.02	-0.26	0.32	0.11	
Professional Services												
SIZE		0.02	0.01	0.01	0.01	0.02	0.00		0.01	-0.02	0.00	0.00
URB	0.00		0.15	0.44	0.19	0.39	0.43		0.70	-0.43	0.26	-0.03
LOC	0.01	0.31		0.41	0.15	0.03	0.31		0.11	-0.15	0.30	0.03
INPUTS	0.00	0.41	0.80		0.41	0.23	0.69		0.28	-0.46	0.75	0.01
MARKETS	0.00	0.25	0.38	0.47		0.10	0.33		0.18	-0.13	0.31	-0.02
DIV	0.00	0.42	0.22	0.32	0.00		0.11		0.22	-0.60	0.16	-0.04
LP	-0.01	0.59	0.39	0.46	0.35	0.19			0.31	-0.35	0.64	0.00
UNIV	0.00	0.90	0.32	0.39	0.28	0.37	0.58			-0.22	0.15	-0.03
LG SHARE	0.00	-0.38	-0.15	-0.25	-0.07	-0.59	-0.26		-0.31		-0.38	0.03
BACH	0.00	0.42	0.60	0.81	0.44	0.29	0.55		0.39	-0.32		0.01
POPGR	0.01	-0.38	0.19	0.16	-0.18	-0.35	-0.18		-0.36	0.39	0.04	

**Above principle diagnal (shaded) = correlations measured at 20 km*
***Below principle diagnal (not shaded) = correlations measured at 160 km*

Table 5.10
Drugs, Farm & Garden Machinery, Metalworking Machinery
Bivariate Correlations, Measured at 20 km* and 160 km**

	SIZE	URB	LOC	INPUTS	MARKETS	DIV	LP	KNOW	UNIV	LG SHARE	BACH	POPGR
Drugs												
SIZE		0.28	-0.07	0.11	-0.10	0.10	0.16	0.00	0.12	-0.12	0.02	0.08
URB	0.09		-0.13	0.37	-0.21	0.32	0.39	-0.07	0.66	-0.38	0.02	-0.20
LOC	-0.03	0.32		0.25	0.12	-0.03	0.05	0.39	0.02	-0.11	0.18	-0.07
INPUTS	0.06	0.59	0.36		-0.01	0.44	0.25	0.23	0.34	-0.40	0.38	-0.06
MARKETS	-0.07	-0.04	-0.04	-0.45		-0.15	-0.41	-0.09	-0.11	0.46	-0.24	-0.15
DIV	0.06	0.39	0.16	0.44	-0.29		0.10	-0.11	0.18	-0.57	0.12	-0.28
LP	0.03	0.52	0.29	0.23	0.01	0.23		0.44	0.37	-0.36	0.59	0.12
KNOW	-0.03	0.43	0.38	0.48	-0.23	0.25	0.44		0.21	-0.05	0.58	0.05
UNIV	0.04	0.91	0.29	0.49	-0.01	0.28	0.56	0.63		-0.14	0.26	-0.16
LG SHARE	-0.08	-0.36	-0.19	-0.20	0.11	-0.57	-0.37	-0.51	-0.43		-0.15	0.09
BACH	0.01	0.37	0.25	0.62	-0.38	0.27	0.47	0.78	0.51	-0.44		0.17
POPGR	-0.01	-0.37	-0.09	0.01	-0.47	-0.41	-0.27	-0.19	-0.34	0.50	0.01	
Farm and Garden Machinery												
SIZE		0.08	-0.07	-0.08	-0.01	0.10	0.08	-0.05	0.01	-0.04	-0.03	0.01
URB	0.04		-0.15	-0.22	-0.13	0.70	-0.10	-0.07	0.55	-0.38	0.45	-0.02
LOC	-0.06	-0.48		0.93	0.70	-0.32	-0.14	0.35	-0.07	-0.02	-0.23	-0.13
INPUTS	-0.07	-0.37	0.74		0.64	-0.38	-0.07	0.32	-0.13	-0.01	-0.34	-0.14
MARKETS	-0.02	-0.36	0.84	0.66		-0.25	-0.05	0.09	-0.07	-0.05	-0.20	-0.11
DIV	0.12	0.69	-0.57	-0.49	-0.41		-0.10	-0.17	0.35	-0.60	0.59	0.01
LP	0.01	0.27	-0.13	0.12	0.03	0.33		-0.11	-0.10	0.13	-0.28	-0.13
KNOW	-0.06	-0.05	0.42	0.28	0.39	-0.19	0.09		-0.03	0.02	-0.03	-0.05
UNIV	-0.05	0.73	-0.35	-0.31	-0.27	0.52	0.07	-0.10		-0.20	0.37	0.00
LG SHARE	-0.09	-0.49	0.44	0.22	0.30	-0.64	-0.32	0.16	-0.39		-0.33	-0.01
BACH	0.02	0.53	-0.36	-0.61	-0.31	0.56	-0.06	0.07	0.41	-0.25		0.01
POPGR	0.05	0.02	-0.42	-0.51	-0.42	0.13	-0.16	-0.27	-0.02	-0.10	0.30	
Metalworking Machinery												
SIZE		0.02	0.00	-0.02	0.07	0.05	0.02	-0.03	0.00	-0.04	-0.03	-0.10
URB	0.06		-0.13	-0.21	-0.23	0.51	-0.18	-0.07	0.40	-0.44	0.41	-0.17
LOC	0.05	0.11		0.88	0.68	-0.17	0.62	0.03	-0.11	0.03	-0.22	-0.19
INPUTS	-0.01	-0.10	0.76		0.71	-0.27	0.68	0.09	-0.16	0.10	-0.37	-0.20
MARKETS	0.05	-0.08	0.86	0.75		-0.27	0.59	-0.01	-0.14	0.13	-0.38	-0.22
DIV	0.03	0.37	0.47	0.29	0.27		-0.24	-0.02	0.27	-0.69	0.48	-0.22
LP	0.03	0.30	0.57	0.34	0.48	0.20		0.04	-0.16	0.05	-0.36	-0.27
KNOW	-0.02	0.26	0.24	0.10	0.03	0.30	0.27		-0.05	-0.18	0.37	0.15
UNIV	0.03	0.67	-0.09	-0.18	-0.16	0.24	0.21	0.23		-0.14	0.18	-0.14
LG SHARE	-0.05	-0.29	-0.36	-0.32	-0.34	-0.50	-0.39	-0.31	-0.29		-0.47	0.11
BACH	-0.03	0.54	-0.23	-0.39	-0.49	0.30	0.09	0.63	0.42	-0.17		0.16
POPGR	-0.08	-0.30	-0.57	-0.53	-0.55	-0.34	-0.48	-0.07	-0.29	0.45	0.19	

**Above principle diagnal (shaded) = correlations measured at 20 km*
***Below principle diagnal (not shaded) = correlations measured at 160 km*

Table 5.11
Electronic Components, Motor Vehicle Parts, Measuring Devices
Bivariate Correlations, Measured at 20 km* and 160 km**

	SIZE	URB	LOC	INPUTS	MARKETS	DIV	LP	KNOW	UNIV	LG SHARE	BACH	POPGR
Electronic Components & Accessories												
SIZE		-0.01	0.04	0.02	0.05	-0.02	0.03	0.03	0.03	-0.03	-0.02	0.09
URB	-0.06		0.29	0.34	0.28	0.40	0.26	0.26	0.42	-0.47	0.38	-0.18
LOC	0.01	0.23		0.82	0.89	-0.28	0.74	0.84	0.39	-0.23	0.31	-0.05
INPUTS	0.00	0.32	0.76		0.82	-0.14	0.63	0.69	0.35	-0.26	0.27	-0.10
MARKETS	0.03	0.15	0.90	0.69		-0.20	0.71	0.85	0.39	-0.32	0.48	0.01
DIV	-0.04	0.38	0.07	0.19	0.09		-0.14	-0.24	-0.04	-0.55	0.21	-0.12
LP	-0.03	0.35	0.12	0.13	0.11	0.25		0.66	0.25	-0.28	0.22	-0.10
KNOW	0.04	0.01	0.80	0.51	0.84	-0.10	-0.06		0.49	-0.25	0.47	0.03
UNIV	0.01	0.56	0.48	0.36	0.54	0.23	0.29	0.44		-0.20	0.38	-0.09
LG SHARE	-0.02	-0.34	-0.39	-0.29	-0.46	-0.52	-0.30	-0.31	-0.47		-0.47	0.06
BACH	0.02	0.29	0.70	0.51	0.81	0.15	0.18	0.71	0.58	-0.43		0.15
POPGR	0.06	-0.48	-0.07	-0.16	-0.03	-0.35	-0.36	0.15	-0.33	0.41	0.02	
Motor Vehicle Parts & Accessories												
SIZE		-0.09	0.10	0.14	0.30	-0.12	0.17	0.00	-0.03	0.08	-0.18	-0.05
URB	-0.07		-0.15	-0.25	-0.16	0.52	-0.15	-0.14	0.50	-0.47	0.39	-0.18
LOC	0.23	-0.03		0.57	0.50	-0.24	0.51	0.19	-0.08	0.13	-0.28	-0.04
INPUTS	0.09	-0.18	0.57		0.33	-0.39	0.57	0.23	-0.15	0.35	-0.54	-0.17
MARKETS	0.34	-0.21	0.66	0.50		-0.16	0.44	0.12	-0.05	0.15	-0.15	0.01
DIV	0.07	0.47	0.13	-0.05	0.17		-0.32	-0.08	0.24	-0.73	0.52	-0.13
LP	0.15	0.15	0.60	0.52	0.63	0.14		0.22	-0.09	0.18	-0.43	-0.12
KNOW	0.01	0.12	0.45	0.36	0.29	0.19	0.57		-0.10	0.03	0.01	0.05
UNIV	-0.08	0.74	-0.05	-0.21	-0.25	0.40	0.02	0.03		-0.16	0.16	-0.14
LG SHARE	-0.08	-0.32	-0.23	-0.12	-0.27	-0.55	-0.29	-0.13	-0.28		-0.53	0.02
BACH	-0.18	0.55	-0.33	-0.46	-0.49	0.43	-0.19	0.11	0.49	-0.26		0.17
POPGR	-0.05	-0.30	-0.21	-0.38	-0.27	-0.23	-0.40	-0.20	-0.19	0.23	0.16	
Measuring & Controlling Devices												
SIZE		0.02	0.07	0.06	0.05	0.05	0.13	0.07	0.04	0.00	0.11	0.02
URB	-0.03		0.05	0.28	0.08	0.50	0.15	0.17	0.41	-0.50	0.26	-0.23
LOC	0.11	0.28		0.48	0.35	-0.21	0.28	0.50	0.12	-0.07	0.20	0.03
INPUTS	-0.01	0.33	0.57		0.57	0.01	0.59	0.75	0.16	-0.30	0.30	-0.09
MARKETS	0.08	0.08	0.45	0.29		-0.12	0.40	0.59	0.09	-0.11	0.16	-0.05
DIV	-0.02	0.46	0.25	0.27	0.11		-0.04	-0.12	0.21	-0.52	0.15	-0.29
LP	0.06	0.43	0.39	0.33	0.17	0.29		0.52	0.04	-0.24	0.20	-0.08
KNOW	0.08	0.13	0.79	0.50	0.53	0.08	0.16		0.24	-0.17	0.40	0.00
UNIV	0.01	0.69	0.19	0.21	0.08	0.37	0.31	0.09		-0.12	0.26	-0.14
LG SHARE	-0.03	-0.37	-0.35	-0.32	-0.20	-0.57	-0.32	-0.25	-0.35		-0.21	0.10
BACH	0.04	0.35	0.70	0.44	0.35	0.25	0.32	0.69	0.33	-0.33		0.03
POPGR	0.01	-0.44	-0.18	-0.19	-0.15	-0.48	-0.36	-0.07	-0.33	0.52	-0.06	

**Above principle diagnal (shaded) = correlations measured at 20 km*
***Below principle diagnal (not shaded) = correlations measured at 160 km*

Table 5.12
Advertsing, Computer & Data Processing, Research & Testing Services
Bivariate Correlations, Measured at 20 km* and 160 km**

	SIZE	URB	LOC	INPUTS	MARKETS	DIV	LP	UNIV	LG SHARE	BACH	POPGR
Advertising											
SIZE		0.08	0.06	0.06	0.05	0.04	0.04	0.09	-0.04	0.02	-0.03
URB	0.06		0.54	0.63	0.38	0.32	0.54	0.59	-0.42	0.24	-0.22
LOC	0.04	0.53		0.67	0.42	0.37	0.51	0.33	-0.46	0.39	-0.08
INPUTS	0.06	0.53	0.61		0.62	0.41	0.63	0.29	-0.60	0.70	-0.04
MARKETS	0.05	0.67	0.43	0.65		0.34	0.46	0.15	-0.45	0.51	-0.11
DIV	0.04	0.37	0.45	0.47	0.33		0.12	0.11	-0.59	0.10	-0.31
LP	0.03	0.73	0.47	0.46	0.62	0.20		0.28	-0.44	0.66	0.11
UNIV	0.05	0.83	0.54	0.41	0.50	0.40	0.67		-0.13	0.08	-0.17
LG SHARE	-0.03	-0.36	-0.16	-0.24	-0.32	-0.59	-0.25	-0.28		-0.39	0.10
BACH	0.05	0.44	0.36	0.79	0.70	0.30	0.54	0.37	-0.33		0.16
POPGR	-0.01	-0.37	0.01	0.14	-0.20	-0.33	-0.20	-0.38	0.40	0.03	
Computer & Data Processing Services											
SIZE		0.03	0.03	0.05	0.04	0.02	0.03	0.02	-0.03	0.03	-0.02
URB	-0.01		0.16	0.29	0.28	0.28	0.30	0.81	-0.42	0.17	-0.24
LOC	0.02	0.33		0.85	0.57	-0.10	0.72	0.13	-0.33	0.68	0.13
INPUTS	0.03	0.36	0.98		0.71	-0.02	0.81	0.22	-0.44	0.80	0.10
MARKETS	0.03	0.44	0.79	0.82		0.00	0.59	0.30	-0.30	0.66	-0.07
DIV	0.00	0.28	0.29	0.27	0.12		-0.11	0.03	-0.50	-0.06	-0.30
LP	-0.01	0.57	0.58	0.57	0.56	0.15		0.36	-0.31	0.76	0.18
UNIV	-0.02	0.93	0.33	0.34	0.46	0.16	0.62		-0.20	0.17	-0.19
LG SHARE	-0.01	-0.34	-0.48	-0.43	-0.37	-0.55	-0.34	-0.27		-0.29	0.12
BACH	0.02	0.33	0.90	0.90	0.82	0.15	0.66	0.36	-0.35		0.17
POPGR	0.01	-0.46	0.08	0.10	-0.17	-0.33	-0.22	-0.39	0.36	0.04	
Research & Testing Services											
SIZE		0.03	0.02	0.04	0.02	0.03	0.04	0.01	-0.03	0.04	0.01
URB	0.02		0.13	0.43	0.44	0.37	0.13	0.72	-0.44	0.25	-0.22
LOC	0.02	0.26		0.41	0.21	-0.11	0.40	0.20	-0.04	0.39	-0.03
INPUTS	0.03	0.36	0.78		0.49	0.17	0.60	0.31	-0.38	0.81	0.09
MARKETS	0.02	0.50	0.62	0.63		0.15	0.19	0.50	-0.17	0.35	-0.26
DIV	0.01	0.40	0.15	0.33	0.07		-0.06	0.24	-0.57	0.09	-0.22
LP	0.00	0.49	0.48	0.48	0.45	0.14		0.08	0.00	0.67	0.10
UNIV	0.01	0.94	0.36	0.38	0.55	0.44	0.54		-0.22	0.24	-0.28
LG SHARE	-0.02	-0.40	-0.25	-0.34	-0.11	-0.57	-0.25	-0.43		-0.27	0.12
BACH	0.03	0.37	0.80	0.90	0.62	0.25	0.63	0.41	-0.34		0.12
POPGR	0.01	-0.40	0.04	0.23	-0.21	-0.29	-0.15	-0.48	0.34	0.11	

**Above principle diagnal (shaded) = correlations measured at 20 km*
***Below principle diagnal (not shaded) = correlations measured at 160 km*

5.5 Pairwise Correlations

Multicollinearity is a major concern when jointly modeling multiple sources of external economies. The alternate sources of external economies are all interrelated. In his original formulation, Marshall (1920 [1890]) does not distinguish deep pools of specialized labor, abundant local intermediate goods suppliers, and knowledge spillover as mutually exclusive entities, but as types of benefits all derived from the local concentration of industry. While every attempt was made to develop measures based on the conceptual distinctions of the underlying constructs, the fact remains that they all share a common origin and may lack sufficient spatial variation to reliably estimate their independent effects. A similar problem holds for different aspects of urbanization. Large cities tend to be more diverse, even if only because they attract activity of all types in proportion to their total size.

To check whether the measured variables relate to one another in a theoretically consistent and independent manner, I calculate pairwise correlations between the key independent variables. Due to limited space, I only present correlations measured at the smallest (20 km) and largest (160 km) spatial scales in Tables 5.9 through 5.12. The shaded cells above the principle diagonal include correlations estimated at 20 km, while cells below the principle diagonal show correlations estimated at 160 km. Correlations at the intermediate distances (40 km and 80 km) are provided in Appendix F.

Most of the independent variables are reasonably distinct and relate to one another in predictable ways. The specific sources of localization (input suppliers, intermediate markets, labor pooling and knowledge spillover) generally have moderate positive correlations with both the localization measure and to each other. There are several exceptions where localization is negatively correlated with its components, such as labor pooling in farm and garden machinery because of the industry's relative isolation from major population centers. There are several cases where high correlations may pose problems for joint estimation. The pairwise correlation between input suppliers and intermediate goods markets exceeds 0.7 in computer and data processing, metalworking machinery, and electronic components. High correlations also exist between intermediate markets and knowledge spillovers in electronic components, knowledge spillover and input suppliers in measuring and controlling devices, and between labor pooling and input suppliers in computer and data processing services. Also as expected, region size (URB) and diversity also have moderate positive correlations but none to the point where the two lack independent variation.

Urbanization and university strength are highly correlated with one another in both sectors and in several study industries. The correlations are particularly high when estimated at larger spatial scales. Correlations are highest for the three professional services industries where pairwise correlations consistently exceed 0.8 and 0.9. High correlations between university spillovers and regional employment are also found in drugs, farm and garden machinery and motor vehicle parts. I proceed with analysis using both variables, testing how the inclusion of exclusion university spillovers influences the estimates for urbanization in multivariate specifications.

The pairwise correlations also reveal some interesting relationships involving the non-externality variables. Establishment size is only weakly correlated with agglomeration proxies, providing little evidence that new firms are smaller (or larger) in areas of higher localization or urbanization (Holmes and Stevens 2002). The share of regional employment in large establishments is higher in smaller areas and in places with less industrial diversity. The share of the population with bachelors degrees is positively correlated with regional size, reflecting the higher human capital of cities. The association between educational attainment and localization is positive in knowledge intensive manufacturing industries, such as drugs, electronic components and measuring and controlling devices and in the three professional services industries. These correlations are particularly high (> 0.7) in measuring and controlling devices, computer and data processing, and research and testing services. Educational attainment is negative in more traditional manufacturing sectors: farm and garden machinery, metalworking, and motor vehicle parts.

5.6 Summary

This chapter describes the measurement of key independent variables. Guided by theory and past research, I develop empirical measures representing both broad and detailed definitions of external economies. Each external economy variable is constructed following a common framework recognizing the three key criteria required for empirical proxies of agglomeration: the economic distance between sectors (industries, occupations, etc.); geographic distance based on inter-centroid distances between zip codes and/or census tracts; and an indicator representing the underlying source of the external economy (e.g. establishments, employment, resident occupations, or patent counts). I also develop measures to control for other establishment and regional attributes, such as establishment size, age, regional industrial dominance, regional educational attainment, population growth, and local university strength in related disciplines. Developing these measures required integrating data from over a dozen different secondary data sources.

The empirical measures represent a balance of theoretical, empirical and statistical considerations. A major challenge throughout the entire research project was addressing concerns of high multicolinearity. New firms are geographically concentrated and frequently lack the regional variation necessary to distinguish independent effects of closely related spatial constructs. When based on the absolute level of own- and related- industry activity, localization-based measures were too highly correlated with urbanization proxies to discern first and second order spatial effects. I also calculated indicators of industrial specialization with regression residuals to provide estimates of the level of industry activity above or below the level expected by overall regional employment (Czamanski and Ablas 1979; Feser *et al.* 2005). This approach reduced correlations with regional size, but produced specialization-based variables that are highly correlated with one another and that overly penalized large regions where the local share of industry was below national levels. After considerable testing, I selected location quotient based measures of relative specialization. Location quotient indicators control for first order spatial effects by standardizing regional activity by national shares, and are only moderately correlated with one another. I also tested several alternative variable specifications based on data from different sources or using alternate economic weights. Most produced inconsistent results or were or too were highly correlated with other variables.

CHAPTER VI

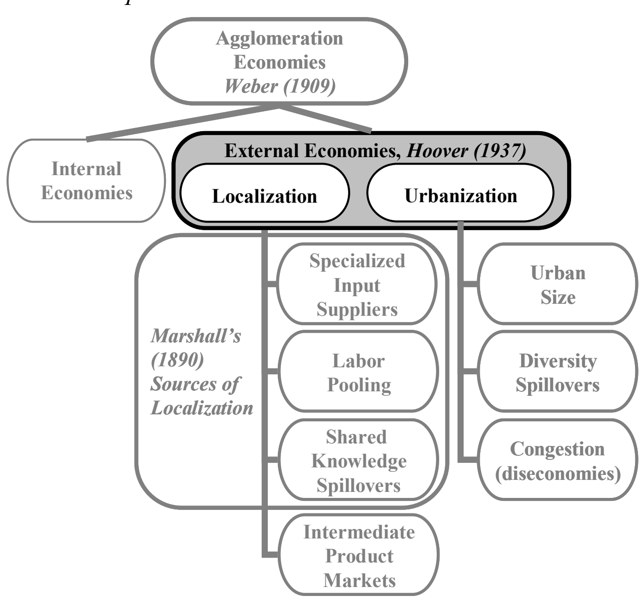
ECONOMIES OF LOCALIZATION AND URBANIZATION

6.1 Introduction

This chapter and the next present my findings regarding the influence of external economies on the survival of new firms in their early years. This chapter follows in the tradition of Hoover (1937), representing external economies with broadly defined measures of urbanization and localization economies (see Figure 6.1). Analysis based on precise measures of the sources of external economies is the focus of Chapter Seven.

I begin Chapter Six with an investigation of the unconditional influence of localization and urbanization economies on new firm survival. I estimate survival curves for new firms in areas of high and low own-industry specialization and total employment and test for differences between those groups. I find significant benefits to local industrial specialization in most of the manufacturing and professional services industries examined. The size of the regional economy is associated with higher survival rates in the drugs, measuring and controlling devices and

Figure 6.1
Typology of Agglomeration
Emphasis on Urbanization and Localization



professional service-based industries.

Section 6.3 takes the analysis a step further, using the multivariate framework described in Chapter Three to isolate the unique contribution of localization and urbanization economies on a new firm's hazard of failure. I estimate event duration models both with and without regional controls for industrial dominance, university strength in related disciplines, regional educational attainment, and population growth. After controlling for establishment size and other regional factors, industrial specialization (localization) is found to reduce the hazard of new firm failure in most industries, but only by a modest amount. Regional size (urbanization) has an insignificant influence on hazard rates in most industries. When region size is significant its influence is small and usually increases new firm hazard rates.

In the final section, I test whether economies of localization and urbanization are more influential on the longevity of smaller establishments, which are presumably more reliant on local external resources to compensate for deficient internal resources. I find that while establishment size often conditions the relationship between external economies and new firm survival, the smallest firms are not always the biggest beneficiaries. Of the eight industries with significant interactions, there are five where an increase in regional industrial specialization increases the longevity of smaller plants relative to larger ones. In the other three industries, medium-sized plants benefit more from localization. An increase in the size of a region tends to increases the hazard rates of larger plants while having little influence on smaller ones. It is likely that the high congestion and factor costs of large cities weigh greater on bigger plants because land and labor comprise a higher portion of their operational costs. Large plants are also less likely to substitute external for internal resources.

6.2 Preliminary Findings: Life-Table Analysis

As a preliminary investigation, I estimate survival curves for new firms in areas of differing levels of localization and urbanization economies and test whether they differ from one another. I classify new firms by whether they are above the 75th percentile (high) or below the 25th percentile (low) on the localization and urbanization measures. For establishments in each strata, I estimate the survival rate at each time period *t* as:

$$\begin{aligned} S(t_i) &= 1 && i = 0 \\ S(t_i) &= S(t_{i-1})\left(1 - \frac{d_{i-1}}{n_{i-1}}\right) && i > 0 \end{aligned} \tag{6.1}$$

where d_i is the number of events (failures) experienced during the interval i, and n_i is the size of the population at risk of experiencing the event.

I calculate log rank and Wilcoxan statistics to test the null hypothesis of homogeneity between survival functions for the high and low groups. Both statistics measure the actual versus expected number of failures over the study period, but differ by the weight given to early versus late exits. The log rank statistic for group j is

$$LogRank_j = \sum_i \left(d_{ij} - n_{ij}\frac{d_i}{n_i} \right) \tag{6.2}$$

where d_{ij} is the number of events in group j at time period i, n_{ij} is the number of at risk cases in group j at time i, and d_i is the total number of events and n_i the total at risk population at time i. The Wilcoxon tests weigh the log-rank measuring by the at risk population at each interval, or

$$Wilcoxon_j = \sum_i n_i \left(d_{ij} - n_{ij}\frac{d_i}{n_i} \right). \tag{6.3}$$

Because n_i always decreases with time, the Wilcoxon statistic gives greater weight to group differences at earlier intervals. When squared and divided by their estimated variance, both statistics are chi-squared distributed, with probabilities presented in Table 6.1. Log rank and Wilcoxon tests only detect differences between groups, and not the direction of those differences. To address this deficiency, I include a directional indicator calculated as the difference between the survival rate of the high and low strata of each annual interval, averaged over all intervals. The indicator is positive (+) if, on average, the survival curve for the high group is above survival curve of the low group, and negative (-) if the opposite is the case. Visual inspection of plotted survival curves confirm that this measure adequately characterizes the general direction of the relationship when there are significant differences between strata. To aid in interpretation, I include the plotted survival functions for localization (in Appendix G) and urbanization (in Appendix H) when measured for the area within 80 km of each new firm.

Table 6.1 summarizes the homogeneity tests between the survival curves of firms in high and low areas of localization and urbanization. Firms in areas with a high concentration of same-industry establishments have a lower probability of survival for manufacturing and a higher probability of survival for professional services. Although statistically significant, the difference between high and low groups is almost negligible. For example, at 80km the probability that manufacturing plants in areas of low localization survive the entire study period is only 0.04 higher than the probability for plants high specialization areas (see Appendix G). For professional services, the probability that high localization establishments survive the entire period is only 0.006 higher than in low localization areas. In manufacturing, the results for urbanization are mixed. Urbanization is harmful at closer proximities and beneficial at larger scales. Urbanization is commonly beneficial to professional services establishments at most spatial scales. Again the differences between high and low groups are small.

High and low group survival curves are typically more distinct when estimated on homogenous industries. Localization economies have a positive influence on new firm survival in the majority of study industries, although their strength varies by the spatial scale of measurement. Only the drugs and research and testing services industries show no evidence of significant localization effects at any distance.[42] While drugs and research and testing services are both knowledge intensive, they may place great value on secrecy and therefore limit their participation in

Table 6.1
Life Table Analysis: Homogenity Tests
Localization and Urbanization
Top vs. Bottom 25th Percentile

	Localization				**Urbanization**			
	20	**40**	**80**	**160**	**20**	**40**	**80**	**160**
Manufacturing	+	-	-	-	-	-	+	+
Log rank	0.68	0.00	0.00	0.00	0.00	0.00	0.07	0.00
Wilcoxon	0.54	0.01	0.00	0.00	0.00	0.51	0.23	0.00
Professional Services	+	+	+	+	+	+	+	+
Log rank	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Wilcoxon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Drugs	+	+	+	+	+	+	+	+
Log rank	0.48	0.42	0.27	0.88	0.08	0.09	0.19	0.38
Wilcoxon	0.44	0.42	0.30	0.99	0.04	0.07	0.17	0.35
Farm & garden machinery	+	+	+	+	-	+	-	+
Log rank	0.24	0.08	0.13	0.39	0.18	0.92	0.38	0.39
Wilcoxon	0.12	0.04	0.12	0.43	0.25	0.84	0.76	0.42
Metalworking machinery	+	+	+	+	-	+	-	+
Log rank	0.01	0.03	0.02	0.04	0.19	0.99	0.47	0.22
Wilcoxon	0.01	0.03	0.02	0.05	0.18	0.85	0.53	0.10
Electronic components	+	+	+	+	+	-	+	-
Log rank	0.15	0.03	0.16	0.06	0.77	0.56	0.81	0.97
Wilcoxon	0.22	0.05	0.12	0.07	0.99	0.64	0.84	0.96
Motor vehicle parts	+	+	+	+	-	-	-	-
Log rank	0.10	0.04	0.07	0.44	0.24	0.06	0.19	0.31
Wilcoxon	0.20	0.07	0.08	0.46	0.40	0.17	0.43	0.63
Measuring devices	+	+	+	+	+	+	+	+
Log rank	0.09	0.15	0.13	0.02	0.11	0.03	0.14	0.04
Wilcoxon	0.11	0.15	0.12	0.02	0.11	0.03	0.11	0.03
Advertising	+	+	+	+	+	+	+	+
Log rank	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Wilcoxon	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Computer & data processing	+	+	+	+	+	+	+	+
Log rank	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wilcoxon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Research & testing services	+	+	-	-	-	+	+	+
Log rank	1.00	0.84	0.62	0.24	0.20	0.46	0.15	0.00
Wilcoxon	0.77	0.82	0.84	0.22	0.40	0.27	0.06	0.00

(grey) = 90% significance (Pr $\chi 2$ <= .1)
(black) = 95% significance (Pr $\chi 2$ <= .05)
+ if mean high group survival > mean low group survival
- if mean high group survival < mean low group survival

[42] Although the null hypothesis of homogeneity cannot be rejected, the survival plots for the drugs sector does show a higher average survival rate in areas of high localization at most distances (see Appendix E). By contrast, the high and low survival plots in research and testing are virtually undistinguishable.

local information networks. In metalworking machinery, advertising, and computer and data processing services, plants in areas of high localization more likely to survive at every distance measured. Of these, localization is strongest for metalworking and weakest for computer and data processing. A new metalworking machinery plant located in an area of high industrial specialization is roughly 1.20 (160 km) to 1.29 (20 km) times more likely to survive the entire study period than one located in a low specialization region. For computer and data processing services the probability that a new firm survives the entire study period is only 1.06 (80 km) to 1.13 times (40 km) higher in an area of high industrial specialization. Localization also has significant and positive benefits for new firms in farm and garden machinery (40 km), electronic components (40 km), motor vehicle parts (40 km), and measuring and controlling devices (160 km).

Urbanization economies primarily favor new firms in the business and professional service industries. Urbanization economies are significant and positive in advertising, computer and data processing and research and testing services (160 km). In each case the benefits from urbanization are small, with the highest survival probabilities for computer and data processing where new firms in large regions (160 km) are 1.39 more likely to survive beyond seven years compared to new firms in small regions. Urbanization is insignificant for most manufacturing industries, with the notable exception of drugs (20 km) and measuring and controlling devices (40 and 160 km). In drugs, new firms in large regions are 1.45 times more likely to survive the entire study period compared to new firms in small regions. Measuring devices are 1.29 times more likely to survive in high urbanization regions.

6.3 Multivariate Event Duration Analysis

6.3.1 Empirical Modeling Framework

In Section 6.2, I found that industrial localization improves the survival chances of new independent plants in seven of the eight industries studied. Beneficial urbanization economies are less prevalent in traditional manufacturing, but were found in two technology-intensive manufacturing industries (drugs and measuring and controlling devices) and in the three business and professional services industries. This section extends the preceding analysis by estimating the unique contribution of localization and urbanization economies in a multivariate framework.

The statistical event duration model developed in Chapter III provides the framework for estimating the influence of external economies on the risk of new firm failure. The model describes the new firm hazard as a function of establishment-specific (**E**), industry-specific (**I**), and region-specific factors (**R**), or

$$\log[-\log(1-\lambda_{it})] = \alpha(t) + \mathbf{E}_i\boldsymbol{\beta} + \mathbf{I}_i\boldsymbol{\delta} + \mathbf{R}_i\boldsymbol{\gamma}\,. \qquad (6.4)$$

To operationalize the model I substitute the attribute vectors with the independent variables defined in Chapter V.

Establishment characteristics ($\mathbf{E}_i$) are the establishment's age and its maximum employment over its early life (*SIZE*). The influence of an establishment's age on its instantaneous risk of failure (i.e., its baseline hazard) is captured by including time as an explanatory factor. As described in Chapter V, I follow two alternate approaches for empirical identification of the baseline hazard. The first approach follows the recommendation of Allison (1995), using dummy variables to capture the instantaneous probability of failure for each year of the plant's life. The second approach imposes restrictions for on the shape of the underlying hazard through sequential testing of higher order polynomials to determine the most parsimonious representation of the baseline hazard for each industry. The specific representation of the baseline hazard was found to have very little influence on the parameter estimates of the other key independent variables. Because the key results do not change, I only report results from the restricted specifications.[43]

I also include quarterly dummies to control for seasonal fluctuations (*QTR1 – QTR3*). The fourth quarter (October, November and December) is used as the reference group. In the sector level models, I control for unmeasured industry specific attributes ($\mathbf{I}_i$) with two-digit SIC fixed effects.[44] By using fixed effects, unmeasured industry characteristics shift the intercept of the baseline hazard function.[45] Industry-specific fixed effects are not necessary for models estimated on homogenous industry definitions.

The vector of regional attributes ($\mathbf{R}_i$) includes measures for urbanization (*URB*) and localization economies (*LOC*). I also include Census Division fixed effects to account for any residual regional influences in hazard rates.[46] Census Division dummy variables are included for establishments located in the Midwest (*MWEST*), Northeast (*NEAST*), and the South (*SOUTH*), with the Western Census Division withheld as the reference group. The estimating equation for industry level models is:

$$\begin{aligned}\log[-\log(1-\lambda_{it})] &= \alpha(t) + b_1 QTR1_i + b_2 QTR2_i + b_3 QTR3_i + b_4 MWEST_i \\ &+ b_5 NEAST_i + b_6 SOUTH_i + b_7 SIZE_i + b_8 URB_i + b_9 LOC_i\end{aligned} \quad . \tag{6.5}$$

[43] The results using dummy-variable representations of the baseline hazard are available upon request.

[44] Models with more detailed industry fixed effects (i.e., 3 digit SIC) could not be estimated because many industries do not have enough observations at this level of detail.

[45] Coefficient estimates for the industry fixed effects are available upon request.

[46] Census region-based fixed effects were tried, but were found to lack sufficient within-region variation to reliably estimate models with external economies measured at 80 and 160 km.

The summary industry models (manufacturing and professional services) differ from the detailed industry models by the formers inclusion of additional two digit SIC fixed effects.[47]

I also estimate a revised model that includes additional regional controls for university strength in related disciplines (*UNIV*), the share of regional employment in the four largest establishments (*LGSH*), regional educational attainment (*BACH*) and regional population growth (*POPGR*)

$$\begin{aligned}\log\left[-\log\left(1-\lambda_{it}\right)\right] &= \alpha(t) + b_1 QTR1_i + b_2 QTR2_i + b_3 QTR3_i + b_4 MWEST_i \\ &+ b_5 NEAST_i + b_6 SOUTH_i + b_7 SIZE_i + b_8 URB_i + b_9 LOC_i + b_{10} UNIV_i \\ &+ b_{11} LGSH_i + b_{12} BACH_i + b_{13} POPGR_i\end{aligned} \quad . \qquad (6.6)$$

To estimate these models, the establishment database is arranged longitudinally with separate observations for each establishment in each time period of its existence. As a result, the number of observations used in each model is much larger than actual number of new firms. The inclusion of multiple records for each individual does not violate assumptions of observational independence and the coefficients and standard errors remain unbiased (Allison 1984; Allison 1995). The large *n* of the models is does not necessarily favor rejection of the null hypothesis because there is no within-establishment variation in most independent variables.[48]

6.3.2 Results

The full results of the localization/urbanization models are included in Appendices I and J, the latter including the full set of regional controls. Because the event duration model

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[47] All continuous variables are mean centered. Mean centering helps reduce Multicollinearity of interacted continuous variables but does not affect coefficients estimates or standard errors (Aiken and West 1991).

[48] In most practical applications, estimates and standard errors from a discrete time event duration model are very similar to those produced with continuous-time methods (Allison 1995).

estimates changes in the firm's hazard of *failure,* the signs of coefficient estimates are opposite from the life-table estimates of plant *survival* (see Table 6.1). The model results include basic model fit statistics, coefficient estimates (b), significance levels ($Pr>X^2$), exponentiated coefficients (exp b) and tolerance values (tol). Because the complementary log-log model is the discrete time equivalent of continuous-time proportionate hazards when the data is measured coarsely, the exponentiated coefficients have a similar interpretable as hazard ratios, or the estimated change in the hazard rate given a one unit change in the independent variables (Prentice and Gloeckler 1978; Allison 1982, 1995). Tolerance values are included to detect potential problems from high multicolinearity. Tolerance is calculated as one minus the R^2 of a linear regression where each covariate is sequentially modeled as dependent on the other independent variables. While there is no magical number that indicates excessive multicolinearity, I pay particular attention to variables with tolerance values below 0.25, noting changes in the interpretation of key variables after the omission of the highly correlated variables.

The parsimonious baseline hazard rate varies by industry. A cubic hazard function (i.e. $\alpha(t)=a_1t+a_2t^2+ a_3t^3$) is the preferred form of the baseline hazard for manufacturing, professional services, metalworking machinery, and motor vehicle parts. A second order polynomial is used for advertising ($\alpha(t)=a_1t+a_2t^2$), and a fourth order polynomial for computer and data processing services ($\alpha(t)=a_1t+a_2t^2+ a_3t^3+ a_4t^4$). The remaining industries (drugs, farm and garden machinery, electronic components, and measuring and controlling devices) all have linear baseline hazard functions. In every industry, the shape of the estimated baseline hazards was found to be insensitive to the spatial scale of the agglomeration variables and the inclusion of additional regional controls.

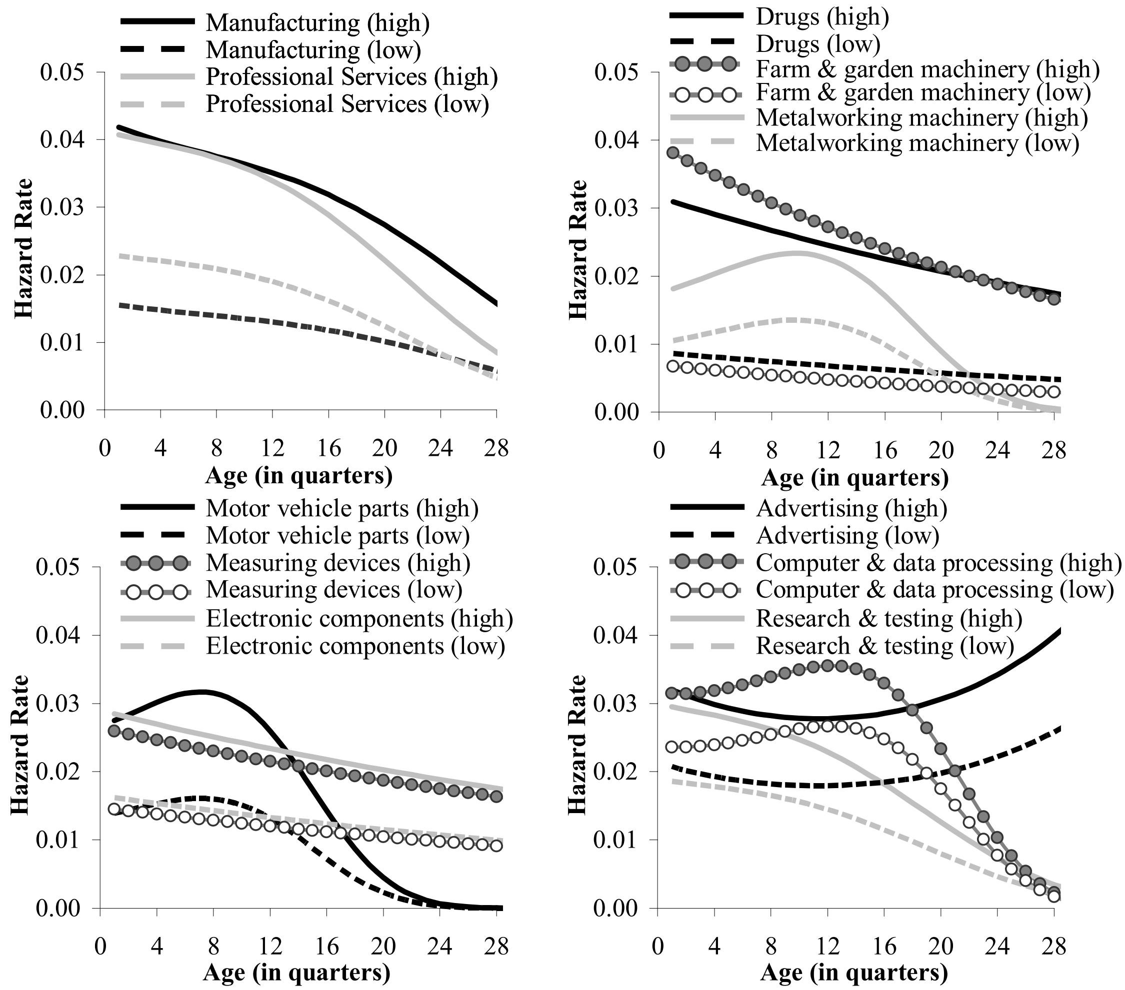
The baseline hazard is estimated by substituting estimated coefficients into the empirical hazard function. For example, the empirical hazard with a cubic baseline hazard is calculated as:

$$\hat{\lambda}_t = 1 - \exp\left[-\exp\left(a_0 + a_1 t + a_2 t^2 + a_3 t^3 + \mathbf{Xb}\right)\right], \tag{6.5}$$

where the intercept coefficient is substituted for a_0, t is the plant's age measured in quarters, a_1 through a_3 are coefficient estimates associated with different transformations of time, and **b** and **X** are coefficient and variable vectors. The estimate of the hazard rate depends on the values of the other independent variables. Because of the assumption of proportionality, changes in the values of **X** produce an upward or downward shift in the intercept of the baseline hazard. I calculate the hazard rate for each period while holding all continuous variables at their means. The dummy variables are allowed to vary between their highest and lowest coefficient values to represent a range of the hazard estimates over the different quarters, Census Divisions and two digit industries in the manufacturing and professional services models. The resulting hazard curves for the parsimonious localization/urbanization model are plotted in Figure 6.2

Declining hazards are confirmed for all but a single industry, advertising, where the hazard rates increase following the third year. Measuring and controlling devices, farm and garden machinery, and motor vehicles parts all have hazard rates that peak between the second and fourth year of the plant's life and drop sharply thereafter. These patterns are consistent with the "liability of adolescence" hypothesis, where an ailing firm survives until exhausting its initial resources (Brüderl and Schussler 1990; Mahmood 2000). The plotted hazard functions for these industries also tend to converge to zero in the final quarters. This is a result of the constraints imposed on the hazard, reflecting the continuation of the trend of a sharp decline following the adolescent peak, and should not be interpreted literally..

Figure 6.2
Baseline Hazard Rates, Complementary Log-Log Estimates



Seasonal fluctuations in hazard rates are also consistent across different model specifications. For all industries except drugs and motor vehicle parts, the highest hazard of failure is for the 2nd quarter followed by the 4th quarter. The differences between the 2nd and 4th quarter are only significant among the business and professional services industries. In drugs and motor vehicle parts, new firms are most likely to fail in the 4th quarter. In the manufacturing and professional services sectors, new firms face the lowest hazard of failure in the 1st quarter. The 1st quarter also has the lowest hazard rate in farm and garden machinery, advertising, computer and data processing, and research and testing services. In the remaining five manufacturing study industries, the 3rd quarter is associated with the lowest probability of failure.

The estimated coefficients for the Census Division dummies are sensitive to the scale of the agglomeration variables, generally declining in strength and significance as the agglomeration variables cover more area. However, the relative ordering among regions usually holds as the spatial scale increases, and the estimates are fairly robust to the inclusion of additional regional controls. To emphasize the initial differences in hazard rates between Census Division, I interpret these coefficients using an assumption of 20 km. Plants in the Northeast have the lowest risk of failure in every industry, while plants in the South are most likely to fail in both the manufacturing and professional services sectors and in five of the nine study industries. Midwestern establishments have the highest hazard in the remaining study industries. These results were unexpected, considering the southerly migration of industry and population in the past few decades.

More investigation is necessary to identify the cause of broad regional variation in survival rates. It may be that the types of businesses drawn to relative low-cost areas of the South and the Midwest are more cost-sensitive and have a higher hazard from greater competitive pressure. Unionization may also play a role in or delaying the closure of northern plants, although it somewhat doubtful that unions have much sway over small independent firms. A more likely explanation is that growing regions have higher birth rates, which reflects greater local competition between new businesses. Hazard rates for *individual* establishments will be higher in these fast growing places if short-run entry exceeds the level that can be sustained by the expansion of the local market.[49]

Establishment size is the most consistently significant predictor of a firm's survival. An increase in the size of the establishment decreases its likelihood of failure in every industry. Establishment size estimates are also fairly robust to alternate specifications of the agglomeration variables. Plant size has the largest impacts in metalworking machinery, where the addition of a single employee reduces the risk of failure by nearly 4 percent. This is followed by advertising and research and testing services where an additional employee reduces the hazard by approximately 3 and 2 percent, respectively. At the low end, a one-unit increase in electronic components and motor vehicle parts reduces the risk of failure by only 0.6 percent. Audretsch and Mahmood (1995) hypothesize that the influence of plant size on survival will be strongest in industries where a higher minimum efficient scale of production puts more growth pressure on small businesses. My data suggest that establishment size has more impact in industries where incumbents are smaller, such as advertising, research and testing services and metalworking machinery.

The key findings for the agglomeration variables are summarized in Table 6.2, which shows the sign and significance of urbanization and localization when measured at different distances, both with and without the additional regional controls. I begin by interpreting the results for the parsimonious specification.

[49] It is well established that fast growing (a.k.a. "dynamic") regions have greater numbers of entrants and failures. This does not necessarily result in higher hazard rates for *individual* establishments in these places, because while there may be more failures in dynamic regions, there are also more survivors.

Similar to the life-table estimates of survival rates, localization consistently has a favorable impact on the longevity of new business. New firms in areas of higher own industry specialization have a significantly lower hazard of failure for the professional services sector and in five of the nine study industries: farm and garden machinery, metalworking machinery, motor vehicle parts, advertising and computer and data processing services. Localization is associated with an elevated hazard in manufacturing as a whole, a result clearly at odds with those of the individual manufacturing study industries. As found in the life table analysis, new plants in drugs and research and testing show no significant benefit to localization at any spatial scale. The estimates of significant benefits to localization in measuring and controlling devices and electronic components in Table 6.1 are not present in the multivariate setting.

Table 6.2
Event Duration Model Summary
Localization and Urbanization

	Manufacturing	Professional Services	Drugs	Farm & garden machinery	Metalworking machinery	Electronic components	Motor vehicle parts	Measuring devices	Advertising	Computer & data processing	Research & testing
without Regional Controls											
Urbanization											
20 km	+	+	+	+	+	+	+	-	+	-	+
40 km	+	-	+	+	+	+	+	-	+	-	+
80 km	+	-	+	+	+	+	+	-	+	-	-
160 km	+	-	+	-	+	+	+	-	-	-	-
Localization											
20 km	+	-	-	-	-	-	-	+	-	-	+
40 km	+	-	+	-	-	-	-	+	-	-	+
80 km	+	-	+	-	-	-	-	-	-	-	+
160 km	+	-	+	-	-	-	-	+	-	-	+
with Regional Controls											
Urbanization											
20 km	+	+	+	+	+	+	+	+	+	-	+
40 km	+	+	+	+	+	-	+	-	+	-	+
80 km	+	+	+	+	+	-	+	-	+	-	+
160 km	+	+	+	+	+	-	+	-	+	-	+
Localization											
20 km	+	-	+	-	-	-	-	+	-	-	+
40 km	+	-	+	-	-	-	-	-	-	-	+
80 km	+	-	+	-	-	-	-	-	-	-	-
160 km	+	-	+	-	-	-	-	+	-	-	+

+ = Increased hazard rate (grey) *= 90% significance (Pr $\chi 2$ <= .1)*
- = Reduced hazard rate (black) *= 95% significance (Pr $\chi 2$ <= .05)*

The strongest benefits for localization, when significant, are generally at larger spatial scales. In professional services, the strongest benefits for localization are measured at 160 km where a one unit increase in the same industry location quotient reduces the hazard rate nearly ten percent. A similar change in localization reduces the hazard rate by eight percent in farm and garden machinery (80 km), by 15 percent in metalworking machinery (160 km), by 19 percent in motor vehicle parts (80km) and by 17 percent in advertising (160 km). New firms in computer and data processing significantly benefit from same-industry specialization only at 20 km where a unit change increase reduces the hazard rate by 2 percent.

The size of the region has little significant influence on the longevity of new firms, after controlling for temporal influences, establishment size, Census Division fixed effects and localization. In cases where region size is significant, its net impact typically increases failure rates. This contrasts with the life-table estimates where urbanization offered a generally favorable environment for new establishments. Diseconomies are particularly prevalent at smaller spatial scales, where an increase in the same number of workers generates a much higher density of activity.

Urbanization significantly increases hazard rates in the manufacturing sector at distances below 80 km, and for professional services at 20 km. In both cases the magnitude of effects are very small, increasing the odds of failure by one percent or less. At a less stringent level of statistical significance (90 percent), congestion diseconomies are also found in farm and garden machinery (≤ 40 km) and electronic components (20 km). Computer and data processing is the sole exception where new firm longevity is significantly higher in areas of larger employment (≥ 20 km). Again the effect is very small, with an additional 10,000 regional workers reducing the hazard rate by only less than one percent.

Adding controls for university strength, large plant dominance, educational attainment and population growth only produces minor changes in the localization coefficients. In several cases (metalworking, motor vehicle parts and advertising) the additional variables increase the standard errors of localization but changes hazard ratios by just a few percentage points. The biggest change is for computer and data processing, where localization is now significant at every scale and reduces the new firm hazard rate by a greater amount, especially at larger distances. Some of this change may be the result of high colinearity with regional educational attainment, as indicated by the high tolerance values.

Urbanization is more sensitive to the inclusion of the additional regional controls. Urbanization still has a negative influence on hazard rates in computer and data processing, with additional net diseconomies indicated for manufacturing, professional services, drugs, and advertising. The addition of the highly correlated university strength variable has greatly reduced the tolerance values of the urbanization variable, most notably in three of the newly significant industries: professional services, drugs, advertising and computer and data processing.[50] The urbanization coefficients for professional services remain significant but have switched from negative to positive (≥ 20 km). Removing universities also reduces the estimated benefits for urbanization in drugs and advertising.

The regional control variables themselves have little influence on new firm survival. Likelihood ratio tests of the joint significance of all additional regional controls fail to reject the null hypothesis in several industries (see Table 6.3). Of the four controls, only university strength is consistently significant over several industries.

[50] To check for multicollinearity, I re-estimated the full model excluding just the university variable. The coefficients for manufacturing and computer and data processing barely changed after universities were removed, suggesting no problems with multicollinearity.

Table 6.3
Likelihood Ratio Tests of Regional Controls
Localization-Urbanization Models

	χ^2 Probabilities			
	20 km	**40 km**	**80 km**	**160 km**
Manufacturing	0.14	0.02	0.01	0.01
Drugs	0.47	0.21	0.01	0.08
Farm & garden machinery	0.05	0.32	0.54	0.10
Metalworking machinery	0.43	0.43	0.31	0.43
Electronic components	0.15	0.10	0.05	0.09
Motor vehicle parts	0.70	0.42	0.56	0.33
Measuring & controlling devices	0.79	0.74	0.27	0.39
Professional services	0.00	0.00	0.00	0.00
Advertising	0.09	0.00	0.01	0.02
Computer & data processing	0.03	0.00	0.00	0.01
Research & testing services	0.34	0.09	0.02	0.08

Based largely on the arguments of Chinitz (1961) and Feser (2002), I expected new firms to have higher hazard rates in regions where a small number of large employers dominate the local economy. This hypothesis was only supported in manufacturing (40 km and 80 km) and drugs (80 km). A one percent change in large plant employment share significantly increases hazard of exit for new firms in manufacturing (40 and 80 km), but only by less than a percent. In the drugs industry, a unit change in large plant dominance increases the hazard rate by 11 percent. The contrary effect is found in professional services and computer and data processing, where new firms appear slightly more likely to survive in regions where large plants are dominant.

I also expected that regions with a higher share college educated adults would have lower hazard rates, under the assumption that higher levels of regional human capital are associated with more educated entrepreneurs and more highly skilled workers. This only appears to be the case in metalworking machinery (80 km). It is more common for higher educational attainment to increase the likelihood of exit, as seen in manufacturing (40 km and 80 km), professional services (40 km and 80 km), and computer and data processing services (20 km, 80 km, and 160 km). The harmful influence of educational attainment is very small in most industries and may be due to higher labor costs.

The results for population growth also conflict with prior expectations. Previous studies have consistently found local growth to stimulate entry (Reynolds 1994; Sutaria and Hicks 2004). I expected local growth to reflect expanding opportunities for niche production and reduced competitive pressure, both resulting in lower hazard rates. Instead the results are rarely significant. When population growth is significant it has a small positive effect on hazard rates. Findings of higher hazard rates in areas of higher growth may be the negative consequence of higher entry rates in growing areas. If local entry exceeds the level that can be sustained through the growth of local demand then the heightened intensity of local competition among new firms may reduce survival rates in the short-run. It is worth noting that the census division coefficients change little after controlling for local population growth, suggesting that market expansion does not explain broad regional differences in survival rates.

Universities have a more widespread influence on fortunes of new firms, but low tolerance values warrant cautious interpretation of individual coefficient estimates. The influence of proximity to a university with a strong presence in related academic disciplines is mixed, beneficial to new firms in some industries while apparently harmful in others. University strength significantly reduces hazard rates for new firms in professional services, farm and garden machinery (160 km) and advertising. New firms in manufacturing (20 km, 40 km and 160 km), drugs (40 km and 80 km) and research and testing services (≥ 80 km) also appear to benefit from proximity to universities, but only at 90 percent significance levels. New firms in electronic components and computer and data processing services (40 km) are more likely to fail when located in regions with a high share of related University R&D. This is somewhat surprising considering the prevailing view that localized academic spillovers are an important input to high-tech entrepreneurs, stimulating both local innovation (Jaffe 1989; Fischer and Varga 2003) and entry (Bania *et al.* 1993; Woodward *et al.* 2004). These counterintuitive findings may reveal a spurious association between hazard rates and universities. The types of start-ups choosing to pay a premium to locate near universities may do so to in order to access university knowledge and basic research. These establishments are also more likely to focus emerging technologies and may have a higher likelihood of failure because of the inherent risk associated with innovation.

6.4 Establishment Size and External Economies

There are several reasons to believe that small firms are more embedded in their local economies and should derive greater benefits from localized external economies. According to Malecki (1992) the principle disadvantage faced by small firms is deficient internal resources of capital, labor and information. Small firms rely on the local environment to offset these disadvantages. Classical theorists, such as Marshall (1920 [1890]), Weber (1929 [1909]) and Stigler (1951) focus on the spatial division of labor as a substitute for internal scale economies, allowing small firms to compete at comparable efficiencies as larger plants. In addition to internal scale efficiencies, large firms are also more integrated into national and/or global supply chains and have negotiated contacts with dedicated suppliers, making them less reliant on independent local suppliers (Chinitz 1961; Mason 1991). Deep markets also provide greater opportunities for niche production, making cities the most suitable location for small and specialized businesses (Hoover and Vernon 1959; Vernon 1960). Contemporary investigations eschew traditional scale benefits in favor of network spillovers and social ties as the primary source of proximity benefits (Granovetter 1985; Malecki 1994;

Sternberg 1999; Minniti 2005). Large firms, by contrast, have the capability of accessing wide information networks (Malecki 1994). Large firms also spend considerably more on R&D, while small firms seek external sources of innovation generating knowledge (Acs and Audretsch 1990).

There is only limited econometric evidence on the relationship between establishment size and external economies. Holmes and Stevens (2002) find that manufacturing plants are *larger* in areas of own industry concentration. They explain their findings in terms of firm demography. Citing findings of Dumais *et al.* (2002), Holmes and Stevens postulate that mature, and presumably larger, firms are more likely to populate existing industry concentrations, while newer, and smaller, establishments favor decentralization. Feser (2001a) looks specifically at how Marshallian externalities vary by establishment size, concluding that medium sized firms derive greater proximity advantages. These results support earlier findings from Sweeney and Feser (1998) of an inverted U relationship between establishment size and industrial concentration among North Carolina manufacturers. Significant own-industry clustering only occurs for plants roughly between 10 and 50 employees. The authors speculate that the smallest manufacturers may not have the volume of production to justify paying a premium to locate near related businesses.

6.4.1 Modeling Interactions

I test the complex hypothesis that plant size mediates the relationship between external economies and new firm survival by modeling the interaction between establishment size and localization economies. I expect smaller new firms to have a lower hazard of failure in larger urban areas and in areas of greater own-industry specialization. In terms of the basic localization and urbanization model (equation 6.5) the estimating equation is:

$$\begin{aligned}\log[-\log(1-\lambda_{it})] &= \alpha(t) + b_1 QTR1_i + b_2 QTR2_i + b_3 QTR3_i + b_4 MWEST_i \\ &+ b_5 NEAST_i + b_6 SOUTH_i + b_7 SIZE_i + b_8 URB_i + b_9 LOC_i \\ &+ b_{10}(SIZE_i * URB_i) + b_{11}(SIZE_i * LOC_i)\end{aligned} \quad . \qquad (6.7)$$

The summary results of the interactive models are presented in Appendix K with coefficient signs and significance levels for the interactive variables summarized in Table 6.4. The estimated interaction parameters indicate whether the combination of establishment size and external economies increase or decrease the hazard rate beyond the level expected by each variable separately. Associated statistical tests indicate whether the influence of external economies on the hazard rate varies significantly over the range of establishment sizes (Aiken and West 1991).[51]

Table 6.4
Model Summary: Interactive Analysis
Establishment Size by Localization and Urbanization

	Manufacturing	Professional Services	Drugs	Farm & garden machinery	Metalworking machinery	Electronic components	Motor vehicle parts	Measuring devices	Advertising	Computer & data processing	Research & testing
Size*Urbanization											
20 km	+	+	+	+	-	+	+	-	-	+	+
40 km	+	+	+	+	-	+	+	-	+	+	+
80 km	+	+	-	+	+	-	+	-	+	+	+
160 km	+	+	-	-	-	+	+	-	+	+	+
Size*Localization											
20 km	+	-	-	+	+	-	+	+	+	+	-
40 km	+	-	-	+	+	-	-	+	+	+	-
80 km	+	-	-	+	+	-	-	+	+	+	-
160 km	+	-	-	+	+	-	-	+	+	+	-

+ = Increased hazard rate (grey) *= 90% significance (Pr χ2 <= .1)*
- = Reduced hazard rate (black) *= 95% significance (Pr χ2 <= .05)*

The results support the urban incubator hypothesis that large regions and cities provide a favorable environment for small, new firms (Leone and Struyk 1976), at least for those in professional service-based industries. The interactions

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[51] Establishment size is measured at the maximum size of the plant over its first seven years to account for downsizing prior to closure. See Chapter V, section 5.4.2 for a discussion.

between urbanization and size are significant and positive in manufacturing, professional services, motor vehicle parts (≤ 80 km), advertising (80 and 160 km), computer and data processing, and research and testing services (≤ 80 km). A significant positive coefficient implies a higher hazard rate for larger establishments in larger regions and for smaller plants in smaller regions. In measuring and controlling devices the interaction between size and urbanization is negative, implying a lower hazard rate for larger establishments in large areas and for smaller firms in small areas.

The relationship between size and localization is less uniform across industries. The interaction is positive and significant in manufacturing, farm and garden machinery (40 km), metalworking machinery (160 km), measuring devices, and computer and data processing services. Three industries (professional services, drugs and electronic components) have a significant negative interaction between size and localization. In these industries, larger firms have a lower risk of failure in areas where localization is high.

A more in depth investigation of the relationship between establishment size, external economies and new firm survival requires substituting particular values for the interacted variables. Using localization (*LOC*) to illustrate, equation 6.7 can be rearranged to emphasize how the hazard varies with localization,

$$\log[-\log(1-\lambda_{it})] = \alpha(t) + \mathbf{X\beta} + b_7 SIZE_i + (b_9 + b_{11} SIZE_i) LOC_i, \qquad (6.8)$$

where $\mathbf{X\beta}$ represents all other variables and parameters, and $(b_9 + b_{11} SIZE_i)$ is the equivalent to the simple slope of localization in a standard linear regression (Aiken and West 1991). The conditional hazard ratio for a unit change in localization is computed by taking the exponent of the simple slope, $\exp(b_9)\exp(b_{11} SIZE_i)$, and evaluating the expression at specific values of establishment size (SIZE). The corresponding standard errors for the simple slope also vary according to establishment size and are calculated:

$$s_b = \sqrt{s_9 + 2SIZEs_{9,11} + SIZE^2 s_{11}}\ , \qquad (6.9)$$

where s_9 is the variance of b_9, s_{10} is the variance for b_{11} and $s_{9,11}$ is the covariance of b_9 and b_{11}. A *t*-test of whether the hazard rate for establishments of a specific size differs from zero is computed by dividing its simple slope $(b_9 + b_{11}SIZE)$ by its standard error (equation 6.9) with (*n-k-1*) degrees of freedom. To represent a likely range of new firm establishment sizes, I estimate conditional hazard ratios at the median, 10th and 90th percentiles values of *SIZE*. Because many new firms are very small, my estimates are based on a narrow range of possible establishment sizes (see Table 6.5), although they are representative of the size distribution of new firms. By absolute standards, the 10th and 90th percentile sized new firms in most study industries are equivalent to very small and medium sized establishments.

Estimated simple slope hazard ratios and significance levels for the localization and urbanization interactions are presented in Table 6.6. The hazard ratios are interpretable as the change in the hazard rate given a unit change in the values of the localization and urbanization variables. As a

Table 6.5
Percentile Establishment Sizes

	Establishment Size*		
	10th percentile	**50th percentile**	**90th percentile**
Manufacturing	2	8	49
Drugs	2	14	77
Farm & garden machinery	2	8	43
Metalworking machinery	2	8	29
Electronic components	3	17	107
Motor vehicle parts	2	10	114
Measuring & controlling devices	2	8	47
Professional Services	1	4	28
Advertising	1	4	19
Computer & data processing	1	4	36
Research & testing services	1	6	36

**Establishment size measured at the maximum employment of each establishment. Percentiles based on the longitudinal (observation-event) structured database.*

visual aid to interpretation, I calculate the predicted hazard rates for new firms of different sizes across a range of the values of the external economy variables. By holding all other continuous variables at their means (zero) and all dummy variables to the value of the withheld group (zero) the hazard rate can be simplified as a function of just size and a single source of external economy. In the case of localization, the predicted hazard rate is:

$$\hat{\lambda} = 1 - \exp[-\exp(b_7 SIZE + (b_9 + b_{11} SIZE) LOC)]. \quad (6.10)$$

To emphasize how the hazard rate for new firms of a particular size changes in areas with different levels of localization and urbanization economies, I fix establishment size at its 10^{th}, 50^{th} and 90^{th} percentile values and let the external economy measure vary between one standard deviation below and above its mean. Line plots of the predicted hazard curves are included in Appendices L (localization) and M (urbanization). The height of the plotted hazard rate reveals the pure effects of the establishment's size. Larger establishments always have a lower hazard rates. The slope of the hazard is of greater interest. It indicates how much the hazard rate increases or decreases with changes in the levels of localization and urbanization.

6.4.2 Results

In most industries, the influence of localization on duration is affected by establishment's size, despite the limited size distribution of new firms. The most common pattern is for the hazard rates of smaller establishments to decline as localization increases. Such is the case for farm and garden machinery, metalworking machinery, and advertising. In metalworking, a unit change in own industry specialization reduces the hazard rate for a new firm of two employees (10^{th} percentile) from between four to eight percent while a similar increase does not have a significant effect on 90th percentile sized plants. Higher specialization reduces the hazard rate for small plants from between four to eight percent in farm and garden machinery and from eleven to nineteen percent in advertising. In computer and data processing services and increase in localization reduces hazard rates for small plants and increases hazard rates for larger plants. In each case the greatest reduction in small plant hazards was found with specialization measured at the largest spatial scales.

Table 6.6
Interaction Analysis: Simple Slope Hazard Ratios and Statistical Significance

	Establishment Size * Localization											
	20 km			**40 km**			**80 km**			**160 km**		
	Sm	**Med**	**Lg**	**Sm**	**Med**	**Lg**	**Sm**	**Med**	**Lg**	**Sm**	**Med**	**Lg**
Manufacturing	1.00	1.00	1.02	1.01	1.01	1.03	1.01	1.01	1.03	1.02	1.02	1.04
Drugs	1.10	1.00	0.58	1.25	1.02	0.36	1.29	1.07	0.41	1.39	1.11	0.34
Farm & garden machinery	0.96	0.97	1.00	0.95	0.97	1.08	0.92	0.92	0.95	0.92	0.93	0.97
Metalworking machinery	0.93	0.94	0.96	0.93	0.94	0.97	0.87	0.90	0.99	0.79	0.84	1.06
Electronic components	1.01	1.00	0.95	1.03	1.01	0.90	1.00	0.99	0.88	1.07	1.03	0.77
Motor vehicle parts	0.93	0.93	0.98	0.93	0.92	0.81	0.85	0.84	0.73	0.92	0.90	0.70
Measuring devices	0.95	0.98	1.13	0.97	0.99	1.13	0.89	0.96	1.54	0.95	1.01	1.48
Professional Services	0.97	0.96	0.94	0.97	0.97	0.93	0.96	0.96	0.91	0.91	0.91	0.88
Advertising	0.89	0.90	0.93	0.82	0.83	0.91	0.82	0.84	0.95	0.81	0.82	0.91
Computer processing	0.96	0.97	1.05	0.97	0.97	1.09	0.97	0.98	1.11	0.93	0.95	1.12
Research & testing	1.04	1.03	0.93	1.05	1.04	0.99	1.05	1.04	0.96	1.05	1.05	1.04

	Establishment Size * Urbanization											
	20 km			**40 km**			**80 km**			**160 km**		
	Sm	**Med**	**Lg**	**Sm**	**Med**	**Lg**	**Sm**	**Med**	**Lg**	**Sm**	**Med**	**Lg**
Manufacturing	1.01	1.01	1.02	1.00	1.00	1.01	1.00	1.00	1.01	1.00	1.00	1.00
Drugs	1.01	1.01	1.02	1.00	1.01	1.02	1.01	1.01	1.01	1.00	1.00	1.00
Farm & garden machinery	1.04	1.05	1.12	1.02	1.03	1.06	1.00	1.00	1.00	1.00	1.00	0.99
Metalworking machinery	1.02	1.01	0.99	1.01	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00
Electronic components	1.01	1.02	1.06	1.00	1.00	1.01	1.00	1.00	0.99	1.00	1.00	1.00
Motor vehicle parts	0.99	1.00	1.15	0.99	1.00	1.05	1.00	1.00	1.03	1.00	1.00	1.01
Measuring devices	1.00	0.99	0.94	1.00	0.99	0.96	1.00	1.00	0.96	1.00	1.00	0.97
Professional Services	1.00	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Advertising	1.01	1.00	1.00	1.00	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00
Computer processing	0.99	0.99	1.00	0.99	0.99	1.00	0.99	0.99	1.00	1.00	1.00	1.00
Research & testing	1.00	1.00	1.03	0.99	1.00	1.02	1.00	1.00	1.01	1.00	1.00	1.00

P10 = 10th percentile size — [grey] = *90% significance (Pr t <= .1)*
P50 = 50th percentile size (median) — [black] = *95% significance (Pr t <= .05)*
P90 = 90th percentile size

In manufacturing and measuring and controlling devices the positive interaction effect is due to *higher* hazard rates for larger establishments in areas of higher localization. In these industries, localization does not benefit small establishments so much as it poses greater harm to larger ones. At 20 km a unit increase in localization increases the hazard of 90th percentile manufacturing establishments (i.e. 49 employees) by two percent. The same change does not significantly affect the hazard rates for establishments at the 10th and 50th size percentiles. At larger distances the hazard rates for all three size classes are significant and increase in localization, but 90th percentile establishments consistently have a hazard rate two percentage points higher than median and 10th percentile establishments. New firms in measuring and controlling devices follow a similar pattern, where an increase in localization results in a significantly greater hazard for larger establishments, but has no significant effect on 10th and 50th percentile establishments.

There are also several instances where localization favors larger plants more than smaller ones. In professional services and drugs, larger plants have lower hazard rates and smaller plants high hazard rates in areas of greater own-industry concentration. In electronic components, an increase in localization reduces hazard rates for larger firms but has no significant effect on smaller plants.

For urbanization, the interactions with size are positive and significant in both sectors and four industries (see Table 6.4). In manufacturing, motor vehicle parts (≤ 80 km), advertising (160 km) and research and testing services (≤ 80 km), the positive interactions are driven by higher hazard rates of larger establishments in regions with high employment. Of these, large firms in motor vehicle parts face the greatest rise in hazard rates with regional employment, approaching fifteen percent for an additional 10,000 workers within 20 km. In professional services and computer and data processing the typical pattern is one of declining hazards for smaller plants and increasing hazards for larger plants. Measuring and controlling devices is the only industry where an increase in regional size significantly decreases the hazard facing larger establishments (≥ 40 km). An increase in 10,000 workers reduces the hazard rate of the typical measuring devices plant with 47 employees (90^{th} percentile) from between three to four percent.

6.5 Discussion

In this chapter, I examine the effects of localization and urbanization economies on the survival of new firms. The most consistent effects are found for localization economies. New firms in regions with greater industrial specialization have a significantly lower risk of failure in the professional services sector and five detailed industries. Although significant, regional industrial specialization has only a relatively minor influence on the economic performance of individual businesses. For example, the hazard rates for new firms in a region with twice the national share of own-industry establishment are, at a maximum, only eighteen percent lower than those located in regions mirroring the nation. As I argue in the final chapter, short-run policy interventions are not capable of generating such dramatic changes in a region's industrial composition. After controlling for localization, the size of the local economy is more characteristic of congestion diseconomies rather than beneficial economies. Urbanization only reduces hazard rates for new firms in the computer and data processing industry.

The many novel aspects of this study confound direct comparison to past work. The dynamics for new firms may well differ from the full population of businesses. Still, it is worthwhile to consider these findings in relation to other studies. The most comparable recent studies of localization and urbanization are Feser (2001b) and Henderson (2003) both of whom study establishment productivity using micro data from the Census Bureau's *Longitudinal Research Database*. Feser finds that localization significantly increases productivity in measuring and controlling devices, but not in farm and garden machinery. I find the opposite, significant localization effects in farm and garden machinery but not measuring and controlling devices. Both Feser and Henderson suggest that localization may be more relevant to tech-intensive industries. I find no obvious connection between industrial technological intensity and localization. If anything, localization economies tend to be significant in more traditional equipment manufacturing industries, such as farm and garden machinery, metalworking machinery and motor vehicle parts. Then again, new firms may be more innovative and/or technologically intensive than incumbents of the same industry. Localization is also beneficial in several service-based industries, particularly advertising and computer and data processing.

My findings on urbanization also differ from Feser (2001b). He finds a positive influence of urbanization in the farm and garden machinery industry. My results suggest prevailing urbanization diseconomies in farm and garden machinery, at least at a 90 percent level of statistical significance at distances below 40 km. My results for urbanization closely match Henderson's (2003), who finds no benefit to regional size in manufacturing establishments.

I also investigate how establishment size influences the relationship between localization and urbanization and new firm survival. Feser (2001a) and Sweeney and Feser (1998) are the most comparable recent studies, the first a study of manufacturing productivity, the second an analysis of geographic concentration by manufacturing establishments of varying sizes. Both studies conclude that medium sized firms are more likely to benefit from localization economies than either very small or large plants. I find that smaller firms typically have lower hazard rates in areas of greater localization, although there are several cases where localization favors medium sized plants over smaller ones. The typical influence of urbanization economies is to reduce the hazard for small plants in the professional services industries and increase the hazard for larger (i.e. medium-sized) plants in the manufacturing sector and motor vehicle parts industry. Only in measuring and controlling devices does an increase in regional employment reduce the hazard for larger plants relative to smaller ones.

CHAPTER VII

THE SOURCES OF EXTERNAL ECONOMIES

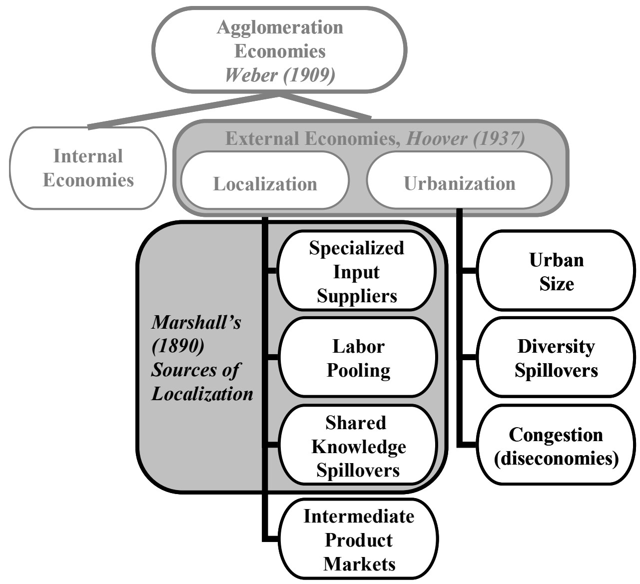
7.1 Introduction

In the previous chapter, I found that new firms in several industries are more likely to survive in areas of own-industry specialization and slightly less likely to survive in areas of high regional employment. These measures provide a broad indication of the types of industrial environments that may favor the post-entry performance of new firms, but say relatively little about the root source of environmental advantages and disadvantages. Specific information of whether beneficial localization economies reside in localized networks of input suppliers, product markets, specialized labor pools, or knowledge spillovers can help policy makers target resources to areas that provide the greatest benefits to new business. For example, if labor pools are most important then workforce development initiatives might be warranted. If specialized input suppliers are the source of localization externalities, policy makers may want to target supporting industries. Separation of industrial diversity from other sources of urbanization similarly provides useful information on the comparative advantages/disadvantages of cities and the types of industries that might do well in such places, despite higher costs.

In this chapter, I model the influence of the specific sources of external economies on the survival and failure of new firms: covering Marshall's three sources of localization, intermediate product markets, industrial diversity and the size of the region (see Figure 7.1).

The chapter is organized similarly to the last. I begin with an analysis of bivariate survival rates for new firms in areas of high and low levels of agglomeration. New firms frequently have higher survival rates in areas of higher industrial diversity, specialized input suppliers and intermediate goods markets. Proximity to deep labor pools increases the likelihood of new firm survival at larger spatial scales, but lowers it at close proximities. Positive benefits to industrial knowledge spillovers are most apparent in the drugs industry.

Figure 7.1
Typology of Agglomeration
Emphasis on detailed sources of External Economies



In the second section, I estimate multivariate event duration models to isolate the individual contribution of regional size, industrial diversity, labor pooling, specialized input supplier, intermediate goods markets and knowledge spillovers on new firm longevity. I find that industrial diversity provides a favorable environment for the survival of new firms, particularly for those in the professional service-based industries and drugs manufacturing. After controlling for other external economies, the size of the region has little effect on the survival of new firms in most industries. When it is significant, an increase in regional employment usually raises hazard rates, presumably a consequence of prevailing congestion externalities and higher production costs.

Of the specific sources of localization, proximity to specialized input suppliers most consistently reduces the hazard rates of new firms. When significant, proximity to specialized input suppliers has a somewhat stronger influence on new firm hazard rates than a comparable change in own-industry specialization. Proximity to intermediate goods markets and industry knowledge spillovers only reduce the hazard of new firm failure in limited instances. After controlling for the other sources of localization, proximity to specialized labor pools is more likely to increase the hazard rate of new firms in several professional service-based industries and has little influence in manufacturing.

The chapter concludes by testing whether establishment size conditions the relationship between new firm longevity and the specific sources of external economies. In support of the findings of the previous chapter, I find that external economies act differently among new firms of different sizes. While the volume of detailed results makes broad generalizations difficult, there is an overall tendency for increases in regional diversity, specialized input suppliers and intermediate goods markets to favor smaller establishment relative to larger ones. An increase in regional employment tends to increase hazard rates of larger new firms, but has little influence on the survival of smaller plants. The results for specialized labor pools and knowledge spillovers are mixed. The significantly negative interactions in several industries suggest that labor pooling may be complementary with establishment size, presumably because larger establishments have greater need for specialized labor. Industrial knowledge spillovers act mainly on larger plants, perhaps because smallest plants do not compete in innovative product markets. In measuring and controlling devices, higher regional patenting increases the hazard rates of both small and larger plants, but the effect is much greater on larger plants. In electronic components and motor vehicle parts a similar increase reduces the hazard rate of large plants in electronic components and motor vehicle parts, but has no significant effect on smaller plants.

Table 7.1

Life Table Analysis: Homogenity Tests, Industrial Diversity and the Sources of Localization

Top vs. Bottom 25th Percentile

	Relative Diversity				Specialized Input Suppliers				Intermediate Goods Markets				Labor Pooling				Knowledge Spillover			
	20	40	80	160	20	40	80	160	20	40	80	160	20	40	80	160	20	40	80	160
Manufacturing	-	+	+	+	-	-	-	-	-	-	-	-	-	+	-	-	+	+	+	-
Log rank	0.00	0.09	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.04	0.17	0.00	0.00	0.02	0.00
Wilcoxon	0.18	0.63	0.00	0.00	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.93	0.01	0.03	0.27	0.00	0.00	0.00	0.02
Professional Services	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+				
Log rank	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Wilcoxon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Drugs	+	+	+	+	+	+	+	+	-	-	-	-	-	+	+	+	+	+	+	+
Log rank	0.06	0.21	0.24	0.36	0.65	0.10	0.20	0.75	0.45	0.77	0.39	0.51	0.11	0.09	0.03	0.18	0.02	0.04	0.02	0.01
Wilcoxon	0.03	0.18	0.19	0.27	0.49	0.06	0.08	0.61	0.30	0.61	0.24	0.30	0.11	0.05	0.02	0.21	0.01	0.01	0.01	0.01
Farm & garden machinery	-	+	-	+	+	+	+	-	+	+	+	+	-	+	+	-	+	+	+	+
Log rank	0.29	0.92	0.21	0.38	0.04	0.60	0.40	0.91	0.00	0.03	0.15	0.21	0.56	0.54	0.88	0.74	0.77	0.84	0.11	0.11
Wilcoxon	0.26	0.71	0.40	0.20	0.06	0.54	0.45	0.83	0.00	0.01	0.08	0.19	0.33	0.99	0.95	0.54	0.70	0.83	0.23	0.15
Metalworking machinery	-	+	-	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+
Log rank	0.09	0.93	0.50	0.17	0.05	0.04	0.08	0.08	0.24	0.08	0.04	0.02	0.28	0.29	0.42	0.22	0.21	0.13	0.29	0.95
Wilcoxon	0.12	0.71	0.64	0.13	0.03	0.02	0.08	0.06	0.16	0.06	0.05	0.03	0.26	0.25	0.38	0.23	0.15	0.07	0.20	0.82
Electronic components	+	+	+	-	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+
Log rank	0.45	0.82	0.88	0.28	0.15	0.08	0.43	0.23	0.43	0.24	0.32	0.03	0.38	0.19	0.05	0.30	0.42	0.39	0.34	0.10
Wilcoxon	0.47	0.61	0.97	0.24	0.28	0.09	0.35	0.21	0.42	0.14	0.25	0.03	0.34	0.21	0.06	0.28	0.36	0.31	0.23	0.08
Motor vehicle parts	-	-	-	-	+	+	+	+	+	+	+	+	-	+	+	+	+	+	-	-
Log rank	0.10	0.05	0.15	0.74	0.05	0.21	0.00	0.08	0.03	0.01	0.00	0.00	0.01	0.01	0.00	0.02	0.23	0.51	0.89	0.73
Wilcoxon	0.13	0.07	0.28	0.87	0.07	0.32	0.01	0.17	0.07	0.01	0.00	0.01	0.01	0.00	0.00	0.02	0.24	0.55	0.82	0.84
Measuring devices	+	+	+	+	+	+	+	+	+	-	-	-	-	+	+	+	+	+	+	+
Log rank	0.01	0.04	0.04	0.70	0.00	0.07	0.34	0.16	0.16	0.97	0.79	0.67	0.23	0.44	0.98	0.77	0.69	0.66	0.46	0.63
Wilcoxon	0.02	0.04	0.03	0.65	0.01	0.13	0.26	0.19	0.35	0.93	0.64	0.33	0.30	0.50	0.95	0.74	0.76	0.65	0.33	0.50
Advertising	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+				
Log rank	0.02	0.00	0.00	0.00	0.01	0.01	0.00	0.04	0.02	0.05	0.24	0.03	0.03	0.03	0.02	0.03				
Wilcoxon	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.09	0.00	0.02	0.01	0.00	0.01				
Computer & data processing	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+				
Log rank	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.01	0.40	0.00	0.00	0.00	0.02	0.00	0.00	0.00				
Wilcoxon	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Research & testing services	-	+	+	+	-	-	-	-	-	+	+	+	-	+	+	-				
Log rank	0.43	0.22	0.04	0.00	1.00	0.51	0.45	0.75	0.62	0.79	0.69	0.13	0.14	0.55	0.33	0.68				
Wilcoxon	0.37	0.22	0.03	0.01	0.98	0.50	0.44	0.66	0.82	0.67	0.62	0.13	0.09	0.44	0.44	0.83				

(grey) *= 90% significance (Pr χ2 <= .1)*

(black) *= 95% significance (Pr χ2 <= .05)*

+ if mean high group survival > mean low group survival

- if mean high group survival < mean low group survival

7.2 Life Table Analysis

Life table analysis provides baseline estimates of the survival rates for new firms in areas of high (≥ 75th percentile) and low (≤ 25th percentile) industrial diversity, specialized input suppliers, intermediate goods markets, labor pools and knowledge spillovers. Probabilities from log-rank and Wilcoxon homogeneity tests and indicators of the average direction of the high-low association are provided in Table 7.1. The corresponding survival curves estimated at 80 km to provide a visual aid to interpretation (see Appendices N through R).

Areas of greater diversity have significantly higher survival rates for new firms in two knowledge intensive manufacturing industries, drugs (20 km) and measuring and controlling devices (≤ 80 km), and the three professional services industries, advertising, computer and data processing and research and testing services (≥ 80 km). These are the same industries where beneficial unconditional urbanization economies were detected in the previous chapter (Table 6.1), raising some concerns that diversity and urbanization may be too closely associated to distinguish independent effects. It remains to be seen whether diversity continues to be beneficial to establishments in these industries after controlling for regional size and the sources of localization.

Most industries show some benefit from proximity to specialized input suppliers in related industries, with sign and significance patterns nearly matching those found for the own-industry specialization. In the professional services sector entrants are significantly more likely to survive when located near input suppliers, although the actual differences between the high and low groups are very small (see Appendix O). Highly significant and positive effects in metalworking machinery, motor vehicle parts, advertising and computer and data processing cover a range of distances. For farm and garden machinery and measuring devices significantly higher survival rates are limited to small spatial scales. In drugs and electronic components, the differences between the high and low groups are only significant at the 90 percent level, although the plotted high group survival curves are visibly higher in drugs (Appendix O). There are no apparent benefits to specialized input suppliers for new firms in the research and testing services industry. New firms in manufacturing face a significantly lower probability of survival in areas with a high concentration of specialized input suppliers.

Thick intermediate goods markets are associated with higher survival rates for new firms in professional services, farm and garden machinery, metalworking machinery, motor vehicle parts, advertising and computer and data processing services. The results for intermediate goods markets are also similar to those found for input suppliers. This is not surprising, considering that key specialized input supplier and intermediate product markets often include many of the same industries. Intermediate goods markets and input suppliers differ primarily in drugs, electronic components, and measuring and controlling devices, three of the most knowledge intensive manufacturing industries studied. Intermediate goods markets also show a slight tendency for higher significance at larger spatial scales compared to input suppliers. This result coincides with the conventional wisdom that benefits from market access is dictated by regional transportation networks and span fairly large spatial externality fields.

The influence of labor pooling critically depends on spatial scale at which it is measured. Deep labor pools are associated with a higher likelihood of survival at large spatial scales and a reduced likelihood at the smallest. In manufacturing, proximity to deep labor pools is associated with a significantly higher likelihood of survival at 40 km and a lower likelihood of survival at 80 km. In professional services, proximity to deep labor pools is hazardous at 20km, but beneficial at all larger scales. There are an additional four industries (drugs, motor vehicle parts, advertising and computer and data processing) where deep labor pools are associated with higher survival rates at scales of 40 km and above. In motor vehicle parts, advertising and computer and data processing, areas of dense labor pools at 20 km are associated with a significantly lower probability of survival. The regional character of labor pooling benefits coincides with intra-metropolitan commuting preferences and spatial separation of land uses. Unlike the other localization variables, labor pools are measured at the worker's place of residence. There may be little benefit to locating near residential areas when workers are willing to commute further distances. Professional services firms may be at a particular disadvantage when located too close to residential areas, possibly because they lack access to potential corporate clients in distant business districts.

The results for knowledge spillovers are most dissimilar to the other sources of localized external economies. Local specialization in related utility patents increases the survival prospects in the manufacturing sector at 80 km and below, but lowers it at 160 km, providing limited support that knowledge spillovers are intra-metropolitan by nature because they rely on tacit knowledge requiring a greater intimacy and frequency of face to face interaction. New firms in the drugs industry are the largest beneficiaries of location in areas of high patenting activity at all distances measured. Using a 90 percent significance threshold, beneficial knowledge spillovers are also detected for metalworking machinery (40 km) and electronic components (160 km).

7.3 Event Duration Modeling

7.3.1 Empirical Modeling Framework

Following the hierarchical typology depicted in Figure 5.1, I re-estimate the empirical event duration models of the last chapter (equations 6.5 and 6.6) after replacing the summary measures of localization with variables representing the detailed sources of localization described by Marshall: specialized input suppliers (*INPUTS*), labor pooling (*LABOR*), and industrial knowledge spillovers (*KNOW*). I also include a variable representing proximity to intermediate product markets (*MARKETS*), and two measures of urbanization, relative industrial diversity (*DIV*) and regional total employment (*URB*). After controlling for diversity and Marshallian localization, I expect *URB* to represent congestion diseconomies in most industries. Making these substitutions results in the following estimating equation for manufacturing-based industries,

$$\begin{aligned}\log[-\log(1-\lambda_{it})] &= \alpha(t) + b_1 QTR1_i + b_2 QTR2_i + b_3 QTR3_i + b_4 SIZE_i \\ &+ b_5 MWEST_i + b_6 NEAST_i + b_7 SOUTH_i + b_8 URB_i + b_9 DIV_i \\ &+ b_{10} INPUTS_i + b_{11} MARKETS_i + b_{12} LABOR_i + b_{13} KNOW_i\end{aligned} \quad . \qquad (7.1)$$

The models for the professional services industry differs from equation 7.1 in the omission of the patent-based knowledge spillovers variable.[52] As before, I also estimate an additional set of models inclusive of regional controls for university strength (*UNIV*), large plant dominance (*LGSH*), regional educational attainment (*BACH*) and regional population growth (*POPGR*).

[52] As discussed in Chapter Five, patents are highly aggregated in non-manufacturing industries and could not be used to measure related-industry knowledge spillovers for professional services.

7.3.2 Results

Appendix S reports model fit statistics, parameter estimates, hazard ratios, significance tests and tolerance values for all variables in the basic event duration models, except the two digit SIC fixed effects included in the sector level models. Estimates of baseline hazards, seasonal dummies, and establishment size change only slightly from the basic localization-urbanization models, and do not warrant additional discussion. The Census Division fixed effects are sensitive to the inclusion of alternate specifications for the agglomeration variables, but only at the largest scales. Adding several variables to measure localization explains more of the large scale spatial variation in survival, reducing the size and significance, but not relative ordering, of the

Table 7.2
Model Summary
Sources of External Economies

	Manufacturing	Professional Services	Drugs	Farm & garden machinery	Metalworking machinery	Electronic components	Motor vehicle parts	Measuring devices	Advertising	Computer & data processing	Research & testing
Urbanization											
20 km	+	+	+	+	+	+	+	+	+	-	+
40 km	+	-	+	+	+	+	-	-	+	-	-
80 km	+	-	+	+	+	+	-	-	-	-	+
160 km	+	+	+	+	+	-	-	-	-	-	-
Diversity											
20 km	+	-	-	+	+	-	+	-	-	-	-
40 km	-	+	-	-	-	+	+	-	-	-	-
80 km	-	-	-	-	-	+	+	-	-	-	-
160 km	-	-	-	-	-	+	+	-	-	-	-
Input Suppliers											
20 km	+	-	+	-	-	-	-	-	-	-	+
40 km	+	-	-	+	-	-	+	-	-	-	+
80 km	+	-	-	-	-	-	-	-	-	-	+
160 km	+	-	-	-	-	-	-	-	-	-	+
Intermediate Goods Markets											
20 km	+	-	-	+	+	+	-	-	-	+	+
40 km	+	-	+	-	+	+	-	+	+	+	+
80 km	+	-	+	-	+	+	-	+	+	+	-
160 km	+	-	+	-	+	+	-	+	+	+	+
Labor Pools											
20 km	+	+	-	+	-	-	-	-	+	+	+
40 km	+	+	-	+	+	-	-	+	+	+	+
80 km	+	+	+	+	-	-	+	+	+	+	-
160 km	-	+	+	+	-	-	+	+	+	+	+
Knowledge Spillovers											
20 km	-		-	-	-	-	-	+			
40 km	-		+	-	-	-	-	+			
80 km	-		-	-	-	-	-	+			
160 km	-		-	-	-	-	-	-			

+ = *Increased hazard rate* (grey) = *90% significance (Pr χ2 <= .1)*
- = *Reduced hazard rate* (black) = *95% significance (Pr χ2 <= .05)*

estimated coefficients for Census Divisions. The Northeast still has lower hazard rates in all industries. Hazard rates for new firms are highest either in the South or the Midwest, depending on the industry examined.

Table 7.2 summarizes the direction and statistical significance of the specific sources for external economies in the parsimonious models. As in the basic localization-urbanization model, the regional size variable is predominantly positive, but there now are fewer industries where congestion diseconomies are significant. Computer and data processing establishments remain less likely to fail in larger regions, although an additional 10,000 workers decreases the plant's hazard rate by less than one percent.

Unlike urbanization, industrial diversity retains most of its beneficial character even after controlling for other external economies. The strongest benefits of industrial diversity are for new firms in the drugs industry, where a one unit increase in the relative diversity index decreases the odds of failure by roughly 40 percent (20 and 160 km).[53] Diversity also provides a favorable environment for new firms in manufacturing, advertising, computer and data processing and research and testing services. The benefits to diversity are predominantly metropolitan or inter-regional, with strongest and most significant effects at 80 and 160 km. There are no industries where higher diversity reduces the likelihood of survival.

Proximity to specialized input suppliers is the most consistently beneficial source of localization economies in my disaggregate models. Proximity to input suppliers reduces the hazard for new firms in professional services, metalworking machinery (≥ 40 km), advertising (20 km, 40 km, and 160 km), and computer and data processing services (≤ 80

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[53] A unit change in the diversity index is quite dramatic and should be considered in interpretation of coefficient estimates. In the continental U.S. the relative industrial diversity index only ranges from .8 to 4.6.

km). Although significant in fewer industries, a change in specialized input suppliers typically produces a larger reduction in new firm hazard rates than a comparable change in the own-industry specialization variable of the previous chapter. The strongest effects found at larger distances. At 160 km, a one unit change in the relative concentration of input suppliers reduces the hazard rate in professional services by approximately 25 percent. A corresponding change reduces the risk of failure by 53 percent in metalworking machinery, by 40 percent in advertising and by 22 percent in computer and data processing services.

New firms in most industries do not benefit from proximity to intermediate goods markets. Intermediate product markets significantly reduce the hazard of failure in professional services, but the effects are considerably more modest in magnitude than found for input suppliers. At 80 km, a unit increase in the relative concentration in the specialization of intermediate market industries reduces the hazard rate by 12 percent. At the 90 percent significance level, deep intermediate markets also reduce hazard rates in two key intermediate goods industries: farm and garden machinery (160 km) and motor vehicle parts (40 and 80 km). In the remaining industries, proximity to product markets increases new firm hazard rates. New manufacturing (20 km and 160 km) and computer and data processing services firms (160 km) face a higher risk of failure when located in areas with deep intermediate markets. Relatively high multicollinearity in the computer services industry (160 km) is one possibility for the counter-intuitive findings. A second explanation is that my measure does not capture the true local market for intermediate goods if new firms primary sell goods and services to other small businesses. I measure intermediate goods markets with employment under the assumption that employment represents the size of the potential market. But employment may be indicative of large plants in upstream industries, which may be less likely to source inputs from local independent vendors (Chinitz 1961).[54]

After controlling for the other sources of localization, labor pooling is insignificant in most manufacturing industries and associated with a higher likelihood of failure in most of the professional services industries.[55] This is contrary to theoretical expectations and contrasts with previous studies finding significant benefits to labor pooling when estimated on both new and incumbent firms (Rosenthal and Strange 2001; Feser 2002; Rigby and Essletzbichler 2002). Labor pooling may be irrelevant to new firms because they are so much smaller than incumbents and have little trouble finding qualified workers. Coinciding with my results, Feser (2001a) only found significant benefits to labor pooling for larger plants. Significantly higher hazard rates for new firms in the drugs (160 km), advertising (40 km), and computer and data processing services (≥ 40 km) are more difficult to explain.[56] In the life table analysis these three industries all had a significant positive relationship between labor pooling and new firm survival at distances beyond 20 km (see Table 7.1). Labor pooling only increases the likelihood of failure after other sources of localized economies are controlled. This suggests that previously observed benefits to localization are due to other sources of external economies, such as specialization among input suppliers. Once these beneficial influences are isolated, the residual variation of the labor pooling measure may be

[54] I attempted to measure small plant markets with an establishment-based measure of intermediate goods markets, but the variable was too highly correlated with the specialized input suppliers to distinguish independent effects.

[55] The lone exception in manufacturing is for the drugs industry, which has a positive and significant influence of labor pooling at 160 km. The validity of this finding is doubtful, however, because of the combination of an unreasonably high coefficient estimate and low tolerance.

[56] The unrealistically high hazard ratio of labor pooling in the drugs industry (160 km) is at least partially due to high multicolinearity.

capturing congestion diseconomies relating to the spatial distribution of the residential population.[57]

A high concentration of patent counts is associated with a reduced hazard of failure for new firms in drugs (160 km) and the motor vehicles industry (≤ 40 km). The findings of significant spillovers for new firms in the drugs industry coincides with evidence from the life table analysis. In the drugs industry, a unit change in the relative concentration of relevant patents reduces the hazard of failure from between 14 percent (20 km) to 21 percent (40 km).

7.3.3 Regional Controls

The inclusion of the additional regional controls generates only minor changes in the interpretation of the external economy variables. As a whole, the addition of the regional control variables only significantly improves model fit in the manufacturing, professional services, electronic components, advertising, and computer and data processing (see Table 7.3). Much of the improvement is due to the university strength variable,

Table 7.3
Likelihood Ratio Tests of Regional Controls*
Sources of External Economies

	χ^2 Probabilities			
	20 km	**40 km**	**80 km**	**160 km**
Manufacturing	0.06	0.02	0.00	0.00
Drugs	0.27	0.42	0.27	0.38
Farm & garden machinery	0.08	0.44	0.57	0.07
Metalworking machinery	0.36	0.57	0.29	0.66
Electronic components	0.04	0.06	0.03	0.07
Motor vehicle parts	0.26	0.53	0.74	0.33
Measuring & controlling devices	0.86	0.74	0.37	0.22
Professional services	0.00	0.00	0.00	0.00
Advertising	0.12	0.00	0.00	0.00
Computer & data processing	0.26	0.01	0.00	0.00
Research & testing services	0.22	0.07	0.04	0.07

**Regional controls include University Strength, Large Plant Dominance, Educational Attainment and Population Growth*

[57] A labor pooling measure based on more disaggregate occupation groups may be more capable of distinguishing first and second order spatial concentration in the residence-based occupations. Unfortunately, greater occupational detail is only attainable at the expense of spatial precision.

which, unfortunately, is also highly correlated with regional employment. The other three controls (large plant dominance, educational attainment, and population growth) have little influence on the survival of new firms in all but a small number of the industries studied.

Table 7.4 summarizes the results of the external economy variables after controlling for university strength, large plant dominance, educational attainment and population growth. The full model results are presented in Appendix T. Congestion diseconomies from regional size are now significant in advertising, computer and data processing, and research and testing services, but low tolerance levels in these industries warrant cautious interpretation. In the revised model, diversity is now shown to have a

Table 7.4
Model Summary
Sources of External Economies w/ Regional Controls

	Manufacturing	Professional Services	Drugs	Farm & garden machinery	Metalworking machinery	Electronic components	Motor vehicle parts	Measuring devices	Advertising	Computer & data processing	Research & testing
Urbanization											
20 km	**+**	**+**	**+**	-	+	+	+	+	+	+	+
40 km	**+**	**+**	**+**	+	+	-	+	-	**+**	*-*	+
80 km	**+**	**+**	+	+	+	-	+	-	*+*	+	**+**
160 km	**+**	**+**	**+**	*+*	-	-	+	-	+	**+**	*+*
Diversity											
20 km	+	**-**	**-**	+	+	*-*	+	-	-	-	-
40 km	-	**-**	*-*	-	-	-	+	-	-	**-**	-
80 km	**-**	**-**	-	-	*-*	+	+	-	**-**	**-**	-
160 km	**-**	**-**	**-**	-	-	+	+	+	-	**-**	-
Input Suppliers											
20 km	**+**	**-**	+	*-*	-	-	-	*-*	-	**-**	-
40 km	*+*	**-**	-	+	**-**	-	+	-	*-*	**-**	-
80 km	+	**-**	-	-	**-**	-	-	-	-	**-**	-
160 km	*+*	**-**	-	-	**-**	-	-	-	-	**-**	*-*
Intermediate Goods Markets											
20 km	**+**	**-**	-	+	*+*	+	-	+	+	+	+
40 km	+	**-**	+	-	+	+	*-*	+	+	**+**	+
80 km	*+*	**-**	+	-	+	-	*-*	+	+	**+**	+
160 km	**+**	**-**	+	-	+	-	-	*+*	+	+	+
Labor Pools											
20 km	-	**+**	**-**	+	*-*	+	+	-	+	+	+
40 km	+	**+**	-	+	+	-	+	+	**+**	**+**	-
80 km	+	**+**	+	+	+	-	+	+	**+**	**+**	+
160 km	**-**	**+**	**+**	-	-	-	+	*+*	**+**	*+*	+
Knowledge											
20 km	*-*		+	-	-	*-*	**-**	**+**			
40 km	-		+	-	+	-	**-**	-			
80 km	**-**		-	-	+	-	-	-			
160 km	-		-	-	-	-	-	+			

+ = Increased hazard rate *= 90% significance (Pr χ2 <= .1)*
- = Reduced hazard rate *= 95% significance (Pr χ2 <= .05)*

negative and significant influence of hazard rates in the professional services sector. Previous findings of a lower hazard rates in areas of high regional diversity (80 km and 160 km) for research and testing services establishments are no longer significant, although the associated coefficient estimates themselves only change by a small amount. The main change in specialized input suppliers is for advertising, where negative coefficients at 20, 40 and 160 km are no longer significant. Again the reduced significance is mainly due to larger standard errors and not to major changes in the coefficient estimates. There are few significant changes in intermediate markets, except for computer and data processing service where positive effects are now significant at 40 and 80 km and no longer at 20 and 160 km. After controlling for other regional factors, new firms in advertising now face a significantly higher hazard of failure in areas of deep labor pools at distances above 20 km. Knowledge spillovers are no longer significant for the drugs industry at any distance after controlling for educational attainment.

There is little change in interpretation of the regional control variables from the localization-urbanization model of the previous chapter. Most are still either insignificant and/or have counterintuitive signs. As before, university strength is the most consistently significant regional control variable, although with low tolerance values. The estimates for university strength largely coincide with prior results, except in computer and data processing services, where a unit change in the regional share of related university completions reduces new firm hazard (80 and 160 km) by roughly 2 percent. The industry dominance effects previously found to retard the survival of new firm in the manufacturing sector and drugs are no longer highly significant, although a higher employment share in large plants now results in a significant reduction of hazard rates for electronic components

(20 km) and for computer and data processing (80 km) establishments. Educational attainment significantly increases the hazard rates of new firms in manufacturing, professional services, computer and data processing and research and testing services. Significant effects for population growth are limited to professional services, computer and data processing and research and testing services, where growth in the residential population increases the hazard rate by a small amount.

7.4 Establishment Size and the Sources of External Economies

In this section, I return to the issue of whether size conditions the ability of a new firm to benefit from its local environment, this time by interacting establishment size with the specific measures of external economies. I initially estimated models inclusive of interaction terms for each of the sources of external economies. This resulted in excessive multicollinearity in nearly all industries. To check for inferential bias, I also estimated restricted models where each interaction is modeled separately, with only the *SIZE*URB* interaction repeated in each model.[58] Most of the interaction effects changed little between the full and restricted specification, but in cases where the two diverge, the restricted models produced more plausible estimates. I proceed by interpreting the interactions estimated independently, with the caveat that some of interactions may not fully control for other size-related interactions. Using the generic variable *X* to represent diversity, specialized input suppliers, intermediate goods markets, labor pooling or knowledge spillover, the estimating equation is:

[58] I include the region size interactions in all models because it is not excessively correlated with the other interactions and provides a theoretically necessary control.

$$
\begin{aligned}
&\log[-\log(1-\lambda_{it})] = \alpha(t) + b_1 QTR1_i + b_2 QTR2_i + b_3 QTR3_i + b_4 SIZE_i \\
&+ b_5 MWEST_i + b_6 NEAST_i + b_7 SOUTH_i + b_8 URB_i + b_9 DIV_i + b_{10} INPUTS_i \\
&+ b_{11} MARKETS_i + b_{12} LABOR_i + b_{13} KNOW_i + b_{14}(SIZE_i \bullet URB_i) \\
&+ b_{15}(SIZE_i \bullet X_i)
\end{aligned} \quad . \quad (7.2)
$$

To economize on space I only report coefficient estimates for the particular interactions and related first order terms from each model (Appendix U). The signs and significance values of the interactions are summarized in Table 7.5. I also estimate the hazard ratios for the external economy variables with size evaluated at the 10^{th}, 50^{th} and 90^{th} percentiles (see Table 7.6) following the approach outlined in the previous chapter.[59]

I interpret the establishment size-regional size (ie. *SIZE*URB*) interactions based on estimates from models controlling for the establishment size-diversity interaction (*SIZE*DIV*). Since regional size and industrial diversity are the two specific dimensions of urbanization controlling for diversity interactions helps isolate pure regional size effects. I expect that the burden of higher costs in large cities bears greater on larger start-ups, who favor the cheaper land and labor costs of decentralized locations.

Consistent with my expectations, an increase in the size of a region typically increases the hazard for larger firms and has less influence on the survival of smaller plants. These results roughly coincide with the localization-urbanization models of the previous chapter and the localization-size interaction models. The interaction between size and urbanization is positive and significant in manufacturing, professional services, motor vehicles parts (≤ 80 km), computer and data processing and research and testing services (≤ 80 km). In manufacturing and professional services, the hazard rate increases with urbanization for all three establishment sizes, with larger plants having the highest rate of increase. Larger firms

59 Establishment sizes at each percentile are reported in Table 6.5.

in larger regions also have relatively higher hazards in motor vehicle parts and research and testing services, while smaller establishments in these industries experience no significant change in hazard rates. Smaller new firms in computer and data processing have significantly lower hazard rates in large areas while larger plants have higher hazard rates only at small spatial scales.

Large regions provide a more suitable environment for larger new firms in the drugs (160 km), metalworking machinery (≤40 km) and measuring and controlling devices (≥ 80 km) industries. In the drugs and metalworking machinery industries, an increase in regional employment increases the hazard rate for new firms at the 10th size percentile

Table 7.5
Model Summary: Interactive Analysis
Sources of External Economies

	Manufacturing	Professional Services	Drugs	Farm & garden machinery	Metalworking machinery	Electronic components	Motor vehicle parts	Measuring devices	Advertising	Computer & data processing	Research & testing
Size*Urbanization											
20 km	+	+	+	-	-	+	+	-	-	+	+
40 km	+	+	-	-	-	-	+	-	+	+	+
80 km	+	+	-	-	-	-	+	-	+	+	+
160 km	+	+	-	-	-	+	+	-	+	+	+
Size*Diversity											
20 km	+	+	+	+	+	+	-	+	+	+	+
40 km	-	+	+	+	+	+	-	+	-	+	+
80 km	+	+	+	+	+	+	+	+	-	+	+
160 km	+	-	+	+	+	-	-	-	-	+	+
Size*Input Suppliers											
20 km	+	-	-	-	-	-	+	+	+	+	-
40 km	-	-	+	+	+	-	+	+	+	+	-
80 km	-	-	+	-	+	-	-	+	+	+	-
160 km	+	-	+	+	+	-	-	+	+	+	+
Size*Intermediate Markets											
20 km	+	-	-	+	+	-	+	+	+	+	+
40 km	+	-	-	+	+	-	+	+	+	+	+
80 km	+	-	-	+	+	-	-	+	+	+	+
160 km	+	-	-	+	+	-	-	+	+	+	+
Size*Labor Pooling											
20 km	+	-	+	+	-	-	-	+	+	+	-
40 km	-	-	-	+	-	-	-	+	+	+	-
80 km	-	-	-	+	+	-	-	+	+	-	-
160 km	-	-	+	+	+	-	-	+	-	-	-
Size*Knowledge Spillovers											
20 km	+		-	-	-	-	-	+			
40 km	+		-	-	-	-	-	+			
80 km	+		-	-	+	-	-	+			
160 km	+		+	+	+	-	-	+			

+ = Increased hazard rate [grey] *= 90% significance (Pr χ2 <= .1)*
- = Reduced hazard rate [black] *= 95% significance (Pr χ2 <= .05)*

but has no significant effect on 90th percentile establishments. An increase in regional employment has a negligible influence on smaller establishments in measuring and controlling devices, but reduces the hazard rate of new firms with 47 employees (90th percentile) from three to five percent.

Industrial diversity typically benefits smaller new firms relative to larger ones. The coefficient of the interaction term is positive and significant in the manufacturing sector (160 km), professional services (≤ 40 km) and for five study industries. In most of these industries an increase in regional size reduces the hazard for smaller firms with little effect on larger establishments. In metalworking machinery and computer and data processing diversity reduces the hazard rates of smaller plant hazards *and* increases hazard rates for larger ones. Only in the advertising (≥ 40 km) and professional services sector (160 km) do smaller plants have relatively higher hazard rates in areas of greater diversity.

The interaction between establishment size and specialized input suppliers is positive for most industries; specifically drugs (40 km and 80 km), metalworking machinery (≥ 80 km), motor vehicle parts (20 km), measuring devices (20 km and 80 km), advertising (20 km) and computer and data processing (≥ 40 km). In all but motor vehicle parts, smaller establishments are more likely to survive in areas with a greater specialization of input suppliers. For motor vehicle parts, an increase in the density of input suppliers increases hazard rates of larger plants but has no significant impact on smaller ones. The interaction between size and input suppliers is negative and significant for new firms in electronic components (≤ 40 km) where an increase in the regional specialization of input suppliers reduces the hazard rates for establishments at the 90th percentile. In professional services, hazard rates for all establishments decline with greater specialization of input suppliers, with larger establishments declining at a faster rate than smaller establishments.

Deeper markets for intermediate goods also typically reduce the hazard rates of smaller establishments relative to larger ones. There is a significant positive coefficient on the *SIZE*MARKETS* interaction in manufacturing (≤ 40 km), farm and garden machinery (≤ 40 km), metalworking machinery, motor vehicle parts (20 km), measuring devices (≥ 80 km) and advertising. Greater concentration of intermediate goods markets increases hazard rates of 90th percentile establishments in manufacturing, metalworking machinery, measuring devices and computer and data processing, but has little influence on 10th and 50th percentile establishments. In farm and garden machinery and advertising, 10th percentile establishments have lower hazard rates and 90th percentile establishments have higher hazard rates in areas of specialized product markets. The *SIZE*MARKETS* interaction is negative and significant in professional services, drugs (40 km), and electronic components (20 km and 160 km), favoring larger plants over smaller ones. In professional services, hazard rates for entrants of all three size classes decline with deepening local intermediate goods markets while the hazards for 90th percentile plants decline at a faster rate.

Establishment size has a mixed effect on the relationship between labor pooling and new firm survival. The *SIZE*LABOR* interaction is negative and significant in professional services, electronic components (≤ 80 km), computer and data processing (160 km) and research and testing services (≥ 40 km). Of these, electronic components and research and testing services are characterized by increasing hazard rates for smaller plants and declining hazard rates for larger plants given an increase in the regional concentrations of specialized workers. The hazard rates for professional services and computer and data processing increase for all establishments between the 10th and 90th percentiles, but larger establishments are burdened less than smaller plants. The *SIZE*LABOR* interaction is positive and significant in manufacturing (20 km), farm and garden machinery (160 km) and advertising (≤ 80 km). In these industries, the positive interaction is largely the product of significantly higher hazard rates for 90th percentile plants. The hazard rates for establishments between the10th percentile and the median size are not significantly different from zero.

The results are also mixed for industrial knowledge spillovers. When measured by the geographic concentration of related patents, the interaction between knowledge spillovers and establishment size is positive for manufacturing (≤ 40 km) and measuring devices and negative for electronic components (≤ 40 km) and motor vehicle parts (20 km, 40 km and 160 km). An increase in the relative specialization of related patents reduces the hazard rate for smaller new firms in manufacturing while increasing the hazard for 90th percentile plants in measuring and controlling devices. In motor vehicle parts and electronic components 90th percentile plants an increase in patent specialization reduces the hazard rates for 90th percentile plants, but has no significant effect on smaller plants.

Table 7.6
Interaction Analysis: Simple Slope Hazard Ratios and Statistical Significance
Sources of External Economies

	Establishment Size * Urbanization											
	20 km			**40 km**			**80 km**			**160 km**		
	P10	**P50**	**P90**	**P10**	**P50**	**P90**	**P10**	**P50**	**P90**	**P10**	**P50**	**P90**
Manufacturing	1.01	1.01	1.02	1.00	1.00	1.01	1.00	1.00	1.01	1.00	1.00	1.00
Drugs	1.02	1.02	1.05	1.02	1.02	1.02	1.03	1.02	0.99	1.02	1.02	0.98
Farm & garden machinery	1.05	1.04	0.99	1.04	1.04	1.04	1.03	1.02	1.00	1.01	1.01	0.98
Metalworking machinery	1.03	1.01	0.92	1.01	1.00	0.97	1.01	1.01	0.99	1.00	1.00	1.00
Electronic components	1.02	1.03	1.04	1.01	1.01	1.00	1.00	1.00	0.98	1.00	1.00	1.00
Motor vehicle parts	0.97	0.99	1.20	0.99	0.99	1.06	0.99	0.99	1.02	1.00	1.00	1.01
Measuring & controlling devices	1.02	1.02	0.98	1.00	1.00	0.97	1.00	1.00	0.98	1.00	1.00	0.98
Professional Services	1.00	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Advertising	1.01	1.00	1.00	1.00	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.00
Computer & data processing	0.99	1.00	1.01	0.99	0.99	1.00	0.99	1.00	1.00	1.00	1.00	1.00
Research & testing services	1.00	1.00	1.04	0.99	1.00	1.02	1.00	1.00	1.01	1.00	1.00	1.00

	Establishment Size * Diversity											
	20 km			**40 km**			**80 km**			**160 km**		
	P10	**P50**	**P90**	**P10**	**P50**	**P90**	**P10**	**P50**	**P90**	**P10**	**P50**	**P90**
Manufacturing	1.00	1.01	1.05	0.99	0.99	0.99	0.95	0.95	0.98	0.95	0.96	0.98
Drugs	0.45	0.54	1.37	0.53	0.63	1.61	0.45	0.62	3.18	0.35	0.50	3.10
Farm & garden machinery	0.97	1.05	1.61	0.89	0.89	0.91	0.60	0.67	1.28	0.58	0.65	1.22
Metalworking machinery	0.79	1.05	2.87	0.74	0.91	1.88	0.71	0.82	1.33	0.82	0.88	1.13
Electronic components	0.91	0.92	1.06	0.91	0.97	1.43	1.06	1.08	1.22	1.34	1.20	0.57
Motor vehicle parts	1.18	1.11	0.45	1.20	1.16	0.75	1.19	1.20	1.39	1.11	1.10	0.92
Measuring & controlling devices	0.82	0.83	0.94	0.74	0.82	1.51	0.76	0.82	1.29	0.99	0.97	0.86
Professional Services	0.98	0.99	1.03	1.00	1.00	1.03	0.99	0.99	1.00	1.00	1.00	0.96
Advertising	0.98	0.99	1.02	1.02	0.98	0.81	0.95	0.91	0.74	0.97	0.93	0.75
Computer & data processing	0.96	0.97	1.01	0.93	0.95	1.15	0.88	0.90	1.17	0.90	0.91	1.12
Research & testing services	0.93	0.96	1.17	0.94	0.96	1.09	0.84	0.88	1.13	0.82	0.85	1.13

	Establishment Size * Input Suppliers											
	20 km			**40 km**			**80 km**			**160 km**		
	P10	**P50**	**P90**	**P10**	**P50**	**P90**	**P10**	**P50**	**P90**	**P10**	**P50**	**P90**
Manufacturing	1.01	1.01	1.02	1.01	1.01	0.99	1.01	1.01	0.97	1.02	1.02	1.02
Drugs	2.43	2.27	1.59	0.24	0.59	67.3	0.03	0.08	31.7	0.22	0.45	16.7
Farm & garden machinery	0.78	0.77	0.68	1.11	1.13	1.25	0.67	0.57	0.22	0.60	0.68	1.41
Metalworking machinery	0.93	0.88	0.74	0.53	0.58	0.80	0.44	0.55	1.26	0.30	0.47	2.27
Electronic components	1.06	1.01	0.72	1.06	0.98	0.57	0.90	0.86	0.62	0.98	0.87	0.41
Motor vehicle parts	0.89	0.93	1.68	0.98	1.02	1.70	0.72	0.70	0.50	0.91	0.85	0.38
Measuring & controlling devices	0.73	0.76	0.97	0.83	0.85	1.01	0.75	0.82	1.46	0.71	0.74	0.96
Professional Services	0.93	0.93	0.86	0.93	0.91	0.80	0.90	0.88	0.75	0.76	0.75	0.66
Advertising	0.67	0.74	1.21	0.62	0.68	1.06	0.74	0.79	1.07	0.52	0.59	1.13
Computer & data processing	0.88	0.90	1.07	0.82	0.83	1.00	0.86	0.88	1.11	0.74	0.76	1.03
Research & testing services	1.07	1.04	0.87	1.11	1.08	0.90	1.25	1.23	1.10	1.00	1.01	1.08

P10 = 10^{th} percentile size
P50 = 50^{th} percentile size (median)
P90 = 90^{th} percentile size

[grey] = *90% significance (Pr t ≤ .1, two tailed)*
[black] = *95% significance (Pr t ≤ .05, two tailed)*

Table 7.6 (continued)
Interaction Analysis: Simple Slope Hazard Ratios and Statistical Significance
Sources of External Economies

	Establishment Size * Intermediate Goods											
	20 km			40 km			80 km			160 km		
	P10	P50	P90	P10	P50	P90	P10	P50	P90	P10	P50	P90
Manufacturing	1.00	1.00	1.02	1.00	1.00	1.02	1.01	1.01	1.01	1.01	1.02	1.03
Drugs	1.22	0.88	0.16	1.98	0.95	0.02	3.58	1.53	0.02	6.92	3.58	0.11
Farm & garden machinery	0.97	0.99	1.08	0.94	0.96	1.07	0.94	0.95	1.02	0.90	0.91	1.00
Metalworking machinery	1.03	1.05	1.14	1.04	1.08	1.23	0.95	1.05	1.45	0.95	1.10	1.81
Electronic components	1.09	1.07	0.94	1.18	1.15	0.97	1.17	1.14	1.01	1.23	1.16	0.77
Motor vehicle parts	0.93	0.93	1.00	0.88	0.88	0.89	0.86	0.85	0.74	0.83	0.81	0.58
Measuring & controlling devices	0.99	1.00	1.06	1.04	1.05	1.12	1.03	1.08	1.47	1.16	1.25	2.01
Professional Services	0.97	0.97	0.92	0.94	0.93	0.86	0.91	0.90	0.81	0.93	0.92	0.85
Advertising	0.84	0.95	1.69	0.77	0.94	2.56	0.69	0.97	5.39	0.92	1.22	5.02
Computer & data processing	1.06	1.07	1.16	1.06	1.06	1.11	1.04	1.04	1.14	1.16	1.19	1.55
Research & testing services	0.99	1.02	1.20	0.98	1.03	1.39	0.92	0.94	1.04	0.88	1.01	2.22

	Establishment Size * Labor Pools											
	20 km			40 km			80 km			160 km		
	P10	P50	P90	P10	P50	P90	P10	P50	P90	P10	P50	P90
Manufacturing	1.00	1.00	1.02	1.01	1.01	1.01	1.01	1.01	0.98	0.99	0.99	0.96
Drugs	0.54	0.57	0.76	0.74	0.70	0.50	1.68	1.53	0.91	4.67	5.22	9.42
Farm & garden machinery	0.84	0.93	1.73	0.91	0.99	1.53	0.95	1.05	1.83	0.77	0.99	4.43
Metalworking machinery	0.89	0.84	0.67	1.05	1.03	0.98	0.97	1.00	1.10	0.90	0.92	0.99
Electronic components	1.09	1.00	0.57	1.12	0.97	0.39	1.02	0.90	0.39	1.01	0.92	0.51
Motor vehicle parts	1.01	1.01	0.97	1.06	1.03	0.75	1.42	1.33	0.55	1.56	1.45	0.58
Measuring & controlling devices	0.85	0.87	1.06	1.11	1.12	1.19	1.12	1.12	1.14	1.32	1.33	1.38
Professional Services	1.06	1.05	0.95	1.09	1.09	1.02	1.10	1.10	1.06	1.18	1.17	1.07
Advertising	0.99	1.02	1.20	1.05	1.06	1.16	1.03	1.06	1.23	1.15	1.13	1.06
Computer & data processing	1.02	1.02	1.02	1.10	1.11	1.12	1.06	1.06	1.06	1.09	1.09	1.08
Research & testing services	1.07	1.04	0.88	1.11	1.05	0.73	1.11	1.01	0.57	1.29	1.12	0.48

	Establishment Size * Knowledge Spillovers											
	20 km			40 km			80 km			160 km		
	P10	P50	P90	P10	P50	P90	P10	P50	P90	P10	P50	P90
Manufacturing	0.99	0.99	1.00	0.99	0.99	1.01	0.98	0.98	1.00	0.99	0.99	1.02
Drugs	1.07	1.01	0.78	1.06	1.02	0.82	0.88	0.88	0.85	0.50	0.52	0.66
Farm & garden machinery	0.97	0.97	0.94	1.00	0.93	0.59	0.97	0.93	0.73	0.87	0.89	0.98
Metalworking machinery	0.97	0.92	0.77	0.99	0.93	0.75	0.91	0.91	0.91	0.80	0.87	1.19
Electronic components	1.01	0.99	0.88	0.99	0.98	0.90	1.01	0.99	0.89	1.01	0.99	0.85
Motor vehicle parts	1.01	0.93	0.34	0.96	0.88	0.30	0.97	0.92	0.44	1.02	0.96	0.45
Measuring & controlling devices	1.08	1.09	1.17	0.98	0.99	1.05	0.94	0.96	1.15	0.90	0.94	1.24

P10 = 10th percentile size
P50 = 50th percentile size (median)
P90 = 90th percentile size

[grey] = *90% significance (Pr t ≤ .1, two tailed)*
[black] = *95% significance (Pr t ≤ .05, two tailed)*

7.5 Discussion

In this chapter I examine how the sources of external economies influence the duration of new firms. I classify urbanization economies into those derived from the size of the region and industrial diversity, and model four specific sources of localization economies: specialized input suppliers, intermediate goods markets, labor pooling and knowledge spillovers. In general, I found the specific measures of localization tend to be less significant, but otherwise stronger, predictors of new firm hazard rates than the aggregate own-industry specialization indicator used in the previous chapter. Their low statistical significance may be due to limited spatial variation. The specific sources of external economies commonly have moderate to high correlations with one another, and require considerable spatial variation to effectively parse their individual effects. Analysis based on a larger sample of new firms may be necessary.

After controlling for other influences, regional size has a largely indeterminate effect on the duration of new firms, the result of offsetting forces of positive urbanization economies and negative congestion diseconomies. Diversity was found to reduce the hazard rates of new firms in manufacturing, drugs, advertising, computer and data processing services, and research and testing services. The recent literature emphasizes diversity as a source of dynamic knowledge spillovers but diversity may also benefit new firms in other ways. Access to a potentially diverse client base may buffer local serving businesses from industry specific shocks. Industrial diversity may also represent inherent advantages of a competitively organized regional economy (Evans 1986). Of these potential benefits, diversity spillovers may be more relevant in the drugs industry, where new firms compete on the basis of innovation. New firms in the professional services industries predominantly serve other local businesses and are more likely to benefit from the diversity of clientele found in urban areas.

Proximity to deeper pools of specialized input suppliers is the most consistently significant source of localization economies. Predominantly small new firms are unlikely to have the requisite internal demand to efficiently produce their own auxiliary goods and services and may rely heavily on other local businesses to fill those needs. Although not directly comparable, my findings of significant benefits to specialized input suppliers coincide with previous studies. Feser (2002) includes separate measures for producer services and input product suppliers, and finds that producer services increase productivity in measuring and controlling devices industry and the input product suppliers increase productivity in the farm and garden machinery industry. My combined measure of specialized input suppliers is weakly significant in both of these industries. Rigby and Essletzbichler (2002) use a supply-chain measure that combines input suppliers with intermediate goods markets. This measure is found to increases productivity for plants in numerous two-digit manufacturing industries. In my models, proximity to intermediate goods markets has little influence on new firm survival.

Net of other sources of localization, proximity to specialized labor pools has little influence on the survival of new firms in manufacturing industries and increases hazard rates for new firms in several business and producer services industries. These results are contrary to past studies where labor pooling is linked with higher productivity in manufacturing (Feser 2002; Rigby and Essletzbichler 2002). Both these studies are based on analysis of the *Longitudinal Research Database* micro-files and systematically exclude the small establishments. After partitioning his dataset by plant size, Feser (2001a) found that labor pooling was only significant for larger establishments. Regional specialization in labor markets may be complementary to internal scale economies, contrary to the traditional perspective of external and internal economies as partial substitutes. Larger plants are more likely to face labor supply constraints since they have a more refined internal division of labor that requires greater occupational specialization. New firms, by contrast, are very small and may have little need for deep reserves of specialized workers, or at least not to the extent that deficient regional labor pools pose a major barrier to survival in the early years. As successful new firms move along the life cycle, expand production and incorporate more specialized machinery, their reliance on specialized labor pools may also grow. The environmental isolation of large branch plants suggests there may be limits to the need for specialized labor with greater capitalization and adoption of large batch modes of production (Feser 2001a; Henderson 2003).

My measure of industrial knowledge spillovers is also insignificant in most industries. My results may say more about the value of patents as a measure of knowledge spillovers in particular industries than whether knowledge spillovers are, or are not, a relevant influence on the post-entry behavior of new firms. The propensity to patent and the economic value associated with patenting are known to vary greatly by industry, and the many patents can only be loosely matched to industry classes (Griliches 1979; Griliches 1990; Acs *et al.* 2002). Drugs manufacturing is one area where patents may provide a decent metric of knowledge and innovation. I find some evidence that new firms in the drugs industry were more likely to survive in areas where there is a higher concentration of patenting.

Establishment size plays an important role in determining the relationship between a business and its external environment and deserves greater consideration in future empirical work. Failing to adequately account for the differential effects of establishment size may lead one to falsely conclude that external economies are insignificant. In this chapter and the last, I found many instances where external economies were insignificant when estimated on the entire population of establishments, but were significant when interacted with the establishment size. In several cases the same external conditions had opposite influences on smaller and larger plants. In others, a change in the external economies only had significant influences on either larger or smaller plants.

The weight of my evidence suggests that smaller plants are the most common beneficiaries of external economies, particularly those stemming from specialized input suppliers, intermediate goods markets, and diversity. Small new firms are unlikely to have the requisite internal demand to efficiently produce their own auxiliary goods and services, and may rely heavily on other local businesses to fill these needs. They are also less likely to export their goods and services and are more reliant on local markets. However, there are several industries where an increase in external economies produces a relative reduction in hazard rates for medium sized plants (i.e. the new firms at the 90^{th} percentile) over smaller plants. Thus my results only partially refute the existence of an inverted U relationship between size and external economies (Sweeney and Feser 1998; Feser 2001a). Instead they stress the importance of industry-specific conditions in regulating the relationship between a business and its environment.

My estimates of the influence of plant size contrast with Feser's (2001a) specific results for the measuring and controlling devices and the farm and garden machinery industries. In measuring and controlling devices, he finds no influence of external economies on small plants (< 31 employees), but producer services and specialized labor pools become significant after raising the size limit to 88 employees. I find that specialized input suppliers favor smaller measuring and controlling devices plants (at 20 km) and have no significant influence on hazard rates of plants of 47 employees (the 90th percentile). There is no significant relationship between labor pools and new firms in measuring and controlling devices of any size. In the farm and garden machinery industry, Feser finds significantly higher productivity resulting from labor pools, patent rates, and producer services for plants larger than 27 employees. In my sample of new farm and garden machinery firms, specialized input suppliers and knowledge spillovers does not significantly influence the longevity of plants of any size. Deep labor pools greatly increase hazard rates for farm and garden machinery plants with 45 employees (90th percentile) and has no effect on plants of 10 employees and below.

CHAPTER VIII

IMPLICATIONS FOR RESEARCH AND POLICY

8.1 Summary of Findings

This study models the influence of external economies on the survival and longevity of new independent businesses in the continental U.S. External economies provide a theoretical basis for understanding how small firms compete against typically larger and more resource rich incumbents, either on the basis of price or innovation. I hypothesize that new firms with access to specialized inputs, labor and product markets will outlive those born in areas of relative isolation. The size of the region and its industrial diversity are other potential sources of beneficial externalities, such as access to superior infrastructure, cultural amenities, greater opportunities for niche production and the spread of new ideas between persons of differing backgrounds.

I show that external economies have a statistically significant influence on new firm survival. Although statistically significant, the magnitudes of parameter estimates are typically small. A slight change in the regional composition of industry will, at best, only have a modest influence of the survival prospects of new firms.

The most consistently significant effects are found for localization, defined as the relative specialization of own-industry establishments. Industrial specialization significantly lowers the risk of new firm failure in five of the nine detailed study industries examined: farm and garden machinery, metalworking machinery, motor vehicle parts, advertising and computer and data programming services. The parameter estimates for localization are fairly robust to alternate model specifications and the inclusion of additional regional controls. After controlling for localization, urbanization –measured as total regional employment –is largely insignificant in most industries. I view this as the likely outcome of offsetting positive economies from infrastructure and market access and diseconomies from the higher congestion, land and factor input costs associated with large cities. After including additional controls for regional human capital, population growth, local university strength and the possible dominance of large employers, an increase in the size of the region increases the likelihood of failure for new firms in most industries. Only in computer and data programming services do new firms consistently benefit from location in bigger places.

In general, measures representing the specific sources of localization are significant in fewer industries than when localization is represented by a single measure of own-industry specialization. In several industries, moderate to high multi-colinearity among the specific sources of localization reduces the amount of unique variation, confounding efficient estimation. But when they are significant, the detailed measures typically have a stronger effect on new firm hazard rates. This suggests that while the detailed measures of the sources of localization may provide a closer approximation of the theoretical forces of agglomeration, they lack sufficient spatial variation to effectively distinguish their separate effects in many industries.

Among the specific sources of localization, proximity to specialized input suppliers was the most consistently significant, reducing hazard rates for new firms in metalworking machinery, advertising, and computer and data processing services. As with the broad localization measure, the estimates for specialized input suppliers are fairly robust to the inclusion of additional regional controls. These results add to the growing body of evidence that specialized input suppliers are an important source of proximity benefits (Dumais *et al.* 1997; Feser 2001a; Rosenthal and Strange 2001; Feser 2002; Rigby and Essletzbichler 2002). Proximity to intermediate product markets is only significantly beneficial in the professional services sector. Labor pooling is either insignificant or found to increase new firm hazard rates, but only after the other sources of localization are controlled. Industry knowledge spillovers significantly reduce hazard rates for new firms in the drugs and motor vehicle parts industry, but the accuracy of the variable may be sensitive to industry-specific differences in the economic value of patenting.

Regional industrial diversity also reduces hazard rates for new firms in several industries, particularly drugs, advertising, computer and data processing services, and research and testing services. While the recent literature emphasizes diversity as a source of dynamic knowledge spillovers, I think benefits from access to a potentially diverse clientele are a more likely explanation for the value of industrial diversity to business and professional services firms.

8.2 Implications for Theory and Research

My research has several important implications for future research on external economies and spatial influences on new business performance.

(1) Importance of Industry Structure

Industry-specific conditions apparently play an important role in mediating a new firm's ability to tap into local resources. My findings of endemic industrial heterogeneity suggest that researchers and policy markers should be careful in drawing broad inferences from single cases. The existing research on the relationship between external economies and the performance of small and medium sized enterprises is dominated by case studies of single industries in specific regions. While such studies foster a deeper appreciation of the complex interactions of economic, sociological, historical and cultural forces that collectively define a particular region's entrepreneurial milieu, their relevance to policy and theory is best viewed within the context of the larger body of research.

Researchers should be equally wary of in falling prey to the ecological fallacy that analysis on aggregated industries accurately represents specific sub-industries. In contrast to Moomaw (1998), I found that industrial aggregation makes a large difference on the significance, magnitude, and direction of the estimated agglomeration effects.[60] More specifically, I found that localization and access to specialized input suppliers are predominantly negative and significant when estimated for specific manufacturing industries, but positive and significant when estimated for the whole sector. For most other types of external economies, industrial aggregation tends to wash out industry-level estimates. The larger sample of new firms in manufacturing and professional services often assures significant coefficients, but the balance of positive and negative effects among the component industries result in much smaller estimates at the sector level.

More research is needed to identify the underlying source(s) of industry-specific variation in external economies. At its core, agglomeration is a theory of the organization of industry in space (Marshall 1920 [1890]; Stigler 1951; Richardson 1972). Framing the empirical study of external economies within the context of industrial organization would help to

[60] Moomaw (1998) only compares the effect of two versus three digit level aggregation in manufacturing, not the effect of industrial aggregation to the sector level.

advance our understanding of how the technological requirements of production and competition in specific industries interact with the local environment to influence establishment production decisions.

I found few obvious patterns in the types of industries where external economies were or were not relevant, and can only speculate on the potential sources of industry heterogeneity. Industrial diversity apparently favors service-based industries. It was significant for all three business and professional services industries as well as for the more knowledge-intensive drugs manufacturing industry. There was little evidence that localization economies are of greater relevance to the most technologically intensive industries, namely drugs, electronic components and measuring devices. Instead, new firms in durable equipment manufacturing industries –farm and garden equipment, metalworking machinery and motor vehicle parts – and professional services appear to be the greatest beneficiaries.

(2) The Role of Establishment Size

The relationship between the size of the establishment and external economies also deserves greater consideration in future empirical work. If the forces of agglomeration act differently on plants of different sizes, failing to account for these differences may cause the analyst to falsely reject the null hypothesis of no external economies. On its own, establishment size was the most significant factor in explaining a firm's likelihood of failure. I also found that establishment size conditions the relationship between a business and its external environment. My evidence suggests that smaller businesses are the most common beneficiaries of external economies, but not in all cases. There are several examples, most commonly for urbanization, where external economies increase the failure rates of larger plants while having little effect on smaller ones. There are also several industries where an increase in external economies produces a relative reduction in hazard rates for medium sized plant, but either harmed or had no effect on smaller plants.

(3) Spatial Aggregation

Researchers should also be cognizant of how spatial aggregation may influence the empirical modeling of external economies and spillovers. Again, broad generalization is difficult because distance effects vary across industries and types of external economies. There is a tendency for localization economies and industrial diversity to both have the most influence when measured at larger spatial scales, i.e. those approximating the size of metropolitan areas and/or expanded labor market areas.[61] These results provide some validation to the many studies whose estimates of external economies are based on county and metropolitan spatial units (Nakamura 1985; Henderson 1986; Moomaw 1988; Viladecans-Marsal 2004; Koo 2005a).

Urbanization diseconomies are most prevalent at intra-regional distances. This result is consistent with historical trends of decentralizing metropolitan employment caused by higher land and congestion costs in the area immediately surrounding the city core, while beneficial economies from infrastructure and urban amenities extending into the periphery (Hansen 1990; Phelps *et al.* 2001). The spatial range of the specific sources of localization –labor pools, input suppliers, intermediate goods, and knowledge spillover –are more difficult to summarize, because of their sporadic significance.

[61] These results contrast with Rosenthal and Strange (2003) who a sharp attenuation of localization benefits with distance.

8.3 Implications for Regional Development Policy

In his highly influential, but controversial, analysis of job creation in the U.S., Birch (1987) argues that most of the regional differences in job creation to is largely due to variation in entry rates. He claims that job losses from failure, on the other hand, are largely constant across regions. He advises policy makers to focus their energies on entrepreneurship and creation, rather than retention, arguing that survival is governed by idiosyncratic forces largely beyond the control of local and regional policy.

I do not test the validity of Birch's claims directly, but I do show that new business survival rates are influenced by regional factors. Whether these influences are strong enough to warrant a dramatic shift in public resources is another matter. Even the most influential of the external economies have only modest effects on firm survival and hazard rates. Consider the case of industrial localization in the motor industry parts industry, where a unit increase in the regional own-industry location quotient reduces the risk of failure by roughly 19 percent. To bring about this 19 percent risk reduction would require a dramatic change in the region's industry mix, roughly equivalent to doubling the number of local motor vehicle industry establishments. The marginal benefit of recruiting one or two more business is unlikely to have noticeable spillover benefits for entrepreneurs. Even the most ambitious and successful industrial recruitment or business development initiatives cannot expect to change the composition of a regional economy by the amount necessary to noticeably improve the survival chances of individual new firms.

Rather than try to build capacity in entirely new industries, my research suggests that entrepreneurial development strategies may be more effective if designed to capitalize upon a region's *existing* strengths and assets, as advocated by the industry cluster approach to economic development.[62] There is little indication that competition with existing business in the same industry retards the potential development of new business. Instead, new firms benefit more from access to the same resources that favor incumbents, such as input suppliers and producer services, formal and informal information networks and supporting institutions. A region may also be able to build upon its inherent industrial diversity by supporting entrepreneurship in industries like professional services and drugs that prefer a diverse environment.

A policy recommendation of building on regional strengths offers little guidance for the many rural and peripheral areas that lack a critical mass in growing industry agglomerations (Barkley and Henry 1997). In recognition of this deficiency, contemporary research on industry clusters has taken great interest in identifying potential clusters in rural places and developing policy solutions to capitalize any advantages that do exist. A common recommendation is for rural development policy to strengthen ties to clusters in nearby metropolitan areas, typically through the improvement of infrastructure and business networks (Henry and Drabenstott 1996; Phelps *et al.* 2001; Porter *et al.* 2004).

My research provides some conditional support for development strategies aimed at strengthening ties between rural and nearby metropolitan areas. I find that spatial externality fields extend over fairly large distances. For most industries, the influence of localization and diversity are strongest and most significant at a spatial range of 80 and 160 kilometers. At these distances, peripheral areas may be able to "piggyback" on the specializations of neighboring jurisdictions.

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[62] A recent conference hosted by the Hubert Humphrey Institute at the University of Minnesota focused explicitly on exploring new initiatives aimed bridging entrepreneurial development with regional cluster strategies (Hubert Humphrey Institute 2004).

The discovery of expansive spatial externality fields also lends additional support to arguments favoring a cross-jurisdictional approach to economic development planning (Feser et al. 2001). The jurisdictional nature of state and local politics reinforces a territorial view of economic space. When economic developers do look to their neighbors, it is usually as potential rivals in the continual struggle for mobile capital. But while policy makers must show preference for their home district in the *delivery* of economic development services, it does not preclude them from considering assets and advantages of neighboring regions in economic development *planning*. As found in this study, the sources of regional advantage commonly permeate state and regional borders. Failing to recognize the strategic assets of neighboring areas is an opportunity missed. In this respect, the new Workforce Innovation and Regional Economic Development (WIRED) initiative of the U.S. DOL takes a step in the right direction by encouraging neighboring states to submit joint applications when regional boundaries cross state borders.

APPENDIX A
Study Industries

Manufacturing (ex. SIC 21)

Wood Household Furniture

2511	Wood household furniture
2512	Upholstered household furniture

Drugs

2833	Medicinals and botanicals
2834	Pharmaceutical preparations
2835	Diagnostic substances
2836	Biological products exc. diagnostic

Farm & garden machinery

3523	Farm machinery and equipment
3524	Lawn and garden equipment

Electronic components & accessories

3671	Electron tubes
3672	Printed circuit boards
3674	Semiconductors and related devices
3675	Electronic capacitors
3676	Electronic resistors
3677	Electronic coils and transformers
3678	Electronic connectors
3679	Electronic components, nec

Measuring & controlling devices

3822	Environmental controls
3823	Process control instruments
3824	Fluid meters and counting devices
3825	Instruments to measure electricity
3826	Analytical instruments
3829	Measuring & controlling devices, nec

Professional Services (SIC 73 & 87)

Advertising

7311	Advertising agencies
7312	Outdoor advertising services
7313	Radio, TV, publisher representatives
7319	Advertising, nec

Computer & data processing services

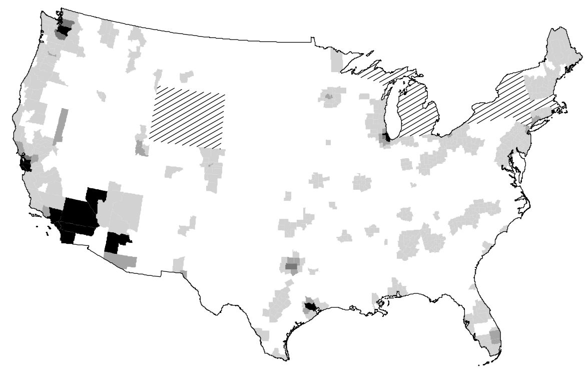
7371	Computer programming services
7372	Prepackaged software
7373	Computer integrated systems design
7374	Data processing and preparation
7375	Information retrieval services
7376	Computer facilities management
7377	Computer rental & leasing
7378	Computer maintenance & repair
7379	Computer related services, nec

Research & testing services

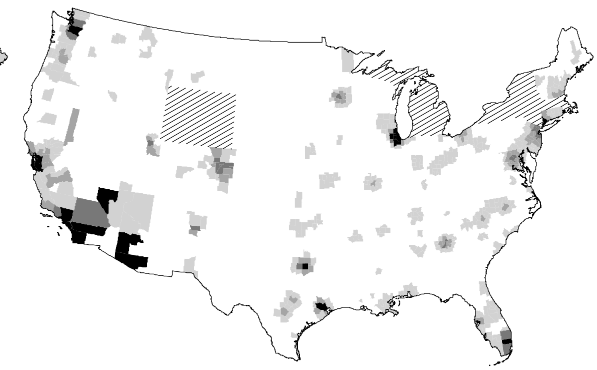
8731	Commercial physical research
8732	Commercial nonphysical research
8733	Noncommercial research organizations
8734	Testing laboratories

APPENDIX B
New Firm Location, Spatially Weighted Averages

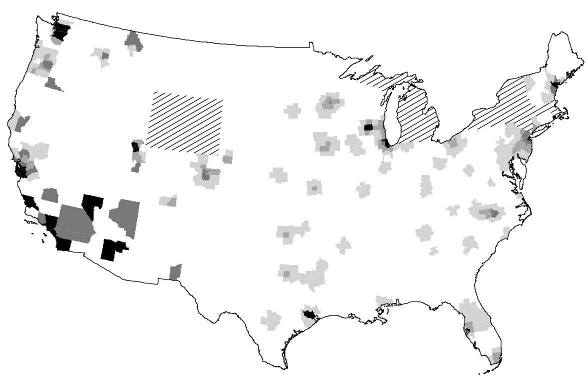
Manufacturing



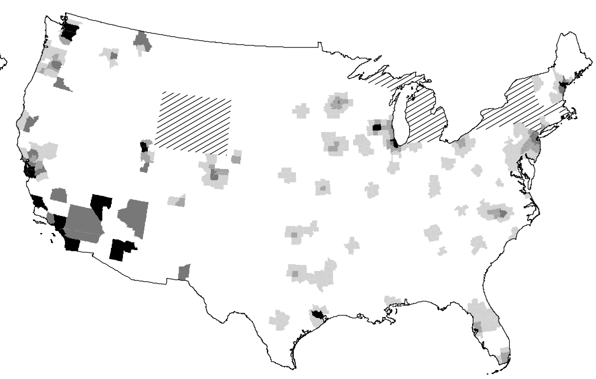
Business & Professional Services



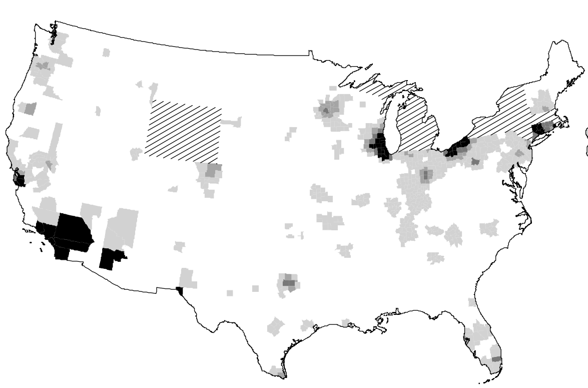
Drugs



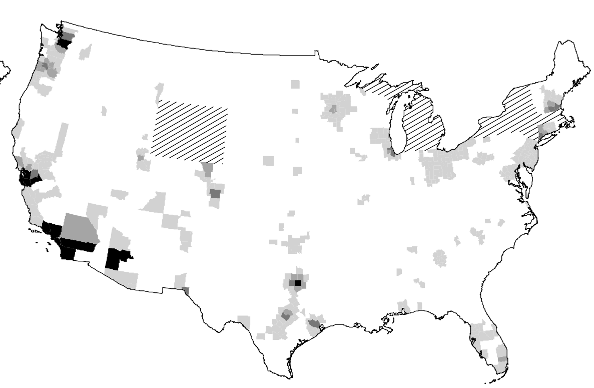
Farm & Garden Machinery



Metalworking Machinery



Electronic Components



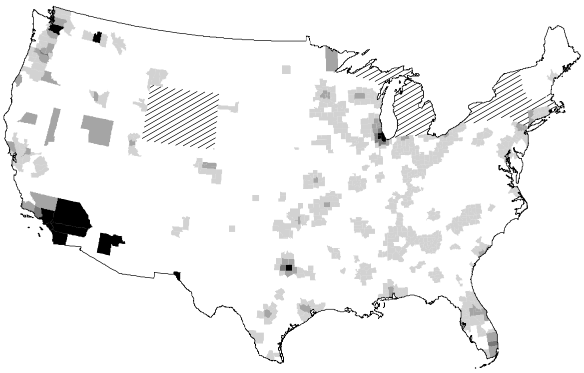
Source: US BLS Longitudinal Database (LDB)

Legend

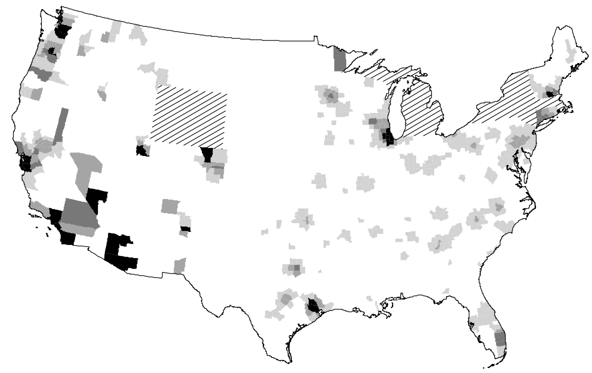
0-1 Std Dev.
1-2 Std Dev.
2-3 Std Dev.
>3 Std Dev.

APPENDIX B (continued)
New Firm Location, Spatially Weighted Averages

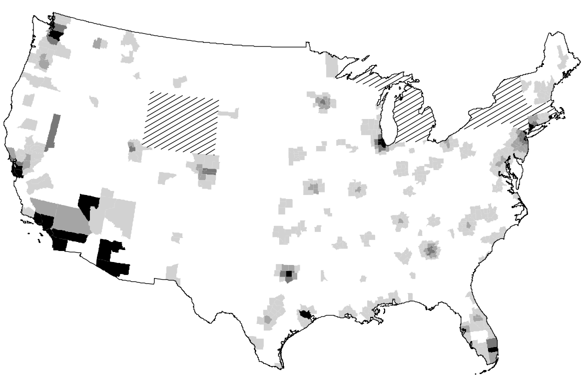
Motor Vehicle Parts



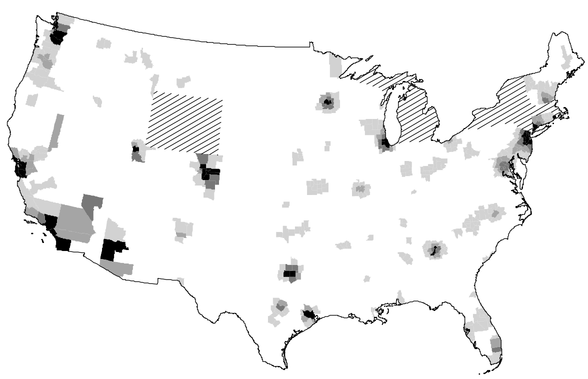
Measuring & Controlling Devices



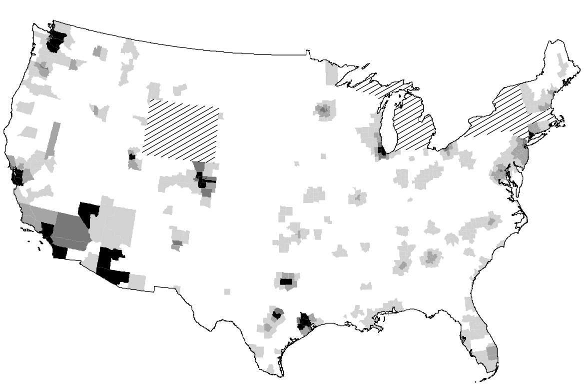
Advertising



Computer & Data Processing Services



Research & Testing Services

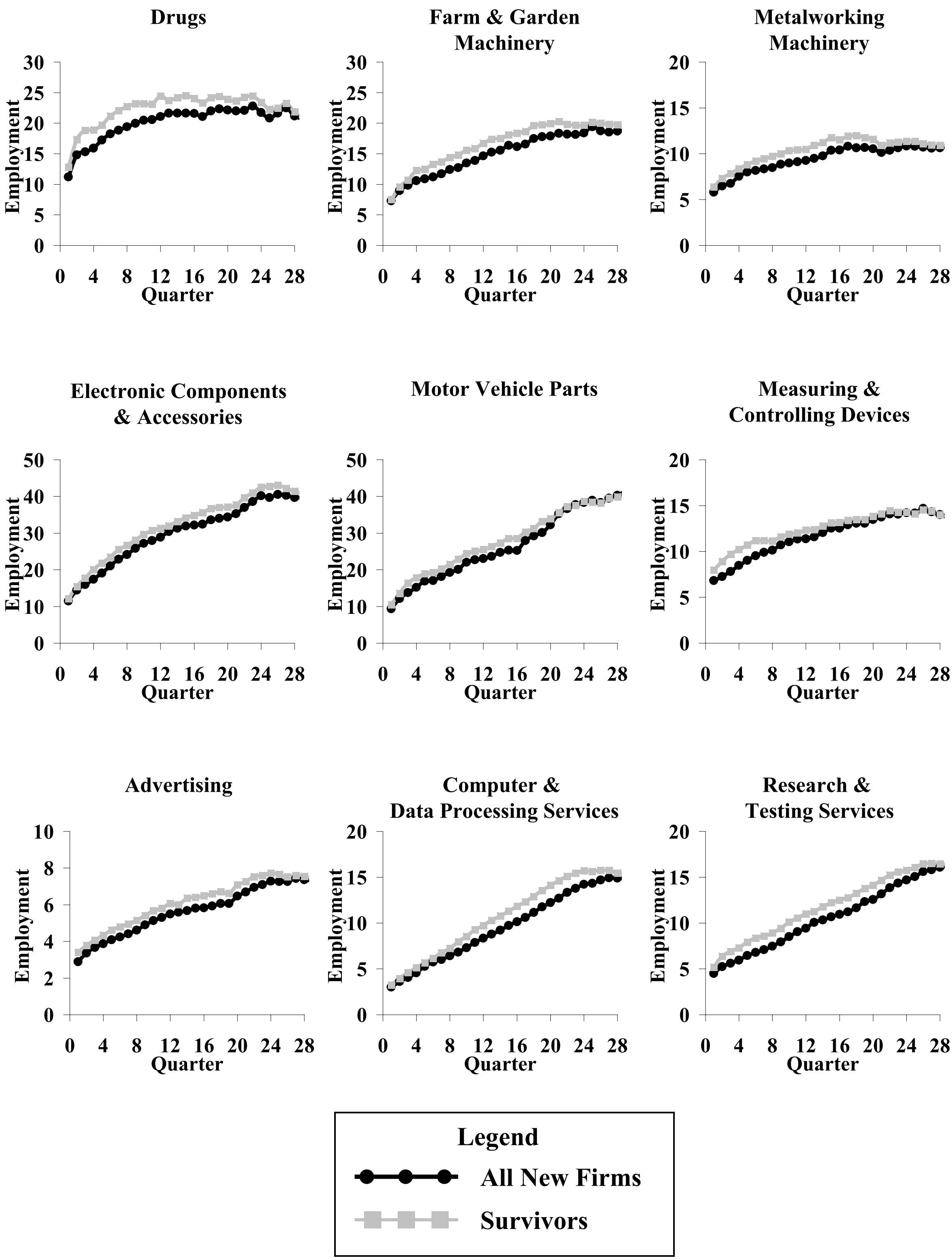


Source: US BLS Longitudinal Database (LDB)

Legend

0-1 Std Dev.
1-2 Std Dev.
2-3 Std Dev.
>3 Std Dev.

APPENDIX C
Average Establishment Size by Age - Study Industries



APPENDIX D
Establishment with High (> 25)Location Quotients
Number and Median Regional Employment*

	20 km		40 km		80 km		160 km	
	N	Median Emp	N	Median Emp	N	Median Emp	N	Median Emp
Own-Industry Specialization								
Manufacturing	1725	0.0026	961	0.0105	269	0.0536	5	0.0308
Drugs	36	0.0010	0	n/a	0	n/a	0	n/a
Farm & garden machinery	12	0.0198	0	n/a	0	n/a	0	n/a
Metalworking machinery	2	0.0003	0	n/a	0	n/a	0	n/a
Professional services	24	0.0071	19	0.0126	7	0.0194	0	n/a
Advertising	4	0.0103	3	0.0157	0	n/a	0	n/a
Computer & data processing	4	0.0090	2	0.0057	0	n/a	0	n/a
Specialized Input Suppliers								
Manufacturing	448	0.0007	153	0.0023	7	0.0033	1	0.1386
Intermediate Product Markets								
Manufacturing	1215	0.0031	978	0.0130	350	0.0440	62	0.6290
Drugs	13	0.0008	0	n/a	0	n/a	0	n/a
Labor Pooling								
Manufacturing	193	0.0008	116	0.0021	26	0.0115	0	n/a
Knowledge Spillovers								
Manufacturing	41	0.0062	29	0.0206	4	0.3778	1	0.8848

**Regional employment measured in 10,000 workers*
Industries that do not have any observations with LQs > 25 at any distance are not shown

APPENDIX E
Study Industry-Academic Discipline Crosswalk

Industry	**Related Academic Disciplines**
Drugs*	Biological sciences, Chemistry, Medical science
Farm & garden machinery*	Computer Science, Materials Engineering, Mechanical Engineering
Electronic components*	Electrical Engineering, Materials Engineering, Mechanical Engineering
Motor vehicle parts*	Chemistry, Computer Science, Electrical Engineering, Mechanical Engineering, Physics
Measuring & controlling devices*	Computer Science, Electrical Engineering, Mechanical Engineering
Advertising**	Communications (inc. advertising & journalism, CIP 09)
Computer & data processing**	Computer & information sciences (CIP 11)
Research & testing services**	Bioengineering & Biomedical Engineering (CIP 14.05), Biology (CIP 26.01), Biochemistry & Biophysics (CIP 26.02), Cell and Molecular Biology (CIP 26.04), Medicine (CIP 51.12)

*Related disciplines in manufacturing identified by Carnegie-Mellon Survey of R&D Managers, as reported in Cohen *et al.* (2002). Categories based on National Science Foundation (NSF) classification of academic disciplines reported in the WEBCASPAR database.
**Related disciplines in business & professional service industries identified by the author from the 2000 Classification of Instructional Programs (CIP) manual of the National Center of Education Statistics (2000)

APPENDIX F
Pairwise Correlations, 40 km and 80 km

	SIZE	URB	LOC	INPUTS	MARKETS	DIV	LP	KNOW	UNIV	LG SHARE	BACH	POPGR
Manufacturing												
SIZE		0.04	0.01	-0.02	0.00	0.02	-0.02	0.00	0.02	-0.03	0.00	-0.01
URB	0.03		-0.05	-0.09	-0.10	0.55	-0.06	0.00	0.69	-0.44	0.39	-0.16
LOC	0.01	-0.03		0.40	0.48	-0.17	0.33	0.00	-0.05	0.14	-0.16	-0.04
INPUTS	-0.02	-0.10	0.53		0.49	-0.31	0.76	0.01	-0.09	0.34	-0.28	-0.14
MARKETS	0.01	-0.11	0.44	0.55		-0.23	0.46	0.01	-0.08	0.19	-0.21	-0.07
DIV	0.02	0.53	-0.18	-0.31	-0.23		-0.28	-0.01	0.41	-0.68	0.56	-0.06
LP	-0.02	-0.05	0.45	0.73	0.50	-0.24		0.01	-0.08	0.27	-0.23	-0.10
KNOW	0.02	0.07	0.01	-0.01	0.03	0.06	0.00		0.01	0.00	0.02	0.00
UNIV	0.02	0.71	-0.06	-0.12	-0.10	0.41	-0.05	0.10		-0.31	0.40	-0.12
LG SHARE	-0.03	-0.44	0.13	0.19	0.13	-0.58	0.10	-0.10	-0.37		-0.51	-0.04
BACH	0.00	0.48	-0.17	-0.28	-0.21	0.53	-0.18	0.17	0.53	-0.44		0.19
POPGR	-0.01	-0.18	-0.08	-0.16	-0.09	-0.09	-0.13	-0.01	-0.14	0.10	0.17	
Professional Services												
SIZE		0.01	0.01	0.01	0.00	0.02	0.00		0.00	-0.01	0.00	0.00
URB	0.00		0.23	0.45	0.18	0.38	0.52		0.79	-0.43	0.34	-0.02
LOC	0.01	0.30		0.58	0.24	0.10	0.34		0.21	-0.25	0.43	0.06
INPUTS	0.00	0.46	0.72		0.43	0.28	0.55		0.38	-0.50	0.79	0.01
MARKETS	0.00	0.23	0.33	0.46		0.03	0.33		0.22	-0.11	0.35	-0.02
DIV	0.01	0.37	0.16	0.29	-0.03		0.12		0.23	-0.58	0.23	-0.03
LP	-0.01	0.53	0.34	0.45	0.33	0.10			0.51	-0.35	0.53	-0.01
UNIV	0.00	0.85	0.32	0.44	0.27	0.26	0.53			-0.29	0.29	-0.02
LG SHARE	0.00	-0.44	-0.28	-0.46	-0.12	-0.52	-0.30		-0.34		-0.45	0.03
BACH	0.00	0.42	0.56	0.82	0.40	0.26	0.49		0.39	-0.45		0.01
POPGR	0.01	-0.27	0.14	0.14	-0.16	-0.20	-0.11		-0.28	0.16	0.08	

**Above principle diagnal (shaded) = correlations measured at 40 km*

***Below principle diagnal (not shaded) = correlations measured at 80 km*

APPENDIX F (continued)
Pairwise Correlations, 40 km and 80 km

	SIZE	URB	LOC	INPUTS	MARKETS	DIV	LP	KNOW	UNIV	LG SHARE	BACH	POPGR
						Drugs						
SIZE		0.24	-0.04	0.14	-0.09	0.15	0.15	0.00	0.16	-0.13	0.07	0.02
URB	0.17		-0.07	0.50	-0.30	0.33	0.58	0.04	0.75	-0.40	0.19	-0.23
LOC	-0.03	0.03		0.19	0.24	0.05	0.06	0.41	0.07	-0.09	0.25	-0.03
INPUTS	0.15	0.61	0.26		-0.32	0.46	0.25	0.28	0.45	-0.43	0.46	-0.03
MARKETS	-0.13	-0.26	0.17	-0.51		-0.34	-0.31	-0.09	-0.21	0.46	-0.35	-0.25
DIV	0.12	0.38	0.09	0.50	-0.41		0.13	0.03	0.24	-0.56	0.21	-0.16
LP	0.10	0.55	0.08	0.28	-0.17	0.14		0.33	0.56	-0.31	0.49	-0.03
KNOW	0.02	0.19	0.43	0.45	-0.13	0.13	0.27		0.34	-0.14	0.62	0.03
UNIV	0.12	0.82	0.12	0.56	-0.24	0.26	0.58	0.53		-0.25	0.43	-0.17
LG SHARE	-0.12	-0.45	-0.13	-0.54	0.48	-0.59	-0.35	-0.28	-0.44		-0.23	0.06
BACH	0.08	0.40	0.24	0.65	-0.45	0.34	0.43	0.68	0.65	-0.47		0.13
POPGR	0.00	-0.27	-0.04	0.02	-0.32	-0.20	-0.16	-0.07	-0.22	0.18	0.02	
						Farm and Garden Machinery						
SIZE		0.11	-0.08	-0.11	-0.04	0.11	0.06	-0.08	-0.04	-0.07	0.02	0.03
URB	0.09		-0.28	-0.37	-0.22	0.69	-0.06	-0.09	0.61	-0.42	0.51	0.11
LOC	-0.07	-0.35		0.73	0.59	-0.50	-0.13	0.29	-0.19	0.29	-0.36	-0.50
INPUTS	-0.13	-0.40	0.69		0.48	-0.59	0.03	0.19	-0.29	0.36	-0.54	-0.42
MARKETS	-0.04	-0.21	0.71	0.51		-0.36	-0.02	0.09	-0.15	0.17	-0.24	-0.36
DIV	0.16	0.71	-0.54	-0.57	-0.33		-0.01	-0.23	0.43	-0.63	0.69	0.31
LP	0.00	0.07	-0.14	0.11	-0.05	0.16		-0.12	-0.08	-0.10	-0.25	-0.03
KNOW	-0.07	-0.06	0.25	0.21	0.29	-0.19	0.05		-0.04	0.19	-0.05	-0.17
UNIV	-0.03	0.65	-0.23	-0.29	-0.13	0.49	0.14	-0.03		-0.23	0.52	0.13
LG SHARE	-0.09	-0.43	0.35	0.23	0.15	-0.54	-0.20	0.09	-0.26		-0.40	-0.25
BACH	0.08	0.53	-0.37	-0.58	-0.24	0.70	-0.09	-0.05	0.41	-0.28		0.32
POPGR	0.06	0.14	-0.41	-0.46	-0.34	0.35	-0.09	-0.24	0.08	-0.19	0.40	
						Metalworking Machinery						
SIZE		0.02	0.01	-0.01	0.06	0.03	0.00	-0.05	0.00	-0.01	-0.03	-0.09
URB	0.01		-0.14	-0.22	-0.27	0.55	-0.13	0.05	0.56	-0.43	0.48	-0.10
LOC	0.05	-0.10		0.86	0.74	-0.13	0.67	0.08	-0.17	-0.04	-0.27	-0.33
INPUTS	0.00	-0.19	0.80		0.77	-0.24	0.67	0.07	-0.23	0.03	-0.42	-0.34
MARKETS	0.06	-0.25	0.85	0.80		-0.30	0.61	-0.02	-0.23	0.10	-0.47	-0.33
DIV	0.03	0.54	0.02	-0.10	-0.17		-0.17	0.14	0.37	-0.65	0.58	-0.13
LP	0.02	-0.01	0.54	0.42	0.47	0.01		0.09	-0.19	-0.06	-0.30	-0.37
KNOW	-0.01	0.22	0.18	0.10	0.02	0.27	0.20		0.07	-0.32	0.50	0.09
UNIV	-0.01	0.63	-0.23	-0.29	-0.30	0.36	0.02	0.18		-0.24	0.33	-0.12
LG SHARE	-0.03	-0.42	-0.18	-0.12	-0.08	-0.55	-0.19	-0.43	-0.27		-0.48	0.07
BACH	-0.03	0.54	-0.30	-0.43	-0.50	0.51	-0.02	0.59	0.47	-0.43		0.24
POPGR	-0.08	-0.11	-0.45	-0.46	-0.44	-0.13	-0.41	-0.03	-0.11	0.17	0.22	

**Above principle diagnal (shaded) = correlations measured at 40 km*
***Below principle diagnal (not shaded) = correlations measured at 80 km*

APPENDIX F (continued)
Pairwise Correlations, 40 km and 80 km

Electronic Components & Accessories

	SIZE	URB	LOC	INPUTS	MARKETS	DIV	LP	KNOW	UNIV	LG SHARE	BACH	POPGR
SIZE		-0.05	0.03	0.01	0.04	-0.03	0.02	0.04	0.00	-0.04	-0.02	0.09
URB	-0.06		0.14	0.24	0.12	0.49	0.17	0.09	0.44	-0.38	0.28	-0.22
LOC	0.02	0.26		0.82	0.91	-0.23	0.62	0.91	0.58	-0.28	0.48	-0.07
INPUTS	0.01	0.39	0.79		0.83	-0.08	0.51	0.71	0.49	-0.32	0.40	-0.12
MARKETS	0.03	0.18	0.89	0.75		-0.19	0.59	0.88	0.58	-0.32	0.62	0.01
DIV	-0.01	0.47	-0.02	0.16	-0.04		-0.04	-0.24	-0.04	-0.49	0.19	-0.09
LP	-0.02	0.20	0.24	0.21	0.23	0.11		0.51	0.28	-0.30	0.29	-0.18
KNOW	0.04	0.09	0.83	0.59	0.83	-0.13	0.08		0.62	-0.28	0.58	0.07
UNIV	0.01	0.50	0.58	0.50	0.63	0.07	0.27	0.53		-0.28	0.53	-0.09
LG SHARE	-0.03	-0.43	-0.39	-0.41	-0.39	-0.51	-0.27	-0.30	-0.42		-0.47	0.09
BACH	0.03	0.34	0.65	0.53	0.76	0.17	0.22	0.69	0.69	-0.48		0.15
POPGR	0.04	-0.33	-0.09	-0.17	0.00	-0.19	-0.23	0.13	-0.21	0.22	0.05	

Motor Vehicle Parts & Accessories

	SIZE	URB	LOC	INPUTS	MARKETS	DIV	LP	KNOW	UNIV	LG SHARE	BACH	POPGR
SIZE		-0.09	0.15	0.17	0.28	-0.13	0.20	0.01	-0.07	0.06	-0.23	-0.06
URB	-0.09		-0.14	-0.25	-0.21	0.54	-0.07	-0.12	0.67	-0.43	0.45	-0.17
LOC	0.19	-0.08		0.60	0.53	-0.21	0.62	0.28	-0.12	-0.02	-0.33	-0.02
INPUTS	0.14	-0.18	0.59		0.45	-0.37	0.67	0.27	-0.25	0.12	-0.58	-0.17
MARKETS	0.37	-0.26	0.60	0.43		-0.19	0.51	0.22	-0.13	0.05	-0.27	-0.08
DIV	-0.10	0.53	-0.10	-0.25	-0.07		-0.31	-0.05	0.35	-0.65	0.65	-0.07
LP	0.18	0.00	0.62	0.60	0.55	-0.10		0.29	-0.11	-0.01	-0.43	-0.19
KNOW	0.01	-0.04	0.39	0.30	0.26	0.12	0.44		-0.09	-0.02	-0.02	-0.10
UNIV	-0.08	0.75	-0.06	-0.16	-0.21	0.40	-0.02	-0.03		-0.24	0.34	-0.13
LG SHARE	0.07	-0.40	-0.09	0.00	-0.03	-0.54	-0.12	-0.14	-0.31		-0.50	-0.02
BACH	-0.23	0.50	-0.31	-0.55	-0.33	0.58	-0.27	0.03	0.46	-0.43		0.14
POPGR	-0.09	-0.18	-0.14	-0.33	-0.13	-0.06	-0.33	-0.13	-0.13	0.07	0.25	

Measuring & Controlling Devices

	SIZE	URB	LOC	INPUTS	MARKETS	DIV	LP	KNOW	UNIV	LG SHARE	BACH	POPGR
SIZE		0.00	0.12	0.04	0.08	0.05	0.14	0.07	0.03	-0.03	0.09	0.02
URB	-0.01		0.08	0.21	0.02	0.45	0.14	0.06	0.52	-0.44	0.28	-0.24
LOC	0.13	0.22		0.69	0.52	-0.03	0.54	0.75	0.16	-0.21	0.42	-0.06
INPUTS	0.02	0.30	0.62		0.53	0.07	0.51	0.69	0.15	-0.35	0.37	-0.12
MARKETS	0.06	0.04	0.37	0.31		-0.09	0.42	0.62	0.08	-0.16	0.21	-0.10
DIV	0.04	0.47	0.17	0.25	-0.02		0.06	-0.11	0.22	-0.53	0.20	-0.25
LP	0.14	0.22	0.40	0.29	0.18	0.17		0.42	0.02	-0.30	0.25	-0.17
KNOW	0.10	0.16	0.80	0.61	0.45	0.02	0.19		0.16	-0.20	0.45	-0.04
UNIV	0.04	0.57	0.19	0.18	0.06	0.21	0.18	0.17		-0.21	0.30	-0.15
LG SHARE	0.00	-0.46	-0.34	-0.38	-0.13	-0.53	-0.27	-0.29	-0.31		-0.34	0.16
BACH	0.07	0.38	0.63	0.45	0.19	0.24	0.27	0.64	0.43	-0.45		0.06
POPGR	0.02	-0.31	-0.18	-0.18	-0.14	-0.33	-0.22	-0.08	-0.19	0.27	-0.04	

**Above principle diagnal (shaded) = correlations measured at 40 km*
***Below principle diagnal (not shaded) = correlations measured at 80 km*

APPENDIX F (continued)
Pairwise Correlations, 40 and 80 km

Advertising

	SIZE	URB	LOC	INPUTS	MARKETS	DIV	LP	UNIV	LG SHARE	BACH	POPGR
SIZE		0.08	0.05	0.06	0.06	0.04	0.04	0.09	-0.04	0.04	-0.03
URB	0.07		0.54	0.61	0.48	0.33	0.60	0.75	-0.43	0.33	-0.21
LOC	0.04	0.54		0.69	0.46	0.48	0.44	0.43	-0.45	0.41	0.04
INPUTS	0.05	0.59	0.67		0.63	0.51	0.45	0.40	-0.62	0.77	0.08
MARKETS	0.06	0.60	0.48	0.66		0.40	0.49	0.30	-0.48	0.57	-0.08
DIV	0.04	0.33	0.48	0.50	0.35		0.13	0.12	-0.58	0.26	-0.20
LP	0.04	0.68	0.47	0.43	0.60	0.11		0.48	-0.36	0.45	-0.03
UNIV	0.07	0.77	0.51	0.44	0.46	0.22	0.63		-0.20	0.22	-0.23
LG SHARE	-0.03	-0.43	-0.35	-0.51	-0.46	-0.53	-0.32	-0.26		-0.49	0.06
BACH	0.05	0.42	0.42	0.81	0.66	0.31	0.47	0.35	-0.49		0.12
POPGR	-0.01	-0.27	0.09	0.14	-0.11	-0.20	-0.12	-0.27	0.16	0.08	

Computer & Data Processing Services

	SIZE	URB	LOC	INPUTS	MARKETS	DIV	LP	UNIV	LG SHARE	BACH	POPGR
SIZE		0.02	0.04	0.04	0.03	0.01	0.02	0.00	-0.03	0.03	0.00
URB	0.00		0.25	0.33	0.36	0.21	0.47	0.85	-0.39	0.24	-0.25
LOC	0.04	0.32		0.87	0.63	-0.01	0.60	0.24	-0.46	0.74	0.08
INPUTS	0.04	0.36	0.97		0.76	0.04	0.67	0.31	-0.54	0.85	0.09
MARKETS	0.03	0.43	0.78	0.82		-0.05	0.60	0.44	-0.37	0.74	-0.10
DIV	0.01	0.18	0.11	0.13	-0.04		-0.07	-0.07	-0.47	-0.02	-0.18
LP	0.00	0.48	0.51	0.51	0.52	-0.01		0.61	-0.38	0.66	-0.02
UNIV	-0.01	0.88	0.33	0.34	0.49	-0.06	0.57		-0.24	0.29	-0.23
LG SHARE	-0.02	-0.40	-0.56	-0.57	-0.45	-0.44	-0.35	-0.29		-0.40	0.10
BACH	0.03	0.31	0.89	0.91	0.81	0.04	0.55	0.36	-0.48		0.14
POPGR	0.00	-0.35	0.10	0.11	-0.15	-0.17	-0.15	-0.30	0.16	0.07	

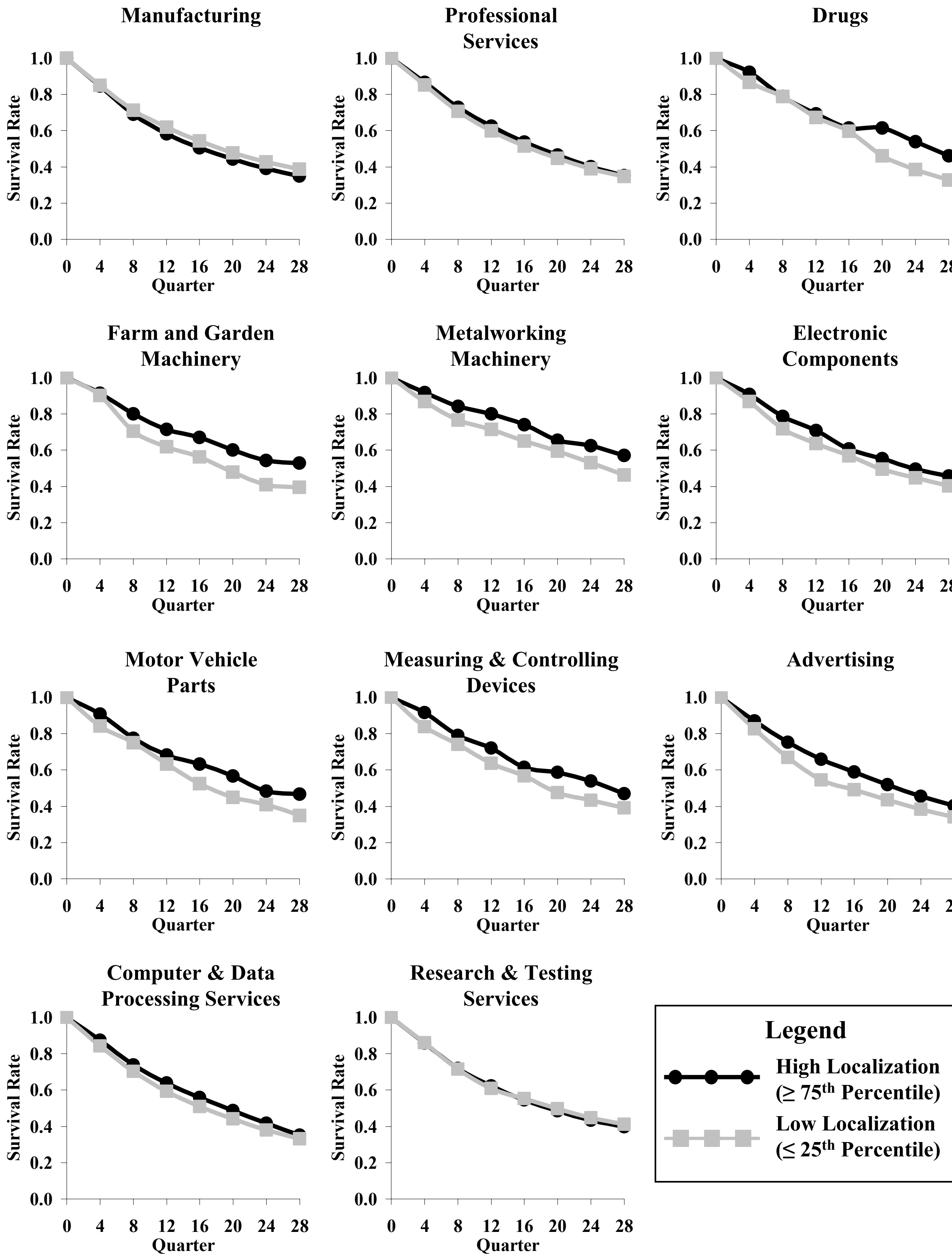
Research & Testing Services

	SIZE	URB	LOC	INPUTS	MARKETS	DIV	LP	UNIV	LG SHARE	BACH	POPGR
SIZE		0.03	0.02	0.04	0.02	0.05	0.03	0.03	-0.04	0.04	0.00
URB	0.02		0.17	0.42	0.40	0.36	0.31	0.78	-0.44	0.32	-0.21
LOC	0.04	0.28		0.73	0.38	-0.08	0.40	0.27	-0.08	0.51	0.22
INPUTS	0.04	0.42	0.80		0.56	0.21	0.55	0.42	-0.46	0.82	0.23
MARKETS	0.03	0.48	0.64	0.64		0.05	0.27	0.50	-0.21	0.49	-0.19
DIV	0.04	0.34	0.02	0.24	-0.03		0.03	0.29	-0.56	0.14	-0.13
LP	0.01	0.42	0.47	0.46	0.38	0.07		0.31	-0.27	0.68	0.05
UNIV	0.01	0.86	0.46	0.48	0.58	0.30	0.49		-0.32	0.41	-0.30
LG SHARE	-0.03	-0.45	-0.30	-0.50	-0.24	-0.52	-0.25	-0.42		-0.39	0.09
BACH	0.04	0.39	0.82	0.91	0.60	0.18	0.56	0.48	-0.43		0.12
POPGR	0.00	-0.29	-0.01	0.18	-0.23	-0.14	-0.09	-0.39	0.14	0.11	

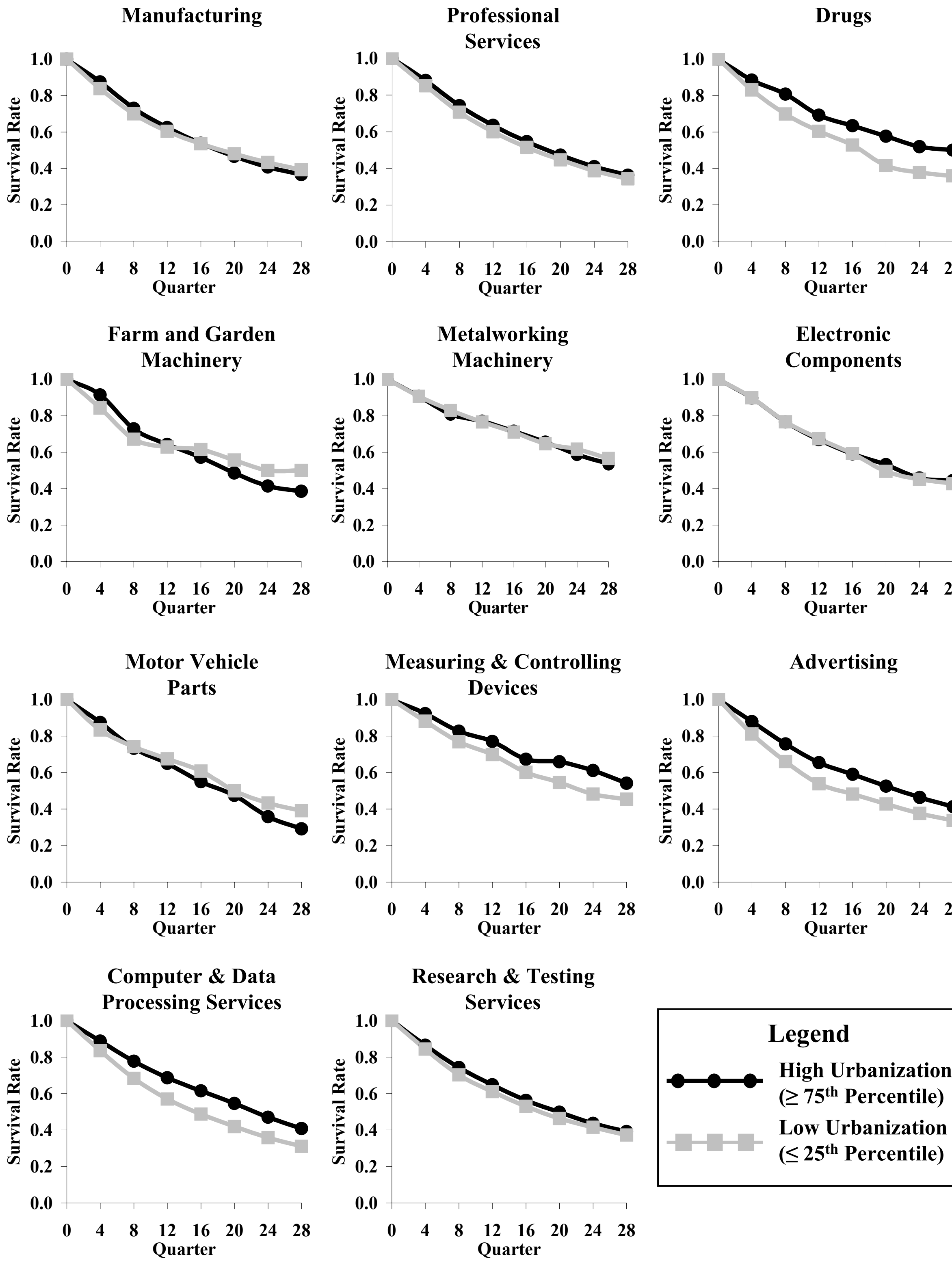
**Above principle diagnal (shaded) = correlations measured at 40 km*

***Below principle diagnal (not shaded) = correlations measured at 80 km*

APPENDIX G
Survival Curves, Localization (80km)



APPENDIX H
Survival Curves, Urbanization (80km)



APPENDIX I
Event Duration Modeling Results: Localization & Urbanization

Manufacturing

	20 km				40 km				80 km				160 km			
Observations	785,997				798,478				809,146				813,353			
-2 LL (null)	242,402				246,665				250,453				251,925			
-2 LL (model)	236,006				240,184				243,860				245,309			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.530	0.00	0.03		-3.527	0.00	0.03		-3.528	0.00	0.03		-3.527	0.00	0.03	
AGE	-0.021	0.00	0.98	0.17	-0.021	0.00	0.98	0.17	-0.022	0.00	0.98	0.17	-0.022	0.00	0.98	0.17
AGE^2	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57
AGE^3	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13
QTR1	-0.228	0.00	0.80	0.65	-0.226	0.00	0.80	0.65	-0.228	0.00	0.80	0.65	-0.225	0.00	0.80	0.65
QTR2	0.014	0.18	1.01	0.65	0.015	0.13	1.02	0.65	0.016	0.11	1.02	0.65	0.014	0.15	1.01	0.65
QTR3	-0.160	0.00	0.85	0.65	-0.158	0.00	0.85	0.65	-0.156	0.00	0.86	0.65	-0.156	0.00	0.86	0.65
MWEST	-0.011	0.28	0.99	0.70	-0.011	0.29	0.99	0.69	-0.010	0.35	0.99	0.67	-0.017	0.11	0.98	0.70
NEAST	-0.159	0.00	0.85	0.83	-0.159	0.00	0.85	0.83	-0.160	0.00	0.85	0.82	-0.145	0.00	0.87	0.69
SOUTH	0.057	0.00	1.06	0.71	0.060	0.00	1.06	0.69	0.060	0.00	1.06	0.68	0.046	0.00	1.05	0.72
SIZE	-0.012	0.00	0.99	0.99	-0.012	0.00	0.99	0.99	-0.012	0.00	0.99	1.00	-0.012	0.00	0.99	1.00
URB	0.011	0.00	1.01	0.91	0.004	0.00	1.00	0.89	0.002	0.00	1.00	0.83	0.000	0.33	1.00	0.70
LOC	0.007	0.00	1.01	0.98	0.013	0.00	1.01	0.99	0.014	0.00	1.01	1.00	0.022	0.00	1.02	0.99

Business and Professional Services

	20 km				40 km				80 km				160 km			
Observations	2,314,792				2,314,839				2,315,055				2,315,185			
-2 LL (null)	774,606				774,661				774,723				774,759			
-2 LL (model)	760,411				760,482				760,540				760,537			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.371	0.00	0.03		-3.371	0.00	0.03		-3.370	0.00	0.03		-3.368	0.00	0.03	
AGE	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18
AGE^2	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50
AGE^3	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13
QTR1	-0.255	0.00	0.78	0.66	-0.255	0.00	0.78	0.66	-0.255	0.00	0.78	0.66	-0.254	0.00	0.78	0.66
QTR2	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65
QTR3	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65
MWEST	-0.014	0.01	0.99	0.70	-0.014	0.01	0.99	0.70	-0.016	0.01	0.98	0.69	-0.024	0.00	0.98	0.66
NEAST	-0.151	0.00	0.86	0.80	-0.149	0.00	0.86	0.78	-0.147	0.00	0.86	0.68	-0.135	0.00	0.87	0.48
SOUTH	0.021	0.00	1.02	0.70	0.017	0.01	1.02	0.70	0.015	0.02	1.02	0.69	0.009	0.14	1.01	0.70
SIZE	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	1.00
URB	0.003	0.00	1.00	0.90	0.000	0.71	1.00	0.81	0.000	0.61	1.00	0.68	0.000	0.20	1.00	0.50
LOC	-0.041	0.00	0.96	0.91	-0.044	0.00	0.96	0.86	-0.058	0.00	0.94	0.84	-0.102	0.00	0.90	0.82

APPENDIX I (continued)
Event Duration Modeling Results: Localization & Urbanization

Drugs

	20 km				40 km				80 km				160 km			
Observations		4,071				4,071				4,071				4,071		
-2 LL (null)		1,047				1,047				1,047				1,047		
-2 LL (model)		1,020				1,020				1,019				1,020		
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.675	0.00	0.03		-3.676	0.00	0.03		-3.687	0.00	0.03		-3.684	0.00	0.03	
AGE	-0.027	0.02	0.97	1.00	-0.027	0.02	0.97	1.00	-0.026	0.02	0.97	1.00	-0.027	0.02	0.97	1.00
QTR1	-0.032	0.85	0.97	0.65	-0.032	0.85	0.97	0.65	-0.033	0.84	0.97	0.65	-0.032	0.85	0.97	0.65
QTR2	-0.073	0.66	0.93	0.65	-0.073	0.66	0.93	0.65	-0.072	0.67	0.93	0.65	-0.072	0.66	0.93	0.65
QTR3	-0.343	0.06	0.71	0.65	-0.343	0.06	0.71	0.65	-0.343	0.06	0.71	0.65	-0.343	0.06	0.71	0.65
MWEST	0.248	0.13	1.28	0.85	0.262	0.11	1.30	0.85	0.290	0.08	1.34	0.84	0.283	0.11	1.33	0.82
NEAST	-0.397	0.13	0.67	0.85	-0.417	0.12	0.66	0.82	-0.497	0.08	0.61	0.77	-0.475	0.12	0.62	0.62
SOUTH	0.234	0.25	1.26	0.87	0.242	0.24	1.27	0.86	0.286	0.17	1.33	0.86	0.268	0.22	1.31	0.82
SIZE	-0.007	0.02	0.99	0.88	-0.007	0.02	0.99	0.90	-0.007	0.02	0.99	0.93	-0.007	0.02	0.99	0.96
URB	0.013	0.59	1.01	0.79	0.005	0.61	1.01	0.79	0.007	0.28	1.01	0.76	0.002	0.63	1.00	0.59
LOC	-0.006	0.91	0.99	0.93	0.026	0.79	1.03	0.93	0.048	0.73	1.05	0.93	0.079	0.74	1.08	0.79

Farm and Garden Machinery

	20 km				40 km				80 km				160 km			
Observations		3,998				4,486				4,732				4,736		
-2 LL (null)		1,279				1,388				1,445				1,452		
-2 LL (model)		1,208				1,318				1,363				1,377		
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.636	0.00	0.03		-3.645	0.00	0.03		-3.772	0.00	0.02		-3.689	0.00	0.02	
AGE	-0.027	0.01	0.97	0.98	-0.030	0.00	0.97	0.98	-0.032	0.00	0.97	0.98	-0.035	0.00	0.97	0.99
QTR1	-0.536	0.00	0.59	0.66	-0.519	0.00	0.59	0.66	-0.548	0.00	0.58	0.66	-0.554	0.00	0.57	0.66
QTR2	0.162	0.26	1.18	0.66	0.151	0.27	1.16	0.65	0.164	0.23	1.18	0.65	0.159	0.24	1.17	0.65
QTR3	-0.313	0.06	0.73	0.66	-0.307	0.05	0.74	0.66	-0.304	0.05	0.74	0.66	-0.306	0.05	0.74	0.66
MWEST	0.169	0.26	1.18	0.59	0.130	0.38	1.14	0.55	0.263	0.08	1.30	0.55	0.183	0.24	1.20	0.53
NEAST	-0.541	0.09	0.58	0.79	-0.539	0.09	0.58	0.79	-0.609	0.06	0.54	0.74	-0.452	0.19	0.64	0.59
SOUTH	0.309	0.10	1.36	0.65	0.380	0.03	1.46	0.63	0.332	0.07	1.39	0.63	0.291	0.13	1.34	0.63
SIZE	-0.017	0.00	0.98	0.94	-0.018	0.00	0.98	0.93	-0.018	0.00	0.98	0.94	-0.018	0.00	0.98	0.96
URB	0.050	0.09	1.05	0.89	0.031	0.05	1.03	0.83	0.003	0.77	1.00	0.77	-0.004	0.52	1.00	0.54
LOC	-0.032	0.03	0.97	0.87	-0.017	0.33	0.98	0.78	-0.078	0.00	0.92	0.72	-0.071	0.05	0.93	0.58

APPENDIX I (continued)
Event Duration Modeling Results: Localization & Urbanization

Metalworking Machinery

	20 km				40 km				80 km				160 km			
Observations	20,100				20,448				20,448				20,448			
-2 LL (null)	4,309				4,363				4,363				4,363			
-2 LL (model)	4,199				4,252				4,253				4,252			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-4.224	0.00	0.01		-4.218	0.00	0.01		-4.227	0.00	0.01		-4.243	0.00	0.01	
AGE	0.028	0.05	1.03	0.17	0.030	0.03	1.03	0.17	0.030	0.04	1.03	0.17	0.030	0.04	1.03	0.17
AGE^2	0.003	0.00	1.00	0.80	0.003	0.00	1.00	0.81	0.003	0.00	1.00	0.81	0.003	0.00	1.00	0.81
AGE^3	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15
QTR1	-0.088	0.30	0.92	0.65	-0.079	0.35	0.92	0.65	-0.080	0.34	0.92	0.65	-0.079	0.35	0.92	0.65
QTR2	0.041	0.61	1.04	0.65	0.047	0.56	1.05	0.65	0.047	0.55	1.05	0.65	0.047	0.56	1.05	0.65
QTR3	-0.170	0.05	0.84	0.65	-0.172	0.05	0.84	0.65	-0.172	0.05	0.84	0.65	-0.172	0.05	0.84	0.65
MWEST	0.116	0.12	1.12	0.48	0.094	0.20	1.10	0.49	0.128	0.10	1.14	0.44	0.182	0.04	1.20	0.39
NEAST	-0.100	0.34	0.91	0.59	-0.076	0.46	0.93	0.53	-0.100	0.33	0.91	0.53	-0.153	0.18	0.86	0.55
SOUTH	-0.071	0.51	0.93	0.62	-0.088	0.41	0.92	0.60	-0.086	0.43	0.92	0.58	-0.091	0.41	0.91	0.62
SIZE	-0.039	0.00	0.96	0.99	-0.039	0.00	0.96	0.99	-0.039	0.00	0.96	0.99	-0.039	0.00	0.96	0.99
URB	0.013	0.25	1.01	0.91	0.003	0.58	1.00	0.88	0.002	0.50	1.00	0.86	0.001	0.60	1.00	0.78
LOC	-0.066	0.01	0.94	0.84	-0.064	0.02	0.94	0.81	-0.104	0.02	0.90	0.76	-0.166	0.01	0.85	0.65

Electronic Components

	20 km				40 km				80 km				160 km			
Observations	15,759				15,759				15,759				15,759			
-2 LL (null)	4,172				4,172				4,172				4,172			
-2 LL (model)	4,055				4,057				4,057				4,057			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.632	0.00	0.03		-3.639	0.00	0.03		-3.652	0.00	0.03		-3.646	0.00	0.03	
AGE	-0.019	0.00	0.98	0.99	-0.019	0.00	0.98	0.99	-0.019	0.00	0.98	0.99	-0.019	0.00	0.98	0.99
QTR1	-0.256	0.00	0.77	0.66	-0.256	0.00	0.77	0.66	-0.256	0.01	0.77	0.66	-0.256	0.01	0.77	0.66
QTR2	0.017	0.84	1.02	0.65	0.017	0.84	1.02	0.65	0.017	0.84	1.02	0.65	0.017	0.84	1.02	0.65
QTR3	-0.280	0.00	0.76	0.65	-0.280	0.00	0.76	0.65	-0.280	0.00	0.76	0.65	-0.280	0.00	0.76	0.65
MWEST	-0.058	0.50	0.94	0.78	-0.042	0.63	0.96	0.73	-0.048	0.59	0.95	0.66	-0.038	0.68	0.96	0.56
NEAST	-0.136	0.25	0.87	0.86	-0.154	0.20	0.86	0.88	-0.155	0.21	0.86	0.85	-0.164	0.25	0.85	0.58
SOUTH	0.274	0.01	1.31	0.82	0.259	0.02	1.30	0.78	0.230	0.05	1.26	0.71	0.248	0.05	1.28	0.59
SIZE	-0.006	0.00	0.99	0.98	-0.006	0.00	0.99	0.98	-0.006	0.00	0.99	0.98	-0.006	0.00	0.99	0.98
URB	0.022	0.09	1.02	0.85	0.003	0.58	1.00	0.93	0.001	0.86	1.00	0.84	0.000	0.89	1.00	0.65
LOC	-0.005	0.68	0.99	0.77	-0.003	0.90	1.00	0.77	-0.030	0.49	0.97	0.66	-0.012	0.88	0.99	0.47

APPENDIX I (continued)

Event Duration Modeling Results: Localization & Urbanization

Motor Vehicle Parts

	20 km				40 km				80 km				160 km			
Observations			8,561				8,572				8,572				8,572	
-2 LL (null)			2,613				2,621				2,621				2,621	
-2 LL (model)			2,502				2,509				2,508				2,513	
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.678	0.00	0.03		-3.685	0.00	0.03		-3.703	0.00	0.02		-3.684	0.00	0.03	
AGE	0.027	0.12	1.03	0.18	0.028	0.11	1.03	0.18	0.028	0.11	1.03	0.18	0.027	0.12	1.03	0.18
AGE^2	0.003	0.02	1.00	0.57	0.003	0.02	1.00	0.57	0.003	0.02	1.00	0.57	0.003	0.02	1.00	0.57
AGE^3	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14
QTR1	-0.096	0.37	0.91	0.65	-0.084	0.43	0.92	0.65	-0.084	0.43	0.92	0.65	-0.084	0.43	0.92	0.65
QTR2	-0.276	0.01	0.76	0.65	-0.280	0.01	0.76	0.65	-0.280	0.01	0.76	0.65	-0.280	0.01	0.76	0.65
QTR3	-0.313	0.01	0.73	0.65	-0.317	0.01	0.73	0.65	-0.317	0.01	0.73	0.65	-0.317	0.01	0.73	0.65
MWEST	0.053	0.61	1.05	0.61	0.072	0.49	1.07	0.59	0.101	0.35	1.11	0.56	0.075	0.53	1.08	0.59
NEAST	-0.209	0.29	0.81	0.86	-0.245	0.23	0.78	0.86	-0.300	0.15	0.74	0.85	-0.292	0.22	0.75	0.69
SOUTH	-0.034	0.78	0.97	0.60	-0.032	0.79	0.97	0.59	-0.013	0.92	0.99	0.56	-0.013	0.92	0.99	0.60
SIZE	-0.006	0.00	0.99	0.95	-0.006	0.00	0.99	0.94	-0.006	0.00	0.99	0.92	-0.006	0.00	0.99	0.87
URB	0.012	0.38	1.01	0.86	0.003	0.57	1.00	0.83	0.003	0.44	1.00	0.76	0.002	0.61	1.00	0.67
LOC	-0.064	0.07	0.94	0.91	-0.108	0.04	0.90	0.89	-0.205	0.02	0.82	0.87	-0.153	0.23	0.86	0.76

Measuring and Controlling Devices

	20 km				40 km				80 km				160 km			
Observations			11,775				11,833				11,833				11,833	
-2 LL (null)			2,881				2,884				2,884				2,884	
-2 LL (model)			2,827				2,828				2,829				2,829	
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.744	0.00	0.02		-3.749	0.00	0.02		-3.745	0.00	0.02		-3.728	0.00	0.02	
AGE	-0.018	0.01	0.98	0.99	-0.018	0.01	0.98	0.99	-0.018	0.01	0.98	0.99	-0.018	0.01	0.98	0.99
QTR1	-0.228	0.04	0.80	0.65	-0.228	0.04	0.80	0.65	-0.228	0.04	0.80	0.65	-0.228	0.04	0.80	0.65
QTR2	0.036	0.72	1.04	0.65	0.035	0.72	1.04	0.65	0.035	0.72	1.04	0.65	0.035	0.72	1.04	0.65
QTR3	-0.257	0.02	0.77	0.65	-0.257	0.02	0.77	0.65	-0.256	0.02	0.77	0.65	-0.256	0.02	0.77	0.65
MWEST	0.035	0.72	1.04	0.70	0.040	0.68	1.04	0.69	0.022	0.82	1.02	0.70	-0.006	0.95	0.99	0.66
NEAST	-0.296	0.04	0.74	0.81	-0.279	0.06	0.76	0.84	-0.250	0.09	0.78	0.83	-0.166	0.33	0.85	0.56
SOUTH	0.166	0.15	1.18	0.70	0.155	0.20	1.17	0.66	0.141	0.26	1.15	0.62	0.134	0.33	1.14	0.50
SIZE	-0.009	0.00	0.99	0.97	-0.009	0.00	0.99	0.97	-0.009	0.00	0.99	0.97	-0.009	0.00	0.99	0.97
URB	-0.011	0.53	0.99	0.95	-0.011	0.14	0.99	0.96	-0.005	0.24	0.99	0.88	-0.004	0.19	1.00	0.61
LOC	0.006	0.87	1.01	0.82	0.013	0.81	1.01	0.77	0.000	1.00	1.00	0.73	0.024	0.86	1.02	0.55

APPENDIX I (continued)
Event Duration Modeling Results: Localization & Urbanization

Advertising

	20 km				40 km				80 km				160 km			
Observations			66,168				66,168				66,168				66,168	
-2 LL (null)			21,549				21,549				21,549				21,549	
-2 LL (model)			21,030				21,027				21,031				21,030	
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	
INT	-3.498	0.00	0.03		-3.501	0.00	0.03		-3.497	0.00	0.03		-3.489	0.00	0.03	
AGE	-0.031	0.00	0.97	0.87	-0.031	0.00	0.97	0.87	-0.031	0.00	0.97	0.87	-0.031	0.00	0.97	0.87
AGE^2	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87
QTR1	-0.193	0.00	0.82	0.65	-0.193	0.00	0.82	0.65	-0.193	0.00	0.82	0.65	-0.193	0.00	0.82	0.65
QTR2	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65
QTR3	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65
MWEST	-0.048	0.16	0.95	0.66	-0.037	0.30	0.96	0.63	-0.048	0.19	0.95	0.63	-0.068	0.08	0.93	0.65
NEAST	-0.185	0.00	0.83	0.79	-0.191	0.00	0.83	0.77	-0.174	0.00	0.84	0.69	-0.124	0.06	0.88	0.47
SOUTH	0.065	0.06	1.07	0.68	0.067	0.06	1.07	0.67	0.055	0.14	1.06	0.66	0.033	0.40	1.03	0.69
SIZE	-0.032	0.00	0.97	0.98	-0.032	0.00	0.97	0.98	-0.032	0.00	0.97	0.99	-0.032	0.00	0.97	0.99
URB	0.003	0.55	1.00	0.66	0.003	0.25	1.00	0.59	0.001	0.58	1.00	0.49	0.000	0.74	1.00	0.37
LOC	-0.105	0.01	0.90	0.67	-0.176	0.00	0.84	0.63	-0.163	0.02	0.85	0.63	-0.190	0.02	0.83	0.65

Computer and Data Processing Services

	20 km				40 km				80 km				160 km			
Observations			366,059				366,030				366,116				366,116	
-2 LL (null)			119,615				119,632				119,645				119,645	
-2 LL (model)			117,683				117,663				117,659				117,626	
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.502	0.00	0.03		-3.500	0.00	0.03		-3.494	0.00	0.03		-3.484	0.00	0.03	
AGE	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13
AGE^2	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08
AGE^3	0.000	0.65	1.00	0.06	0.000	0.64	1.00	0.06	0.000	0.65	1.00	0.06	0.000	0.65	1.00	0.06
AGE^4	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05
QTR1	-0.162	0.00	0.85	0.65	-0.161	0.00	0.85	0.65	-0.161	0.00	0.85	0.65	-0.161	0.00	0.85	0.65
QTR2	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64
QTR3	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65
MWEST	-0.039	0.01	0.96	0.71	-0.043	0.00	0.96	0.71	-0.068	0.00	0.93	0.69	-0.102	0.00	0.90	0.66
NEAST	-0.173	0.00	0.84	0.78	-0.145	0.00	0.87	0.73	-0.086	0.00	0.92	0.57	0.000	1.00	1.00	0.38
SOUTH	0.032	0.04	1.03	0.74	0.014	0.36	1.01	0.73	-0.008	0.64	0.99	0.73	-0.029	0.08	0.97	0.72
SIZE	-0.016	0.00	0.98	0.99	-0.016	0.00	0.98	0.99	-0.016	0.00	0.98	0.99	-0.016	0.00	0.98	0.99
URB	-0.003	0.10	1.00	0.95	-0.006	0.00	0.99	0.84	-0.005	0.00	1.00	0.59	-0.004	0.00	1.00	0.39
LOC	-0.021	0.02	0.98	0.94	-0.012	0.30	0.99	0.89	-0.005	0.77	1.00	0.83	-0.032	0.16	0.97	0.79

APPENDIX I (continued)

Event Duration Modeling Results: Localization & Urbanization

Research and Testing Services

	20 km				40 km				80 km				160 km			
Observations	67,267				67,296				67,305				67,305			
-2 LL (null)	20,382				20,397				20,398				20,398			
-2 LL (model)	19,791				19,804				19,806				19,804			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**		**b**	**Pr > X^2**	**exp b**		**b**	**Pr > X^2**	**exp b**	
INT	-3.605	0.00	0.03		-3.605	0.00	0.03		-3.604	0.00	0.03		-3.594	0.00	0.03	
AGE	-0.016	0.02	0.98	0.17	-0.016	0.01	0.98	0.17	-0.016	0.02	0.98	0.17	-0.016	0.02	0.98	0.17
AGE^2	0.001	0.11	1.00	0.62	0.001	0.11	1.00	0.62	0.001	0.11	1.00	0.62	0.001	0.11	1.00	0.62
AGE^3	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14
QTR1	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65
QTR2	0.096	0.01	1.10	0.65	0.095	0.01	1.10	0.65	0.095	0.01	1.10	0.65	0.095	0.01	1.10	0.65
QTR3	-0.190	0.00	0.83	0.65	-0.191	0.00	0.83	0.65	-0.191	0.00	0.83	0.65	-0.191	0.00	0.83	0.65
MWEST	-0.004	0.93	1.00	0.75	0.000	1.00	1.00	0.74	-0.005	0.90	1.00	0.70	-0.026	0.54	0.97	0.62
NEAST	-0.137	0.01	0.87	0.84	-0.133	0.01	0.88	0.80	-0.131	0.02	0.88	0.70	-0.072	0.26	0.93	0.48
SOUTH	-0.018	0.64	0.98	0.79	-0.025	0.53	0.98	0.79	-0.023	0.57	0.98	0.79	-0.037	0.35	0.96	0.75
SIZE	-0.023	0.00	0.98	0.99	-0.023	0.00	0.98	0.99	-0.023	0.00	0.98	0.99	-0.023	0.00	0.98	0.99
URB	0.004	0.41	1.00	0.94	0.000	0.99	1.00	0.88	0.000	0.79	1.00	0.73	-0.002	0.10	1.00	0.50
LOC	0.017	0.38	1.02	0.90	0.034	0.21	1.03	0.84	0.029	0.45	1.03	0.79	0.047	0.38	1.05	0.71

APPENDIX J
Event Duration Modeling Results: Localization, Urbanization & Regional Controls

Manufacturing

	20 km				40 km				80 km				160 km			
Observations	785,997				798,478				809,146				813,353			
-2 LL (null)	242,402				246,665				250,453				251,925			
-2 LL (model)	235,999				240,172				243,847				245,296			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.530	0.00	0.03		-3.526	0.00	0.03		-3.526	0.00	0.03		-3.526	0.00	0.03	
AGE	-0.021	0.00	0.98	0.17	-0.021	0.00	0.98	0.17	-0.022	0.00	0.98	0.17	-0.022	0.00	0.98	0.17
AGE^2	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57
AGE^3	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13
QTR1	-0.228	0.00	0.80	0.65	-0.226	0.00	0.80	0.65	-0.228	0.00	0.80	0.65	-0.225	0.00	0.80	0.65
QTR2	0.014	0.18	1.01	0.65	0.015	0.13	1.02	0.65	0.016	0.11	1.02	0.65	0.014	0.15	1.01	0.65
QTR3	-0.160	0.00	0.85	0.65	-0.158	0.00	0.85	0.65	-0.156	0.00	0.86	0.65	-0.156	0.00	0.86	0.65
MWEST	-0.010	0.32	0.99	0.65	-0.010	0.32	0.99	0.62	-0.005	0.63	0.99	0.59	-0.018	0.12	0.98	0.53
NEAST	-0.157	0.00	0.85	0.78	-0.151	0.00	0.86	0.74	-0.150	0.00	0.86	0.71	-0.132	0.00	0.88	0.56
SOUTH	0.058	0.00	1.06	0.68	0.060	0.00	1.06	0.66	0.060	0.00	1.06	0.61	0.051	0.00	1.05	0.55
SIZE	-0.012	0.00	0.99	0.99	-0.012	0.00	0.99	0.99	-0.012	0.00	0.99	1.00	-0.012	0.00	0.99	1.00
URB	0.012	0.00	1.01	0.51	0.006	0.00	1.01	0.44	0.003	0.00	1.00	0.42	0.001	0.01	1.00	0.36
LOC	0.007	0.00	1.01	0.89	0.013	0.00	1.01	0.90	0.015	0.00	1.02	0.92	0.022	0.00	1.02	0.94
UNIV	-0.017	0.09	0.98	0.61	-0.014	0.08	0.99	0.50	-0.002	0.71	1.00	0.42	-0.011	0.01	0.99	0.35
LG SH	0.000	0.65	1.00	0.64	0.002	0.07	1.00	0.67	0.005	0.05	1.00	0.71	0.005	0.20	1.01	0.72
BACH	0.001	0.14	1.00	0.70	0.002	0.07	1.00	0.61	0.003	0.09	1.00	0.51	0.003	0.13	1.00	0.51
POPGR	0.000	0.25	1.00	0.86	0.001	0.07	1.00	0.78	0.001	0.02	1.00	0.72	0.001	0.24	1.00	0.64

Business and Professional Services

	20 km				40 km				80 km				160 km			
Observations	2,314,792				2,314,839				2,315,055				2,315,185			
-2 LL (null)	774,606				774,661				774,723				774,759			
-2 LL (model)	760,386				760,422				760,396				760,391			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.371	0.00	0.03		-3.370	0.00	0.03		-3.369	0.00	0.03		-3.365	0.00	0.03	
AGE	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18
AGE^2	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50
AGE^3	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13
QTR1	-0.255	0.00	0.78	0.66	-0.255	0.00	0.78	0.66	-0.254	0.00	0.78	0.66	-0.254	0.00	0.78	0.66
QTR2	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65
QTR3	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65
MWEST	-0.013	0.02	0.99	0.66	-0.011	0.05	0.99	0.66	-0.010	0.10	0.99	0.57	-0.021	0.00	0.98	0.49
NEAST	-0.148	0.00	0.86	0.75	-0.145	0.00	0.86	0.74	-0.133	0.00	0.88	0.61	-0.109	0.00	0.90	0.45
SOUTH	0.021	0.00	1.02	0.69	0.020	0.00	1.02	0.68	0.015	0.02	1.02	0.65	-0.001	0.85	1.00	0.58
SIZE	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	1.00
URB	0.006	0.00	1.01	0.41	0.002	0.00	1.00	0.30	0.002	0.00	1.00	0.23	0.002	0.00	1.00	0.15
LOC	-0.042	0.00	0.96	0.67	-0.058	0.00	0.94	0.57	-0.070	0.00	0.93	0.56	-0.101	0.00	0.90	0.54
UNIV	-0.022	0.00	0.98	0.49	-0.018	0.00	0.98	0.34	-0.023	0.00	0.98	0.25	-0.018	0.00	0.98	0.17
LG SH	0.000	0.59	1.00	0.70	-0.003	0.00	1.00	0.68	-0.007	0.00	0.99	0.68	-0.016	0.00	0.98	0.67
BACH	0.000	0.90	1.00	0.62	0.002	0.02	1.00	0.54	0.002	0.03	1.00	0.48	0.001	0.48	1.00	0.44
POPGR	0.000	0.93	1.00	0.86	0.000	0.21	1.00	0.99	0.001	0.02	1.00	0.74	0.001	0.00	1.00	0.58

APPENDIX J (continued)
Event Duration Modeling Results: Localization, Urbanization & Regional Controls

Drugs

	20 km				40 km				80 km				160 km			
Observations	4,071				4,071				4,071				4,071			
-2 LL (null)	1,047				1,047				1,047				1,047			
-2 LL (model)	1,016				1,014				1,006				1,011			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.676	0.00	0.03		-3.696	0.00	0.02		-3.779	0.00	0.02		-3.714	0.00	0.02	
AGE	-0.026	0.03	0.97	0.99	-0.025	0.03	0.97	0.99	-0.021	0.07	0.98	0.99	-0.025	0.03	0.98	0.99
QTR1	-0.032	0.85	0.97	0.65	-0.036	0.83	0.96	0.65	-0.040	0.81	0.96	0.65	-0.032	0.85	0.97	0.65
QTR2	-0.075	0.65	0.93	0.65	-0.075	0.65	0.93	0.65	-0.075	0.65	0.93	0.65	-0.076	0.65	0.93	0.65
QTR3	-0.342	0.06	0.71	0.65	-0.340	0.07	0.71	0.65	-0.336	0.07	0.71	0.65	-0.341	0.07	0.71	0.65
MWEST	0.306	0.07	1.36	0.77	0.247	0.15	1.28	0.80	0.341	0.05	1.41	0.75	0.199	0.28	1.22	0.62
NEAST	-0.373	0.16	0.69	0.81	-0.442	0.10	0.64	0.75	-0.614	0.03	0.54	0.66	-0.399	0.22	0.67	0.54
SOUTH	0.211	0.31	1.24	0.80	0.296	0.16	1.35	0.80	0.236	0.28	1.27	0.76	0.268	0.26	1.31	0.62
SIZE	-0.008	0.01	0.99	0.85	-0.007	0.02	0.99	0.90	-0.008	0.01	0.99	0.93	-0.008	0.01	0.99	0.93
URB	0.060	0.09	1.06	0.36	0.030	0.04	1.03	0.33	0.022	0.04	1.02	0.24	0.017	0.06	1.02	0.15
LOC	0.015	0.80	1.01	0.88	0.086	0.38	1.09	0.82	0.163	0.20	1.18	0.85	0.108	0.64	1.11	0.76
UNIV	-0.193	0.21	0.82	0.46	-0.209	0.07	0.81	0.33	-0.064	0.58	0.94	0.18	-0.140	0.12	0.87	0.13
LG SH	0.020	0.12	1.02	0.72	0.022	0.28	1.02	0.76	0.108	0.01	1.11	0.59	0.138	0.15	1.15	0.44
BACH	0.008	0.49	1.01	0.76	-0.003	0.88	1.00	0.64	-0.021	0.50	0.98	0.36	-0.006	0.88	0.99	0.42
POPGR	0.005	0.43	1.00	0.83	-0.002	0.78	1.00	0.84	-0.008	0.36	0.99	0.74	-0.010	0.37	0.99	0.51

Farm and Garden Machinery

	20 km				40 km				80 km				160 km			
Observations	3,998				4,486				4,732				4,736			
-2 LL (null)	1,279				1,388				1,445				1,452			
-2 LL (model)	1,198				1,313				1,359				1,369			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.634	0.00	0.03		-3.635	0.00	0.03		-3.762	0.00	0.02		-3.518	0.00	0.03	
AGE	-0.024	0.03	0.98	0.97	-0.029	0.01	0.97	0.98	-0.031	0.00	0.97	0.98	-0.034	0.00	0.97	0.98
QTR1	-0.532	0.00	0.59	0.66	-0.521	0.00	0.59	0.66	-0.548	0.00	0.58	0.66	-0.555	0.00	0.57	0.66
QTR2	0.160	0.26	1.17	0.66	0.151	0.27	1.16	0.65	0.164	0.22	1.18	0.65	0.156	0.25	1.17	0.65
QTR3	-0.319	0.05	0.73	0.66	-0.307	0.05	0.74	0.66	-0.304	0.05	0.74	0.66	-0.304	0.05	0.74	0.66
MWEST	0.134	0.38	1.14	0.56	0.066	0.67	1.07	0.49	0.210	0.18	1.23	0.45	-0.092	0.64	0.91	0.45
NEAST	-0.494	0.12	0.61	0.77	-0.567	0.08	0.57	0.71	-0.653	0.05	0.52	0.61	0.208	0.65	1.23	0.20
SOUTH	0.248	0.21	1.28	0.61	0.412	0.03	1.51	0.58	0.381	0.05	1.46	0.58	0.027	0.91	1.03	0.49
SIZE	-0.016	0.00	0.98	0.93	-0.017	0.00	0.98	0.91	-0.018	0.00	0.98	0.92	-0.018	0.00	0.98	0.95
URB	0.012	0.76	1.01	0.56	0.024	0.22	1.02	0.57	0.009	0.52	1.01	0.47	0.010	0.25	1.01	0.24
LOC	-0.036	0.02	0.96	0.77	-0.022	0.25	0.98	0.66	-0.089	0.00	0.91	0.60	-0.085	0.03	0.92	0.48
UNIV	0.739	0.01	2.09	0.70	0.260	0.30	1.30	0.59	-0.101	0.43	0.90	0.65	-0.177	0.03	0.84	0.12
LG SH	0.009	0.26	1.01	0.74	0.012	0.39	1.01	0.73	0.013	0.61	1.01	0.75	0.001	0.99	1.00	0.66
BACH	0.013	0.33	1.01	0.82	0.004	0.84	1.00	0.50	0.013	0.59	1.01	0.46	-0.023	0.45	0.98	0.48
POPGR	-0.004	0.40	1.00	0.94	-0.009	0.20	0.99	0.72	-0.014	0.17	0.99	0.49	-0.012	0.33	0.99	0.57

APPENDIX J (continued)

Event Duration Modeling Results: Localization, Urbanization & Regional Controls

Metalworking Machinery

	20 km				40 km				80 km				160 km			
Observations	20,100				20,448				20,448				20,448			
-2 LL (null)	4,309				4,363				4,363				4,363			
-2 LL (model)	4,195				4,249				4,248				4,248			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-4.234	0.00	0.01		-4.228	0.00	0.01		-4.250	0.00	0.01		-4.260	0.00	0.01	
AGE	0.028	0.05	1.03	0.17	0.030	0.03	1.03	0.16	0.030	0.03	1.03	0.16	0.030	0.04	1.03	0.17
AGE^2	0.003	0.00	1.00	0.80	0.003	0.00	1.00	0.81	0.003	0.00	1.00	0.81	0.003	0.00	1.00	0.81
AGE^3	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15
QTR1	-0.087	0.30	0.92	0.65	-0.079	0.35	0.92	0.65	-0.080	0.34	0.92	0.65	-0.080	0.34	0.92	0.65
QTR2	0.041	0.61	1.04	0.65	0.047	0.56	1.05	0.65	0.047	0.55	1.05	0.65	0.046	0.56	1.05	0.65
QTR3	-0.171	0.05	0.84	0.65	-0.172	0.05	0.84	0.65	-0.172	0.05	0.84	0.65	-0.171	0.05	0.84	0.65
MWEST	0.121	0.12	1.13	0.45	0.097	0.21	1.10	0.42	0.171	0.04	1.19	0.37	0.215	0.02	1.24	0.35
NEAST	-0.069	0.53	0.93	0.52	-0.039	0.73	0.96	0.43	-0.050	0.67	0.95	0.42	-0.181	0.16	0.83	0.43
SOUTH	-0.112	0.32	0.89	0.60	-0.139	0.22	0.87	0.58	-0.161	0.17	0.85	0.56	-0.105	0.40	0.90	0.50
SIZE	-0.040	0.00	0.96	0.98	-0.040	0.00	0.96	0.99	-0.040	0.00	0.96	0.99	-0.040	0.00	0.96	0.98
URB	0.025	0.07	1.03	0.59	0.009	0.20	1.01	0.48	0.003	0.50	1.00	0.44	0.001	0.84	1.00	0.39
LOC	-0.074	0.00	0.93	0.79	-0.071	0.01	0.93	0.74	-0.118	0.02	0.89	0.61	-0.140	0.05	0.87	0.46
UNIV	-0.025	0.75	0.98	0.79	-0.013	0.83	0.99	0.56	0.051	0.25	1.05	0.47	0.039	0.21	1.04	0.40
LG SH	0.001	0.91	1.00	0.65	0.001	0.95	1.00	0.66	-0.019	0.48	0.98	0.67	0.065	0.15	1.07	0.70
BACH	-0.014	0.08	0.99	0.62	-0.018	0.09	0.98	0.53	-0.029	0.04	0.97	0.44	-0.010	0.58	0.99	0.41
POPGR	0.002	0.62	1.00	0.72	0.003	0.60	1.00	0.61	0.007	0.29	1.01	0.51	0.001	0.88	1.00	0.37

Electronic Components

	20 km				40 km				80 km				160 km			
Observations	15,759				15,759				15,759				15,759			
-2 LL (null)	4,172				4,172				4,172				4,172			
-2 LL (model)	4,048				4,049				4,048				4,049			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.642	0.00	0.03		-3.643	0.00	0.03		-3.680	0.00	0.03		-3.692	0.00	0.02	
AGE	-0.018	0.00	0.98	0.99	-0.018	0.00	0.98	0.99	-0.018	0.00	0.98	0.99	-0.018	0.00	0.98	0.99
QTR1	-0.257	0.00	0.77	0.66	-0.256	0.01	0.77	0.66	-0.256	0.00	0.77	0.66	-0.256	0.01	0.77	0.66
QTR2	0.016	0.84	1.02	0.65	0.017	0.84	1.02	0.65	0.016	0.84	1.02	0.65	0.017	0.84	1.02	0.65
QTR3	-0.279	0.00	0.76	0.65	-0.280	0.00	0.76	0.65	-0.280	0.00	0.76	0.65	-0.280	0.00	0.76	0.65
MWEST	-0.032	0.71	0.97	0.76	-0.023	0.80	0.98	0.70	0.002	0.98	1.00	0.62	0.042	0.67	1.04	0.48
NEAST	-0.152	0.22	0.86	0.77	-0.131	0.31	0.88	0.72	-0.137	0.28	0.87	0.72	-0.226	0.13	0.80	0.47
SOUTH	0.267	0.02	1.31	0.81	0.232	0.05	1.26	0.77	0.137	0.28	1.15	0.66	0.168	0.20	1.18	0.51
SIZE	-0.006	0.00	0.99	0.97	-0.006	0.00	0.99	0.96	-0.006	0.00	0.99	0.97	-0.006	0.00	0.99	0.97
URB	0.002	0.92	1.00	0.58	-0.006	0.45	0.99	0.62	-0.004	0.30	1.00	0.57	-0.002	0.55	1.00	0.49
LOC	-0.013	0.33	0.99	0.71	-0.028	0.22	0.97	0.54	-0.108	0.05	0.90	0.40	-0.092	0.35	0.91	0.28
UNIV	0.112	0.09	1.12	0.74	0.101	0.07	1.11	0.59	0.089	0.02	1.09	0.42	0.070	0.01	1.07	0.43
LG SH	-0.011	0.16	0.99	0.62	-0.012	0.31	0.99	0.69	-0.012	0.59	0.99	0.62	-0.033	0.41	0.97	0.62
BACH	0.004	0.61	1.00	0.61	0.008	0.44	1.01	0.52	0.005	0.70	1.01	0.38	-0.006	0.73	0.99	0.36
POPGR	0.000	0.94	1.00	0.79	0.002	0.64	1.00	0.70	0.003	0.54	1.00	0.67	0.008	0.23	1.01	0.53

APPENDIX J (continued)

Event Duration Modeling Results: Localization, Urbanization & Regional Controls

Motor Vehicle Parts

	20 km				40 km				80 km				160 km			
Observations	8,561				8,572				8,572				8,572			
-2 LL (null)	2,613				2,621				2,621				2,621			
-2 LL (model)	2,500				2,505				2,505				2,509			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.676	0.00	0.03		-3.680	0.00	0.03		-3.697	0.00	0.02		-3.669	0.00	0.03	
AGE	0.028	0.11	1.03	0.18	0.027	0.12	1.03	0.18	0.028	0.12	1.03	0.18	0.027	0.13	1.03	0.18
AGE^2	0.003	0.02	1.00	0.57	0.003	0.02	1.00	0.57	0.003	0.02	1.00	0.57	0.003	0.02	1.00	0.57
AGE^3	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14
QTR1	-0.097	0.37	0.91	0.65	-0.084	0.43	0.92	0.65	-0.084	0.43	0.92	0.65	-0.083	0.44	0.92	0.65
QTR2	-0.276	0.01	0.76	0.65	-0.279	0.01	0.76	0.65	-0.279	0.01	0.76	0.65	-0.279	0.01	0.76	0.65
QTR3	-0.313	0.01	0.73	0.65	-0.318	0.01	0.73	0.65	-0.318	0.01	0.73	0.65	-0.318	0.01	0.73	0.65
MWEST	0.067	0.52	1.07	0.53	0.085	0.42	1.09	0.53	0.087	0.44	1.09	0.48	0.043	0.74	1.04	0.45
NEAST	-0.165	0.42	0.85	0.79	-0.186	0.37	0.83	0.78	-0.281	0.19	0.75	0.77	-0.221	0.38	0.80	0.57
SOUTH	-0.075	0.55	0.93	0.57	-0.061	0.64	0.94	0.56	0.019	0.88	1.02	0.52	0.008	0.95	1.01	0.42
SIZE	-0.006	0.00	0.99	0.92	-0.006	0.00	0.99	0.90	-0.006	0.00	0.99	0.90	-0.006	0.00	0.99	0.86
URB	0.018	0.31	1.02	0.53	0.012	0.19	1.01	0.43	0.008	0.21	1.01	0.35	0.007	0.15	1.01	0.31
LOC	-0.060	0.09	0.94	0.85	-0.104	0.07	0.90	0.78	-0.142	0.13	0.87	0.74	-0.057	0.71	0.94	0.53
UNIV	0.035	0.77	1.04	0.75	-0.081	0.46	0.92	0.54	-0.104	0.29	0.90	0.39	-0.097	0.16	0.91	0.40
LG SH	0.009	0.26	1.01	0.64	0.008	0.56	1.01	0.68	0.018	0.38	1.02	0.75	0.042	0.22	1.04	0.71
BACH	0.004	0.62	1.00	0.62	0.001	0.96	1.00	0.55	0.018	0.26	1.02	0.48	0.011	0.65	1.01	0.34
POPGR	0.004	0.42	1.00	0.75	0.009	0.08	1.01	0.78	0.003	0.67	1.00	0.71	0.006	0.49	1.01	0.61

Measuring and Controlling Devices

	20 km				40 km				80 km				160 km			
Observations	11,775				11,833				11,833				11,833			
-2 LL (null)	2,881				2,884				2,884				2,884			
-2 LL (model)	2,825				2,827				2,824				2,825			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.744	0.00	0.02		-3.753	0.00	0.02		-3.749	0.00	0.02		-3.715	0.00	0.02	
AGE	-0.018	0.01	0.98	0.99	-0.018	0.01	0.98	0.99	-0.017	0.01	0.98	0.99	-0.017	0.01	0.98	0.99
QTR1	-0.228	0.04	0.80	0.65	-0.228	0.04	0.80	0.65	-0.228	0.04	0.80	0.65	-0.227	0.04	0.80	0.65
QTR2	0.036	0.71	1.04	0.65	0.035	0.72	1.04	0.65	0.036	0.72	1.04	0.65	0.035	0.72	1.04	0.65
QTR3	-0.257	0.02	0.77	0.65	-0.257	0.02	0.77	0.65	-0.257	0.02	0.77	0.65	-0.257	0.02	0.77	0.65
MWEST	0.021	0.83	1.02	0.67	0.058	0.56	1.06	0.65	0.049	0.63	1.05	0.64	0.006	0.95	1.01	0.56
NEAST	-0.257	0.09	0.77	0.76	-0.238	0.12	0.79	0.74	-0.202	0.19	0.82	0.72	-0.141	0.43	0.87	0.49
SOUTH	0.134	0.27	1.14	0.64	0.097	0.45	1.10	0.62	0.093	0.48	1.10	0.58	0.192	0.18	1.21	0.44
SIZE	-0.009	0.00	0.99	0.97	-0.009	0.00	0.99	0.96	-0.009	0.00	0.99	0.96	-0.009	0.00	0.99	0.97
URB	0.004	0.87	1.00	0.59	-0.014	0.15	0.99	0.58	-0.006	0.26	0.99	0.51	-0.002	0.70	1.00	0.39
LOC	0.003	0.94	1.00	0.72	-0.004	0.95	1.00	0.64	-0.053	0.61	0.95	0.47	0.109	0.53	1.12	0.35
UNIV	-0.024	0.84	0.98	0.77	0.075	0.30	1.08	0.67	0.050	0.37	1.05	0.57	-0.017	0.69	0.98	0.43
LG SH	0.010	0.20	1.01	0.67	0.006	0.62	1.01	0.72	0.034	0.14	1.03	0.65	0.051	0.24	1.05	0.61
BACH	0.001	0.87	1.00	0.78	0.005	0.64	1.00	0.68	0.021	0.17	1.02	0.46	0.007	0.73	1.01	0.47
POPGR	0.001	0.60	1.00	0.85	0.002	0.57	1.00	0.77	0.002	0.70	1.00	0.69	0.006	0.30	1.01	0.54

APPENDIX J (continued)
Event Duration Modeling Results: Localization, Urbanization & Regional Controls

Advertising

	20 km				40 km				80 km				160 km			
Observations	66,168				66,168				66,168				66,168			
-2 LL (null)	21,549				21,549				21,549				21,549			
-2 LL (model)	21,022				21,009				21,018				21,018			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	
INT	-3.497	0.00	0.03		-3.502	0.00	0.03		-3.499	0.00	0.03		-3.491	0.00	0.03	
AGE	-0.031	0.00	0.97	0.87	-0.030	0.00	0.97	0.87	-0.030	0.00	0.97	0.87	-0.030	0.00	0.97	0.87
AGE^2	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87
QTR1	-0.193	0.00	0.82	0.65	-0.192	0.00	0.83	0.65	-0.192	0.00	0.83	0.65	-0.192	0.00	0.83	0.65
QTR2	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65
QTR3	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65
MWEST	-0.048	0.17	0.95	0.59	-0.002	0.96	1.00	0.50	-0.001	0.98	1.00	0.42	-0.024	0.60	0.98	0.35
NEAST	-0.164	0.00	0.85	0.72	-0.156	0.00	0.86	0.68	-0.146	0.01	0.86	0.60	-0.093	0.17	0.91	0.43
SOUTH	0.055	0.13	1.06	0.67	0.043	0.25	1.04	0.65	0.031	0.42	1.03	0.61	0.002	0.97	1.00	0.55
SIZE	-0.032	0.00	0.97	0.98	-0.032	0.00	0.97	0.98	-0.033	0.00	0.97	0.99	-0.032	0.00	0.97	0.99
URB	0.012	0.07	1.01	0.44	0.013	0.00	1.01	0.29	0.007	0.01	1.01	0.23	0.003	0.06	1.00	0.16
LOC	-0.083	0.06	0.92	0.56	-0.186	0.00	0.83	0.50	-0.195	0.01	0.82	0.48	-0.175	0.06	0.84	0.52
UNIV	-0.037	0.03	0.96	0.61	-0.046	0.00	0.95	0.38	-0.035	0.00	0.97	0.31	-0.032	0.00	0.97	0.23
LG SH	0.001	0.82	1.00	0.67	0.003	0.63	1.00	0.61	-0.001	0.88	1.00	0.64	-0.011	0.44	0.99	0.67
BACH	-0.004	0.14	1.00	0.73	-0.003	0.47	1.00	0.66	-0.001	0.81	1.00	0.58	-0.003	0.70	1.00	0.54
POPGR	0.001	0.33	1.00	0.79	0.004	0.02	1.00	0.73	0.004	0.05	1.00	0.63	0.003	0.24	1.00	0.53

Computer and Data Processing Services

	20 km				40 km				80 km				160 km			
Observations	366,059				366,030				366,116				366,116			
-2 LL (null)	119,615				119,632				119,645				119,645			
-2 LL (model)	117,672				117,642				117,635				117,612			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.501	0.00	0.03		-3.500	0.00	0.03		-3.493	0.00	0.03		-3.484	0.00	0.03	
AGE	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13
AGE2	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08
AGE3	0.000	0.66	1.00	0.06	0.000	0.64	1.00	0.06	0.000	0.64	1.00	0.06	0.000	0.64	1.00	0.06
AGE4	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05
QTR1	-0.162	0.00	0.85	0.65	-0.161	0.00	0.85	0.65	-0.161	0.00	0.85	0.65	-0.161	0.00	0.85	0.65
QTR2	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64
QTR3	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65
MWEST	-0.037	0.01	0.96	0.70	-0.030	0.05	0.97	0.68	-0.055	0.00	0.95	0.55	-0.088	0.00	0.92	0.39
NEAST	-0.163	0.00	0.85	0.69	-0.136	0.00	0.87	0.57	-0.075	0.00	0.93	0.40	-0.004	0.89	1.00	0.23
SOUTH	0.022	0.17	1.02	0.69	-0.007	0.68	0.99	0.64	-0.010	0.57	0.99	0.52	-0.022	0.22	0.98	0.38
SIZE	-0.016	0.00	0.98	0.99	-0.016	0.00	0.98	0.99	-0.016	0.00	0.98	0.99	-0.016	0.00	0.98	0.99
URB	-0.003	0.49	1.00	0.26	-0.009	0.00	0.99	0.20	-0.004	0.00	1.00	0.14	-0.004	0.00	1.00	0.07
LOC	-0.049	0.00	0.95	0.40	-0.046	0.04	0.96	0.26	-0.115	0.00	0.89	0.16	-0.199	0.00	0.82	0.12
UNIV	0.000	0.99	1.00	0.29	0.016	0.03	1.02	0.19	0.001	0.91	1.00	0.13	0.001	0.92	1.00	0.06
LG SH	0.001	0.31	1.00	0.68	0.000	0.97	1.00	0.61	-0.006	0.16	0.99	0.59	-0.021	0.01	0.98	0.55
BACH	0.005	0.00	1.00	0.41	0.004	0.12	1.00	0.27	0.012	0.00	1.01	0.16	0.015	0.01	1.02	0.11
POPGR	0.000	0.61	1.00	0.83	0.002	0.00	1.00	0.79	0.003	0.00	1.00	0.73	0.003	0.03	1.00	0.49

APPENDIX J (continued)
Event Duration Modeling Results: Localization, Urbanization & Regional Controls
Research and Testing Services

	20 km				40 km				80 km				160 km			
Observations	67,267				67,296				67,305				67,305			
-2 LL (null)	20,382				20,397				20,398				20,398			
-2 LL (model)	19,787				19,796				19,794				19,796			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b		b	Pr > X^2	exp b		b	Pr > X^2	exp b	
INT	-3.603	0.00	0.03		-3.598	0.00	0.03		-3.595	0.00	0.03		-3.590	0.00	0.03	
AGE	-0.016	0.02	0.98	0.17	-0.016	0.02	0.98	0.17	-0.015	0.02	0.98	0.17	-0.015	0.02	0.98	0.17
AGE^2	0.001	0.11	1.00	0.62	0.001	0.11	1.00	0.62	0.001	0.12	1.00	0.62	0.001	0.11	1.00	0.62
AGE^3	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14
QTR1	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65
QTR2	0.096	0.01	1.10	0.65	0.095	0.01	1.10	0.65	0.095	0.01	1.10	0.65	0.095	0.01	1.10	0.65
QTR3	-0.190	0.00	0.83	0.65	-0.191	0.00	0.83	0.65	-0.191	0.00	0.83	0.65	-0.191	0.00	0.83	0.65
MWEST	0.003	0.93	1.00	0.72	0.008	0.83	1.01	0.67	0.007	0.87	1.01	0.57	-0.012	0.79	0.99	0.48
NEAST	-0.129	0.01	0.88	0.78	-0.099	0.06	0.91	0.69	-0.107	0.06	0.90	0.59	-0.082	0.21	0.92	0.42
SOUTH	-0.017	0.67	0.98	0.75	-0.037	0.36	0.96	0.71	-0.003	0.93	1.00	0.63	0.009	0.84	1.01	0.52
SIZE	-0.023	0.00	0.98	0.99	-0.023	0.00	0.98	0.99	-0.023	0.00	0.98	0.99	-0.023	0.00	0.98	0.99
URB	0.009	0.28	1.01	0.39	0.003	0.48	1.00	0.30	0.005	0.10	1.01	0.17	0.003	0.29	1.00	0.08
LOC	0.016	0.51	1.02	0.54	0.028	0.50	1.03	0.33	-0.008	0.91	0.99	0.21	0.022	0.81	1.02	0.24
UNIV	-0.042	0.36	0.96	0.42	-0.024	0.55	0.98	0.28	-0.069	0.06	0.93	0.14	-0.058	0.08	0.94	0.07
LG SH	-0.002	0.52	1.00	0.70	0.000	0.98	1.00	0.71	0.011	0.15	1.01	0.68	0.028	0.05	1.03	0.66
BACH	0.001	0.67	1.00	0.53	0.002	0.65	1.00	0.31	0.014	0.08	1.01	0.20	0.016	0.10	1.02	0.23
POPGR	0.002	0.17	1.00	0.80	0.005	0.02	1.00	0.70	0.002	0.35	1.00	0.62	-0.002	0.57	1.00	0.49

APPENDIX K
Event Duration Modeling Results: Interactive Analysis
Establishment Size by Localization and Urbanization
Manufacturing

	20 km				40 km				80 km				160 km			
Observations	785,997				798,478				809,146				813,353			
-2 LL (null)	242,402				246,665				250,453				251,925			
-2 LL (model)	235,907				240,094				243,799				245,267			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.543	0.00	0.03		-3.540	0.00	0.03		-3.537	0.00	0.03		-3.533	0.00	0.03	
AGE	-0.021	0.00	0.98	0.17	-0.021	0.00	0.98	0.17	-0.022	0.00	0.98	0.17	-0.022	0.00	0.98	0.17
AGE^2	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57
AGE^3	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13
QTR1	-0.228	0.00	0.80	0.65	-0.226	0.00	0.80	0.65	-0.228	0.00	0.80	0.65	-0.225	0.00	0.80	0.65
QTR2	0.014	0.18	1.01	0.65	0.015	0.14	1.02	0.65	0.016	0.12	1.02	0.65	0.014	0.15	1.01	0.65
QTR3	-0.160	0.00	0.85	0.65	-0.158	0.00	0.85	0.65	-0.156	0.00	0.86	0.65	-0.156	0.00	0.86	0.65
MWEST	-0.010	0.33	0.99	0.70	-0.009	0.36	0.99	0.69	-0.009	0.41	0.99	0.67	-0.016	0.12	0.98	0.70
NEAST	-0.160	0.00	0.85	0.83	-0.159	0.00	0.85	0.83	-0.159	0.00	0.85	0.82	-0.145	0.00	0.87	0.69
SOUTH	0.058	0.00	1.06	0.71	0.061	0.00	1.06	0.69	0.061	0.00	1.06	0.68	0.047	0.00	1.05	0.72
SIZE	-0.013	0.00	0.99	0.94	-0.013	0.00	0.99	0.96	-0.012	0.00	0.99	0.96	-0.012	0.00	0.99	0.98
URB	0.012	0.00	1.01	0.90	0.005	0.00	1.01	0.88	0.003	0.00	1.00	0.83	0.001	0.01	1.00	0.70
LOC	0.009	0.00	1.01	0.97	0.016	0.00	1.02	0.99	0.017	0.00	1.02	0.99	0.025	0.00	1.02	0.99
SIZE*URB	0.000	0.00	1.00	0.95	0.000	0.00	1.00	0.97	0.000	0.00	1.00	0.96	0.000	0.00	1.00	0.98
SIZE*LOC	0.000	0.00	1.00	0.93	0.000	0.00	1.00	0.97	0.000	0.00	1.00	0.99	0.000	0.00	1.00	0.99

Business and Professional Services

	20 km				40 km				80 km				160 km			
Observations	2,314,792				2,314,839				2,315,055				2,315,185			
-2 LL (null)	774,606				774,661				774,723				774,759			
-2 LL (model)	760,344				760,413				760,450				760,486			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.374	0.00	0.03		-3.372	0.00	0.03		-3.371	0.00	0.03		-3.368	0.00	0.03	
AGE	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18
AGE^2	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50
AGE^3	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13
QTR1	-0.255	0.00	0.78	0.66	-0.255	0.00	0.78	0.66	-0.254	0.00	0.78	0.66	-0.254	0.00	0.78	0.66
QTR2	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65
QTR3	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65
MWEST	-0.014	0.02	0.99	0.70	-0.013	0.02	0.99	0.70	-0.016	0.01	0.98	0.69	-0.024	0.00	0.98	0.66
NEAST	-0.152	0.00	0.86	0.80	-0.149	0.00	0.86	0.78	-0.145	0.00	0.86	0.68	-0.135	0.00	0.87	0.48
SOUTH	0.021	0.00	1.02	0.70	0.017	0.01	1.02	0.70	0.015	0.02	1.01	0.69	0.009	0.14	1.01	0.70
SIZE	-0.008	0.00	0.99	0.95	-0.008	0.00	0.99	0.99	-0.008	0.00	0.99	0.99	-0.008	0.00	0.99	0.94
URB	0.005	0.00	1.00	0.90	0.001	0.04	1.00	0.81	0.001	0.02	1.00	0.68	0.000	0.41	1.00	0.50
LOC	-0.048	0.00	0.95	0.91	-0.054	0.00	0.95	0.86	-0.073	0.00	0.93	0.84	-0.109	0.00	0.90	0.82
SIZE*URB	0.000	0.00	1.00	0.86	0.000	0.00	1.00	0.85	0.000	0.00	1.00	0.85	0.000	0.00	1.00	0.86
SIZE*LOC	-0.001	0.00	1.00	0.88	-0.002	0.00	1.00	0.84	-0.002	0.00	1.00	0.86	-0.001	0.08	1.00	0.90

APPENDIX K (continued)
Event Duration Modeling Results: Interactive Analysis
Establishment Size by Localization and Urbanization
Drugs

	20 km				40 km				80 km				160 km			
Observations		4,071				4,071				4,071				4,071		
-2 LL (null)		1,047				1,047				1,047				1,047		
-2 LL (model)		1,012				1,008				1,013				1,013		
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.793	0.00	0.02		-3.838	0.00	0.02		-3.761	0.00	0.02		-3.755	0.00	0.02	
AGE	-0.026	0.03	0.97	0.99	-0.025	0.03	0.97	0.99	-0.026	0.03	0.97	0.99	-0.026	0.03	0.97	0.99
QTR1	-0.032	0.85	0.97	0.65	-0.031	0.85	0.97	0.65	-0.035	0.83	0.97	0.65	-0.033	0.84	0.97	0.65
QTR2	-0.074	0.66	0.93	0.65	-0.073	0.66	0.93	0.65	-0.071	0.67	0.93	0.65	-0.071	0.67	0.93	0.65
QTR3	-0.343	0.06	0.71	0.65	-0.344	0.06	0.71	0.65	-0.342	0.06	0.71	0.65	-0.344	0.06	0.71	0.65
MWEST	0.241	0.15	1.27	0.85	0.227	0.17	1.26	0.84	0.251	0.14	1.29	0.83	0.252	0.15	1.29	0.80
NEAST	-0.402	0.13	0.67	0.84	-0.432	0.11	0.65	0.81	-0.492	0.08	0.61	0.76	-0.503	0.10	0.60	0.61
SOUTH	0.241	0.24	1.27	0.87	0.268	0.19	1.31	0.86	0.310	0.14	1.36	0.85	0.312	0.16	1.37	0.82
SIZE	-0.014	0.00	0.99	0.57	-0.017	0.00	0.98	0.61	-0.012	0.01	0.99	0.70	-0.012	0.00	0.99	0.68
URB	0.012	0.61	1.01	0.76	0.009	0.41	1.01	0.77	0.009	0.20	1.01	0.75	0.003	0.56	1.00	0.58
LOC	-0.153	0.08	0.86	0.73	-0.262	0.06	0.77	0.82	-0.188	0.31	0.83	0.91	-0.212	0.45	0.81	0.75
SIZE*URB	0.000	0.72	1.00	0.56	0.000	0.30	1.00	0.64	0.000	0.99	1.00	0.72	0.000	0.73	1.00	0.60
SIZE*LOC	-0.009	0.01	0.99	0.52	-0.017	0.00	0.98	0.75	-0.015	0.02	0.98	0.89	-0.019	0.02	0.98	0.66

Farm and Garden Machinery

	20 km				40 km				80 km				160 km			
Observations		3,998				4,486				4,732				4,736		
-2 LL (null)		1,279				1,388				1,445				1,452		
-2 LL (model)		1,207				1,313				1,362				1,376		
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.649	0.00	0.03		-3.645	0.00	0.03		-3.764	0.00	0.02		-3.694	0.00	0.02	
AGE	-0.027	0.02	0.97	0.98	-0.029	0.01	0.97	0.98	-0.032	0.00	0.97	0.98	-0.035	0.00	0.97	0.99
QTR1	-0.535	0.00	0.59	0.66	-0.517	0.00	0.60	0.66	-0.548	0.00	0.58	0.66	-0.554	0.00	0.57	0.66
QTR2	0.162	0.26	1.18	0.66	0.153	0.27	1.16	0.65	0.164	0.22	1.18	0.65	0.159	0.24	1.17	0.65
QTR3	-0.313	0.06	0.73	0.66	-0.309	0.05	0.73	0.66	-0.304	0.05	0.74	0.66	-0.306	0.05	0.74	0.66
MWEST	0.175	0.24	1.19	0.57	0.140	0.34	1.15	0.54	0.263	0.08	1.30	0.55	0.185	0.24	1.20	0.52
NEAST	-0.550	0.08	0.58	0.79	-0.561	0.08	0.57	0.79	-0.613	0.06	0.54	0.74	-0.478	0.17	0.62	0.58
SOUTH	0.321	0.09	1.38	0.64	0.407	0.02	1.50	0.62	0.338	0.06	1.40	0.62	0.308	0.11	1.36	0.61
SIZE	-0.017	0.00	0.98	0.75	-0.016	0.00	0.98	0.74	-0.017	0.01	0.98	0.67	-0.018	0.00	0.98	0.93
URB	0.067	0.08	1.07	0.88	0.036	0.04	1.04	0.77	0.003	0.78	1.00	0.73	-0.006	0.49	0.99	0.53
LOC	-0.026	0.10	0.97	0.86	0.001	0.97	1.00	0.75	-0.073	0.02	0.93	0.57	-0.062	0.14	0.94	0.54
SIZE*URB	0.001	0.45	1.00	0.52	0.001	0.33	1.00	0.49	0.000	0.97	1.00	0.56	0.000	0.74	1.00	0.62
SIZE*LOC	0.001	0.33	1.00	0.61	0.003	0.03	1.00	0.51	0.001	0.74	1.00	0.42	0.001	0.60	1.00	0.61

APPENDIX K (continued)
Event Duration Modeling Results: Interactive Analysis
Establishment Size by Localization and Urbanization

Metalworking Machinery

	20 km				40 km				80 km				160 km			
Observations	20,100				20,448				20,448				20,448			
-2 LL (null)	4,309				4,363				4,363				4,363			
-2 LL (model)	4,198				4,251				4,251				4,249			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-4.223	0.00	0.01		-4.220	0.00	0.01		-4.239	0.00	0.01		-4.274	0.00	0.01	
AGE	0.028	0.05	1.03	0.16	0.030	0.03	1.03	0.16	0.030	0.04	1.03	0.16	0.030	0.04	1.03	0.16
AGE^2	0.003	0.00	1.00	0.80	0.003	0.00	1.00	0.81	0.003	0.00	1.00	0.81	0.003	0.00	1.00	0.81
AGE^3	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15
QTR1	-0.088	0.30	0.92	0.65	-0.079	0.35	0.92	0.65	-0.080	0.35	0.92	0.65	-0.079	0.35	0.92	0.65
QTR2	0.041	0.61	1.04	0.65	0.047	0.55	1.05	0.65	0.047	0.55	1.05	0.65	0.047	0.56	1.05	0.65
QTR3	-0.170	0.05	0.84	0.65	-0.172	0.05	0.84	0.65	-0.172	0.05	0.84	0.65	-0.172	0.05	0.84	0.65
MWEST	0.116	0.13	1.12	0.48	0.095	0.20	1.10	0.49	0.135	0.08	1.14	0.43	0.192	0.03	1.21	0.38
NEAST	-0.097	0.35	0.91	0.59	-0.074	0.47	0.93	0.53	-0.102	0.32	0.90	0.53	-0.165	0.15	0.85	0.55
SOUTH	-0.069	0.52	0.93	0.62	-0.088	0.41	0.92	0.60	-0.087	0.42	0.92	0.58	-0.087	0.43	0.92	0.62
SIZE	-0.038	0.00	0.96	0.85	-0.039	0.00	0.96	0.82	-0.040	0.00	0.96	0.83	-0.042	0.00	0.96	0.67
URB	0.007	0.66	1.01	0.91	0.000	1.00	1.00	0.88	0.003	0.56	1.00	0.86	0.000	0.91	1.00	0.77
LOC	-0.059	0.06	0.94	0.83	-0.054	0.07	0.95	0.81	-0.080	0.09	0.92	0.73	-0.101	0.15	0.90	0.64
SIZE*URB	-0.001	0.51	1.00	0.89	0.000	0.52	1.00	0.71	0.000	0.97	1.00	0.68	0.000	0.45	1.00	0.51
SIZE*LOC	0.001	0.69	1.00	0.85	0.002	0.49	1.00	0.74	0.005	0.15	1.00	0.77	0.011	0.04	1.01	0.67

Electronic Components

	20 km				40 km				80 km				160 km			
Observations	15,759				15,759				15,759				15,759			
-2 LL (null)	4,172				4,172				4,172				4,172			
-2 LL (model)	4,050				4,050				4,052				4,051			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.634	0.00	0.03		-3.640	0.00	0.03		-3.667	0.00	0.03		-3.657	0.00	0.03	
AGE	-0.019	0.00	0.98	0.99	-0.019	0.00	0.98	0.99	-0.019	0.00	0.98	0.99	-0.019	0.00	0.98	0.99
QTR1	-0.257	0.00	0.77	0.66	-0.256	0.00	0.77	0.66	-0.256	0.01	0.77	0.66	-0.257	0.00	0.77	0.66
QTR2	0.017	0.83	1.02	0.65	0.017	0.83	1.02	0.65	0.017	0.84	1.02	0.65	0.017	0.83	1.02	0.65
QTR3	-0.280	0.00	0.76	0.65	-0.280	0.00	0.76	0.65	-0.280	0.00	0.76	0.65	-0.280	0.00	0.76	0.65
MWEST	-0.058	0.51	0.94	0.78	-0.037	0.67	0.96	0.73	-0.043	0.62	0.96	0.65	-0.033	0.72	0.97	0.56
NEAST	-0.139	0.24	0.87	0.86	-0.161	0.18	0.85	0.87	-0.156	0.21	0.86	0.85	-0.166	0.24	0.85	0.57
SOUTH	0.284	0.01	1.33	0.81	0.264	0.02	1.30	0.77	0.226	0.06	1.25	0.71	0.249	0.05	1.28	0.59
SIZE	-0.006	0.00	0.99	0.86	-0.006	0.00	0.99	0.71	-0.006	0.00	0.99	0.60	-0.006	0.00	0.99	0.65
URB	0.032	0.03	1.03	0.84	0.006	0.37	1.01	0.89	-0.002	0.63	1.00	0.73	0.000	0.88	1.00	0.63
LOC	-0.017	0.23	0.98	0.76	-0.029	0.21	0.97	0.76	-0.056	0.28	0.95	0.63	-0.082	0.34	0.92	0.47
SIZE*URB	0.000	0.18	1.00	0.75	0.000	0.41	1.00	0.56	0.000	0.37	1.00	0.35	0.000	0.92	1.00	0.59
SIZE*LOC	-0.001	0.05	1.00	0.71	-0.001	0.02	1.00	0.68	-0.001	0.25	1.00	0.49	-0.003	0.02	1.00	0.69

APPENDIX K (continued)
Event Duration Modeling Results: Interactive Analysis
Establishment Size by Localization and Urbanization

Motor Vehicle Parts

	20 km				40 km				80 km				160 km			
Observations	8,561				8,572				8,572				8,572			
-2 LL (null)	2,613				2,621				2,621				2,621			
-2 LL (model)	2,490				2,499				2,500				2,511			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.706	0.00	0.02		-3.696	0.00	0.02		-3.698	0.00	0.02		-3.655	0.00	0.03	
AGE	0.027	0.13	1.03	0.18	0.028	0.11	1.03	0.18	0.028	0.11	1.03	0.18	0.027	0.12	1.03	0.18
AGE^2	0.003	0.02	1.00	0.57	0.003	0.02	1.00	0.57	0.003	0.02	1.00	0.57	0.003	0.02	1.00	0.57
AGE^3	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14
QTR1	-0.098	0.36	0.91	0.65	-0.086	0.42	0.92	0.65	-0.085	0.43	0.92	0.65	-0.084	0.43	0.92	0.65
QTR2	-0.277	0.01	0.76	0.65	-0.281	0.01	0.76	0.65	-0.280	0.01	0.76	0.65	-0.280	0.01	0.76	0.65
QTR3	-0.313	0.01	0.73	0.65	-0.317	0.01	0.73	0.65	-0.317	0.01	0.73	0.65	-0.317	0.01	0.73	0.65
MWEST	0.073	0.48	1.08	0.61	0.106	0.32	1.11	0.59	0.114	0.30	1.12	0.56	0.075	0.53	1.08	0.59
NEAST	-0.239	0.23	0.79	0.86	-0.305	0.14	0.74	0.86	-0.319	0.13	0.73	0.85	-0.286	0.23	0.75	0.68
SOUTH	-0.015	0.90	0.99	0.60	-0.010	0.93	0.99	0.58	-0.003	0.98	1.00	0.56	-0.014	0.91	0.99	0.60
SIZE	-0.007	0.00	0.99	0.56	-0.006	0.00	0.99	0.52	-0.006	0.00	0.99	0.56	-0.005	0.00	0.99	0.56
URB	0.043	0.01	1.04	0.73	0.014	0.03	1.01	0.69	0.008	0.05	1.01	0.67	0.004	0.25	1.00	0.60
LOC	-0.055	0.11	0.95	0.77	-0.122	0.06	0.89	0.84	-0.211	0.04	0.81	0.74	-0.177	0.19	0.84	0.70
SIZE*URB	0.001	0.00	1.00	0.54	0.001	0.00	1.00	0.51	0.000	0.00	1.00	0.58	0.000	0.16	1.00	0.69
SIZE*LOC	0.000	0.44	1.00	0.83	-0.001	0.45	1.00	0.81	-0.001	0.55	1.00	0.72	-0.002	0.41	1.00	0.67

Measuring and Controlling Devices

	20 km				40 km				80 km				160 km			
Observations	11,775				11,833				11,833				11,833			
-2 LL (null)	2,881				2,884				2,884				2,884			
-2 LL (model)	2,812				2,821				2,812				2,814			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.809	0.00	0.02		-3.800	0.00	0.02		-3.845	0.00	0.02		-3.833	0.00	0.02	
AGE	-0.016	0.02	0.98	0.99	-0.017	0.01	0.98	0.99	-0.017	0.02	0.98	0.99	-0.017	0.02	0.98	0.99
QTR1	-0.227	0.04	0.80	0.65	-0.228	0.04	0.80	0.65	-0.227	0.04	0.80	0.65	-0.227	0.04	0.80	0.65
QTR2	0.034	0.72	1.04	0.65	0.035	0.72	1.04	0.65	0.034	0.73	1.03	0.65	0.034	0.73	1.03	0.65
QTR3	-0.257	0.02	0.77	0.65	-0.257	0.02	0.77	0.65	-0.257	0.02	0.77	0.65	-0.256	0.02	0.77	0.65
MWEST	0.025	0.80	1.03	0.69	0.032	0.74	1.03	0.69	0.008	0.94	1.01	0.70	-0.002	0.98	1.00	0.66
NEAST	-0.293	0.04	0.75	0.81	-0.288	0.05	0.75	0.84	-0.265	0.08	0.77	0.83	-0.230	0.19	0.79	0.56
SOUTH	0.162	0.17	1.18	0.70	0.154	0.20	1.17	0.66	0.153	0.22	1.16	0.62	0.178	0.20	1.19	0.50
SIZE	-0.015	0.00	0.99	0.66	-0.013	0.00	0.99	0.63	-0.017	0.00	0.98	0.57	-0.017	0.00	0.98	0.76
URB	-0.026	0.18	0.97	0.92	-0.020	0.03	0.98	0.93	-0.016	0.01	0.98	0.85	-0.012	0.00	0.99	0.59
LOC	0.025	0.49	1.03	0.81	0.035	0.52	1.04	0.77	0.114	0.22	1.12	0.72	0.137	0.36	1.15	0.55
SIZE*URB	-0.002	0.07	1.00	0.82	-0.001	0.08	1.00	0.75	-0.001	0.00	1.00	0.60	-0.001	0.00	1.00	0.63
SIZE*LOC	0.004	0.00	1.00	0.76	0.004	0.01	1.00	0.79	0.013	0.00	1.01	0.66	0.010	0.03	1.01	0.79

APPENDIX K (continued)
Event Duration Modeling Results: Interactive Analysis
Establishment Size by Localization and Urbanization

Advertising

	20 km				40 km				80 km				160 km			
Observations		66,168				66,168				66,168				66,168		
-2 LL (null)		21,549				21,549				21,549				21,549		
-2 LL (model)		21,030				21,025				21,025				21,023		
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	
INT	-3.497	0.00	0.03		-3.504	0.00	0.03		-3.503	0.00	0.03		-3.495	0.00	0.03	
AGE	-0.031	0.00	0.97	0.87	-0.031	0.00	0.97	0.87	-0.031	0.00	0.97	0.87	-0.031	0.00	0.97	0.87
AGE^2	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87
QTR1	-0.193	0.00	0.82	0.65	-0.193	0.00	0.82	0.65	-0.193	0.00	0.82	0.65	-0.193	0.00	0.82	0.65
QTR2	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65	0.072	0.03	1.08	0.65
QTR3	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65
MWEST	-0.048	0.16	0.95	0.66	-0.038	0.28	0.96	0.63	-0.050	0.17	0.95	0.62	-0.069	0.07	0.93	0.65
NEAST	-0.187	0.00	0.83	0.79	-0.190	0.00	0.83	0.77	-0.168	0.00	0.85	0.69	-0.122	0.06	0.89	0.47
SOUTH	0.066	0.06	1.07	0.68	0.068	0.06	1.07	0.67	0.055	0.14	1.06	0.66	0.034	0.39	1.03	0.69
SIZE	-0.032	0.00	0.97	0.66	-0.033	0.00	0.97	0.60	-0.034	0.00	0.97	0.66	-0.033	0.00	0.97	0.67
URB	0.001	0.87	1.00	0.65	0.004	0.18	1.00	0.59	0.002	0.27	1.00	0.49	0.000	0.72	1.00	0.36
LOC	-0.095	0.04	0.91	0.67	-0.151	0.01	0.86	0.63	-0.127	0.08	0.88	0.63	-0.160	0.08	0.85	0.64
SIZE*URB	-0.001	0.48	1.00	0.50	0.000	0.56	1.00	0.38	0.000	0.08	1.00	0.46	0.000	0.03	1.00	0.58
SIZE*LOC	0.002	0.68	1.00	0.54	0.006	0.37	1.01	0.44	0.008	0.29	1.01	0.44	0.006	0.51	1.01	0.50

Computer and Data Processing Services

	20 km				40 km				80 km				160 km			
Observations		366,059				366,030				366,116				366,116		
-2 LL (null)		119,615				119,632				119,645				119,645		
-2 LL (model)		117,630				117,611				117,615				117,605		
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.520	0.00	0.03		-3.513	0.00	0.03		-3.501	0.00	0.03		-3.486	0.00	0.03	
AGE	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13
AGE2	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08
AGE3	0.000	0.66	1.00	0.06	0.000	0.65	1.00	0.06	0.000	0.65	1.00	0.06	0.000	0.65	1.00	0.06
AGE4	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05
QTR1	-0.162	0.00	0.85	0.65	-0.161	0.00	0.85	0.65	-0.161	0.00	0.85	0.65	-0.161	0.00	0.85	0.65
QTR2	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64
QTR3	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65
MWEST	-0.037	0.01	0.96	0.71	-0.042	0.00	0.96	0.71	-0.067	0.00	0.94	0.69	-0.102	0.00	0.90	0.66
NEAST	-0.171	0.00	0.84	0.78	-0.142	0.00	0.87	0.73	-0.082	0.00	0.92	0.57	0.003	0.90	1.00	0.38
SOUTH	0.029	0.06	1.03	0.73	0.012	0.46	1.01	0.73	-0.010	0.54	0.99	0.73	-0.031	0.06	0.97	0.72
SIZE	-0.017	0.00	0.98	0.90	-0.017	0.00	0.98	0.86	-0.017	0.00	0.98	0.80	-0.016	0.00	0.98	0.65
URB	0.003	0.20	1.00	0.95	-0.003	0.02	1.00	0.83	-0.003	0.00	1.00	0.58	-0.003	0.00	1.00	0.39
LOC	0.003	0.77	1.00	0.94	0.018	0.19	1.02	0.89	0.031	0.09	1.03	0.83	0.014	0.60	1.01	0.79
SIZE*URB	0.001	0.00	1.00	0.89	0.000	0.00	1.00	0.80	0.000	0.00	1.00	0.70	0.000	0.02	1.00	0.55
SIZE*LOC	0.003	0.00	1.00	0.82	0.003	0.00	1.00	0.72	0.004	0.00	1.00	0.67	0.005	0.00	1.01	0.69

APPENDIX K (continued)
Event Duration Modeling Results: Interactive Analysis
Establishment Size by Localization and Urbanization
Research and Testing Services

	20 km				40 km			
Observations	67,267				67,296			
-2 LL (null)	20,382				20,397			
-2 LL (model)	19,777				19,787			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.617	0.00	0.03		-3.627	0.00	0.03	
AGE	-0.015	0.02	0.98	0.17	-0.015	0.02	0.98	0.17
AGE^2	0.001	0.11	1.00	0.62	0.001	0.12	1.00	0.62
AGE^3	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14
QTR1	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65
QTR2	0.096	0.01	1.10	0.65	0.095	0.01	1.10	0.65
QTR3	-0.190	0.00	0.83	0.65	-0.191	0.00	0.83	0.65
MWEST	-0.001	0.97	1.00	0.75	0.003	0.94	1.00	0.73
NEAST	-0.144	0.00	0.87	0.84	-0.140	0.01	0.87	0.80
SOUTH	-0.017	0.67	0.98	0.79	-0.022	0.58	0.98	0.79
SIZE	-0.024	0.00	0.98	0.94	-0.025	0.00	0.98	0.94
URB	0.014	0.01	1.01	0.94	0.006	0.02	1.01	0.88
LOC	-0.013	0.62	0.99	0.89	0.023	0.52	1.02	0.84
SIZE*URB	0.001	0.00	1.00	0.94	0.001	0.00	1.00	0.95
SIZE*LOC	-0.003	0.06	1.00	0.97	-0.002	0.54	1.00	0.97

	80 km				160 km			
Observations	67,305				67,305			
-2 LL (null)	20,398				20,398			
-2 LL (model)	19,794				19,802			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.616	0.00	0.03		-3.596	0.00	0.03	
AGE	-0.015	0.02	0.98	0.17	-0.016	0.02	0.98	0.17
AGE^2	0.001	0.12	1.00	0.62	0.001	0.11	1.00	0.62
AGE^3	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14
QTR1	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65
QTR2	0.095	0.01	1.10	0.65	0.095	0.01	1.10	0.65
QTR3	-0.191	0.00	0.83	0.65	-0.191	0.00	0.83	0.65
MWEST	-0.003	0.93	1.00	0.70	-0.025	0.55	0.97	0.62
NEAST	-0.134	0.01	0.87	0.70	-0.072	0.26	0.93	0.47
SOUTH	-0.021	0.59	0.98	0.78	-0.037	0.36	0.96	0.75
SIZE	-0.024	0.00	0.98	0.98	-0.023	0.00	0.98	0.97
URB	0.003	0.10	1.00	0.72	-0.001	0.47	1.00	0.50
LOC	0.006	0.90	1.01	0.79	0.045	0.51	1.05	0.70
SIZE*URB	0.000	0.00	1.00	0.95	0.000	0.14	1.00	0.89
SIZE*LOC	-0.003	0.41	1.00	0.94	0.000	0.95	1.00	0.87

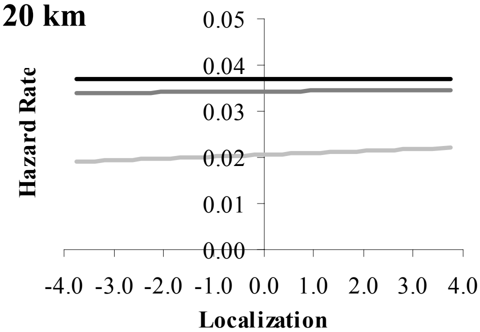
APPENDIX L
Hazard Rates: Establishment Size by Localization

Localization values are mean centered and range between -1 and +1 standard deviations

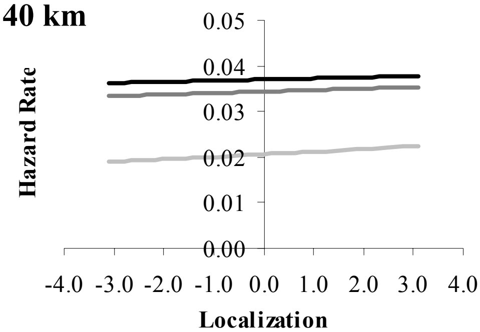
Establishment Size Classes
10th percentile — 50th percentile — 90th percentile

Manufacturing

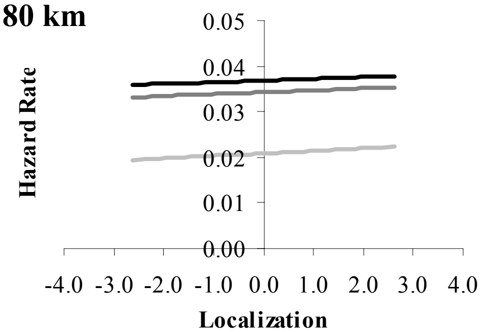
20 km



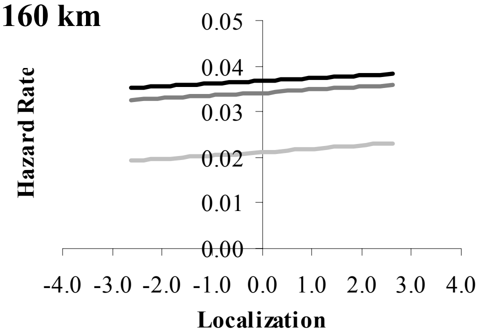
40 km



80 km

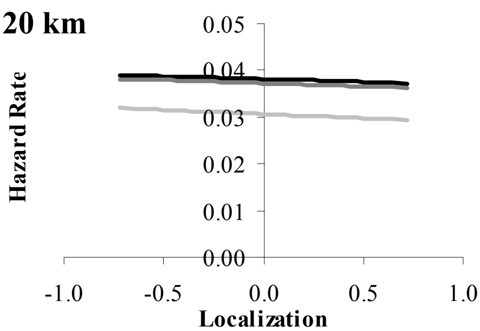


160 km

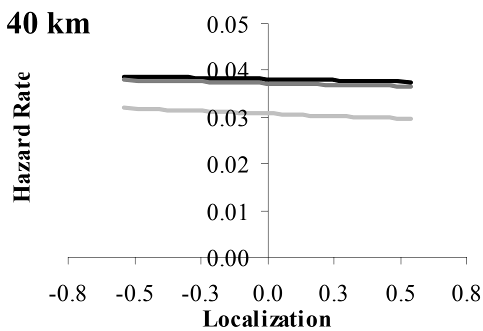


Business and Professional Services

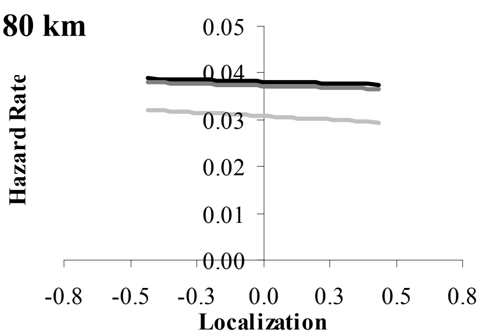
20 km



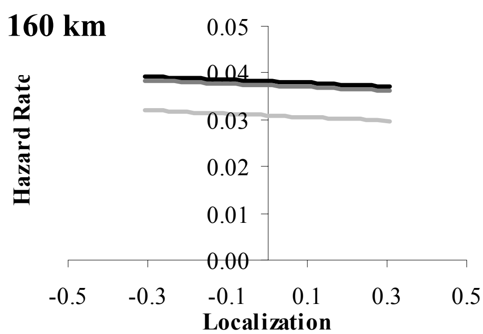
40 km



80 km

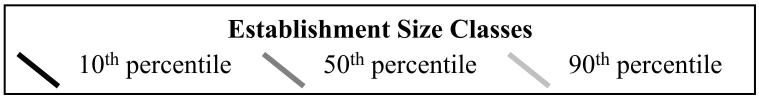


160 km



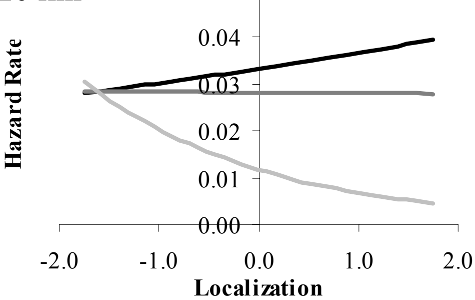
APPENDIX L (continued)
Hazard Rates: Establishment Size by Localization

Localization values are mean centered and range between -1 and +1 standard deviations

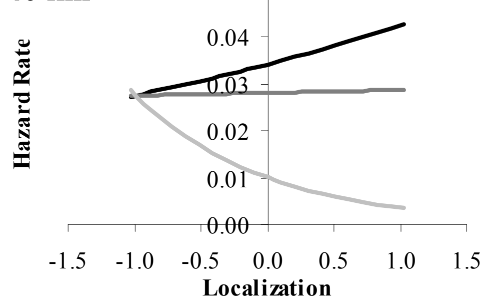


Drugs

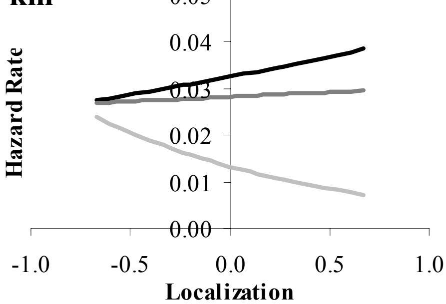
20 km



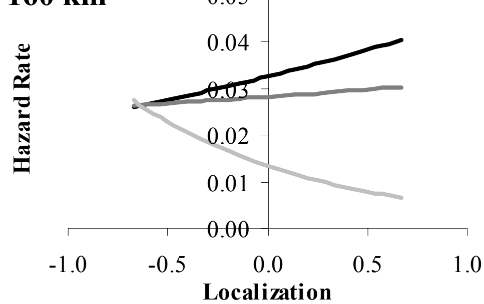
40 km



80 km

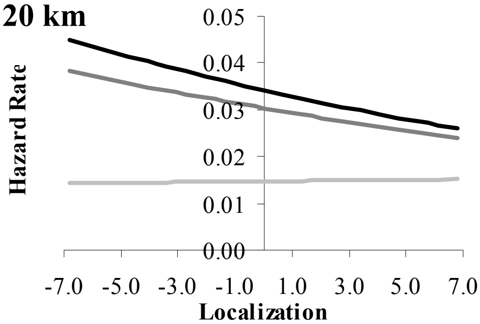


160 km

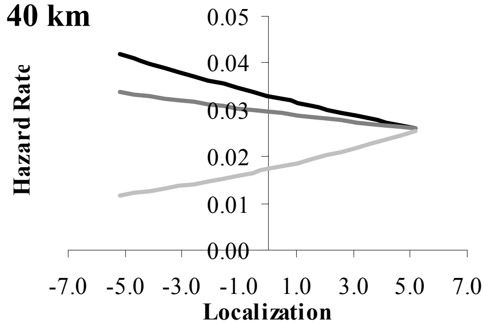


Farm & Garden Machinery

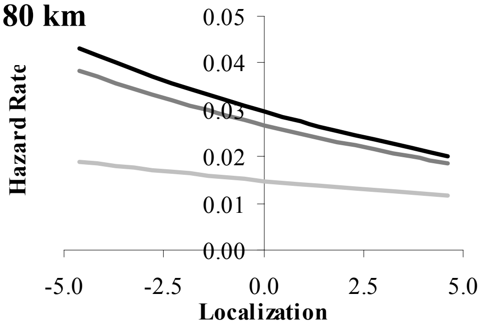
20 km



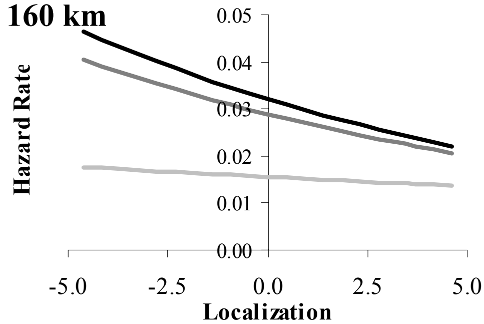
40 km



80 km



160 km



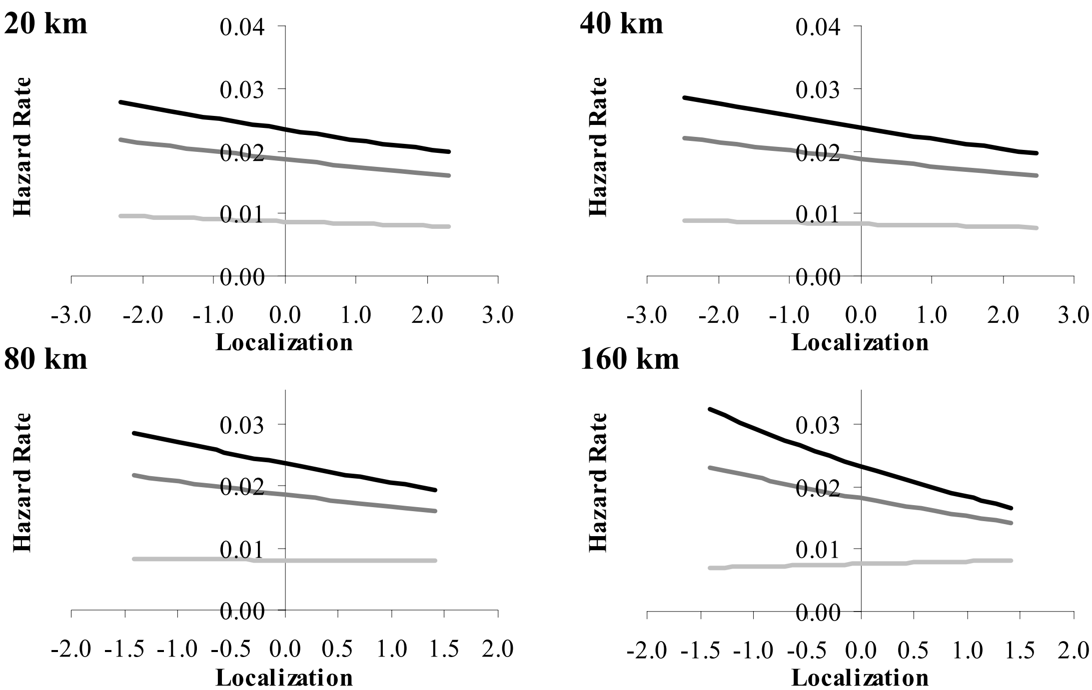
APPENDIX L (continued)
Hazard Rates: Establishment Size by Localization

Localization values are mean centered and range between -1 and +1 standard deviations

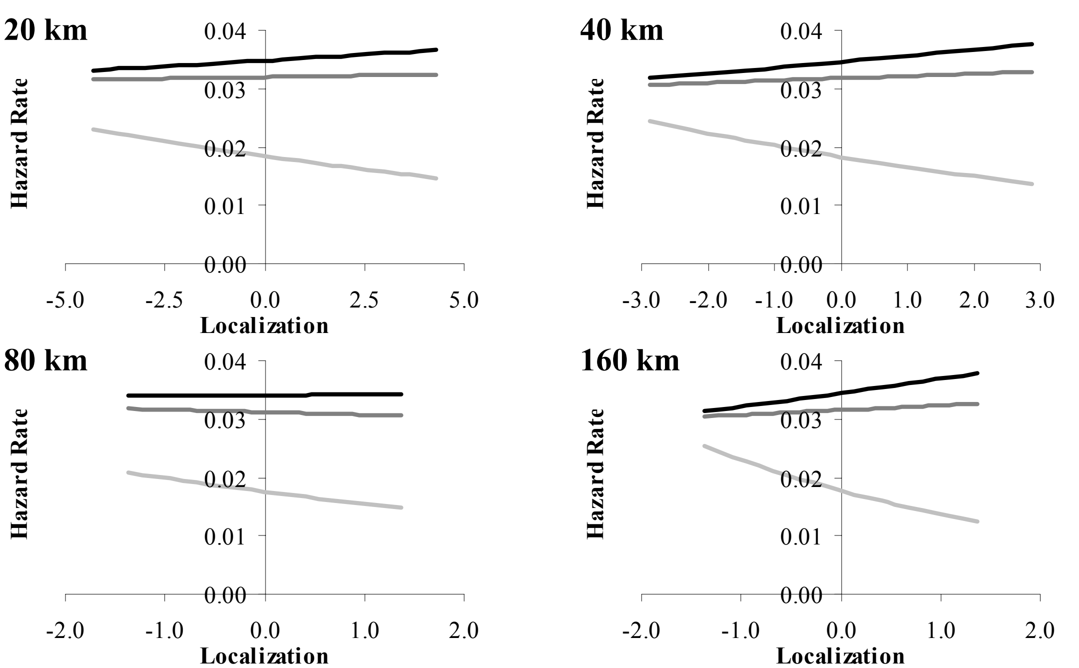
Establishment Size Classes

10th percentile — 50th percentile — 90th percentile

Metalworking Machinery



Electronic Components and Accessories



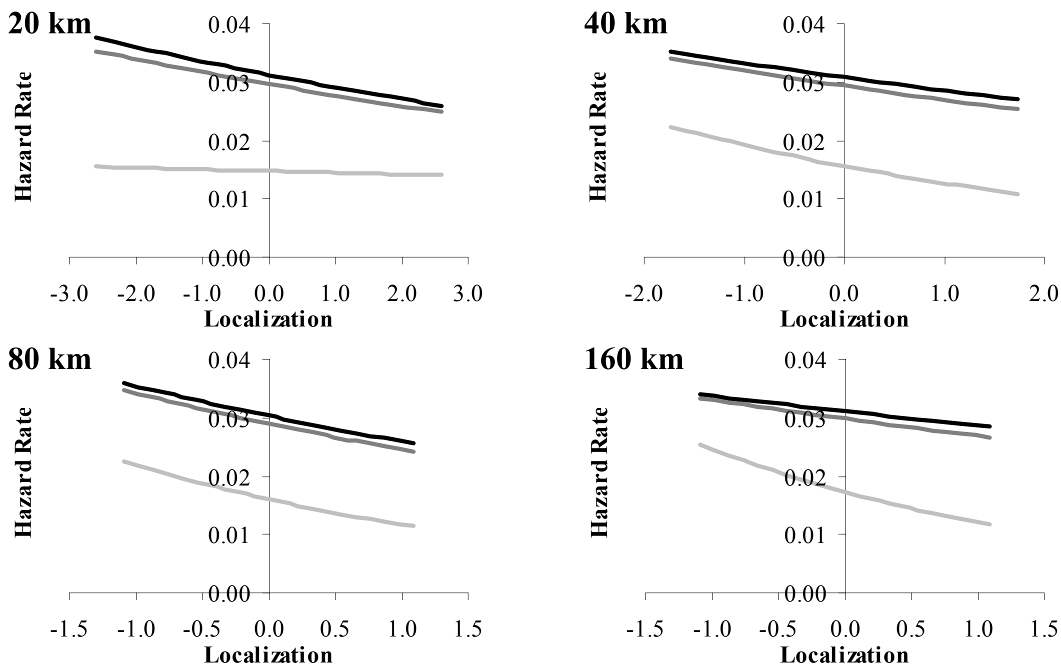
APPENDIX L (continued)
Hazard Rates: Establishment Size by Localization

Localization values are mean centered and range between -1 and +1 standard deviations

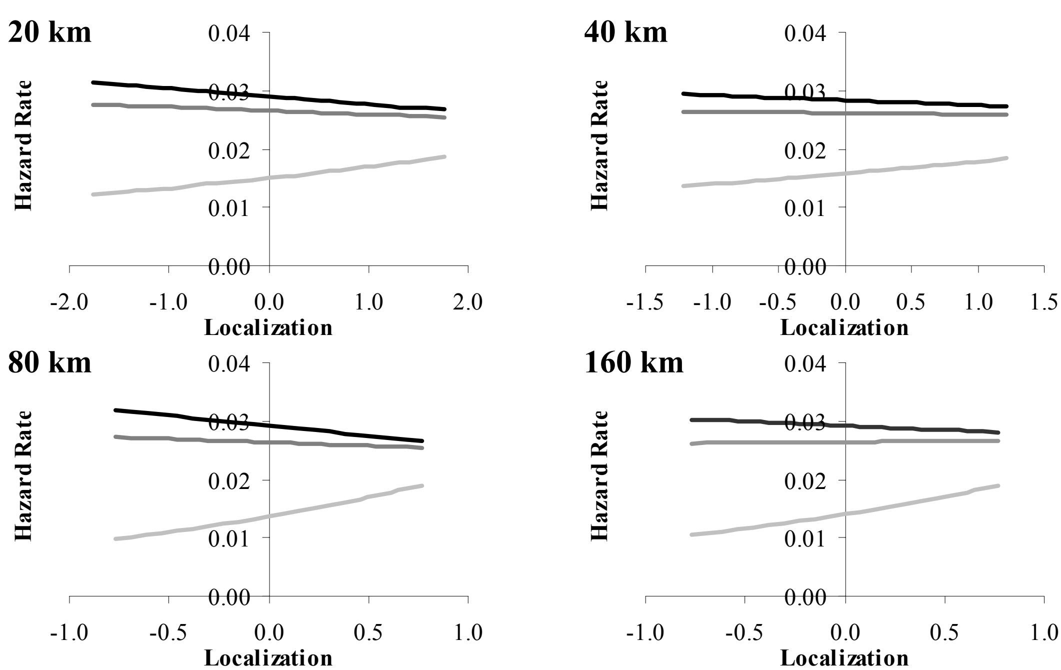
Establishment Size Classes

10th percentile — 50th percentile — 90th percentile

Motor Vehicle Parts

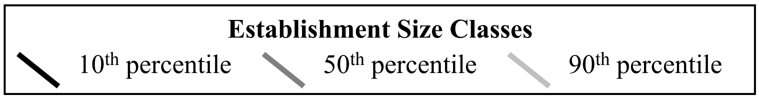


Measuring and Controlling Devices

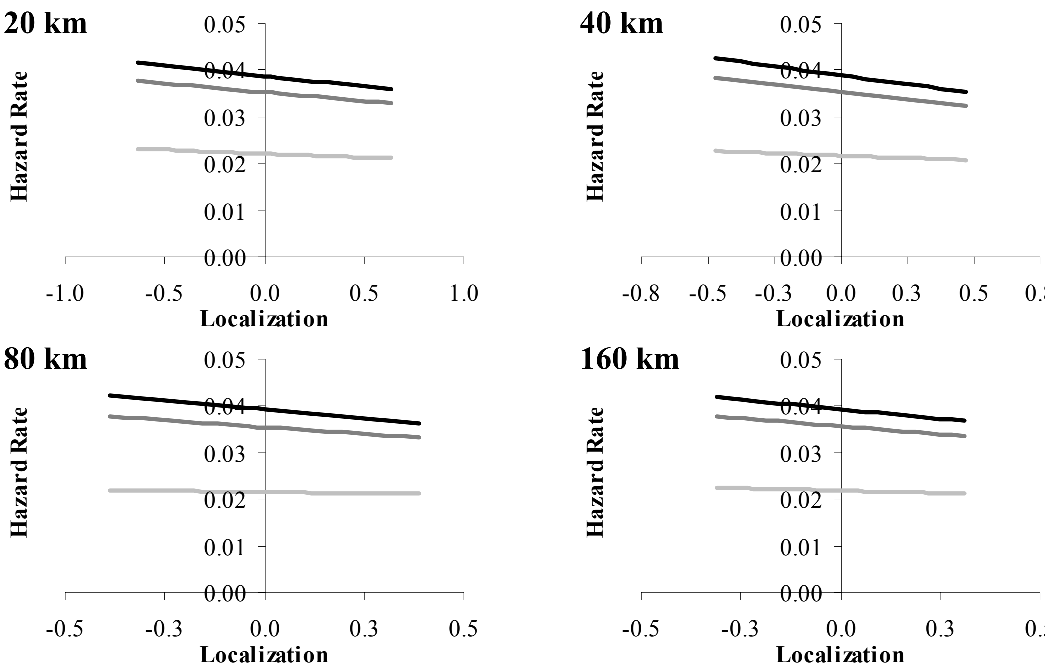


APPENDIX L (continued)
Hazard Rates: Establishment Size by Localization

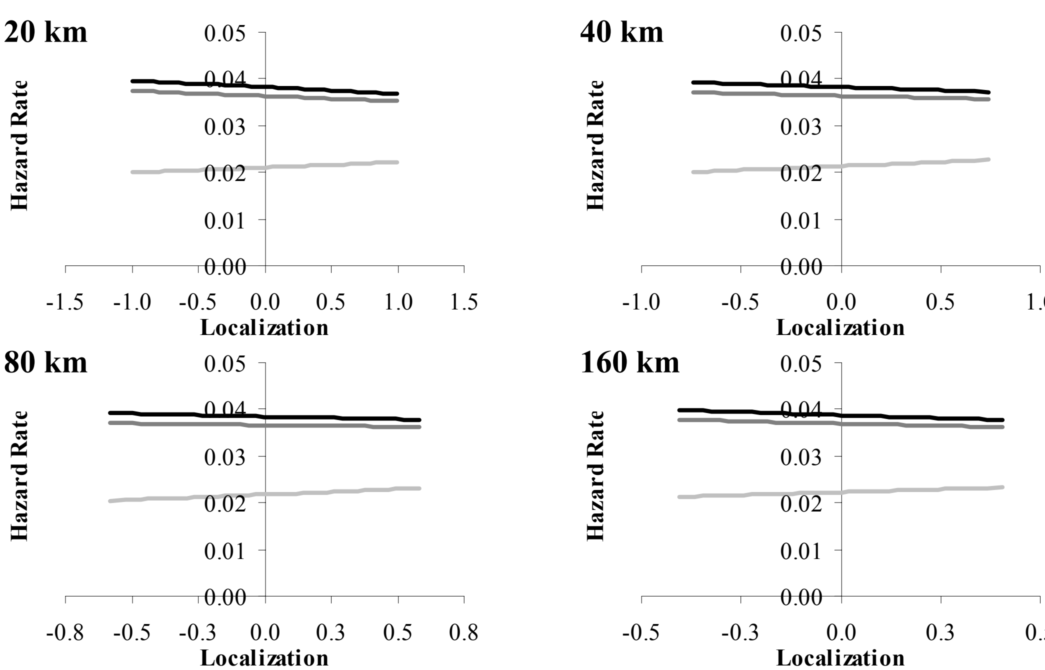
Localization values are mean centered and range between -1 and +1 standard deviations



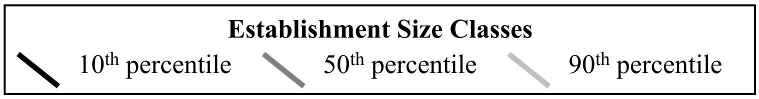
Advertising



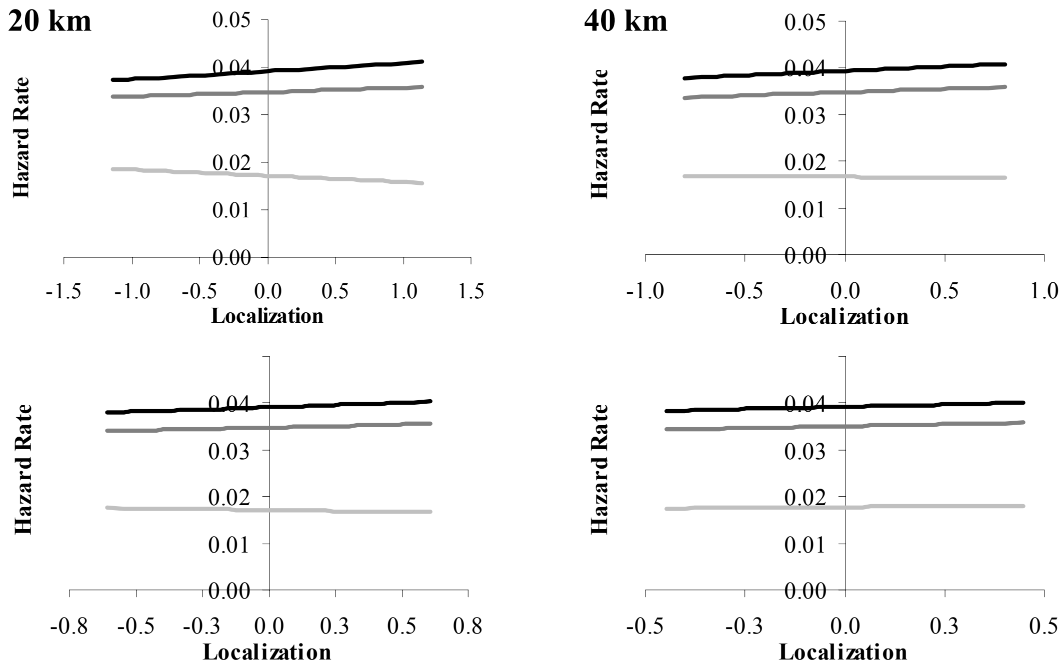
Computer and Data Processing



APPENDIX L (continued)
Hazard Rates: Establishment Size by Localization
Localization values are mean centered and range between -1 and +1 standard deviations

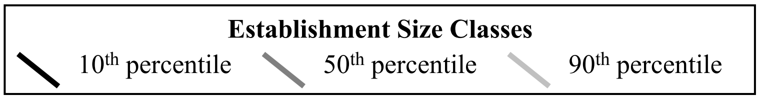


Research and Testing Services

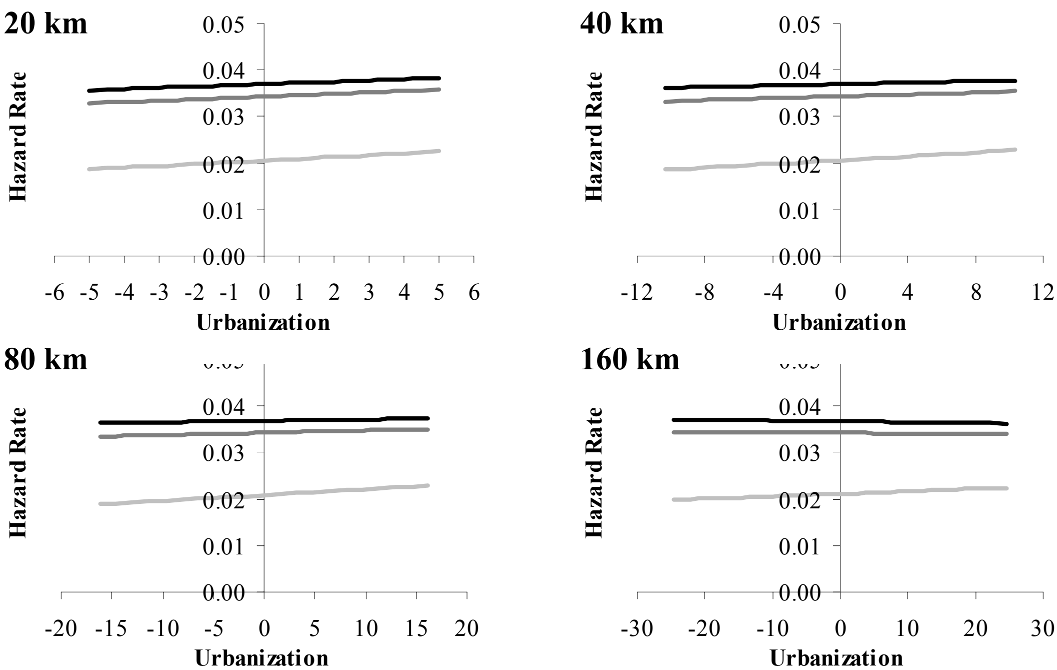


APPENDIX M
Hazard Rates: Establishment Size by Urbanization

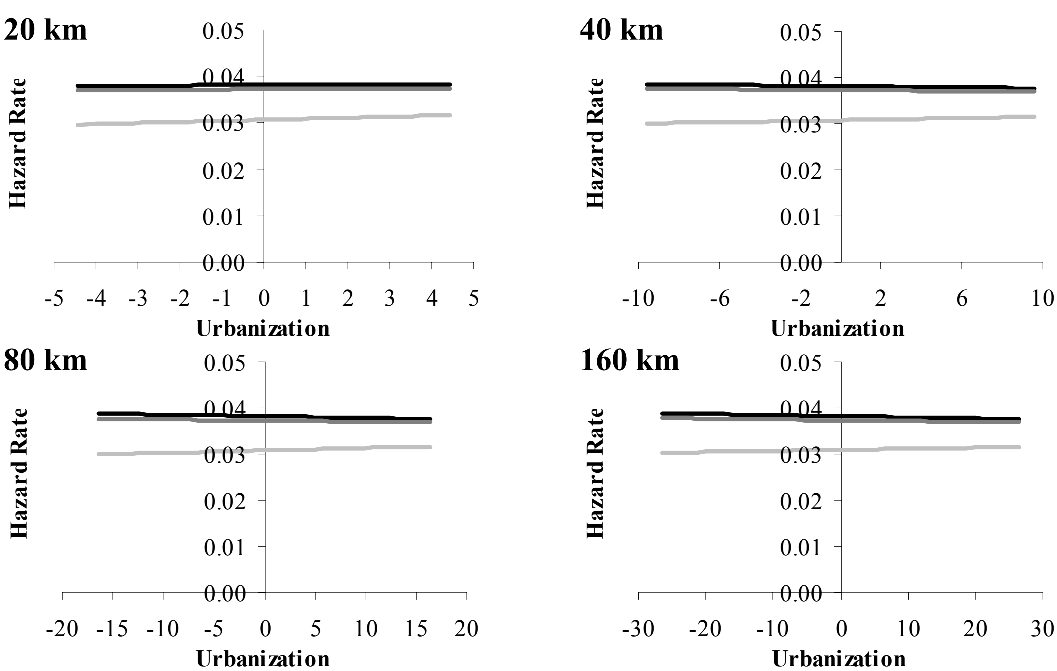
Urbanization values are mean centered and range between -1 and +1 standard deviations



Manufacturing



Business and Professional Services



APPENDIX M (continued)
Hazard Rates: Establishment Size by Urbanization

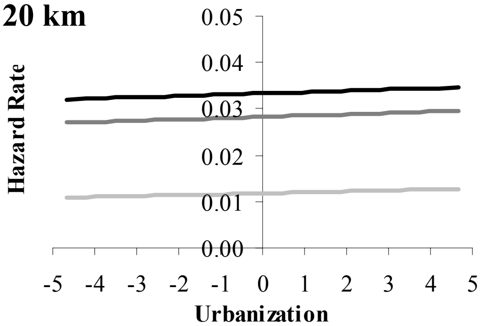
Urbanization values are mean centered and range between -1 and +1 standard deviations

Establishment Size Classes

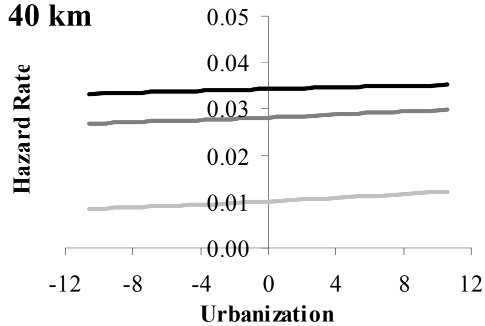
10th percentile — 50th percentile — 90th percentile

Drugs

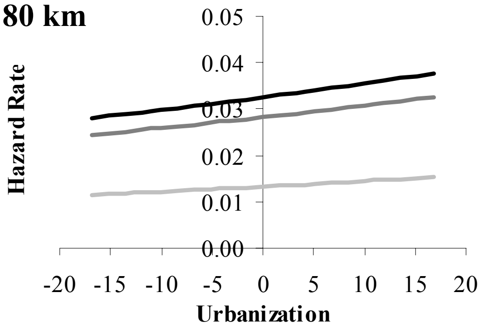
20 km



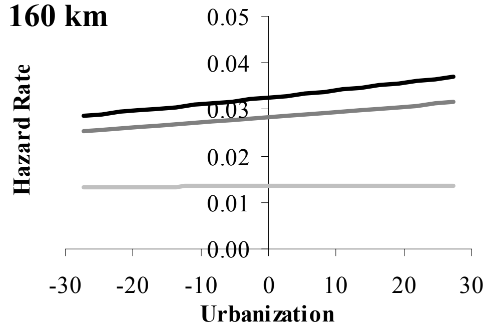
40 km



80 km

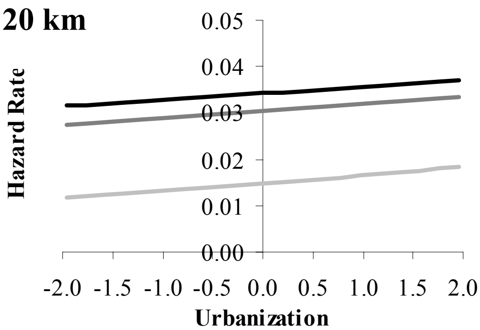


160 km

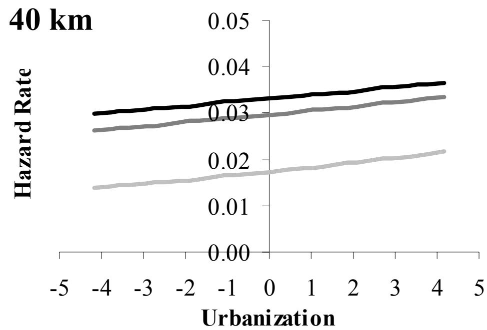


Farm & Garden Machinery

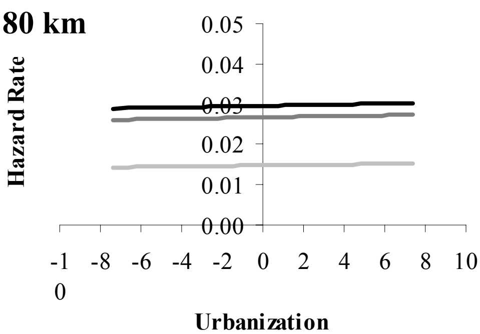
20 km



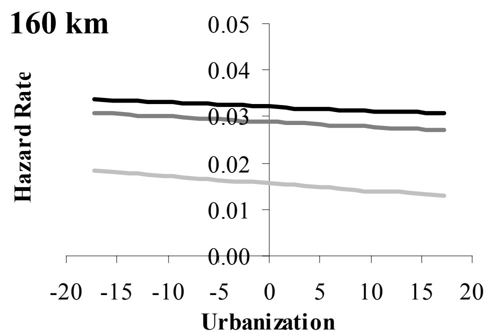
40 km



80 km



160 km



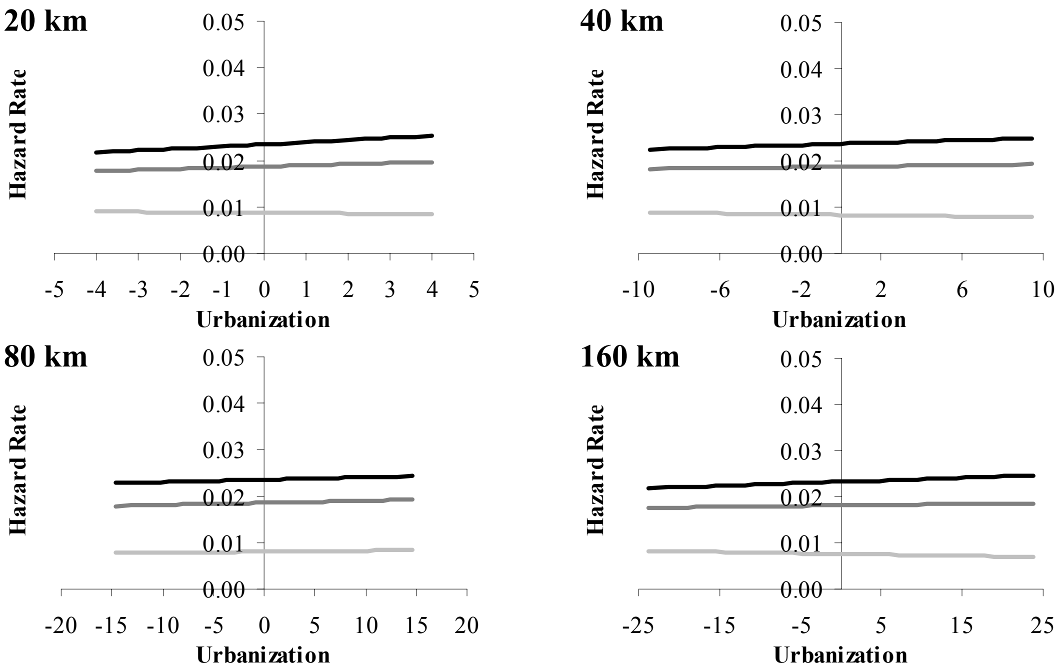
APPENDIX M (continued)
Hazard Rates: Establishment Size by Urbanization

Urbanization values are mean centered and range between -1 and +1 standard deviations

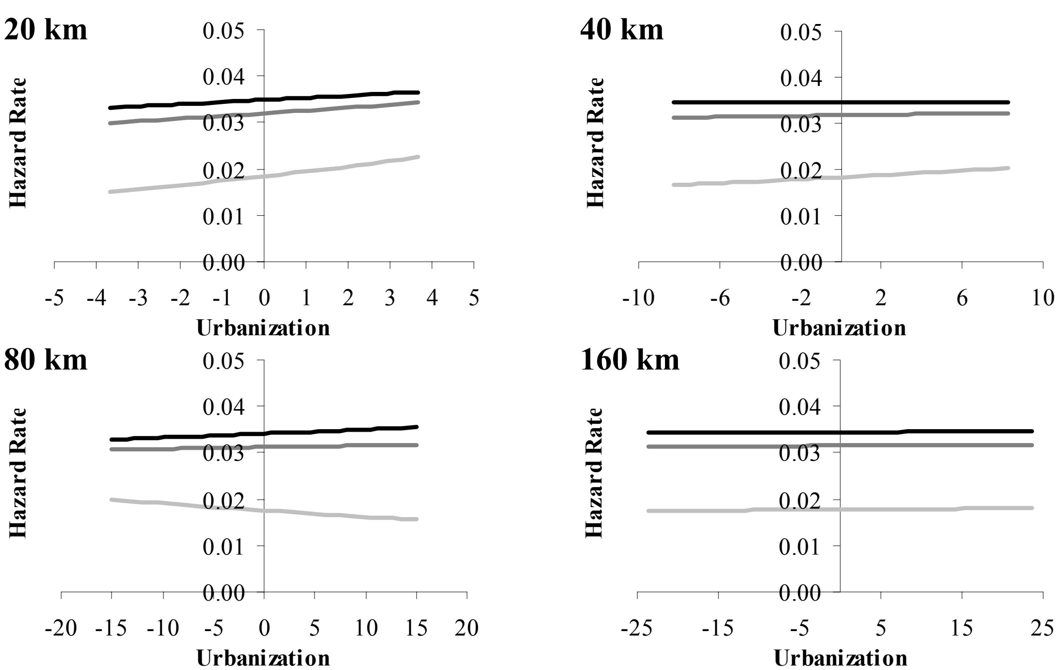
Establishment Size Classes

10th percentile — 50th percentile — 90th percentile

Metalworking Machinery



Electronic Components and Accessories



APPENDIX M (continued)
Hazard Rates: Establishment Size by Urbanization

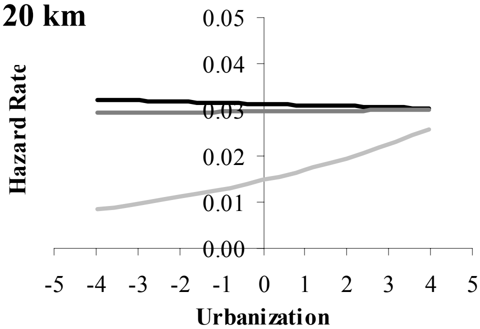
Urbanization values are mean centered and range between -1 and +1 standard deviations

Establishment Size Classes

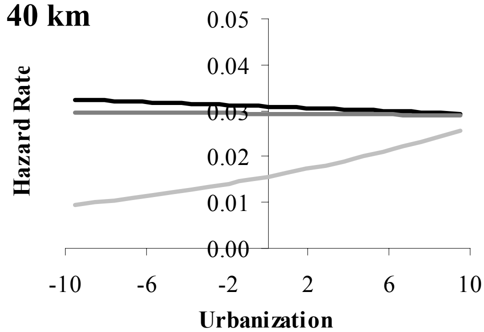
10th percentile — 50th percentile — 90th percentile

Motor Vehicle Parts

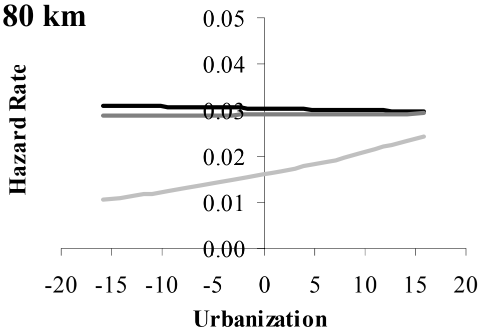
20 km



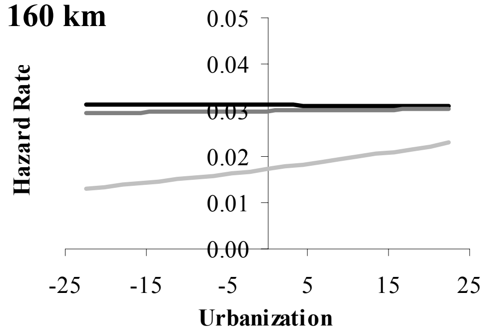
40 km



80 km

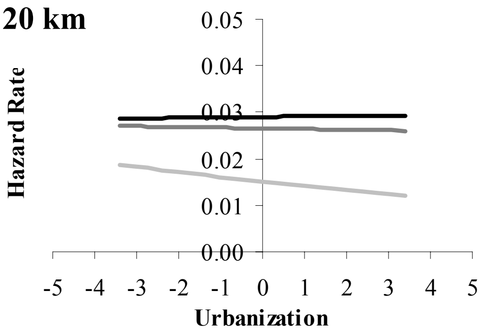


160 km

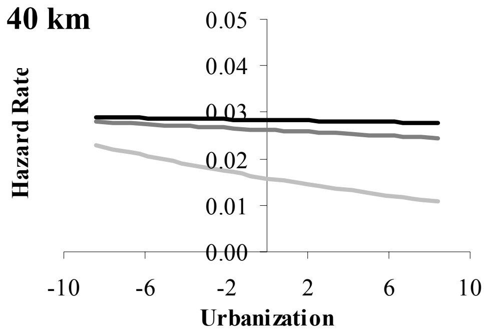


Measuring and Controlling Devices

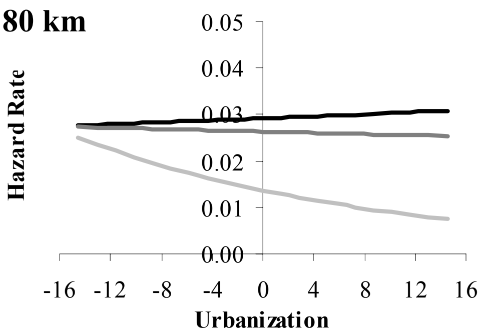
20 km



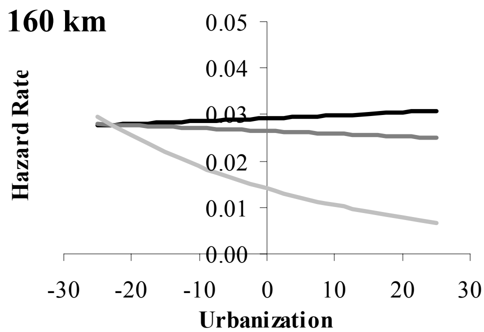
40 km



80 km

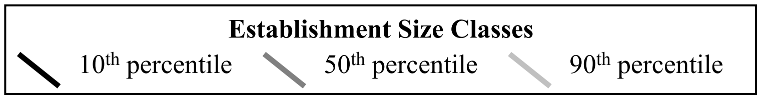


160 km

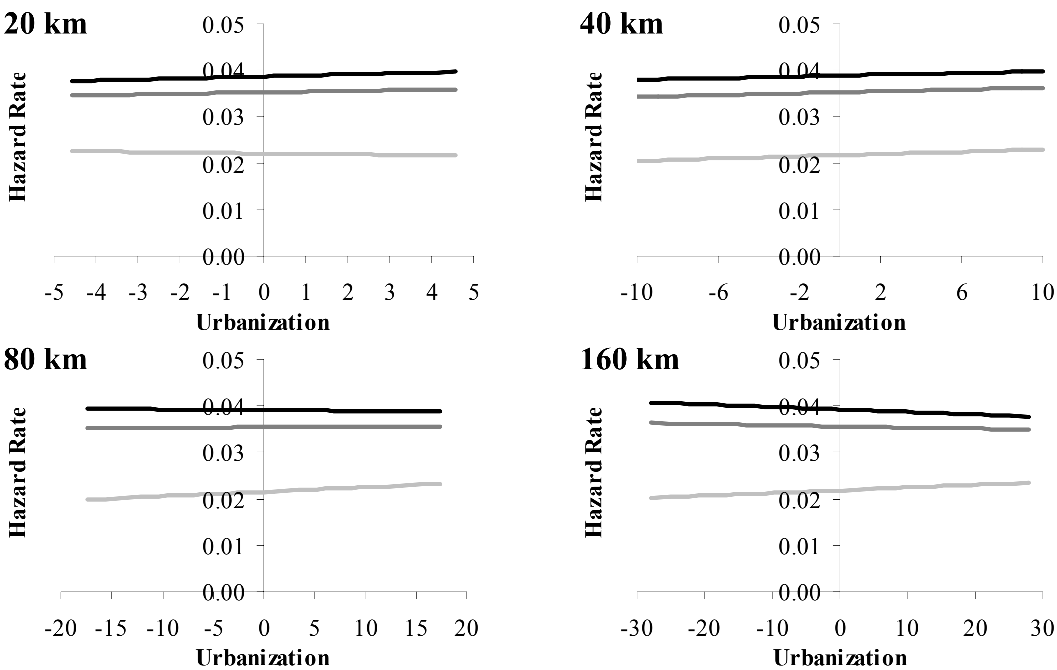


APPENDIX M (continued)
Hazard Rates: Establishment Size by Urbanization

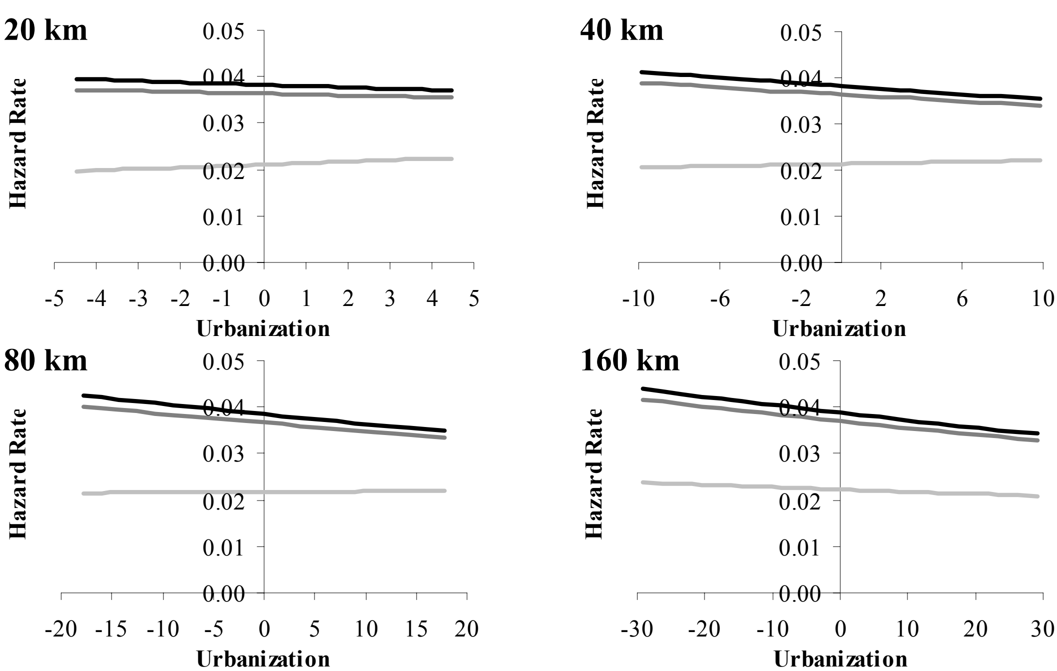
Urbanization values are mean centered and range between -1 and +1 standard deviations



Advertising

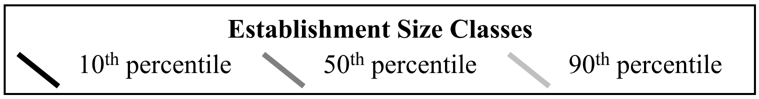


Computer and Data Processing



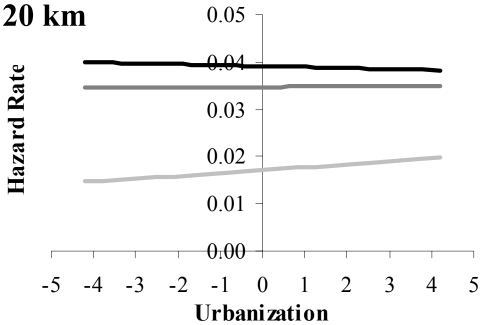
APPENDIX M (continued)
Hazard Rates: Establishment Size by Urbanization

Urbanization values are mean centered and range between -1 and +1 standard deviations

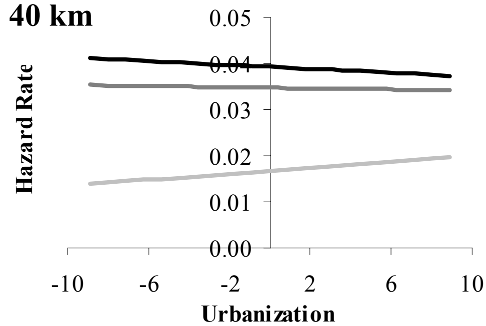


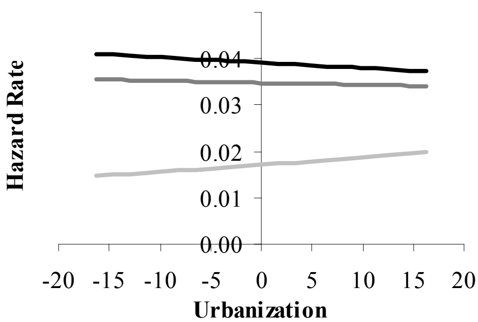
Research and Testing Services

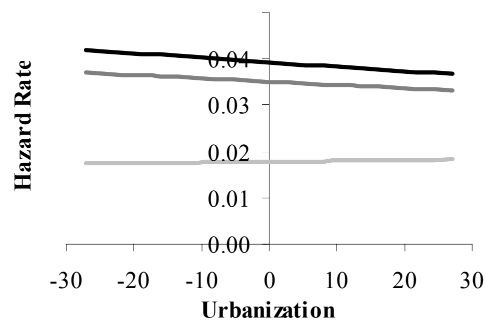
20 km



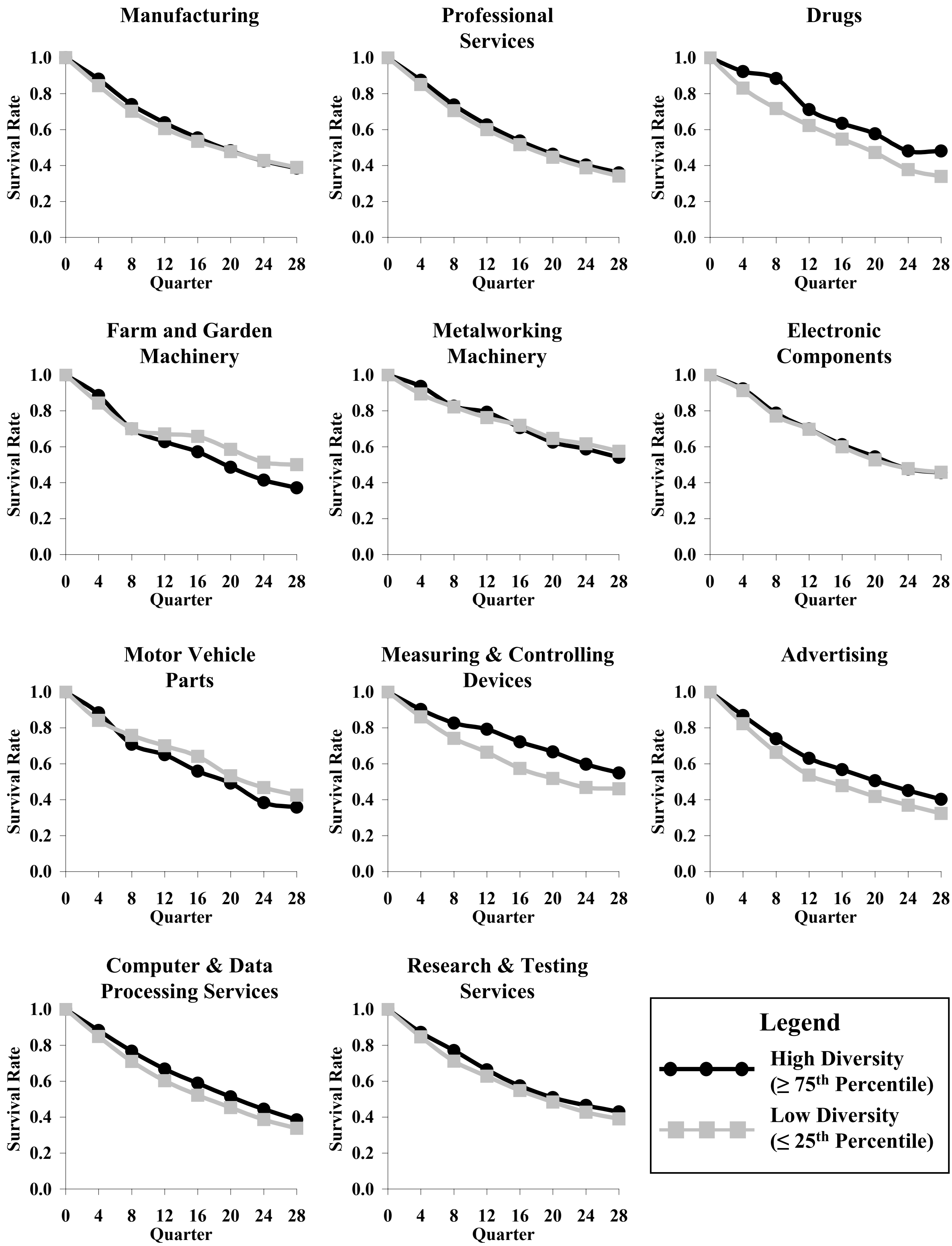
40 km



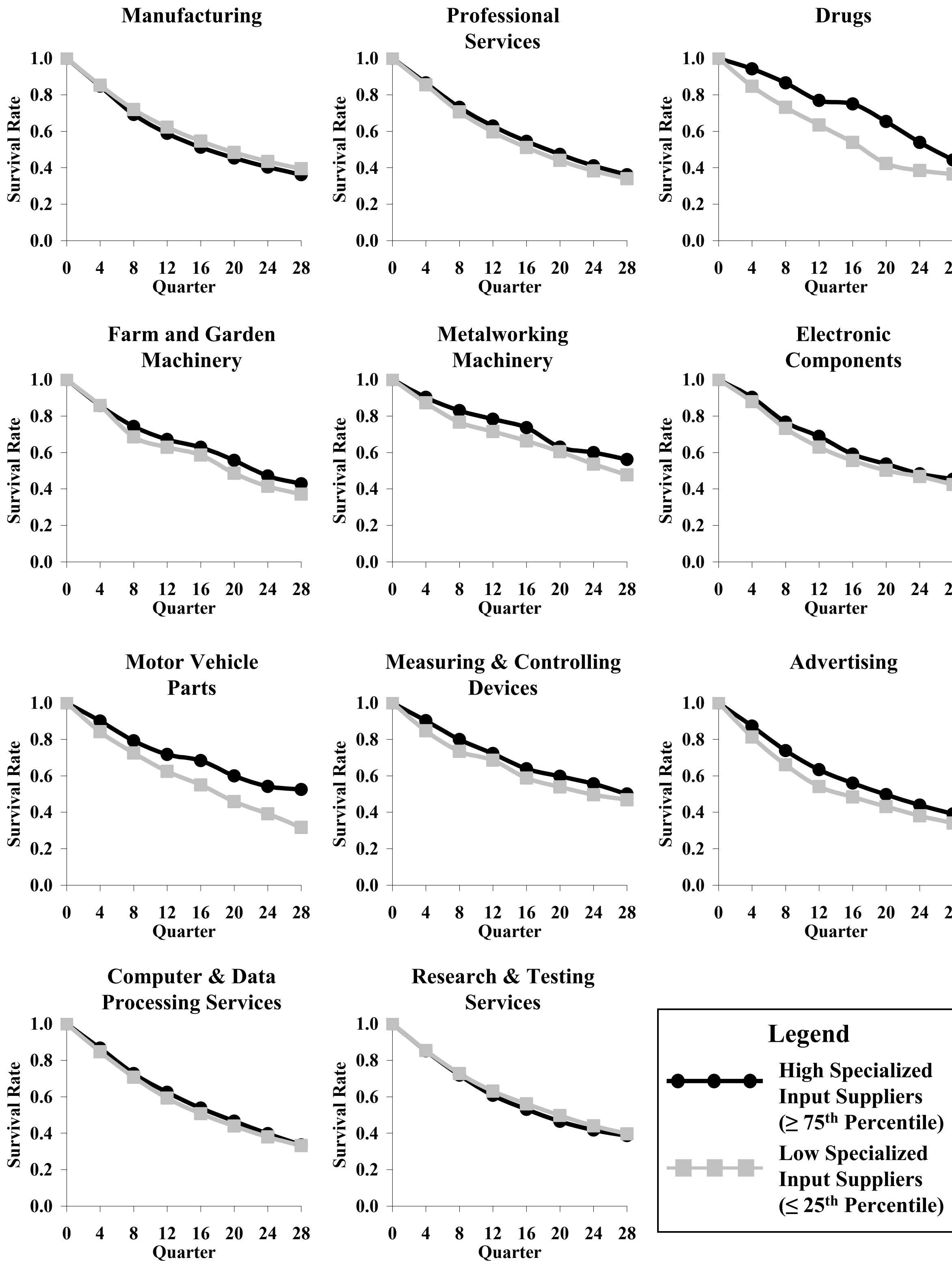




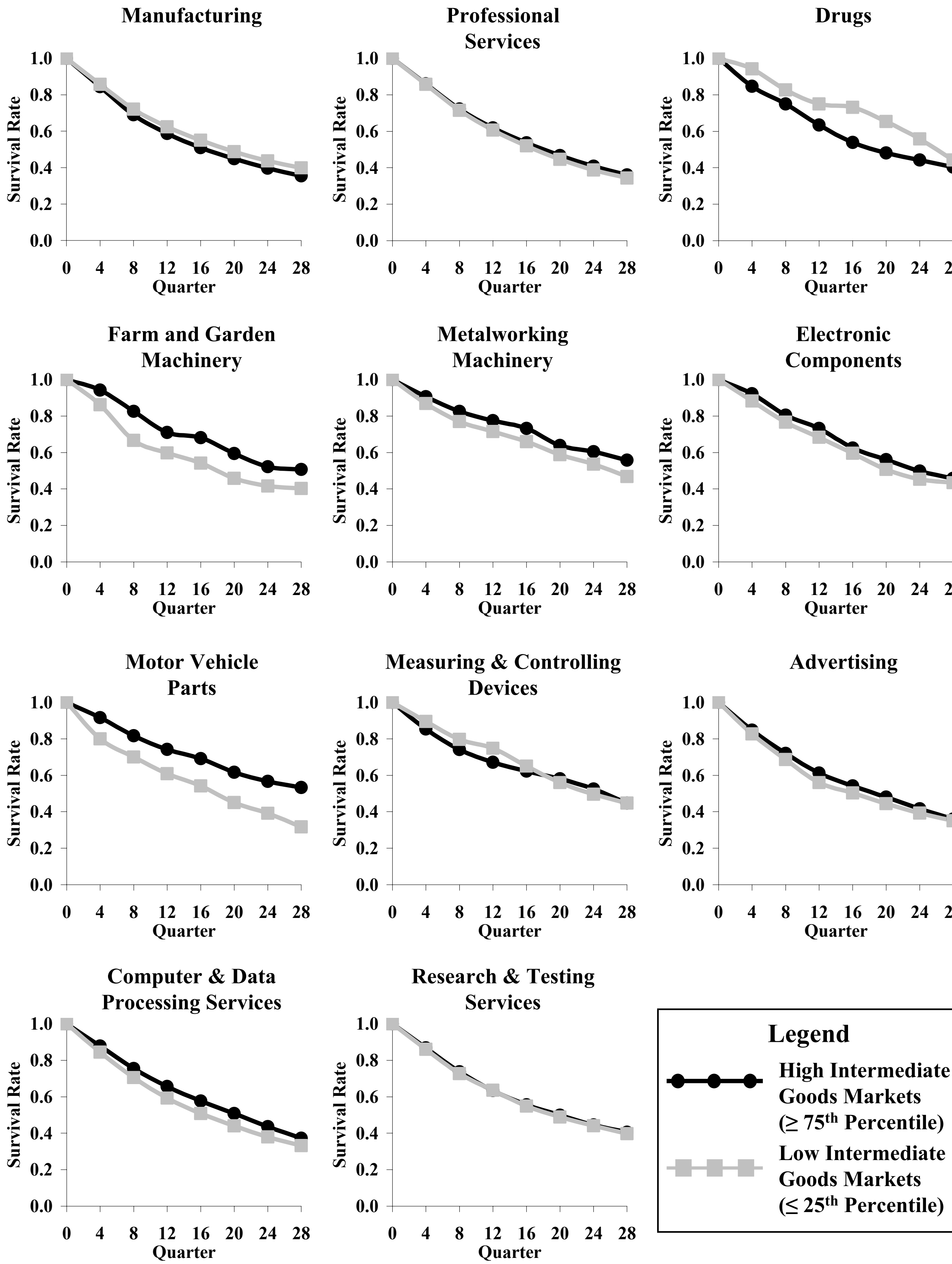
APPENDIX N
Survival Curves, Relative Diversity (80km)



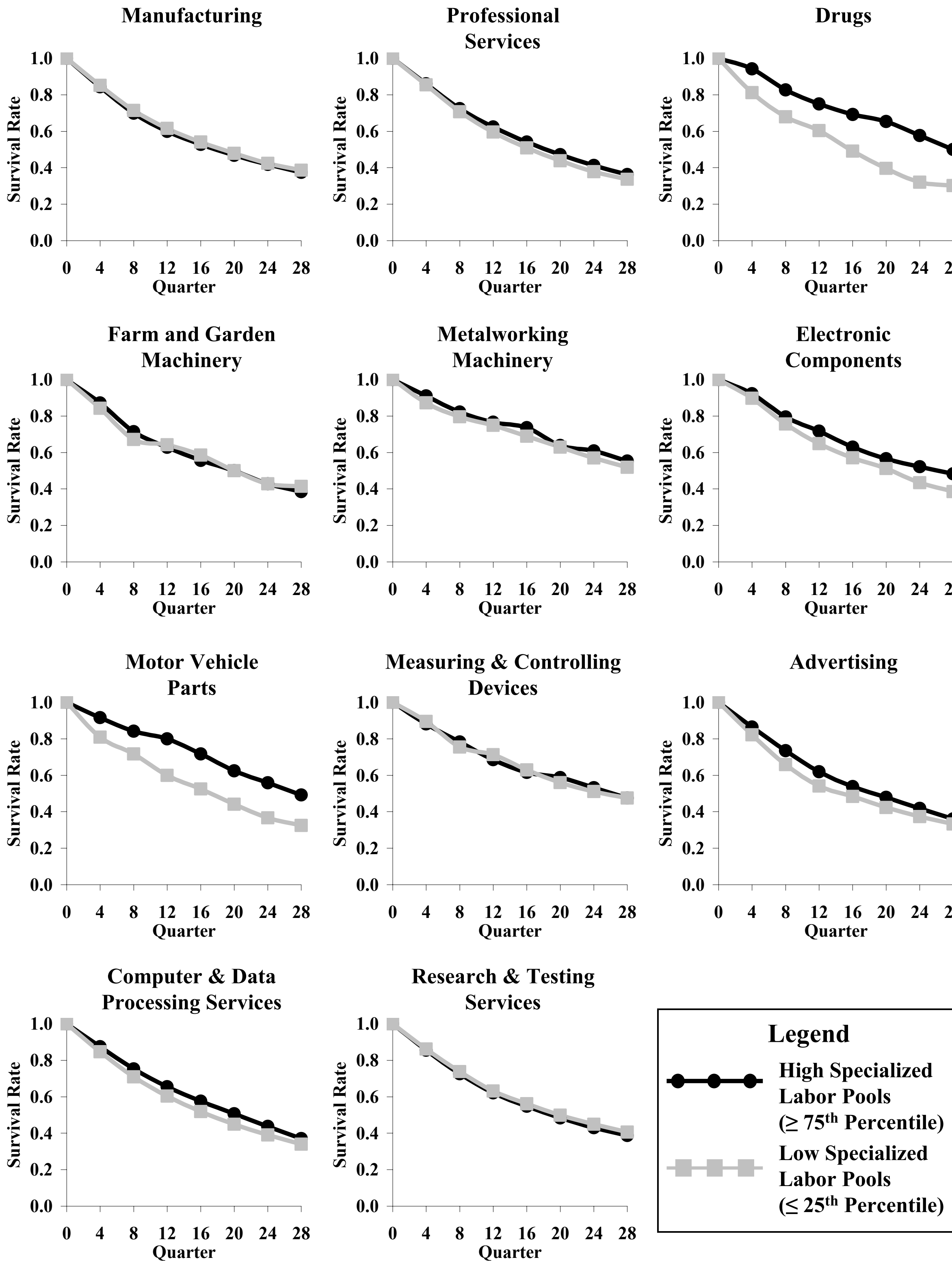
APPENDIX O
Survival Curves, Specialized Input Suppliers (80km)



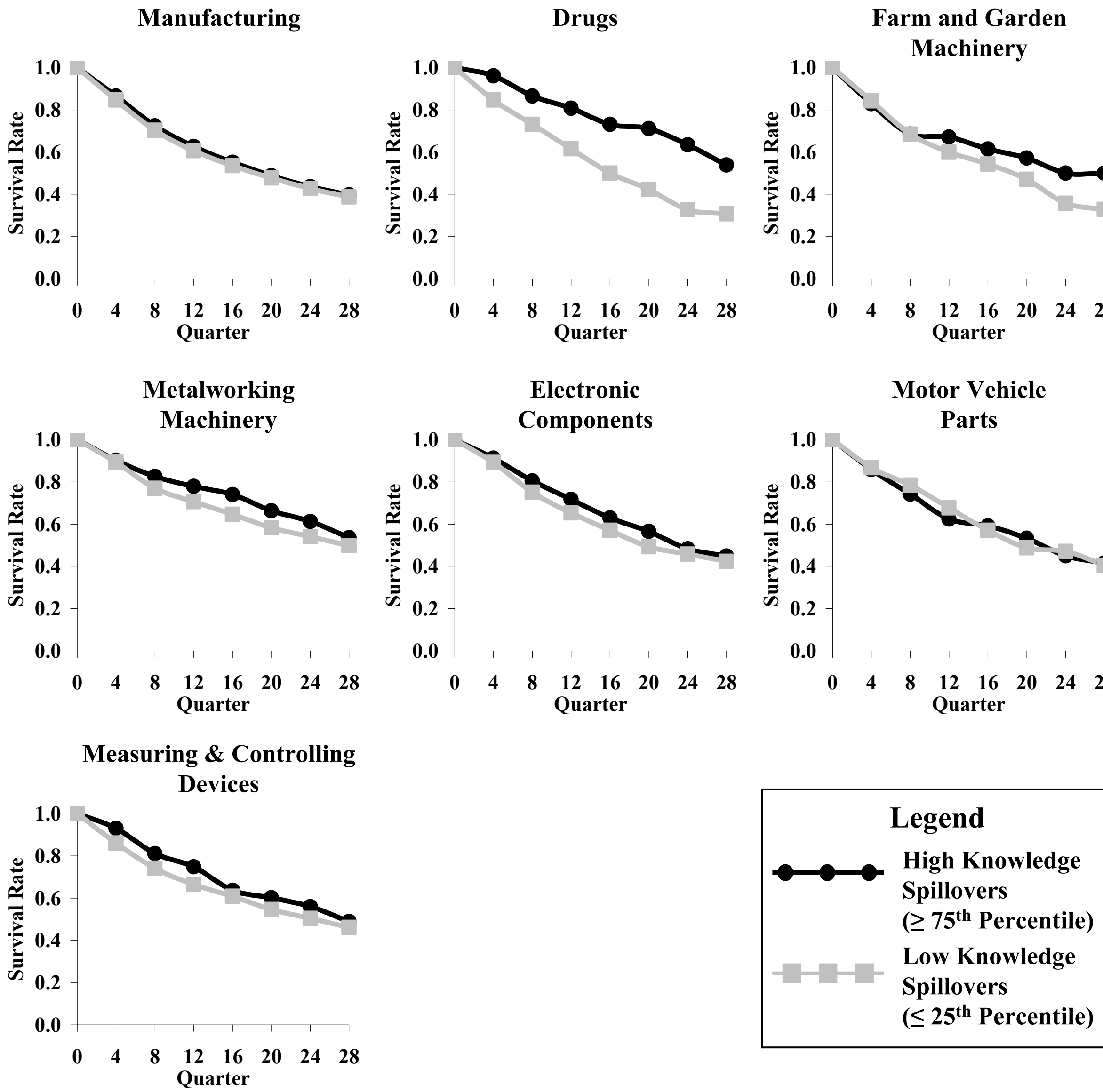
APPENDIX P
Survival Curves, Intermediate Goods Markets (80km)



APPENDIX Q
Survival Curves, Labor Pooling (80km)



APPENDIX R
Survival Curves, Knowledge Spillovers (80km)



APPENDIX S
Event Duration Modeling Results: Sources of External Economies

Manufacturing

	20 km				40 km				80 km				160 km			
Observations	791,461				797,369				807,854				812,387			
-2 LL (null)	244,098				246,097				249,871				251,644			
-2 LL (model)	237,636				239,616				243,262				245,030			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.526	0.00	0.03		-3.525	0.00	0.03		-3.529	0.00	0.03		-3.528	0.00	0.03	
AGE	-0.021	0.00	0.98	0.17	-0.022	0.00	0.98	0.17	-0.022	0.00	0.98	0.17	-0.022	0.00	0.98	0.17
AGE^2	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57
AGE^3	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13
QTR1	-0.227	0.00	0.80	0.65	-0.226	0.00	0.80	0.65	-0.226	0.00	0.80	0.65	-0.225	0.00	0.80	0.65
QTR2	0.014	0.16	1.01	0.65	0.017	0.10	1.02	0.65	0.015	0.14	1.02	0.65	0.014	0.15	1.01	0.65
QTR3	-0.163	0.00	0.85	0.65	-0.162	0.00	0.85	0.65	-0.158	0.00	0.85	0.65	-0.157	0.00	0.85	0.65
MWEST	-0.014	0.16	0.99	0.68	-0.012	0.25	0.99	0.67	-0.005	0.65	1.00	0.64	-0.008	0.47	0.99	0.59
NEAST	-0.155	0.00	0.86	0.82	-0.158	0.00	0.85	0.81	-0.159	0.00	0.85	0.77	-0.154	0.00	0.86	0.61
SOUTH	0.056	0.00	1.06	0.66	0.055	0.00	1.06	0.64	0.050	0.00	1.05	0.64	0.046	0.00	1.05	0.59
SIZE	-0.012	0.00	0.99	0.99	-0.012	0.00	0.99	0.99	-0.012	0.00	0.99	0.99	-0.012	0.00	0.99	0.99
URB	0.011	0.00	1.01	0.69	0.005	0.00	1.00	0.63	0.003	0.00	1.00	0.61	0.001	0.00	1.00	0.50
DIV	0.007	0.63	1.01	0.66	-0.012	0.36	0.99	0.62	-0.048	0.00	0.95	0.64	-0.045	0.00	0.96	0.63
INPUTS	0.008	0.08	1.01	0.55	0.010	0.12	1.01	0.45	0.009	0.31	1.01	0.40	0.020	0.13	1.02	0.40
MARKETS	0.007	0.01	1.01	0.65	0.004	0.21	1.00	0.55	0.006	0.10	1.01	0.40	0.017	0.00	1.02	0.40
LABOR	0.000	0.99	1.00	0.55	0.008	0.16	1.01	0.46	0.005	0.40	1.01	0.44	-0.014	0.08	0.99	0.42
KS	-0.006	0.17	0.99	0.95	-0.006	0.28	0.99	0.93	-0.014	0.09	0.99	0.91	-0.006	0.67	0.99	0.77

Business and Professional Services

	20 km				40 km				80 km				160 km			
Observations	2,315,185				2,315,185				2,315,185				2,315,185			
-2 LL (null)	774,759				774,759				774,759				774,759			
-2 LL (model)	760,534				760,474				760,367				760,356			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.372	0.00	0.03		-3.376	0.00	0.03		-3.383	0.00	0.03		-3.389	0.00	0.03	
AGE	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18
AGE^2	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50
AGE^3	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13
QTR1	-0.254	0.00	0.78	0.66	-0.254	0.00	0.78	0.66	-0.254	0.00	0.78	0.66	-0.254	0.00	0.78	0.66
QTR2	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65
QTR3	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65
MWEST	-0.015	0.01	0.99	0.68	-0.007	0.24	0.99	0.68	0.005	0.46	1.00	0.64	0.012	0.09	1.01	0.53
NEAST	-0.155	0.00	0.86	0.77	-0.179	0.00	0.84	0.65	-0.218	0.00	0.80	0.46	-0.253	0.00	0.78	0.29
SOUTH	0.023	0.00	1.02	0.70	0.028	0.00	1.03	0.69	0.040	0.00	1.04	0.69	0.050	0.00	1.05	0.65
SIZE	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	1.00
URB	0.004	0.00	1.00	0.68	-0.001	0.04	1.00	0.60	0.000	0.28	1.00	0.53	0.000	0.77	1.00	0.37
DIV	-0.005	0.55	1.00	0.80	0.005	0.53	1.00	0.77	-0.011	0.16	0.99	0.72	-0.010	0.24	0.99	0.61
INPUTS	-0.097	0.00	0.91	0.43	-0.118	0.00	0.89	0.48	-0.159	0.00	0.85	0.45	-0.315	0.00	0.73	0.42
MARKETS	-0.043	0.00	0.96	0.81	-0.084	0.00	0.92	0.77	-0.125	0.00	0.88	0.72	-0.100	0.00	0.90	0.69
LABOR	0.029	0.00	1.03	0.46	0.072	0.00	1.07	0.48	0.089	0.00	1.09	0.45	0.142	0.00	1.15	0.36

APPENDIX S (continued)
Event Duration Modeling Results: Sources of External Economies

Drugs

	20 km				40 km				80 km				160 km			
Observations	4,071				4,071				4,071				4,071			
-2 LL (null)	1,047				1,047				1,047				1,047			
-2 LL (model)	1,013				1,015				1,008				1,003			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.681	0.00	0.03		-3.681	0.00	0.03		-3.861	0.00	0.02		-4.043	0.00	0.02	
AGE	-0.025	0.03	0.98	0.99	-0.025	0.03	0.97	0.99	-0.023	0.05	0.98	0.99	-0.022	0.06	0.98	0.99
QTR1	-0.033	0.84	0.97	0.65	-0.033	0.84	0.97	0.65	-0.032	0.85	0.97	0.65	-0.028	0.87	0.97	0.65
QTR2	-0.075	0.65	0.93	0.65	-0.075	0.65	0.93	0.65	-0.077	0.65	0.93	0.65	-0.078	0.64	0.92	0.65
QTR3	-0.342	0.06	0.71	0.65	-0.342	0.06	0.71	0.65	-0.342	0.06	0.71	0.65	-0.344	0.06	0.71	0.65
MWEST	0.301	0.07	1.35	0.75	0.327	0.06	1.39	0.73	0.544	0.01	1.72	0.66	0.776	0.00	2.17	0.55
NEAST	-0.350	0.20	0.70	0.78	-0.371	0.20	0.69	0.57	-0.984	0.01	0.37	0.42	-1.887	0.00	0.15	0.19
SOUTH	0.222	0.28	1.25	0.81	0.199	0.33	1.22	0.76	0.256	0.25	1.29	0.73	0.583	0.03	1.79	0.60
SIZE	-0.007	0.02	0.99	0.88	-0.007	0.02	0.99	0.90	-0.008	0.01	0.99	0.93	-0.008	0.01	0.99	0.93
URB	0.031	0.23	1.03	0.59	0.024	0.10	1.02	0.39	0.018	0.07	1.02	0.32	0.015	0.03	1.02	0.33
DIV	-0.530	0.02	0.59	0.72	-0.403	0.09	0.67	0.68	-0.302	0.23	0.74	0.65	-0.571	0.04	0.57	0.64
INPUTS	0.767	0.21	2.15	0.65	-0.282	0.75	0.75	0.57	-1.257	0.32	0.28	0.36	-0.121	0.93	0.89	0.42
MARKETS	-0.077	0.69	0.93	0.70	0.054	0.87	1.06	0.66	0.485	0.30	1.62	0.60	0.920	0.18	2.51	0.62
LABOR	-0.522	0.20	0.59	0.51	-0.438	0.30	0.65	0.39	0.401	0.25	1.49	0.43	1.659	0.00	5.25	0.29
KS	-0.003	0.96	1.00	0.62	0.006	0.95	1.01	0.71	-0.136	0.29	0.87	0.66	-0.645	0.01	0.52	0.57

Farm and Garden Machinery

	20 km				40 km				80 km				160 km			
Observations	4,469				4,678				4,692				4,736			
-2 LL (null)	1,380				1,434				1,442				1,452			
-2 LL (model)	1,297				1,354				1,362				1,372			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.679	0.00	0.03		-3.675	0.00	0.03		-3.717	0.00	0.02		-3.751	0.00	0.02	
AGE	-0.027	0.01	0.97	0.98	-0.033	0.00	0.97	0.98	-0.033	0.00	0.97	0.98	-0.035	0.00	0.97	0.99
QTR1	-0.632	0.00	0.53	0.66	-0.541	0.00	0.58	0.66	-0.550	0.00	0.58	0.66	-0.557	0.00	0.57	0.66
QTR2	0.190	0.17	1.21	0.66	0.152	0.26	1.16	0.65	0.165	0.22	1.18	0.65	0.159	0.24	1.17	0.65
QTR3	-0.310	0.06	0.73	0.66	-0.326	0.04	0.72	0.66	-0.305	0.05	0.74	0.66	-0.305	0.05	0.74	0.66
MWEST	0.116	0.43	1.12	0.51	0.124	0.41	1.13	0.47	0.226	0.14	1.25	0.47	0.285	0.10	1.33	0.39
NEAST	-0.526	0.10	0.59	0.71	-0.490	0.13	0.61	0.72	-0.446	0.18	0.64	0.66	-0.495	0.17	0.61	0.56
SOUTH	0.354	0.06	1.42	0.55	0.325	0.08	1.38	0.56	0.305	0.10	1.36	0.60	0.314	0.11	1.37	0.54
SIZE	-0.017	0.00	0.98	0.92	-0.018	0.00	0.98	0.91	-0.018	0.00	0.98	0.92	-0.017	0.00	0.98	0.95
URB	0.044	0.25	1.04	0.51	0.042	0.03	1.04	0.50	0.020	0.13	1.02	0.43	0.006	0.41	1.01	0.37
DIV	0.069	0.75	1.07	0.40	-0.113	0.60	0.89	0.36	-0.340	0.12	0.71	0.29	-0.402	0.05	0.67	0.30
INPUTS	-0.275	0.08	0.76	0.67	0.123	0.59	1.13	0.48	-0.579	0.11	0.56	0.43	-0.355	0.45	0.70	0.37
MARKETS	0.002	0.91	1.00	0.84	-0.034	0.13	0.97	0.63	-0.039	0.20	0.96	0.59	-0.080	0.06	0.92	0.40
LABOR	0.009	0.95	1.01	0.83	0.065	0.71	1.07	0.85	0.119	0.51	1.13	0.81	0.104	0.60	1.11	0.71
KS	-0.034	0.34	0.97	0.91	-0.052	0.28	0.95	0.89	-0.063	0.44	0.94	0.91	-0.114	0.56	0.89	0.71

APPENDIX S (continued)
Event Duration Modeling Results: Sources of External Economies

Metalworking Machinery

	20 km				40 km				80 km				160 km			
Observations	20,448				20,448				20,448				20,448			
-2 LL (null)	4,363				4,363				4,363				4,363			
-2 LL (model)	4,248				4,246				4,247				4,244			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-4.220	0.00	0.01		-4.226	0.00	0.01		-4.245	0.00	0.01		-4.260	0.00	0.01	
AGE	0.031	0.03	1.03	0.16	0.031	0.03	1.03	0.16	0.030	0.04	1.03	0.17	0.030	0.03	1.03	0.17
AGE^2	0.003	0.00	1.00	0.81	0.003	0.00	1.00	0.81	0.003	0.00	1.00	0.81	0.003	0.00	1.00	0.81
AGE^3	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15
QTR1	-0.080	0.35	0.92	0.65	-0.079	0.35	0.92	0.65	-0.080	0.34	0.92	0.65	-0.080	0.34	0.92	0.65
QTR2	0.046	0.56	1.05	0.65	0.047	0.55	1.05	0.65	0.047	0.55	1.05	0.65	0.046	0.56	1.05	0.65
QTR3	-0.171	0.05	0.84	0.65	-0.172	0.05	0.84	0.65	-0.172	0.05	0.84	0.65	-0.171	0.05	0.84	0.65
MWEST	0.078	0.29	1.08	0.48	0.092	0.22	1.10	0.44	0.163	0.04	1.18	0.37	0.198	0.03	1.22	0.32
NEAST	-0.069	0.51	0.93	0.53	-0.107	0.33	0.90	0.48	-0.108	0.34	0.90	0.44	-0.124	0.34	0.88	0.41
SOUTH	-0.123	0.27	0.88	0.57	-0.124	0.28	0.88	0.54	-0.137	0.24	0.87	0.48	-0.160	0.19	0.85	0.42
SIZE	-0.040	0.00	0.96	0.98	-0.040	0.00	0.96	0.98	-0.040	0.00	0.96	0.98	-0.040	0.00	0.96	0.98
URB	0.010	0.48	1.01	0.65	0.005	0.40	1.01	0.60	0.006	0.15	1.01	0.55	0.002	0.46	1.00	0.59
DIV	0.032	0.78	1.03	0.64	-0.096	0.37	0.91	0.61	-0.202	0.08	0.82	0.58	-0.135	0.27	0.87	0.59
INPUTS	-0.129	0.23	0.88	0.36	-0.538	0.00	0.58	0.33	-0.584	0.02	0.56	0.35	-0.750	0.01	0.47	0.43
MARKETS	0.068	0.06	1.07	0.41	0.104	0.09	1.11	0.34	0.062	0.50	1.06	0.33	0.105	0.39	1.11	0.36
LABOR	-0.178	0.11	0.84	0.46	0.032	0.78	1.03	0.44	-0.008	0.93	0.99	0.60	-0.090	0.40	0.91	0.48
KS	-0.066	0.14	0.94	0.92	-0.064	0.36	0.94	0.86	-0.091	0.39	0.91	0.74	-0.143	0.35	0.87	0.56

Electronic Components

	20 km				40 km				80 km				160 km			
Observations	15,756				15,759				15,759				15,759			
-2 LL (null)	4,164				4,172				4,172				4,172			
-2 LL (model)	4,045				4,055				4,055				4,055			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.634	0.00	0.03		-3.642	0.00	0.03		-3.639	0.00	0.03		-3.647	0.00	0.03	
AGE	-0.019	0.00	0.98	0.99	-0.019	0.00	0.98	0.99	-0.019	0.00	0.98	0.99	-0.019	0.00	0.98	0.99
QTR1	-0.254	0.01	0.78	0.66	-0.256	0.01	0.77	0.66	-0.256	0.01	0.77	0.66	-0.256	0.00	0.77	0.66
QTR2	0.020	0.80	1.02	0.65	0.017	0.84	1.02	0.65	0.017	0.84	1.02	0.65	0.017	0.84	1.02	0.65
QTR3	-0.289	0.00	0.75	0.65	-0.280	0.00	0.76	0.65	-0.280	0.00	0.76	0.65	-0.280	0.00	0.76	0.65
MWEST	-0.047	0.59	0.95	0.77	-0.025	0.78	0.98	0.73	-0.048	0.60	0.95	0.64	-0.065	0.53	0.94	0.48
NEAST	-0.115	0.35	0.89	0.79	-0.117	0.37	0.89	0.71	-0.086	0.55	0.92	0.57	-0.104	0.56	0.90	0.35
SOUTH	0.253	0.03	1.29	0.80	0.211	0.08	1.23	0.75	0.203	0.10	1.23	0.71	0.213	0.10	1.24	0.64
SIZE	-0.006	0.00	0.99	0.98	-0.006	0.00	0.99	0.98	-0.006	0.00	0.99	0.97	-0.006	0.00	0.99	0.97
URB	0.026	0.07	1.03	0.60	0.004	0.59	1.00	0.63	0.000	0.97	1.00	0.57	0.000	0.94	1.00	0.48
DIV	-0.067	0.59	0.94	0.66	0.010	0.93	1.01	0.62	0.087	0.48	1.09	0.67	0.138	0.35	1.15	0.61
INPUTS	-0.038	0.72	0.96	0.34	-0.083	0.61	0.92	0.29	-0.198	0.45	0.82	0.34	-0.243	0.43	0.78	0.41
MARKETS	0.057	0.26	1.06	0.20	0.119	0.19	1.13	0.12	0.121	0.38	1.13	0.17	0.111	0.60	1.12	0.16
LABOR	-0.049	0.73	0.95	0.48	-0.108	0.44	0.90	0.53	-0.107	0.26	0.90	0.60	-0.097	0.54	0.91	0.49
KS	-0.018	0.38	0.98	0.28	-0.029	0.31	0.97	0.22	-0.022	0.61	0.98	0.28	-0.021	0.76	0.98	0.24

APPENDIX S (continued)
Event Duration Modeling Results: Sources of External Economies

Motor Vehicle Parts

	20 km				40 km				80 km				160 km			
Observations			8,554				8,572				8,572				8,572	
-2 LL (null)			2,619				2,621				2,621				2,621	
-2 LL (model)			2,503				2,497				2,503				2,510	
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.682	0.00	0.03		-3.716	0.00	0.02		-3.722	0.00	0.02		-3.704	0.00	0.02	
AGE	0.029	0.10	1.03	0.18	0.029	0.10	1.03	0.18	0.028	0.11	1.03	0.18	0.028	0.11	1.03	0.18
AGE^2	0.003	0.02	1.00	0.57	0.003	0.02	1.00	0.57	0.003	0.03	1.00	0.57	0.003	0.02	1.00	0.57
AGE^3	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14
QTR1	-0.084	0.43	0.92	0.65	-0.083	0.44	0.92	0.65	-0.085	0.43	0.92	0.65	-0.084	0.43	0.92	0.65
QTR2	-0.280	0.01	0.76	0.65	-0.280	0.01	0.76	0.65	-0.279	0.01	0.76	0.65	-0.279	0.01	0.76	0.65
QTR3	-0.316	0.01	0.73	0.65	-0.318	0.01	0.73	0.65	-0.317	0.01	0.73	0.65	-0.317	0.01	0.73	0.65
MWEST	0.102	0.34	1.11	0.57	0.135	0.21	1.14	0.54	0.166	0.17	1.18	0.46	0.123	0.36	1.13	0.42
NEAST	-0.169	0.40	0.84	0.86	-0.195	0.34	0.82	0.82	-0.307	0.16	0.74	0.76	-0.316	0.20	0.73	0.61
SOUTH	-0.105	0.41	0.90	0.57	-0.116	0.37	0.89	0.55	-0.038	0.78	0.96	0.46	-0.005	0.97	1.00	0.40
SIZE	-0.006	0.00	0.99	0.88	-0.006	0.00	0.99	0.90	-0.006	0.00	0.99	0.87	-0.006	0.00	0.99	0.84
URB	0.005	0.79	1.00	0.60	-0.002	0.76	1.00	0.56	-0.003	0.55	1.00	0.48	-0.001	0.83	1.00	0.41
DIV	0.018	0.89	1.02	0.54	0.079	0.56	1.08	0.55	0.173	0.24	1.19	0.54	0.067	0.67	1.07	0.53
INPUTS	-0.044	0.73	0.96	0.57	0.024	0.91	1.02	0.39	-0.396	0.17	0.67	0.45	-0.200	0.53	0.82	0.55
MARKETS	-0.052	0.24	0.95	0.73	-0.126	0.06	0.88	0.63	-0.190	0.05	0.83	0.47	-0.246	0.11	0.78	0.29
LABOR	-0.040	0.79	0.96	0.59	-0.025	0.90	0.98	0.36	0.189	0.35	1.21	0.32	0.200	0.43	1.22	0.20
KS	-0.150	0.04	0.86	0.85	-0.232	0.03	0.79	0.80	-0.147	0.28	0.86	0.53	-0.107	0.57	0.90	0.31

Measuring and Controlling Devices

	20 km				40 km				80 km				160 km			
Observations			11,833				11,833				11,833				11,833	
-2 LL (null)			2,884				2,884				2,884				2,884	
-2 LL (model)			2,822				2,825				2,826				2,823	
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**	**tol**
INT	-3.740	0.00	0.02		-3.753	0.00	0.02		-3.756	0.00	0.02		-3.767	0.00	0.02	
AGE	-0.017	0.01	0.98	0.99	-0.017	0.01	0.98	0.99	-0.017	0.01	0.98	0.99	-0.017	0.01	0.98	0.99
QTR1	-0.229	0.04	0.80	0.65	-0.228	0.04	0.80	0.65	-0.228	0.04	0.80	0.65	-0.228	0.04	0.80	0.65
QTR2	0.036	0.71	1.04	0.65	0.035	0.72	1.04	0.65	0.035	0.72	1.04	0.65	0.035	0.72	1.04	0.65
QTR3	-0.257	0.02	0.77	0.65	-0.257	0.02	0.77	0.65	-0.257	0.02	0.77	0.65	-0.256	0.02	0.77	0.65
MWEST	0.027	0.79	1.03	0.71	0.031	0.75	1.03	0.71	0.043	0.67	1.04	0.66	0.034	0.76	1.04	0.54
NEAST	-0.210	0.16	0.81	0.75	-0.266	0.09	0.77	0.72	-0.287	0.09	0.75	0.61	-0.353	0.10	0.70	0.39
SOUTH	0.171	0.15	1.19	0.71	0.145	0.22	1.16	0.71	0.151	0.22	1.16	0.66	0.204	0.13	1.23	0.58
SIZE	-0.009	0.00	0.99	0.97	-0.009	0.00	0.99	0.96	-0.009	0.00	0.99	0.96	-0.009	0.00	0.99	0.96
URB	0.013	0.54	1.01	0.61	-0.005	0.55	0.99	0.72	-0.002	0.74	1.00	0.66	-0.003	0.43	1.00	0.47
DIV	-0.171	0.28	0.84	0.64	-0.136	0.32	0.87	0.73	-0.150	0.28	0.86	0.67	-0.048	0.75	0.95	0.64
INPUTS	-0.250	0.07	0.78	0.37	-0.145	0.32	0.87	0.48	-0.135	0.46	0.87	0.58	-0.260	0.20	0.77	0.69
MARKETS	0.000	1.00	1.00	0.64	0.050	0.31	1.05	0.63	0.045	0.47	1.05	0.76	0.250	0.10	1.28	0.70
LABOR	-0.069	0.73	0.93	0.58	0.132	0.46	1.14	0.62	0.115	0.28	1.12	0.71	0.299	0.10	1.35	0.55
KS	0.101	0.01	1.11	0.39	0.004	0.91	1.00	0.45	0.007	0.91	1.01	0.49	-0.012	0.90	0.99	0.46

APPENDIX S (continued)
Event Duration Modeling Results: Sources of External Economies

Advertising

	20 km				40 km				80 km				160 km			
Observations	66,168				66,168				66,168				66,168			
-2 LL (null)	21,549				21,549				21,549				21,549			
-2 LL (model)	21,030				21,023				21,024				21,024			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	
INT	-3.501	0.00	0.03		-3.512	0.00	0.03		-3.512	0.00	0.03		-3.518	0.00	0.03	
AGE	-0.031	0.00	0.97	0.87	-0.031	0.00	0.97	0.87	-0.031	0.00	0.97	0.87	-0.031	0.00	0.97	0.87
AGE^2	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87
QTR1	-0.193	0.00	0.82	0.65	-0.193	0.00	0.82	0.65	-0.193	0.00	0.82	0.65	-0.193	0.00	0.82	0.65
QTR2	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65
QTR3	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65
MWEST	-0.057	0.11	0.94	0.64	-0.032	0.38	0.97	0.64	-0.018	0.64	0.98	0.57	-0.007	0.89	0.99	0.44
NEAST	-0.203	0.00	0.82	0.67	-0.260	0.00	0.77	0.55	-0.256	0.00	0.77	0.36	-0.300	0.00	0.74	0.22
SOUTH	0.065	0.07	1.07	0.68	0.076	0.04	1.08	0.68	0.070	0.09	1.07	0.65	0.089	0.05	1.09	0.56
SIZE	-0.032	0.00	0.97	0.98	-0.032	0.00	0.97	0.98	-0.032	0.00	0.97	0.99	-0.032	0.00	0.97	0.99
URB	0.004	0.52	1.00	0.54	0.000	0.88	1.00	0.46	0.000	0.81	1.00	0.37	0.000	0.75	1.00	0.27
DIV	-0.010	0.85	0.99	0.71	-0.038	0.46	0.96	0.65	-0.106	0.04	0.90	0.57	-0.084	0.13	0.92	0.55
INPUTS	-0.284	0.03	0.75	0.32	-0.355	0.01	0.70	0.35	-0.212	0.24	0.81	0.31	-0.498	0.03	0.61	0.30
MARKETS	-0.002	0.98	1.00	0.57	0.030	0.81	1.03	0.51	0.095	0.57	1.10	0.42	0.325	0.12	1.38	0.38
LABOR	0.044	0.37	1.05	0.49	0.090	0.02	1.09	0.47	0.075	0.12	1.08	0.31	0.118	0.10	1.13	0.28

Computer and Data Processing Services

	20 km				40 km				80 km				160 km			
Observations	366,116				366,116				366,116				366,116			
-2 LL (null)	119,645				119,645				119,645				119,645			
-2 LL (model)	117,708				117,640				117,618				117,602			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.502	0.00	0.03		-3.507	0.00	0.03		-3.504	0.00	0.03		-3.498	0.00	0.03	
AGE	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13
AGE^2	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08
AGE^3	0.000	0.66	1.00	0.06	0.000	0.65	1.00	0.06	0.000	0.64	1.00	0.06	0.000	0.65	1.00	0.06
AGE^4	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05
QTR1	-0.161	0.00	0.85	0.65	-0.161	0.00	0.85	0.65	-0.161	0.00	0.85	0.65	-0.161	0.00	0.85	0.65
QTR2	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64
QTR3	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65
MWEST	-0.026	0.08	0.97	0.67	-0.014	0.39	0.99	0.64	-0.025	0.15	0.98	0.58	-0.038	0.06	0.96	0.45
NEAST	-0.174	0.00	0.84	0.75	-0.188	0.00	0.83	0.61	-0.154	0.00	0.86	0.39	-0.106	0.01	0.90	0.21
SOUTH	0.020	0.21	1.02	0.71	0.012	0.46	1.01	0.71	0.000	0.99	1.00	0.73	-0.001	0.97	1.00	0.66
SIZE	-0.016	0.00	0.98	0.99	-0.016	0.00	0.98	0.99	-0.016	0.00	0.98	0.99	-0.016	0.00	0.98	0.99
URB	-0.003	0.22	1.00	0.79	-0.007	0.00	0.99	0.68	-0.004	0.00	1.00	0.53	-0.003	0.00	1.00	0.31
DIV	-0.035	0.11	0.97	0.83	-0.037	0.07	0.96	0.83	-0.078	0.00	0.93	0.80	-0.071	0.00	0.93	0.62
INPUTS	-0.082	0.01	0.92	0.26	-0.153	0.00	0.86	0.31	-0.099	0.06	0.91	0.24	-0.242	0.00	0.79	0.22
MARKETS	0.075	0.05	1.08	0.44	0.063	0.27	1.06	0.35	0.045	0.57	1.05	0.24	0.209	0.03	1.23	0.25
LABOR	0.018	0.43	1.02	0.32	0.097	0.00	1.10	0.38	0.059	0.00	1.06	0.43	0.085	0.00	1.09	0.29

APPENDIX S (continued)
Event Duration Modeling Results: Sources of External Economies
Research and Testing Services

	20 km				40 km				80 km				160 km			
Observations	67,305				67,305				67,305				67,305			
-2 LL (null)	20,398				20,398				20,398				20,398			
-2 LL (model)	19,803				19,803				19,799				19,795			
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**		**b**	**Pr > X^2**	**exp b**		**b**	**Pr > X^2**	**exp b**	
INT	-3.605	0.00	0.03		-3.606	0.00	0.03		-3.600	0.00	0.03		-3.612	0.00	0.03	
AGE	-0.016	0.02	0.98	0.17	-0.016	0.02	0.98	0.17	-0.016	0.01	0.98	0.17	-0.015	0.02	0.98	0.17
AGE^2	0.001	0.11	1.00	0.62	0.001	0.11	1.00	0.62	0.001	0.12	1.00	0.62	0.001	0.11	1.00	0.62
AGE^3	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14
QTR1	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65
QTR2	0.095	0.01	1.10	0.65	0.095	0.01	1.10	0.65	0.095	0.01	1.10	0.65	0.095	0.01	1.10	0.65
QTR3	-0.191	0.00	0.83	0.65	-0.191	0.00	0.83	0.65	-0.191	0.00	0.83	0.65	-0.191	0.00	0.83	0.65
MWEST	0.004	0.91	1.00	0.75	0.010	0.80	1.01	0.75	0.011	0.79	1.01	0.71	0.042	0.39	1.04	0.56
NEAST	-0.138	0.01	0.87	0.83	-0.136	0.01	0.87	0.68	-0.105	0.13	0.90	0.46	-0.192	0.04	0.83	0.25
SOUTH	-0.024	0.55	0.98	0.77	-0.035	0.40	0.97	0.76	-0.047	0.29	0.95	0.77	0.003	0.94	1.00	0.70
SIZE	-0.023	0.00	0.98	0.99	-0.023	0.00	0.98	0.99	-0.023	0.00	0.98	0.99	-0.023	0.00	0.98	0.99
URB	0.004	0.49	1.00	0.66	0.000	0.92	1.00	0.65	0.000	0.94	1.00	0.54	0.000	0.83	1.00	0.34
DIV	-0.040	0.42	0.96	0.81	-0.046	0.33	0.95	0.75	-0.119	0.02	0.89	0.66	-0.141	0.02	0.87	0.56
INPUTS	0.024	0.77	1.02	0.39	0.070	0.47	1.07	0.39	0.198	0.15	1.22	0.33	0.014	0.94	1.01	0.27
MARKETS	0.026	0.71	1.03	0.65	0.047	0.63	1.05	0.58	-0.067	0.65	0.93	0.42	0.055	0.77	1.06	0.41
LABOR	0.029	0.50	1.03	0.53	0.024	0.63	1.02	0.55	0.000	0.99	1.00	0.51	0.097	0.17	1.10	0.36

APPENDIX T
Event Duration Model Results
Sources of External Economies w/ Regional Controls

Manufacturing

	20 km				40 km				80 km				160 km			
Observations	791,461				797,369				807,854				812,387			
-2 LL (null)	244,098				246,097				249,871				251,644			
-2 LL (model)	237,626				239,604				243,243				245,015			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.525	0.00	0.03		-3.524	0.00	0.03		-3.528	0.00	0.03		-3.526	0.00	0.03	
AGE	-0.021	0.00	0.98	0.17	-0.022	0.00	0.98	0.17	-0.022	0.00	0.98	0.17	-0.022	0.00	0.98	0.17
AGE^2	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57	0.001	0.00	1.00	0.57
AGE^3	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13
QTR1	-0.227	0.00	0.80	0.65	-0.226	0.00	0.80	0.65	-0.226	0.00	0.80	0.65	-0.225	0.00	0.80	0.65
QTR2	0.014	0.16	1.01	0.65	0.017	0.10	1.02	0.65	0.015	0.14	1.02	0.65	0.014	0.15	1.01	0.65
QTR3	-0.163	0.00	0.85	0.65	-0.162	0.00	0.85	0.65	-0.158	0.00	0.85	0.65	-0.157	0.00	0.85	0.65
MWEST	-0.013	0.20	0.99	0.65	-0.011	0.27	0.99	0.62	0.001	0.93	1.00	0.57	-0.006	0.63	0.99	0.47
NEAST	-0.152	0.00	0.86	0.77	-0.151	0.00	0.86	0.72	-0.153	0.00	0.86	0.66	-0.143	0.00	0.87	0.51
SOUTH	0.056	0.00	1.06	0.65	0.055	0.00	1.06	0.63	0.053	0.00	1.05	0.59	0.052	0.00	1.05	0.50
SIZE	-0.012	0.00	0.99	0.99	-0.012	0.00	0.99	0.99	-0.012	0.00	0.99	0.99	-0.011	0.00	0.99	0.99
URB	0.012	0.00	1.01	0.47	0.006	0.00	1.01	0.40	0.003	0.00	1.00	0.39	0.002	0.00	1.00	0.34
DIV	0.004	0.84	1.00	0.42	-0.008	0.61	0.99	0.41	-0.060	0.00	0.94	0.48	-0.052	0.00	0.95	0.46
INPUTS	0.010	0.04	1.01	0.53	0.011	0.09	1.01	0.43	0.014	0.11	1.01	0.38	0.025	0.05	1.03	0.39
MARKETS	0.007	0.01	1.01	0.64	0.005	0.14	1.00	0.54	0.007	0.08	1.01	0.40	0.018	0.00	1.02	0.40
LABOR	0.000	0.98	1.00	0.55	0.008	0.17	1.01	0.45	0.004	0.50	1.00	0.43	-0.017	0.04	0.98	0.41
KS	-0.009	0.07	0.99	0.86	-0.009	0.17	0.99	0.82	-0.023	0.01	0.98	0.80	-0.017	0.24	0.98	0.67
UNIV	-0.015	0.15	0.99	0.61	-0.013	0.10	0.99	0.50	-0.004	0.49	1.00	0.42	-0.010	0.02	0.99	0.35
LG SH	0.000	0.81	1.00	0.46	0.002	0.11	1.00	0.51	0.001	0.57	1.00	0.61	-0.001	0.81	1.00	0.58
BACH	0.002	0.07	1.00	0.61	0.002	0.04	1.00	0.51	0.006	0.00	1.01	0.43	0.006	0.01	1.01	0.42
POPGR	0.001	0.11	1.00	0.82	0.001	0.11	1.00	0.76	0.001	0.11	1.00	0.71	0.001	0.28	1.00	0.62

Business and Professional Services

	20 km				40 km				80 km				160 km			
Observations	2,315,185				2,315,185				2,315,185				2,315,185			
-2 LL (null)	774,759				774,759				774,759				774,759			
-2 LL (model)	760,490				760,374				760,144				760,172			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.372	0.00	0.03		-3.377	0.00	0.03		-3.385	0.00	0.03		-3.389	0.00	0.03	
AGE	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18	-0.013	0.00	0.99	0.18
AGE^2	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.50
AGE^3	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13	0.000	0.00	1.00	0.13
QTR1	-0.254	0.00	0.78	0.66	-0.254	0.00	0.78	0.66	-0.254	0.00	0.78	0.66	-0.254	0.00	0.78	0.66
QTR2	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65	0.068	0.00	1.07	0.65
QTR3	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65	-0.203	0.00	0.82	0.65
MWEST	-0.013	0.03	0.99	0.65	0.001	0.82	1.00	0.64	0.021	0.00	1.02	0.52	0.031	0.00	1.03	0.41
NEAST	-0.156	0.00	0.86	0.71	-0.179	0.00	0.84	0.63	-0.216	0.00	0.81	0.44	-0.241	0.00	0.79	0.28
SOUTH	0.026	0.00	1.03	0.68	0.031	0.00	1.03	0.67	0.042	0.00	1.04	0.64	0.045	0.00	1.05	0.55
SIZE	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	1.00
URB	0.008	0.00	1.01	0.37	0.002	0.00	1.00	0.28	0.003	0.00	1.00	0.21	0.003	0.00	1.00	0.14
DIV	-0.025	0.01	0.98	0.56	-0.027	0.00	0.97	0.59	-0.051	0.00	0.95	0.60	-0.053	0.00	0.95	0.45
INPUTS	-0.131	0.00	0.88	0.29	-0.203	0.00	0.82	0.26	-0.270	0.00	0.76	0.21	-0.389	0.00	0.68	0.21
MARKETS	-0.038	0.00	0.96	0.77	-0.065	0.00	0.94	0.75	-0.097	0.00	0.91	0.64	-0.064	0.02	0.94	0.57
LABOR	0.024	0.01	1.02	0.41	0.069	0.00	1.07	0.45	0.086	0.00	1.09	0.43	0.130	0.00	1.14	0.33
UNIV	-0.022	0.00	0.98	0.48	-0.022	0.00	0.98	0.33	-0.027	0.00	0.97	0.24	-0.019	0.00	0.98	0.17
LG SH	-0.002	0.01	1.00	0.49	-0.005	0.00	0.99	0.50	-0.012	0.00	0.99	0.56	-0.020	0.00	0.98	0.55
BACH	0.001	0.01	1.00	0.38	0.003	0.00	1.00	0.33	0.005	0.00	1.01	0.27	0.005	0.00	1.00	0.24
POPGR	0.000	0.08	1.00	0.80	0.000	0.63	1.00	0.99	0.000	0.49	1.00	0.65	0.001	0.01	1.00	0.46

APPENDIX T (continued)
Event Duration Model Results
Sources of External Economies w/ Regional Controls

Drugs

	20 km				40 km				80 km				160 km			
Observations		4,071				4,071				4,071				4,071		
-2 LL (null)		1,047				1,047				1,047				1,047		
-2 LL (model)		1,007				1,011				1,003				998		
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.672	0.00	0.03		-3.674	0.00	0.03		-3.860	0.00	0.02		-4.056	0.00	0.02	
AGE	-0.023	0.05	0.98	0.99	-0.024	0.04	0.98	0.99	-0.021	0.08	0.98	0.98	-0.021	0.08	0.98	0.99
QTR1	-0.031	0.85	0.97	0.65	-0.032	0.85	0.97	0.65	-0.034	0.84	0.97	0.65	-0.025	0.88	0.98	0.65
QTR2	-0.079	0.64	0.92	0.65	-0.077	0.64	0.93	0.65	-0.078	0.64	0.92	0.65	-0.080	0.63	0.92	0.65
QTR3	-0.341	0.07	0.71	0.65	-0.341	0.07	0.71	0.65	-0.339	0.07	0.71	0.65	-0.345	0.06	0.71	0.65
MWEST	0.365	0.03	1.44	0.66	0.281	0.11	1.32	0.69	0.455	0.04	1.58	0.52	0.884	0.01	2.42	0.44
NEAST	-0.354	0.19	0.70	0.73	-0.321	0.26	0.73	0.54	-0.946	0.02	0.39	0.42	-2.090	0.01	0.12	0.14
SOUTH	0.267	0.20	1.31	0.71	0.249	0.23	1.28	0.69	0.321	0.17	1.38	0.62	0.771	0.01	2.16	0.49
SIZE	-0.007	0.02	0.99	0.84	-0.007	0.02	0.99	0.89	-0.008	0.01	0.99	0.92	-0.009	0.01	0.99	0.92
URB	0.088	0.03	1.09	0.27	0.045	0.02	1.05	0.19	0.025	0.15	1.03	0.08	0.040	0.02	1.04	0.05
DIV	-0.641	0.02	0.53	0.51	-0.453	0.09	0.64	0.53	-0.207	0.49	0.81	0.45	-0.736	0.04	0.48	0.30
INPUTS	0.353	0.61	1.42	0.52	-0.258	0.79	0.77	0.49	-0.547	0.70	0.58	0.24	-1.642	0.39	0.19	0.25
MARKETS	-0.021	0.92	0.98	0.62	0.108	0.77	1.11	0.56	0.066	0.91	1.07	0.41	0.765	0.44	2.15	0.30
LABOR	-1.067	0.03	0.34	0.34	-0.508	0.29	0.60	0.30	0.569	0.11	1.77	0.35	1.755	0.01	5.78	0.21
KS	0.015	0.85	1.02	0.51	0.039	0.68	1.04	0.50	-0.022	0.90	0.98	0.31	-0.237	0.53	0.79	0.19
UNIV	-0.251	0.13	0.78	0.42	-0.226	0.06	0.80	0.30	-0.129	0.38	0.88	0.10	-0.227	0.08	0.80	0.06
LG SH	-0.002	0.89	1.00	0.46	0.000	1.00	1.00	0.57	0.086	0.07	1.09	0.43	0.111	0.34	1.12	0.28
BACH	0.031	0.05	1.03	0.34	0.018	0.46	1.02	0.34	-0.005	0.89	0.99	0.20	0.032	0.54	1.03	0.21
POPGR	0.002	0.70	1.00	0.74	-0.002	0.79	1.00	0.73	-0.010	0.38	0.99	0.48	-0.006	0.70	0.99	0.25

Farm and Garden Machinery

	20 km				40 km				80 km				160 km			
Observations		4,469				4,678				4,692				4,736		
-2 LL (null)		1,380				1,434				1,442				1,452		
-2 LL (model)		1,289				1,350				1,359				1,363		
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.674	0.00	0.03		-3.651	0.00	0.03		-3.698	0.00	0.02		-3.605	0.00	0.03	
AGE	-0.024	0.02	0.98	0.97	-0.032	0.00	0.97	0.98	-0.032	0.00	0.97	0.98	-0.032	0.00	0.97	0.98
QTR1	-0.631	0.00	0.53	0.66	-0.542	0.00	0.58	0.66	-0.548	0.00	0.58	0.66	-0.556	0.00	0.57	0.66
QTR2	0.187	0.18	1.21	0.66	0.151	0.27	1.16	0.65	0.166	0.22	1.18	0.65	0.157	0.24	1.17	0.65
QTR3	-0.316	0.05	0.73	0.66	-0.327	0.04	0.72	0.66	-0.306	0.05	0.74	0.66	-0.306	0.05	0.74	0.66
MWEST	0.076	0.62	1.08	0.48	0.040	0.80	1.04	0.40	0.145	0.39	1.16	0.36	0.039	0.85	1.04	0.33
NEAST	-0.501	0.12	0.61	0.70	-0.517	0.12	0.60	0.65	-0.501	0.15	0.61	0.52	0.068	0.88	1.07	0.19
SOUTH	0.288	0.15	1.33	0.51	0.385	0.04	1.47	0.53	0.384	0.05	1.47	0.55	0.073	0.76	1.08	0.41
SIZE	-0.016	0.00	0.98	0.91	-0.017	0.00	0.98	0.89	-0.018	0.00	0.98	0.90	-0.018	0.00	0.98	0.92
URB	-0.002	0.97	1.00	0.39	0.030	0.18	1.03	0.41	0.023	0.15	1.02	0.37	0.016	0.08	1.02	0.22
DIV	0.142	0.62	1.15	0.27	-0.141	0.60	0.87	0.21	-0.393	0.14	0.68	0.20	-0.348	0.16	0.71	0.21
INPUTS	-0.274	0.09	0.76	0.64	0.187	0.44	1.21	0.43	-0.546	0.17	0.58	0.36	-0.798	0.15	0.45	0.27
MARKETS	0.000	0.99	1.00	0.84	-0.037	0.11	0.96	0.61	-0.046	0.15	0.96	0.57	-0.066	0.13	0.94	0.37
LABOR	0.061	0.70	1.06	0.76	0.170	0.38	1.19	0.70	0.186	0.33	1.20	0.72	-0.001	1.00	1.00	0.66
KS	-0.046	0.21	0.95	0.80	-0.054	0.25	0.95	0.86	-0.085	0.32	0.92	0.86	-0.160	0.41	0.85	0.67
UNIV	0.749	0.01	2.12	0.68	0.240	0.34	1.27	0.58	-0.130	0.35	0.88	0.64	-0.170	0.04	0.84	0.12
LG SH	0.006	0.47	1.01	0.52	0.004	0.76	1.00	0.58	-0.010	0.71	0.99	0.65	-0.050	0.35	0.95	0.52
BACH	0.008	0.63	1.01	0.60	0.020	0.41	1.02	0.30	0.030	0.33	1.03	0.28	-0.025	0.51	0.98	0.30
POPGR	-0.004	0.35	1.00	0.93	-0.007	0.29	0.99	0.66	-0.014	0.17	0.99	0.48	-0.019	0.14	0.98	0.52

APPENDIX T (continued)
Event Duration Model Results
Sources of External Economies w/ Regional Controls

Metalworking Machinery

	20 km				40 km				80 km				160 km			
Observations	20,448				20,448				20,448				20,448			
-2 LL (null)	4,363				4,363				4,363				4,363			
-2 LL (model)	4,243				4,243				4,242				4,241			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-4.231	0.00	0.01		-4.236	0.00	0.01		-4.272	0.00	0.01		-4.275	0.00	0.01	
AGE	0.031	0.03	1.03	0.16	0.031	0.03	1.03	0.16	0.031	0.03	1.03	0.16	0.031	0.03	1.03	0.16
AGE^2	0.003	0.00	1.00	0.81	0.003	0.00	1.00	0.81	0.003	0.00	1.00	0.81	0.003	0.00	1.00	0.81
AGE^3	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15	0.000	0.00	1.00	0.15
QTR1	-0.079	0.35	0.92	0.65	-0.079	0.35	0.92	0.65	-0.080	0.34	0.92	0.65	-0.080	0.34	0.92	0.65
QTR2	0.047	0.56	1.05	0.65	0.047	0.55	1.05	0.65	0.047	0.55	1.05	0.65	0.046	0.56	1.05	0.65
QTR3	-0.172	0.05	0.84	0.65	-0.172	0.05	0.84	0.65	-0.172	0.05	0.84	0.65	-0.171	0.05	0.84	0.65
MWEST	0.094	0.21	1.10	0.45	0.104	0.19	1.11	0.39	0.222	0.01	1.25	0.32	0.237	0.02	1.27	0.29
NEAST	-0.007	0.95	0.99	0.46	-0.077	0.52	0.93	0.40	-0.096	0.44	0.91	0.36	-0.192	0.20	0.83	0.33
SOUTH	-0.166	0.15	0.85	0.56	-0.151	0.20	0.86	0.54	-0.167	0.17	0.85	0.48	-0.118	0.37	0.89	0.39
SIZE	-0.041	0.00	0.96	0.97	-0.041	0.00	0.96	0.97	-0.041	0.00	0.96	0.98	-0.040	0.00	0.96	0.98
URB	0.021	0.16	1.02	0.53	0.009	0.20	1.01	0.43	0.005	0.33	1.00	0.38	-0.001	0.80	1.00	0.35
DIV	0.185	0.22	1.20	0.36	-0.001	1.00	1.00	0.36	-0.234	0.07	0.79	0.46	-0.175	0.21	0.84	0.45
INPUTS	-0.150	0.16	0.86	0.35	-0.601	0.00	0.55	0.32	-0.666	0.01	0.51	0.32	-0.690	0.02	0.50	0.37
MARKETS	0.069	0.06	1.07	0.40	0.094	0.13	1.10	0.33	0.001	0.99	1.00	0.29	0.140	0.37	1.15	0.22
LABOR	-0.200	0.08	0.82	0.44	0.025	0.84	1.03	0.42	0.003	0.98	1.00	0.57	-0.093	0.40	0.91	0.41
KS	-0.024	0.64	0.98	0.69	0.018	0.84	1.02	0.56	0.005	0.97	1.00	0.40	-0.196	0.34	0.82	0.31
UNIV	-0.027	0.72	0.97	0.79	-0.018	0.76	0.98	0.55	0.057	0.19	1.06	0.46	0.042	0.17	1.04	0.40
LG SH	0.005	0.52	1.01	0.43	0.002	0.92	1.00	0.48	-0.043	0.15	0.96	0.55	0.023	0.65	1.02	0.59
BACH	-0.017	0.08	0.98	0.44	-0.023	0.10	0.98	0.31	-0.032	0.12	0.97	0.21	0.016	0.60	1.02	0.13
POPGR	0.005	0.25	1.00	0.66	0.003	0.58	1.00	0.56	0.005	0.47	1.00	0.48	-0.003	0.77	1.00	0.35

Electronic Components

	20 km				40 km				80 km				160 km			
Observations	15,756				15,759				15,759				15,759			
-2 LL (null)	4,164				4,172				4,172				4,172			
-2 LL (model)	4,035				4,046				4,044				4,047			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
Intercept	-3.659	0.00	0.03		-3.653	0.00	0.03		-3.659	0.00	0.03		-3.697	0.00	0.02	
Time	-0.018	0.00	0.98	0.99	-0.018	0.00	0.98	0.99	-0.018	0.00	0.98	0.99	-0.018	0.00	0.98	0.99
QTR1	-0.255	0.01	0.77	0.66	-0.256	0.00	0.77	0.66	-0.256	0.01	0.77	0.66	-0.256	0.01	0.77	0.66
QTR2	0.020	0.81	1.02	0.65	0.017	0.84	1.02	0.65	0.016	0.84	1.02	0.65	0.017	0.84	1.02	0.65
QTR3	-0.288	0.00	0.75	0.65	-0.280	0.00	0.76	0.65	-0.280	0.00	0.76	0.65	-0.280	0.00	0.76	0.65
MWEST	-0.019	0.83	0.98	0.76	-0.014	0.88	0.99	0.71	-0.013	0.89	0.99	0.61	0.026	0.81	1.03	0.44
NEAST	-0.158	0.22	0.85	0.71	-0.112	0.42	0.89	0.62	-0.034	0.82	0.97	0.51	-0.192	0.31	0.83	0.31
SOUTH	0.239	0.04	1.27	0.79	0.190	0.13	1.21	0.74	0.100	0.46	1.11	0.65	0.136	0.32	1.15	0.55
SIZE	-0.006	0.00	0.99	0.97	-0.006	0.00	0.99	0.96	-0.006	0.00	0.99	0.96	-0.006	0.00	0.99	0.97
URB	0.009	0.60	1.01	0.52	-0.005	0.58	1.00	0.45	-0.007	0.17	0.99	0.40	-0.003	0.33	1.00	0.34
DIV	-0.306	0.06	0.74	0.42	-0.130	0.37	0.88	0.43	0.069	0.62	1.07	0.50	0.081	0.62	1.08	0.50
INPUTS	-0.031	0.79	0.97	0.30	-0.032	0.86	0.97	0.24	-0.090	0.75	0.91	0.31	-0.138	0.68	0.87	0.37
MARKETS	0.017	0.77	1.02	0.18	0.003	0.98	1.00	0.09	-0.082	0.63	0.92	0.13	-0.124	0.65	0.88	0.09
LABOR	0.004	0.98	1.00	0.44	-0.016	0.91	0.98	0.48	-0.138	0.13	0.87	0.57	-0.089	0.57	0.91	0.48
KS	-0.037	0.10	0.96	0.25	-0.041	0.16	0.96	0.21	-0.037	0.42	0.96	0.25	-0.044	0.54	0.96	0.22
UNIV	0.116	0.10	1.12	0.64	0.114	0.05	1.12	0.49	0.111	0.00	1.12	0.36	0.081	0.01	1.08	0.37
LG SH	-0.020	0.04	0.98	0.44	-0.018	0.20	0.98	0.56	-0.009	0.71	0.99	0.50	-0.034	0.47	0.97	0.46
BACH	0.007	0.35	1.01	0.48	0.013	0.28	1.01	0.36	0.012	0.46	1.01	0.28	0.006	0.82	1.01	0.23
POPGR	-0.001	0.84	1.00	0.78	0.003	0.49	1.00	0.71	0.004	0.41	1.00	0.68	0.008	0.25	1.01	0.52

APPENDIX T (continued)
Event Duration Model Results
Sources of External Economies w/ Regional Controls

Motor Vehicle Parts

	20 km				40 km				80 km				160 km			
Observations	8,554				8,572				8,572				8,572			
-2 LL (null)	2,619				2,621				2,621				2,621			
-2 LL (model)	2,498				2,494				2,501				2,505			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.680	0.00	0.03		-3.709	0.00	0.02		-3.715	0.00	0.02		-3.686	0.00	0.03	
AGE	0.029	0.09	1.03	0.18	0.028	0.11	1.03	0.18	0.028	0.11	1.03	0.18	0.028	0.12	1.03	0.18
AGE^2	0.003	0.02	1.00	0.57	0.003	0.02	1.00	0.57	0.003	0.03	1.00	0.57	0.003	0.02	1.00	0.57
AGE^3	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14	0.000	0.00	1.00	0.14
QTR1	-0.086	0.42	0.92	0.65	-0.083	0.44	0.92	0.65	-0.085	0.43	0.92	0.65	-0.083	0.44	0.92	0.65
QTR2	-0.279	0.01	0.76	0.65	-0.279	0.01	0.76	0.65	-0.279	0.01	0.76	0.65	-0.278	0.01	0.76	0.65
QTR3	-0.316	0.01	0.73	0.65	-0.318	0.01	0.73	0.65	-0.317	0.01	0.73	0.65	-0.319	0.01	0.73	0.65
MWEST	0.113	0.29	1.12	0.50	0.129	0.24	1.14	0.50	0.129	0.29	1.14	0.42	0.050	0.73	1.05	0.35
NEAST	-0.087	0.67	0.92	0.77	-0.142	0.51	0.87	0.74	-0.303	0.18	0.74	0.71	-0.256	0.32	0.77	0.55
SOUTH	-0.169	0.20	0.84	0.54	-0.129	0.35	0.88	0.53	-0.012	0.94	0.99	0.43	-0.038	0.81	0.96	0.33
SIZE	-0.006	0.00	0.99	0.86	-0.005	0.00	0.99	0.88	-0.006	0.00	0.99	0.85	-0.006	0.00	0.99	0.83
URB	0.004	0.83	1.00	0.47	0.002	0.84	1.00	0.37	0.001	0.83	1.00	0.29	0.004	0.38	1.00	0.28
DIV	0.205	0.23	1.23	0.36	0.142	0.40	1.15	0.34	0.209	0.21	1.23	0.42	0.208	0.26	1.23	0.39
INPUTS	-0.025	0.85	0.98	0.49	0.098	0.67	1.10	0.32	-0.253	0.45	0.78	0.33	-0.146	0.69	0.86	0.42
MARKETS	-0.068	0.12	0.93	0.69	-0.127	0.06	0.88	0.61	-0.180	0.06	0.84	0.47	-0.260	0.12	0.77	0.24
LABOR	0.059	0.70	1.06	0.51	0.038	0.85	1.04	0.34	0.212	0.30	1.24	0.32	0.281	0.29	1.32	0.19
KS	-0.166	0.03	0.85	0.82	-0.243	0.03	0.78	0.78	-0.152	0.27	0.86	0.53	-0.165	0.39	0.85	0.30
UNIV	0.053	0.65	1.05	0.74	-0.050	0.64	0.95	0.53	-0.094	0.35	0.91	0.38	-0.114	0.11	0.89	0.39
LG SH	0.017	0.07	1.02	0.44	0.014	0.36	1.01	0.49	0.023	0.32	1.02	0.62	0.040	0.28	1.04	0.55
BACH	0.008	0.45	1.01	0.48	0.008	0.61	1.01	0.36	0.011	0.57	1.01	0.32	-0.009	0.75	0.99	0.28
POPGR	0.006	0.23	1.01	0.71	0.008	0.15	1.01	0.75	0.002	0.73	1.00	0.67	0.005	0.58	1.00	0.57

Measuring and Controlling Devices

	20 km				40 km				80 km				160 km			
Observations	11,833				11,833				11,833				11,833			
-2 LL (null)	2,884				2,884				2,884				2,884			
-2 LL (model)	2,821				2,823				2,822				2,817			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
Intercept	-3.738	0.00	0.02		-3.758	0.00	0.02		-3.760	0.00	0.02		-3.761	0.00	0.02	
Time	-0.017	0.01	0.98	0.99	-0.017	0.01	0.98	0.99	-0.017	0.01	0.98	0.99	-0.017	0.02	0.98	0.99
QTR1	-0.229	0.04	0.80	0.65	-0.228	0.04	0.80	0.65	-0.228	0.04	0.80	0.65	-0.227	0.04	0.80	0.65
QTR2	0.036	0.71	1.04	0.65	0.035	0.72	1.04	0.65	0.035	0.72	1.04	0.65	0.034	0.73	1.03	0.65
QTR3	-0.257	0.02	0.77	0.65	-0.257	0.02	0.77	0.65	-0.257	0.02	0.77	0.65	-0.257	0.02	0.77	0.65
MWEST	0.009	0.93	1.01	0.68	0.057	0.57	1.06	0.67	0.065	0.53	1.07	0.62	0.024	0.84	1.02	0.49
NEAST	-0.198	0.19	0.82	0.71	-0.239	0.13	0.79	0.64	-0.256	0.14	0.77	0.55	-0.324	0.16	0.72	0.34
SOUTH	0.181	0.14	1.20	0.66	0.096	0.44	1.10	0.67	0.118	0.37	1.12	0.62	0.241	0.09	1.27	0.54
SIZE	-0.009	0.00	0.99	0.96	-0.009	0.00	0.99	0.96	-0.009	0.00	0.99	0.94	-0.009	0.00	0.99	0.96
URB	0.024	0.30	1.02	0.50	-0.010	0.33	0.99	0.53	-0.004	0.49	1.00	0.46	-0.001	0.84	1.00	0.35
DIV	-0.098	0.59	0.91	0.49	-0.149	0.35	0.86	0.54	-0.109	0.48	0.90	0.54	0.112	0.52	1.12	0.48
INPUTS	-0.255	0.06	0.78	0.36	-0.142	0.34	0.87	0.47	-0.103	0.57	0.90	0.57	-0.255	0.21	0.77	0.68
MARKETS	0.000	0.99	1.00	0.64	0.053	0.28	1.05	0.62	0.065	0.30	1.07	0.73	0.278	0.07	1.32	0.69
LABOR	-0.061	0.76	0.94	0.56	0.148	0.41	1.16	0.59	0.099	0.35	1.10	0.68	0.349	0.06	1.42	0.50
KS	0.113	0.01	1.12	0.33	-0.010	0.81	0.99	0.38	-0.043	0.57	0.96	0.36	0.035	0.76	1.04	0.33
UNIV	-0.102	0.42	0.90	0.73	0.076	0.29	1.08	0.66	0.044	0.43	1.05	0.56	-0.012	0.79	0.99	0.40
LG SH	0.006	0.48	1.01	0.54	0.001	0.93	1.00	0.54	0.028	0.27	1.03	0.54	0.063	0.16	1.07	0.53
BACH	-0.002	0.78	1.00	0.75	0.007	0.54	1.01	0.64	0.022	0.17	1.02	0.44	-0.003	0.90	1.00	0.40
POPGR	0.001	0.76	1.00	0.81	0.002	0.61	1.00	0.75	0.002	0.66	1.00	0.70	0.009	0.14	1.01	0.53

APPENDIX T (continued)
Event Duration Model Results
Sources of External Economies w/ Regional Controls

Advertising

	20 km				40 km				80 km				160 km			
Observations	66,168				66,168				66,168				66,168			
-2 LL (null)	21,549				21,549				21,549				21,549			
-2 LL (model)	21,022				21,004				21,005				21,009			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	
INT	-3.630	0.00	0.03		-3.572	0.00	0.03		-3.615	0.00	0.03		-3.594	0.00	0.03	
AGE	-0.031	0.00	0.97	0.87	-0.030	0.00	0.97	0.87	-0.030	0.00	0.97	0.87	-0.030	0.00	0.97	0.87
AGE^2	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87	0.001	0.00	1.00	0.87
QTR1	-0.193	0.00	0.82	0.65	-0.192	0.00	0.82	0.65	-0.192	0.00	0.83	0.65	-0.192	0.00	0.83	0.65
QTR2	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65	0.073	0.03	1.08	0.65
QTR3	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65	-0.189	0.00	0.83	0.65
MWEST	-0.051	0.15	0.95	0.59	0.007	0.85	1.01	0.53	0.025	0.55	1.03	0.43	0.045	0.40	1.05	0.34
NEAST	-0.191	0.00	0.83	0.60	-0.242	0.00	0.78	0.50	-0.249	0.00	0.78	0.35	-0.283	0.00	0.75	0.22
SOUTH	0.057	0.12	1.06	0.67	0.057	0.14	1.06	0.66	0.052	0.21	1.05	0.62	0.062	0.18	1.06	0.52
SIZE	-0.032	0.00	0.97	0.98	-0.032	0.00	0.97	0.98	-0.032	0.00	0.97	0.99	-0.032	0.00	0.97	0.99
URB	0.009	0.27	1.01	0.29	0.011	0.01	1.01	0.21	0.005	0.07	1.01	0.17	0.003	0.12	1.00	0.11
DIV	-0.033	0.60	0.97	0.52	-0.081	0.16	0.92	0.50	-0.153	0.01	0.86	0.47	-0.108	0.12	0.90	0.35
INPUTS	-0.192	0.24	0.82	0.19	-0.363	0.09	0.70	0.16	-0.155	0.57	0.86	0.13	-0.460	0.18	0.63	0.14
MARKETS	0.004	0.96	1.00	0.56	0.060	0.65	1.06	0.49	0.098	0.58	1.10	0.39	0.302	0.20	1.35	0.31
LABOR	0.072	0.22	1.07	0.35	0.096	0.02	1.10	0.43	0.103	0.04	1.11	0.29	0.150	0.05	1.16	0.26
UNIV	-0.040	0.02	0.96	0.62	-0.058	0.00	0.94	0.37	-0.047	0.00	0.95	0.31	-0.035	0.00	0.97	0.21
LG SH	0.000	0.97	1.00	0.47	-0.001	0.83	1.00	0.48	-0.013	0.23	0.99	0.55	-0.023	0.17	0.98	0.49
BACH	-0.005	0.27	0.99	0.29	-0.002	0.69	1.00	0.29	-0.004	0.59	1.00	0.23	-0.003	0.76	1.00	0.21
POPGR	0.000	0.80	1.00	0.69	0.002	0.22	1.00	0.68	0.001	0.57	1.00	0.56	0.003	0.34	1.00	0.45

Computer and Data Processing Services

	20 km				40 km				80 km				160 km			
Observations	366,116				366,116				366,116							
-2 LL (null)	119,645				119,645				119,645							
-2 LL (model)	117,702				117,627				117,570							
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
INT	-3.393	0.00	0.03		-3.462	0.00	0.03		-3.198	0.00			-3.22	0.00	0.04	
AGE	-0.008	0.01	0.99	0.13	-0.008	0.01	0.99	0.13	-0.008	0.01	0.04	0.13	-0.01	0.01	0.99	0.13
AGE^2	0.003	0.00	1.00	0.08	0.003	0.00	1.00	0.08	0.003	0.00	0.99	0.08	0.00	0.00	1.00	0.08
AGE^3	0.000	0.66	1.00	0.06	0.000	0.65	1.00	0.06	0.000	0.65	1.00	0.06	0.00	0.65	1.00	0.06
AGE^4	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05	0.000	0.01	1.00	0.05	0.00	0.01	1.00	0.05
QTR1	-0.161	0.00	0.85	0.65	-0.161	0.00	0.85	0.65	-0.161	0.00	1.00	0.65	-0.16	0.00	0.85	0.65
QTR2	0.054	0.00	1.06	0.64	0.054	0.00	1.06	0.64	0.054	0.00	0.85	0.64	0.05	0.00	1.06	0.64
QTR3	-0.152	0.00	0.86	0.65	-0.152	0.00	0.86	0.65	-0.152	0.00	1.06	0.65	-0.15	0.00	0.86	0.65
MWEST	-0.030	0.05	0.97	0.65	-0.009	0.59	0.99	0.58	0.008	0.64	0.86	0.36	-0.01	0.80	0.99	0.21
NEAST	-0.165	0.00	0.85	0.66	-0.165	0.00	0.85	0.50	-0.112	0.00	1.01	0.29	-0.06	0.14	0.94	0.13
SOUTH	0.018	0.26	1.02	0.68	0.002	0.90	1.00	0.63	-0.001	0.97	0.89	0.48	-0.01	0.68	0.99	0.29
SIZE	-0.016	0.00	0.98	0.99	-0.016	0.00	0.98	0.99	-0.016	0.00	1.00	0.99	-0.02	0.00	0.98	0.99
URB	0.000	0.99	1.00	0.23	-0.004	0.05	1.00	0.15	0.002	0.14	0.98	0.09	0.00	0.78	1.00	0.04
DIV	-0.038	0.16	0.96	0.57	-0.054	0.03	0.95	0.54	-0.137	0.00	1.00	0.51	-0.10	0.00	0.90	0.46
INPUTS	-0.111	0.00	0.89	0.18	-0.222	0.00	0.80	0.17	-0.483	0.00	0.87	0.08	-0.66	0.00	0.52	0.06
MARKETS	0.061	0.15	1.06	0.38	0.133	0.04	1.14	0.27	0.364	0.00	0.62	0.15	0.57	0.00	1.77	0.13
LABOR	0.000	0.99	1.00	0.25	0.095	0.00	1.10	0.30	0.058	0.00	1.44	0.40	0.07	0.02	1.07	0.22
UNIV	-0.007	0.60	0.99	0.24	-0.010	0.28	0.99	0.13	-0.029	0.00	1.06	0.08	-0.02	0.01	0.98	0.04
LG SH	0.000	0.91	1.00	0.51	-0.003	0.26	1.00	0.48	-0.017	0.00	0.97	0.51	-0.03	0.00	0.97	0.53
BACH	0.004	0.03	1.00	0.29	0.002	0.55	1.00	0.21	0.012	0.01	0.98	0.11	0.01	0.11	1.01	0.07
POPGR	0.000	0.73	1.00	0.72	0.002	0.00	1.00	0.70	0.005	0.00	1.01	0.52	0.01	0.00	1.01	0.27

APPENDIX T (continued)
Event Duration Model Results
Sources of External Economies w/ Regional Controls
Research and Testing Services

	20 km				40 km				80 km				160 km			
Observations		67,305				67,305				67,305				67,305		
-2 LL (null)		20,398				20,398				20,398				20,398		
-2 LL (model)		19,798				19,794				19,789				19,786		
	b	**Pr > X^2**	**exp b**	**tol**	**b**	**Pr > X^2**	**exp b**		**b**	**Pr > X^2**	**exp b**		**b**	**Pr > X^2**	**exp b**	
INT	-3.531	0.00	0.03		-3.408	0.00	0.03		-3.110	0.00	0.04		-2.804	0.00	0.06	
AGE	-0.016	0.02	0.98	0.17	-0.016	0.02	0.98	0.17	-0.016	0.02	0.98	0.17	-0.015	0.02	0.98	0.17
AGE^2	0.001	0.11	1.00	0.62	0.001	0.12	1.00	0.62	0.001	0.12	1.00	0.62	0.001	0.12	1.00	0.62
AGE^3	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14	0.000	0.04	1.00	0.14
QTR1	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65	-0.257	0.00	0.77	0.65
QTR2	0.095	0.01	1.10	0.65	0.095	0.01	1.10	0.65	0.095	0.01	1.10	0.65	0.095	0.01	1.10	0.65
QTR3	-0.191	0.00	0.83	0.65	-0.191	0.00	0.83	0.65	-0.191	0.00	0.83	0.65	-0.191	0.00	0.83	0.65
MWEST	0.015	0.70	1.02	0.72	0.023	0.57	1.02	0.70	0.035	0.42	1.04	0.62	0.062	0.24	1.06	0.49
NEAST	-0.140	0.01	0.87	0.78	-0.117	0.04	0.89	0.64	-0.130	0.07	0.88	0.45	-0.231	0.02	0.79	0.24
SOUTH	-0.020	0.63	0.98	0.74	-0.040	0.36	0.96	0.69	-0.002	0.96	1.00	0.58	0.072	0.19	1.07	0.46
SIZE	-0.023	0.00	0.98	0.99	-0.023	0.00	0.98	0.99	-0.023	0.00	0.98	0.99	-0.023	0.00	0.98	0.99
URB	0.010	0.24	1.01	0.35	0.003	0.43	1.00	0.29	0.006	0.04	1.01	0.18	0.005	0.07	1.01	0.08
DIV	-0.068	0.23	0.93	0.62	-0.060	0.26	0.94	0.60	-0.082	0.14	0.92	0.57	-0.096	0.15	0.91	0.43
INPUTS	-0.096	0.40	0.91	0.22	-0.164	0.26	0.85	0.18	-0.288	0.27	0.75	0.09	-0.677	0.07	0.51	0.08
MARKETS	0.089	0.24	1.09	0.56	0.150	0.17	1.16	0.49	0.120	0.49	1.13	0.32	0.118	0.62	1.13	0.24
LABOR	0.034	0.50	1.03	0.42	0.000	0.99	1.00	0.45	0.001	0.99	1.00	0.45	0.077	0.37	1.08	0.26
UNIV	-0.048	0.31	0.95	0.40	-0.030	0.47	0.97	0.28	-0.073	0.04	0.93	0.15	-0.062	0.05	0.94	0.07
LG SH	-0.004	0.20	1.00	0.50	-0.006	0.31	0.99	0.50	0.001	0.95	1.00	0.51	0.012	0.51	1.01	0.45
BACH	0.003	0.53	1.00	0.25	0.008	0.23	1.01	0.20	0.021	0.05	1.02	0.12	0.037	0.02	1.04	0.10
POPGR	0.002	0.14	1.00	0.76	0.005	0.02	1.01	0.65	0.004	0.15	1.00	0.52	0.002	0.67	1.00	0.31

APPENDIX U
Event Duration Modeling Results: Interactive Analysis
Establishment Size by Sources of External Economies

Manufacturing

	20 km				40 km				80 km				160 km			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
SIZE	-0.012	0.00	0.99	0.98	-0.012	0.00	0.99	0.97	-0.012	0.00	0.99	0.95	-0.012	0.00	0.00	0.99
URB	0.013	0.00	1.01	0.68	0.006	0.00	1.01	0.63	0.004	0.00	1.00	0.61	0.002	0.00	0.00	1.00
DIV	0.023	0.13	1.02	0.66	-0.008	0.58	0.99	0.62	-0.038	0.01	0.96	0.64	-0.036	0.02	0.03	0.96
SIZE*URB	0.000	0.00	1.00	0.74	0.000	0.00	1.00	0.66	0.000	0.00	1.00	0.66	0.000	0.00	0.00	1.00
SIZE*DIV	0.001	0.13	1.00	0.74	0.000	0.96	1.00	0.66	0.001	0.31	1.00	0.67	0.001	0.00	0.42	1.00
SIZE	-0.012	0.00	0.99	0.98	-0.012	0.00	0.99	0.97	-0.012	0.00	0.99	0.94	-0.012	0.00	0.99	0.96
URB	0.013	0.00	1.01	0.68	0.006	0.00	1.01	0.63	0.004	0.00	1.00	0.61	0.002	0.00	1.00	0.50
INPUTS	0.010	0.07	1.01	0.53	0.005	0.55	1.00	0.44	-0.004	0.70	1.00	0.39	0.018	0.23	1.02	0.40
SIZE*URB	0.000	0.00	1.00	0.95	0.000	0.00	1.00	0.97	0.000	0.00	1.00	0.96	0.000	0.00	1.00	0.98
SIZE*INPUTS	0.000	0.41	1.00	0.89	0.000	0.28	1.00	0.91	-0.001	0.06	1.00	0.87	0.000	1.00	1.00	0.91
SIZE	-0.013	0.00	0.99	0.96	-0.012	0.00	0.99	0.96	-0.012	0.00	0.99	0.96	-0.012	0.00	0.99	0.98
URB	0.013	0.00	1.01	0.68	0.006	0.00	1.01	0.63	0.004	0.00	1.00	0.61	0.002	0.00	1.00	0.50
MARKETS	0.010	0.00	1.01	0.64	0.008	0.01	1.01	0.54	0.007	0.06	1.01	0.39	0.019	0.00	1.02	0.40
SIZE*URB	0.000	0.00	1.00	0.98	0.000	0.00	1.00	0.96	0.000	0.00	1.00	0.95	0.000	0.00	1.00	0.97
SIZE*MARKETS	0.000	0.00	1.00	0.95	0.000	0.00	1.00	0.95	0.000	0.40	1.00	0.94	0.000	0.13	1.00	0.94
SIZE	-0.012	0.00	0.99	0.98	-0.012	0.00	0.99	0.97	-0.012	0.00	0.99	0.94	-0.012	0.00	0.99	0.96
URB	0.012	0.00	1.01	0.68	0.006	0.00	1.01	0.63	0.004	0.00	1.00	0.61	0.002	0.00	1.00	0.50
LABOR	0.007	0.26	1.01	0.54	0.008	0.25	1.01	0.45	-0.002	0.78	1.00	0.43	-0.021	0.04	0.98	0.41
SIZE*URB	0.000	0.00	1.00	0.96	0.000	0.00	1.00	0.97	0.000	0.00	1.00	0.95	0.000	0.00	1.00	0.97
SIZE*LABOR	0.001	0.03	1.00	0.92	0.000	0.82	1.00	0.94	-0.001	0.12	1.00	0.87	-0.001	0.21	1.00	0.85
SIZE	-0.012	0.00	0.99	0.94	-0.012	0.00	0.99	0.94	-0.012	0.00	0.99	0.92	-0.012	0.00	0.99	0.94
URB	0.013	0.00	1.01	0.68	0.006	0.00	1.01	0.63	0.004	0.00	1.00	0.61	0.002	0.00	1.00	0.50
KNOW	-0.005	0.28	1.00	0.91	-0.005	0.43	1.00	0.88	-0.011	0.19	0.99	0.87	-0.002	0.91	1.00	0.74
SIZE*URB	0.000	0.00	1.00	0.97	0.000	0.00	1.00	0.96	0.000	0.00	1.00	0.93	0.000	0.00	1.00	0.93
SIZE*KNOW	0.000	0.05	1.00	0.91	0.000	0.00	1.00	0.90	0.000	0.07	1.00	0.90	0.001	0.15	1.00	0.88

Business and Professional Services

	20 km				40 km				80 km				160 km			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
SIZE	-0.008	0.00	0.99	0.87	-0.008	0.00	0.99	0.95	-0.008	0.00	0.99	0.99	-0.008	0.00	0.99	0.95
URB	0.005	0.00	1.01	0.68	0.000	0.70	1.00	0.60	0.000	0.31	1.00	0.53	0.000	0.02	1.00	0.37
DIV	0.011	0.22	1.01	0.80	0.014	0.09	1.01	0.77	-0.006	0.43	0.99	0.72	-0.021	0.02	0.98	0.61
SIZE*URB	0.000	0.00	1.00	0.85	0.000	0.00	1.00	0.89	0.000	0.00	1.00	0.91	0.000	0.00	1.00	0.76
SIZE*DIV	0.002	0.00	1.00	0.78	0.001	0.01	1.00	0.85	0.000	0.22	1.00	0.91	-0.001	0.00	1.00	
SIZE	-0.008	0.00	0.99	0.95	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	0.99	-0.008	0.00	0.99	0.94
URB	0.006	0.00	1.01	0.68	0.000	0.73	1.00	0.60	0.001	0.07	1.00	0.53	0.000	0.02	1.00	0.37
INPUTS	-0.117	0.00	0.89	0.43	-0.158	0.00	0.85	0.48	-0.209	0.00	0.81	0.45	-0.354	0.00	0.70	0.42
SIZE*URB	0.000	0.00	1.00	0.86	0.000	0.00	1.00	0.81	0.000	0.00	1.00	0.82	0.000	0.00	1.00	0.85
SIZE*INPUTS	-0.003	0.00	1.00	0.89	-0.006	0.00	0.99	0.81	-0.007	0.00	0.99	0.82	-0.005	0.00	0.99	0.88
SIZE	-0.008	0.00	0.99	0.95	-0.008	0.00	0.99	1.00	-0.008	0.00	0.99	0.99	-0.008	0.00	0.99	0.95
URB	0.006	0.00	1.01	0.68	0.000	0.98	1.00	0.60	0.000	0.18	1.00	0.53	0.000	0.03	1.00	0.37
MARKETS	-0.059	0.00	0.94	0.80	-0.112	0.00	0.89	0.77	-0.159	0.00	0.85	0.71	-0.127	0.00	0.88	0.69
SIZE*URB	0.000	0.00	1.00	0.91	0.000	0.00	1.00	0.91	0.000	0.00	1.00	0.88	0.000	0.00	1.00	0.88
SIZE*MARKETS	-0.002	0.00	1.00	0.94	-0.004	0.00	1.00	0.91	-0.004	0.00	1.00	0.88	-0.003	0.01	1.00	0.92
SIZE	-0.009	0.00	0.99	0.88	-0.008	0.00	0.99	0.93	-0.008	0.00	0.99	0.93	-0.008	0.00	0.99	0.92
URB	0.007	0.00	1.01	0.68	0.000	0.36	1.00	0.60	0.001	0.05	1.00	0.53	0.001	0.00	1.00	0.37
LABOR	-0.002	0.87	1.00	0.46	0.051	0.00	1.05	0.48	0.076	0.00	1.08	0.44	0.113	0.00	1.12	0.36
SIZE*URB	0.000	0.00	1.00	0.83	0.000	0.00	1.00	0.76	0.000	0.00	1.00	0.61	0.000	0.00	1.00	0.52
SIZE*LP	-0.004	0.00	1.00	0.83	-0.003	0.00	1.00	0.73	-0.002	0.00	1.00	0.58	-0.004	0.00	1.00	0.49

APPENDIX U
Event Duration Modeling Results: Interactive Analysis
Establishment Size by Sources of External Economies

Drugs

	20 km				40 km				80 km				160 km			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
SIZE	-0.011	0.01	0.99	0.56	-0.010	0.01	0.99	0.53	-0.012	0.00	0.99	0.63	-0.012	0.00	0.99	0.77
URB	0.031	0.24	1.03	0.55	0.021	0.15	1.02	0.37	0.013	0.20	1.01	0.32	0.006	0.45	1.01	0.33
DIV	-0.363	0.14	0.70	0.70	-0.204	0.44	0.82	0.65	-0.035	0.90	0.97	0.64	-0.202	0.50	0.82	0.63
SIZE*URB	0.000	0.38	1.00	0.56	0.000	0.99	1.00	0.61	0.000	0.06	1.00	0.70	-0.001	0.01	1.00	0.78
SIZE*DIV	0.015	0.05	1.01	0.80	0.015	0.09	1.01	0.75	0.026	0.00	1.03	0.83	0.029	0.00	1.03	0.86
SIZE	-0.009	0.02	0.99	0.64	-0.010	0.01	0.99	0.65	-0.008	0.03	0.99	0.72	-0.008	0.01	0.99	0.76
URB	0.032	0.22	1.03	0.55	0.018	0.22	1.02	0.37	0.019	0.06	1.02	0.31	0.013	0.07	1.01	0.33
INPUTS	0.722	0.29	2.06	0.63	0.754	0.46	2.12	0.56	-0.899	0.49	0.41	0.36	0.175	0.90	1.19	0.41
SIZE*URB	0.000	0.41	1.00	0.50	0.000	0.32	1.00	0.53	-0.001	0.03	1.00	0.47	0.000	0.08	1.00	0.57
SIZE*INPUTS	-0.006	0.80	0.99	0.68	0.075	0.03	1.08	0.71	0.095	0.00	1.10	0.59	0.058	0.10	1.06	0.68
SIZE	-0.013	0.00	0.99	0.62	-0.014	0.00	0.99	0.64	-0.012	0.01	0.99	0.67	-0.009	0.01	0.99	0.79
URB	0.030	0.25	1.03	0.56	0.019	0.19	1.02	0.37	0.020	0.05	1.02	0.31	0.016	0.03	1.02	0.32
MARKETS	-0.586	0.06	0.56	0.64	-1.099	0.05	0.33	0.66	-0.778	0.25	0.46	0.54	0.338	0.68	1.40	0.61
SIZE*URB	0.000	0.77	1.00	0.57	0.000	0.56	1.00	0.60	0.000	0.26	1.00	0.70	0.000	0.22	1.00	0.75
SIZE*MARKETS	-0.027	0.02	0.97	0.72	-0.061	0.00	0.94	0.86	-0.071	0.00	0.93	0.81	-0.055	0.04	0.95	0.86
SIZE	-0.009	0.02	0.99	0.65	-0.008	0.02	0.99	0.65	-0.008	0.02	0.99	0.72	-0.008	0.02	0.99	0.77
URB	0.029	0.27	1.03	0.55	0.024	0.09	1.02	0.37	0.019	0.06	1.02	0.32	0.013	0.08	1.01	0.31
LABOR	-0.486	0.25	0.62	0.51	-0.448	0.29	0.64	0.38	0.282	0.46	1.33	0.43	1.813	0.01	6.13	0.25
SIZE*URB	0.000	0.77	1.00	0.42	0.000	0.40	1.00	0.31	0.000	0.94	1.00	0.31	0.000	0.32	1.00	0.25
SIZE*LP	0.005	0.66	1.00	0.54	-0.005	0.56	0.99	0.38	-0.008	0.50	0.99	0.37	0.009	0.64	1.01	0.26
SIZE	-0.011	0.01	0.99	0.62	-0.009	0.02	0.99	0.63	-0.007	0.04	0.99	0.66	-0.007	0.07	0.99	0.48
URB	0.030	0.24	1.03	0.55	0.023	0.11	1.02	0.37	0.018	0.08	1.02	0.31	0.013	0.07	1.01	0.33
KNOW	-0.056	0.50	0.95	0.60	-0.042	0.68	0.96	0.69	-0.141	0.29	0.87	0.65	-0.589	0.02	0.55	0.53
SIZE*URB	0.000	0.55	1.00	0.57	0.000	0.57	1.00	0.61	0.000	0.70	1.00	0.70	0.000	0.33	1.00	0.47
SIZE*KNOW	-0.004	0.17	1.00	0.77	-0.003	0.35	1.00	0.83	-0.001	0.91	1.00	0.85	0.004	0.66	1.00	0.48

Farm and Garden Machinery

	20 km				40 km				80 km				160 km			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
SIZE	-0.021	0.00	0.98	0.71	-0.018	0.00	0.98	0.68	-0.022	0.00	0.98	0.56	-0.021	0.00	0.98	0.84
URB	0.029	0.58	1.03	0.50	0.041	0.06	1.04	0.45	0.015	0.34	1.02	0.40	-0.001	0.88	1.00	0.36
DIV	0.163	0.49	1.18	0.40	-0.108	0.65	0.90	0.35	-0.227	0.33	0.80	0.29	-0.271	0.21	0.76	0.30
SIZE*URB	-0.001	0.62	1.00	0.25	0.000	0.96	1.00	0.32	-0.001	0.40	1.00	0.36	-0.001	0.13	1.00	0.34
SIZE*DIV	0.012	0.26	1.01	0.24	0.001	0.96	1.00	0.32	0.018	0.09	1.02	0.27	0.018	0.07	1.02	0.32
SIZE	-0.019	0.01	0.98	0.41	-0.017	0.01	0.98	0.41	-0.022	0.00	0.98	0.49	-0.016	0.00	0.98	0.86
URB	0.050	0.26	1.05	0.51	0.042	0.05	1.04	0.46	0.018	0.25	1.02	0.40	0.005	0.58	1.01	0.36
INPUTS	-0.298	0.09	0.74	0.60	0.145	0.57	1.16	0.43	-0.823	0.05	0.44	0.40	-0.193	0.70	0.82	0.36
SIZE*URB	0.000	0.81	1.00	0.75	0.000	0.96	1.00	0.65	0.000	0.69	1.00	0.75	0.000	0.73	1.00	0.89
SIZE*INPUTS	-0.003	0.80	1.00	0.43	0.003	0.86	1.00	0.37	-0.028	0.20	0.97	0.51	0.021	0.39	1.02	0.82
SIZE	-0.031	0.00	0.97	0.61	-0.018	0.00	0.98	0.74	-0.018	0.00	0.98	0.75	-0.017	0.00	0.98	0.91
URB	0.097	0.04	1.10	0.51	0.047	0.02	1.05	0.46	0.022	0.13	1.02	0.40	0.006	0.51	1.01	0.36
MARKETS	0.014	0.41	1.01	0.83	-0.014	0.55	0.99	0.57	-0.030	0.35	0.97	0.57	-0.066	0.14	0.94	0.39
SIZE*URB	0.004	0.03	1.00	0.59	0.001	0.38	1.00	0.54	0.000	0.67	1.00	0.64	0.000	0.91	1.00	0.77
SIZE*MARKETS	0.003	0.00	1.00	0.71	0.003	0.00	1.00	0.63	0.002	0.19	1.00	0.71	0.003	0.20	1.00	0.78
SIZE	-0.021	0.00	0.98	0.73	-0.019	0.00	0.98	0.72	-0.018	0.00	0.98	0.65	-0.018	0.00	0.98	0.88
URB	0.071	0.12	1.07	0.50	0.043	0.04	1.04	0.46	0.021	0.15	1.02	0.40	0.002	0.85	1.00	0.37
LABOR	0.095	0.54	1.10	0.81	0.103	0.56	1.11	0.84	0.196	0.31	1.22	0.80	0.383	0.11	1.47	0.65
SIZE*URB	0.002	0.31	1.00	0.67	0.000	0.77	1.00	0.69	0.000	0.94	1.00	0.76	-0.001	0.28	1.00	0.70
SIZE*LP	0.018	0.05	1.02	0.82	0.013	0.21	1.01	0.91	0.016	0.28	1.02	0.80	0.043	0.03	1.04	0.68
SIZE	-0.019	0.01	0.98	0.42	-0.026	0.00	0.97	0.40	-0.020	0.00	0.98	0.55	-0.017	0.00	0.98	0.70
URB	0.052	0.24	1.05	0.51	0.040	0.05	1.04	0.46	0.020	0.16	1.02	0.40	0.003	0.71	1.00	0.36
KS	-0.040	0.45	0.96	0.52	-0.196	0.09	0.82	0.53	-0.134	0.31	0.87	0.67	-0.093	0.67	0.91	0.69
SIZE*URB	0.001	0.73	1.00	0.76	0.000	0.96	1.00	0.70	0.000	0.98	1.00	0.75	0.000	0.51	1.00	0.75
SIZE*KNOW	-0.001	0.89	1.00	0.36	-0.013	0.12	0.99	0.37	-0.007	0.43	0.99	0.55	0.003	0.84	1.00	0.65

APPENDIX U
Event Duration Modeling Results: Interactive Analysis
Establishment Size by Sources of External Economies

Metalworking Machinery

	20 km				40 km				80 km				160 km			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
SIZE	-0.044	0.00	0.96	0.61	-0.041	0.00	0.96	0.74	-0.040	0.00	0.96	0.80	-0.040	0.00	0.96	0.66
URB	-0.020	0.33	0.98	0.64	-0.007	0.43	0.99	0.59	0.002	0.72	1.00	0.54	0.000	0.94	1.00	0.59
DIV	0.363	0.02	1.44	0.63	0.131	0.35	1.14	0.60	-0.049	0.75	0.95	0.57	-0.054	0.73	0.95	0.59
SIZE*URB	-0.004	0.04	1.00	0.46	-0.002	0.05	1.00	0.20	-0.001	0.35	1.00	0.23	0.000	0.50	1.00	0.66
SIZE*DIV	0.048	0.00	1.05	0.33	0.035	0.01	1.04	0.18	0.023	0.14	1.02	0.22	0.012	0.41	1.01	0.97
SIZE	-0.040	0.00	0.96	0.64	-0.041	0.00	0.96	0.71	-0.043	0.00	0.96	0.78	-0.045	0.00	0.96	0.67
URB	0.003	0.84	1.00	0.65	0.003	0.65	1.00	0.60	0.008	0.12	1.01	0.54	0.002	0.66	1.00	0.58
INPUTS	-0.180	0.15	0.83	0.36	-0.445	0.02	0.64	0.33	-0.337	0.21	0.71	0.35	-0.270	0.38	0.76	0.42
SIZE*URB	-0.001	0.52	1.00	0.83	0.000	0.71	1.00	0.55	0.000	0.57	1.00	0.48	0.000	0.87	1.00	0.26
SIZE*INPUTS	-0.008	0.39	0.99	0.59	0.016	0.20	1.02	0.47	0.039	0.01	1.04	0.46	0.075	0.00	1.08	0.28
SIZE	-0.047	0.00	0.95	0.90	-0.049	0.00	0.95	0.82	-0.046	0.00	0.95	0.81	-0.048	0.00	0.95	0.66
URB	0.012	0.49	1.01	0.65	0.007	0.38	1.01	0.60	0.009	0.07	1.01	0.55	0.001	0.75	1.00	0.59
MARKETS	0.075	0.04	1.08	0.38	0.113	0.07	1.12	0.31	0.146	0.13	1.16	0.33	0.247	0.05	1.28	0.36
SIZE*URB	0.000	0.85	1.00	0.84	0.000	0.77	1.00	0.67	0.000	0.31	1.00	0.62	0.000	0.75	1.00	0.48
SIZE*MARKETS	0.004	0.00	1.00	0.85	0.006	0.00	1.01	0.75	0.015	0.00	1.02	0.74	0.024	0.00	1.02	0.66
SIZE	-0.041	0.00	0.96	0.81	-0.040	0.00	0.96	0.77	-0.041	0.00	0.96	0.80	-0.040	0.00	0.96	0.66
URB	0.003	0.84	1.00	0.65	0.002	0.80	1.00	0.60	0.006	0.23	1.01	0.55	0.001	0.76	1.00	0.59
LABOR	-0.248	0.06	0.78	0.46	0.018	0.90	1.02	0.44	0.027	0.78	1.03	0.60	-0.062	0.61	0.94	0.47
SIZE*URB	-0.001	0.51	1.00	0.84	0.000	0.49	1.00	0.66	0.000	0.95	1.00	0.69	0.000	0.69	1.00	0.66
SIZE*LP	-0.011	0.31	0.99	0.77	-0.002	0.82	1.00	0.65	0.005	0.49	1.00	0.74	0.004	0.64	1.00	0.96
SIZE	-0.042	0.00	0.96	0.74	-0.041	0.00	0.96	0.66	-0.040	0.00	0.96	0.81	-0.040	0.00	0.96	0.65
URB	0.005	0.78	1.00	0.65	0.003	0.70	1.00	0.60	0.006	0.23	1.01	0.55	0.001	0.85	1.00	0.59
KS	-0.136	0.08	0.87	0.91	-0.141	0.20	0.87	0.82	-0.090	0.51	0.91	0.74	-0.041	0.83	0.96	0.56
SIZE*URB	-0.001	0.58	1.00	0.92	0.000	0.60	1.00	0.83	0.000	0.97	1.00	0.75	0.000	0.57	1.00	0.63
SIZE*KNOW	-0.009	0.23	0.99	0.78	-0.010	0.34	0.99	0.75	0.000	1.00	1.00	0.92	0.015	0.40	1.01	0.83

Electronic Components

	20 km				40 km				80 km				160 km			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
SIZE	-0.006	0.00	0.99	0.86	-0.006	0.00	0.99	0.65	-0.007	0.00	0.99	0.56	-0.007	0.00	0.99	0.68
URB	0.029	0.09	1.03	0.60	0.002	0.84	1.00	0.62	-0.006	0.27	0.99	0.54	0.000	0.93	1.00	0.48
DIV	-0.028	0.84	0.97	0.65	0.113	0.39	1.12	0.62	0.122	0.38	1.13	0.67	-0.096	0.57	0.91	0.60
SIZE*URB	0.000	0.76	1.00	0.65	0.000	0.55	1.00	0.53	0.000	0.06	1.00	0.51	0.000	0.64	1.00	0.65
SIZE*DIV	0.001	0.57	1.00	0.70	0.004	0.07	1.00	0.75	0.001	0.60	1.00	0.85	-0.008	0.01	0.99	0.92
SIZE	-0.006	0.00	0.99	0.85	-0.006	0.00	0.99	0.69	-0.007	0.00	0.99	0.59	-0.006	0.00	0.99	0.63
URB	0.037	0.02	1.04	0.59	0.007	0.34	1.01	0.61	-0.004	0.50	1.00	0.53	0.000	0.93	1.00	0.47
INPUTS	-0.115	0.32	0.89	0.34	-0.222	0.21	0.80	0.29	-0.276	0.33	0.76	0.34	-0.416	0.22	0.66	0.40
SIZE*URB	0.000	0.16	1.00	0.73	0.000	0.31	1.00	0.55	0.000	0.27	1.00	0.38	0.000	0.99	1.00	0.59
SIZE*INPUTS	-0.004	0.04	1.00	0.69	-0.006	0.02	0.99	0.65	-0.004	0.38	1.00	0.51	-0.008	0.10	0.99	0.65
SIZE	-0.006	0.00	0.99	0.87	-0.006	0.00	0.99	0.71	-0.006	0.00	0.99	0.59	-0.006	0.00	0.99	0.67
URB	0.036	0.03	1.04	0.59	0.006	0.46	1.01	0.61	-0.004	0.47	1.00	0.52	0.000	0.97	1.00	0.47
MARKETS	0.018	0.73	1.02	0.20	0.076	0.41	1.08	0.12	0.089	0.53	1.09	0.17	-0.007	0.98	0.99	0.16
SIZE*URB	0.000	0.21	1.00	0.72	0.000	0.59	1.00	0.57	0.000	0.20	1.00	0.37	0.000	0.94	1.00	0.61
SIZE*MARKETS	-0.001	0.04	1.00	0.69	-0.002	0.05	1.00	0.71	-0.001	0.41	1.00	0.54	-0.005	0.03	1.00	0.80
SIZE	-0.007	0.00	0.99	0.87	-0.007	0.00	0.99	0.71	-0.008	0.00	0.99	0.60	-0.007	0.00	0.99	0.64
URB	0.039	0.02	1.04	0.59	0.009	0.25	1.01	0.61	-0.002	0.71	1.00	0.54	0.000	0.95	1.00	0.47
LABOR	-0.211	0.16	0.81	0.48	-0.364	0.02	0.69	0.53	-0.415	0.02	0.66	0.60	-0.302	0.20	0.74	0.48
SIZE*URB	0.000	0.16	1.00	0.83	0.000	0.22	1.00	0.65	0.000	0.48	1.00	0.55	0.000	0.98	1.00	0.44
SIZE*LP	-0.006	0.01	0.99	0.81	-0.010	0.00	0.99	0.89	-0.009	0.03	0.99	0.92	-0.007	0.19	0.99	0.63
SIZE	-0.007	0.00	0.99	0.87	-0.006	0.00	0.99	0.71	-0.007	0.00	0.99	0.59	-0.006	0.00	0.99	0.67
URB	0.039	0.02	1.04	0.59	0.006	0.41	1.01	0.61	-0.002	0.64	1.00	0.51	0.000	0.89	1.00	0.47
KNOW	-0.050	0.03	0.95	0.28	-0.052	0.08	0.95	0.22	-0.049	0.29	0.95	0.27	-0.070	0.33	0.93	0.24
SIZE*URB	0.000	0.08	1.00	0.70	0.000	0.48	1.00	0.53	0.000	0.33	1.00	0.36	0.000	0.73	1.00	0.61
SIZE*KNOW	-0.001	0.00	1.00	0.67	-0.001	0.02	1.00	0.65	-0.001	0.10	1.00	0.54	-0.002	0.06	1.00	0.79

APPENDIX U
Event Duration Modeling Results: Interactive Analysis
Establishment Size by Sources of External Economies

Motor Vehicle Parts

	20 km				40 km				80 km				160 km			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
SIZE	-0.007	0.00	0.99	0.53	-0.006	0.00	0.99	0.52	-0.006	0.00	0.99	0.56	-0.005	0.00	0.99	0.58
URB	0.045	0.01	1.05	0.46	0.010	0.23	1.01	0.47	0.002	0.77	1.00	0.44	0.002	0.67	1.00	0.39
DIV	-0.154	0.33	0.86	0.52	0.026	0.86	1.03	0.55	0.226	0.17	1.25	0.54	0.045	0.80	1.05	0.53
SIZE*URB	0.002	0.00	1.00	0.25	0.001	0.00	1.00	0.32	0.000	0.01	1.00	0.43	0.000	0.14	1.00	0.57
SIZE*DIV	-0.009	0.02	0.99	0.29	-0.004	0.22	1.00	0.46	0.001	0.71	1.00	0.65	-0.002	0.66	1.00	0.74
SIZE	-0.007	0.00	0.99	0.54	-0.006	0.00	0.99	0.50	-0.006	0.00	0.99	0.55	-0.005	0.00	0.99	0.61
URB	0.040	0.03	1.04	0.50	0.009	0.27	1.01	0.48	0.002	0.77	1.00	0.44	0.001	0.78	1.00	0.39
INPUTS	0.093	0.52	1.10	0.56	0.168	0.48	1.18	0.38	-0.450	0.20	0.64	0.44	-0.389	0.33	0.68	0.53
SIZE*URB	0.002	0.00	1.00	0.45	0.001	0.00	1.00	0.47	0.000	0.00	1.00	0.53	0.000	0.23	1.00	0.70
SIZE*INPUTS	0.006	0.05	1.01	0.65	0.005	0.24	1.00	0.65	-0.003	0.68	1.00	0.67	-0.008	0.38	0.99	0.80
SIZE	-0.007	0.00	0.99	0.53	-0.006	0.00	0.99	0.51	-0.006	0.00	0.99	0.53	-0.005	0.00	1.00	0.42
URB	0.037	0.04	1.04	0.50	0.008	0.32	1.01	0.48	0.001	0.80	1.00	0.44	0.001	0.81	1.00	0.39
MARKETS	-0.049	0.27	0.95	0.60	-0.124	0.08	0.88	0.59	-0.205	0.05	0.81	0.41	-0.307	0.05	0.74	0.28
SIZE*URB	0.001	0.00	1.00	0.50	0.001	0.00	1.00	0.49	0.000	0.01	1.00	0.55	0.000	0.30	1.00	0.69
SIZE*MARKETS	0.001	0.04	1.00	0.67	0.000	0.90	1.00	0.73	-0.001	0.52	1.00	0.61	-0.003	0.20	1.00	0.47
SIZE	-0.006	0.00	0.99	0.52	-0.006	0.00	0.99	0.50	-0.006	0.00	0.99	0.53	-0.005	0.00	0.99	0.57
URB	0.033	0.06	1.03	0.50	0.008	0.32	1.01	0.48	0.002	0.70	1.00	0.44	0.002	0.69	1.00	0.39
LABOR	-0.004	0.98	1.00	0.54	-0.062	0.78	0.94	0.35	0.034	0.89	1.03	0.32	0.110	0.70	1.12	0.20
SIZE*URB	0.001	0.00	1.00	0.48	0.000	0.00	1.00	0.49	0.000	0.00	1.00	0.56	0.000	0.13	1.00	0.69
SIZE*LP	0.000	0.90	1.00	0.59	-0.003	0.45	1.00	0.66	-0.008	0.14	0.99	0.67	-0.009	0.08	0.99	0.71
SIZE	-0.010	0.00	0.99	0.52	-0.009	0.00	0.99	0.52	-0.007	0.00	0.99	0.57	-0.006	0.00	0.99	0.66
URB	0.034	0.05	1.03	0.50	0.008	0.30	1.01	0.48	0.002	0.72	1.00	0.44	0.002	0.59	1.00	0.38
KNOW	-0.357	0.00	0.70	0.84	-0.433	0.00	0.65	0.79	-0.297	0.07	0.74	0.53	-0.257	0.20	0.77	0.31
SIZE*URB	0.001	0.00	1.00	0.52	0.001	0.00	1.00	0.51	0.000	0.00	1.00	0.57	0.000	0.05	1.00	0.57
SIZE*KNOW	-0.010	0.01	0.99	0.84	-0.010	0.01	0.99	0.92	-0.007	0.08	0.99	0.91	-0.007	0.05	0.99	0.76

Measuring and Controlling Devices

	20 km				40 km				80 km				160 km			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
SIZE	-0.009	0.00	0.99	0.84	-0.011	0.00	0.99	0.75	-0.011	0.00	0.99	0.76	-0.014	0.00	0.99	0.78
URB	0.004	0.87	1.00	0.60	-0.012	0.23	0.99	0.70	-0.007	0.25	0.99	0.66	-0.008	0.07	0.99	0.45
DIV	-0.144	0.39	0.87	0.63	0.003	0.99	1.00	0.71	-0.049	0.75	0.95	0.65	-0.069	0.68	0.93	0.61
SIZE*URB	-0.001	0.30	1.00	0.79	-0.001	0.08	1.00	0.76	-0.001	0.03	1.00	0.77	-0.001	0.02	1.00	0.49
SIZE*DIV	0.003	0.64	1.00	0.92	0.016	0.02	1.02	0.91	0.012	0.08	1.01	0.90	-0.003	0.65	1.00	0.53
SIZE	-0.011	0.00	0.99	0.82	-0.011	0.00	0.99	0.74	-0.012	0.00	0.99	0.78	-0.014	0.00	0.99	0.71
URB	-0.011	0.66	0.99	0.59	-0.014	0.19	0.99	0.70	-0.010	0.12	0.99	0.64	-0.009	0.04	0.99	0.45
INPUTS	-0.196	0.15	0.82	0.37	-0.105	0.47	0.90	0.48	-0.007	0.97	0.99	0.57	-0.210	0.34	0.81	0.68
SIZE*URB	-0.002	0.05	1.00	0.72	-0.001	0.10	1.00	0.69	-0.001	0.01	1.00	0.61	-0.001	0.00	1.00	0.64
SIZE*INPUTS	0.006	0.02	1.01	0.80	0.004	0.10	1.00	0.83	0.015	0.01	1.02	0.73	0.007	0.53	1.01	0.63
SIZE	-0.010	0.00	0.99	0.80	-0.011	0.00	0.99	0.71	-0.014	0.00	0.99	0.71	-0.018	0.00	0.98	0.77
URB	-0.001	0.98	1.00	0.60	-0.012	0.24	0.99	0.70	-0.010	0.11	0.99	0.65	-0.012	0.01	0.99	0.45
MARKETS	0.016	0.71	1.02	0.63	0.072	0.17	1.07	0.63	0.179	0.02	1.20	0.71	0.380	0.02	1.46	0.69
SIZE*URB	-0.001	0.17	1.00	0.77	-0.001	0.14	1.00	0.72	-0.001	0.01	1.00	0.65	-0.001	0.00	1.00	0.67
SIZE*MARKETS	0.002	0.18	1.00	0.84	0.002	0.23	1.00	0.86	0.008	0.00	1.01	0.77	0.013	0.01	1.01	0.84
SIZE	-0.010	0.00	0.99	0.78	-0.010	0.00	0.99	0.71	-0.010	0.00	0.99	0.67	-0.014	0.00	0.99	0.70
URB	0.003	0.89	1.00	0.60	-0.010	0.29	0.99	0.70	-0.005	0.34	0.99	0.66	-0.009	0.04	0.99	0.46
LABOR	-0.069	0.72	0.93	0.57	0.133	0.45	1.14	0.60	0.120	0.26	1.13	0.66	0.297	0.15	1.35	0.54
SIZE*URB	-0.001	0.25	1.00	0.83	-0.001	0.18	1.00	0.76	0.000	0.09	1.00	0.67	-0.001	0.00	1.00	0.67
SIZE*LP	0.005	0.08	1.01	0.88	0.001	0.59	1.00	0.85	0.000	0.91	1.00	0.73	0.001	0.90	1.00	0.82
SIZE	-0.012	0.00	0.99	0.49	-0.012	0.00	0.99	0.46	-0.015	0.00	0.98	0.40	-0.019	0.00	0.98	0.40
URB	-0.009	0.71	0.99	0.59	-0.014	0.17	0.99	0.69	-0.011	0.09	0.99	0.64	-0.013	0.01	0.99	0.45
KS	0.111	0.01	1.12	0.37	0.009	0.82	1.01	0.43	0.020	0.76	1.02	0.47	0.032	0.75	1.03	0.46
SIZE*URB	-0.002	0.06	1.00	0.59	-0.001	0.08	1.00	0.63	-0.001	0.01	1.00	0.53	-0.001	0.00	1.00	0.43
SIZE*KNOW	0.002	0.01	1.00	0.80	0.002	0.03	1.00	0.69	0.005	0.00	1.00	0.81	0.007	0.00	1.01	0.44

APPENDIX U
Event Duration Modeling Results: Interactive Analysis
Establishment Size by Sources of External Economies

Advertising

	20 km				40 km				80 km				160 km			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
SIZE	-0.032	0.00	0.97	0.52	-0.033	0.00	0.97	0.51	-0.034	0.00	0.97	0.63	-0.033	0.00	0.97	0.71
URB	0.002	0.72	1.00	0.54	0.002	0.45	1.00	0.46	0.001	0.57	1.00	0.37	0.001	0.61	1.00	0.27
DIV	-0.003	0.96	1.00	0.71	-0.089	0.12	0.91	0.65	-0.167	0.00	0.85	0.57	-0.146	0.02	0.86	0.54
SIZE*URB	0.000	0.57	1.00	0.68	0.000	0.03	1.00	0.61	0.000	0.00	1.00	0.72	0.000	0.00	1.00	0.76
SIZE*DIV	0.002	0.78	1.00	0.70	-0.012	0.06	0.99	0.77	-0.014	0.02	0.99	0.79	-0.014	0.05	0.99	0.76
SIZE	-0.033	0.00	0.97	0.49	-0.033	0.00	0.97	0.44	-0.034	0.00	0.97	0.45	-0.034	0.00	0.97	0.46
URB	-0.003	0.67	1.00	0.54	0.000	0.92	1.00	0.46	0.000	0.87	1.00	0.37	0.000	0.97	1.00	0.27
INPUTS	-0.126	0.39	0.88	0.32	-0.229	0.16	0.80	0.35	-0.128	0.52	0.88	0.31	-0.298	0.25	0.74	0.30
SIZE*URB	-0.002	0.08	1.00	0.65	0.000	0.97	1.00	0.57	0.000	0.13	1.00	0.69	0.000	0.19	1.00	0.79
SIZE*INPUTS	0.033	0.03	1.03	0.52	0.030	0.09	1.03	0.47	0.020	0.32	1.02	0.46	0.043	0.08	1.04	0.50
SIZE	-0.033	0.00	0.97	0.68	-0.037	0.00	0.96	0.58	-0.039	0.00	0.96	0.68	-0.036	0.00	0.97	0.79
URB	0.000	0.99	1.00	0.54	0.000	0.91	1.00	0.46	-0.001	0.51	1.00	0.37	-0.001	0.62	1.00	0.27
MARKETS	0.154	0.16	1.17	0.57	0.294	0.03	1.34	0.51	0.583	0.00	1.79	0.42	0.703	0.00	2.02	0.38
SIZE*URB	-0.001	0.14	1.00	0.53	0.000	0.29	1.00	0.49	0.000	0.06	1.00	0.53	0.000	0.65	1.00	0.47
SIZE*MARKETS	0.039	0.00	1.04	0.63	0.067	0.00	1.07	0.56	0.114	0.00	1.12	0.55	0.094	0.00	1.10	0.50
SIZE	-0.032	0.00	0.97	0.61	-0.033	0.00	0.97	0.58	-0.033	0.00	0.97	0.71	-0.033	0.00	0.97	0.80
URB	0.001	0.85	1.00	0.54	0.002	0.59	1.00	0.46	0.000	0.82	1.00	0.37	0.001	0.62	1.00	0.27
LABOR	0.080	0.11	1.08	0.49	0.092	0.02	1.10	0.46	0.109	0.03	1.12	0.31	0.103	0.18	1.11	0.28
SIZE*URB	-0.001	0.13	1.00	0.29	0.000	0.85	1.00	0.33	0.000	0.84	1.00	0.34	0.000	0.02	1.00	0.34
SIZE*LP	0.011	0.02	1.01	0.39	0.006	0.03	1.01	0.47	0.010	0.01	1.01	0.41	-0.004	0.56	1.00	0.37

Computer and Data Processing Services

	20 km				40 km				80 km				160 km			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
SIZE	-0.017	0.00	0.98	0.97	-0.017	0.00	0.98	0.99	-0.016	0.00	0.98	0.93	-0.016	0.00	0.98	0.73
URB	0.003	0.26	1.00	0.79	-0.004	0.00	1.00	0.68	-0.003	0.00	1.00	0.53	-0.003	0.00	1.00	0.31
DIV	-0.015	0.60	0.99	0.82	0.024	0.33	1.02	0.83	0.001	0.97	1.00	0.79	-0.008	0.78	0.99	0.62
SIZE*URB	0.001	0.00	1.00	0.98	0.000	0.00	1.00	0.99	0.000	0.00	1.00	0.95	0.000	0.02	1.00	0.67
SIZE*DIV	0.002	0.36	1.00	0.99	0.006	0.00	1.01	0.99	0.008	0.00	1.01	0.94	0.006	0.00	1.01	0.71
SIZE	-0.018	0.00	0.98	0.85	-0.017	0.00	0.98	0.82	-0.017	0.00	0.98	0.73	-0.016	0.00	0.98	0.60
URB	0.003	0.25	1.00	0.79	-0.004	0.00	1.00	0.68	-0.003	0.00	1.00	0.53	-0.003	0.00	1.00	0.31
INPUTS	-0.039	0.25	0.96	0.26	-0.108	0.00	0.90	0.31	-0.037	0.50	0.96	0.24	-0.153	0.06	0.86	0.22
SIZE*URB	0.001	0.00	1.00	0.84	0.000	0.00	1.00	0.77	0.000	0.00	1.00	0.65	0.000	0.02	1.00	0.54
SIZE*INPUTS	0.005	0.00	1.01	0.73	0.006	0.00	1.01	0.67	0.007	0.00	1.01	0.60	0.010	0.00	1.01	0.66
SIZE	-0.017	0.00	0.98	0.87	-0.016	0.00	0.98	0.85	-0.016	0.00	0.98	0.62	-0.016	0.00	0.98	0.49
URB	0.002	0.30	1.00	0.79	-0.004	0.00	1.00	0.68	-0.002	0.00	1.00	0.53	-0.003	0.00	1.00	0.31
MARKETS	0.103	0.02	1.11	0.44	0.079	0.21	1.08	0.35	0.078	0.37	1.08	0.24	0.282	0.01	1.33	0.25
SIZE*URB	0.001	0.00	1.00	0.97	0.000	0.00	1.00	0.78	0.000	0.00	1.00	0.66	0.000	0.02	1.00	0.59
SIZE*MARKETS	0.003	0.20	1.00	0.87	0.001	0.64	1.00	0.70	0.003	0.40	1.00	0.54	0.008	0.04	1.01	0.61
SIZE	-0.017	0.00	0.98	0.97	-0.016	0.00	0.98	0.99	-0.016	0.00	0.98	0.94	-0.016	0.00	0.98	0.78
URB	0.002	0.30	1.00	0.79	-0.004	0.00	1.00	0.68	-0.002	0.00	1.00	0.53	-0.003	0.00	1.00	0.31
LABOR	0.019	0.42	1.02	0.32	0.107	0.00	1.11	0.37	0.059	0.00	1.06	0.42	0.083	0.01	1.09	0.29
SIZE*URB	0.001	0.00	1.00	0.79	0.000	0.00	1.00	0.75	0.000	0.00	1.00	0.62	0.000	0.00	1.00	0.42
SIZE*LP	0.000	0.98	1.00	0.79	0.001	0.56	1.00	0.75	0.000	0.93	1.00	0.60	0.000	0.91	1.00	0.48

APPENDIX U
Event Duration Modeling Results: Interactive Analysis
Establishment Size by Sources of External Economies

Research and Testing Services

	20 km				40 km				80 km				160 km			
	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol	b	Pr > X^2	exp b	tol
SIZE	-0.025	0.00	0.98	0.92	-0.025	0.00	0.97	0.79	-0.025	0.00	0.98	0.89	-0.023	0.00	0.98	0.95
URB	0.014	0.03	1.01	0.65	0.005	0.08	1.01	0.65	0.003	0.17	1.00	0.54	0.000	0.99	1.00	0.34
DIV	0.035	0.60	1.04	0.81	0.005	0.93	1.01	0.75	-0.034	0.58	0.97	0.66	-0.052	0.48	0.95	0.55
SIZE*URB	0.001	0.00	1.00	0.89	0.001	0.00	1.00	0.73	0.000	0.01	1.00	0.82	0.000	0.59	1.00	0.84
SIZE*DIV	0.007	0.13	1.01	0.89	0.004	0.33	1.00	0.60	0.009	0.02	1.01	0.75	0.009	0.05	1.01	0.81
SIZE	-0.024	0.00	0.98	0.92	-0.025	0.00	0.98	0.93	-0.024	0.00	0.98	0.95	-0.023	0.00	0.98	0.97
URB	0.014	0.02	1.01	0.65	0.006	0.06	1.01	0.65	0.003	0.09	1.00	0.54	0.001	0.69	1.00	0.34
INPUTS	-0.030	0.76	0.97	0.39	0.008	0.95	1.01	0.39	0.164	0.30	1.18	0.33	0.037	0.87	1.04	0.27
SIZE*URB	0.001	0.00	1.00	0.64	0.001	0.00	1.00	0.72	0.000	0.00	1.00	0.81	0.000	0.15	1.00	0.92
SIZE*INPUTS	-0.006	0.31	0.99	0.62	-0.006	0.38	0.99	0.71	-0.004	0.66	1.00	0.78	0.002	0.82	1.00	0.91
SIZE	-0.025	0.00	0.98	0.94	-0.025	0.00	0.97	0.92	-0.024	0.00	0.98	0.99	-0.024	0.00	0.98	0.99
URB	0.013	0.04	1.01	0.65	0.005	0.10	1.01	0.65	0.003	0.13	1.00	0.54	0.000	0.95	1.00	0.34
MARKETS	0.083	0.35	1.09	0.65	0.146	0.23	1.16	0.58	-0.024	0.90	0.98	0.42	0.308	0.18	1.36	0.40
SIZE*URB	0.001	0.00	1.00	0.75	0.001	0.00	1.00	0.88	0.000	0.00	1.00	0.79	0.000	0.76	1.00	0.68
SIZE*MARKETS	0.005	0.35	1.01	0.77	0.010	0.19	1.01	0.90	0.003	0.77	1.00	0.79	0.026	0.06	1.03	0.68
SIZE	-0.024	0.00	0.98	0.90	-0.025	0.00	0.98	0.95	-0.025	0.00	0.97	0.98	-0.025	0.00	0.98	0.98
URB	0.015	0.02	1.01	0.65	0.006	0.04	1.01	0.65	0.005	0.01	1.00	0.53	0.003	0.10	1.00	0.34
LABOR	-0.025	0.65	0.98	0.52	-0.089	0.17	0.92	0.55	-0.205	0.00	0.81	0.47	-0.207	0.04	0.81	0.35
SIZE*URB	0.001	0.00	1.00	0.95	0.001	0.00	1.00	0.90	0.001	0.00	1.00	0.72	0.000	0.00	1.00	0.74
SIZE*LP	-0.005	0.10	0.99	0.94	-0.012	0.00	0.99	0.93	-0.019	0.00	0.98	0.66	-0.028	0.00	0.97	0.69

WORKS CITED

Acs, Z. J., L. Anselin and A. Varga (2002). "Patents and innovation counts as measures of regional production of new knowledge." Research Policy **31**: 1069-1085.

Acs, Z. J. and C. Armington (2002). "Entrepreneurial activity and economic growth." Frontiers of Entrepreneurial Research: 339-348.

Acs, Z. J. and C. Armington (2004). "Employment growth and entrepreneurial activity in cities." Regional Studies **38**(9): 911-927.

Acs, Z. J., C. Armington and A. Robb (1999). Measures of Job Flow Dynamics in the U.S. Economy, U.S. Small Business Administration and the U.S. Census Bureau Center for Economic Statistics.

Acs, Z. J. and D. B. Audretsch (1987). "Innovation, market structure, and firm size." Review of Economics and Statistics **69**(4): 567-574.

Acs, Z. J. and D. B. Audretsch (1988). "Innovation and firm size in manufacturing." Technovation **7**: 197-210.

Acs, Z. J. and D. B. Audretsch (1989). "Births and firm size." Southern Economic Journal **56**(2): 457-475.

Acs, Z. J. and D. B. Audretsch (1990). Innovation and Small Firms. Cambridge, MA and London, MIT Press.

Acs, Z. J., D. B. Audretsch and M. P. Feldman (1992). "Real effects of academic research: Comment." American Economic Review **82**(1): 363-637.

Acs, Z. J., D. B. Audretsch and M. P. Feldman (1994). "R&D spillovers and recipient firm size." Review of Economics and Statistics **76**(2): 336-340.

Acs, Z. J. and A. Varga (2002). "Introduction to the special issue on regional innovation systems." International Regional Science Review **25**(1): 3-7.

Adams, J. D. (2002). "Comparative localization of academic and industrial spillovers." Journal of Economic Geography **2**(3): 253.

Advanced Research Technologies. (2005). The Innovation-Entrepreneurship NEXUS. Powell, OH, U.S. Small Business Administration, Office of Advocacy.

Agarwal, R. (1996). "Technological activity and survival of firms." Economic Letters **52**: 101-108.

Agarwal, R. (1997). "Survival of firms over the product life cycle." Southern Economic Journal **3**: 571-584.

Agarwal, R. (1998). "Small firm survival and technological activity." Small Business Economics **11**: 215-224.

Agarwal, R. and D. B. Audretsch (2001). "Does entry size matter? The impact of the life cycle and technology on firm survival." Journal of Industrial Economics **XLIX**(1): 21-43.

Agarwal, R. and M. Gort (1996). "The evolution of markets and entry, exit and survival of firms." Review of Economics and Statistics **78**(3): 489-498.

Agarwal, R. and M. Gort (2002). "Firm and product life cycle and firm survival." American Economic Review **92**(2): 184-190.

Aiken, L. S. and S. G. West (1991). Multiple Regression: Testing and Interpreting Interactions. Newbury Park, CA, Sage Publications.

Aji, M. A. (1995). "Intra-metropolitan productivity variation of selected manufacturing and business service sectors: What can we learn from Los Angeles." Urban Studies **32**(7): 1071-1096.

Allison, P. D. (1982). "Discrete-time methods for the analysis of event histories." Sociological Methodology **13**: 61-98.

Allison, P. D. (1984). Event History Analysis. Beverly Hills, CA, Sage Publications.

Allison, P. D. (1995). Survival Analysis Using the SAS System: A Practical Guide. Cary, NC, SAS Institute Inc.

Almeida, P. and B. Kogut (1997). "The exploration of technological diversity and the geographic localization of innovation." Small business economics **9**: 21-31.

Alonso, W. (1960). "A theory of the urban land market." Papers and Proceedings of the Regional Science Association **6**: 83-91.

Amin, A. and K. Robins (1990). "The re-emergence of regional economies? The mythical geography of flexible accumulation." Environment and Planning D: Society and Space **8**: 7-34.

Anselin, L., A. Varga and Z. J. Acs (1997). "Local geographic spillovers between university research and high technology innovations." Journal of Urban Economics **42**: 422-448.

Anselin, L., A. Varga and Z. J. Acs (2000). "Geographic spillovers and university research: A spatial econometric perspective." Growth and Change **31**(Fall): 501-515.

Armington, C. and Z. J. Acs (2002). "The determinants of regional variation in new firm formation." Regional Studies **36**(1): 33-45.

Audretsch, D. B. (1991). "New-firm survival and the technological regime." Review of Economics and Statistics **73**(3): 441-450.

Audretsch, D. B. (1995a). Innovation and Industry Evolution. Cambridge, MA, MIT Press.

Audretsch, D. B. (1995b). "Innovation, growth, and survival." International Journal of Industrial Organization **13**: 441-457.

Audretsch, D. B. and M. P. Feldman (1996). "R&D spillovers and the geography of innovation and production." American Economic Review **86**(3): 630-640.

Audretsch, D. B. and M. Fritsch (1994). "The geography of firm births in Germany." Regional Studies **28**(4): 359-365.

Audretsch, D. B., P. Houweling and A. R. Thurik (2000). "Firm survival in the Netherlands." Review of Industrial Organization **16**: 1-11.

Audretsch, D. B. and M. Keilbach (2004). "Entrepreneurship capital and economic performance." Regional Studies **38**(8): 949-959.

Audretsch, D. B. and T. Mahmood (1994). "The rate of hazard confronting new firms and plants in U.S. manufacturing." Review of Industrial Organization **9**: 41-56.

Audretsch, D. B. and T. Mahmood (1995). "New firm survival: New results using a hazard function." Review of Economics and Statistics **77**(1): 97-103.

Audretsch, D. B. and J. Mata (1995). "The post-entry performance of firms: Introduction." International Journal of Industrial Organization **13**: 413-419.

Audretsch, D. B., E. Santarelli and M. Vivarelli (1999). Does startup size influence the likelihood of survival? In Innovation, Industry Evolution, and Employment, D. Audretsch and A.R. Thurik (Eds.), Cambridge; New York and Melbourne, Cambridge University Press**:** 280-96.

Audretsch, D. B. and M. Vivarelli (1996). "Firm size & R&D spillovers: Evidence from Italy." Small Business Economics **8**(3): 249-58.

Bain, J. S. (1956). Barriers to New Competition: Their Character and Consequences in Manufacturing Industries. Cambridge, Harvard University Press.

Baldwin, J. R. and P. K. Gorecki (1991). "Firm entry and exit in the Canadian manufacturing sector, 1970-1982." Canadian Journal of Economics **24**(2): 300-323.

Baldwin, J. R. and M. Rafiquzzaman (1995). "Selection versus evolutionary adaptation: Learning and post-entry performance." International Journal of Industrial Organization **13**: 501-522.

Bania, N., R. Eberts and M. Fogarty (1993). "Universities and the startup of new companies: Can we generalize from Route 128 and Silicon Valley?" Review of Economics and Statistics **75**(4): 761-765.

Barkley, D. L. and M. S. Henry (1997). "Rural industrial development: To cluster or not to cluster?" Review of Agricultural Economics **19**(2): 308-325.

Bates, T. (1990). "Entrepreneurial human capital inputs and small business longevity." Review of Economics and Statistics **LXXII**(4): 551-559.

Baumol, W. J. (1993). Entrepreneurship, Management, and the Structure of Payoffs. Cambridge, MA, MIT Press.

Beeson, P. E. (1987). "Total factor productivity and agglomeration economies in manufacturing, 1959-73." Journal of Regional Science **27**: 183-200.

Beeson, P. E. and E. Montgomery (1993). "The effects of colleges and universities on local labor markets." Review of Economics and Statistics **75**(4): 753-761.

Bellandi, M. (1989). The industrial district in Marshall. In Small Firms and Industry Districts in Italy. E. Goodman and J. Bamford (Eds.). London & New York, Routledge.

Bergman, E. and E. J. Feser (1999). "Industrial and regional clusters: Concepts and comparative applications." Web Book of Regional Science.

Bergsman, J., P. Greenston and R. Healy (1972). "The agglomeration process in urban growth." Urban Studies **9**: 263-288.

Bergsman, J., P. Greenston and R. Healy (1975). "A classification of economic activities based on locational patterns." Journal of Urban Economics **2**: 1-28.

Birch, D. (1987). Job Creation in America: How Our Smallest Companies Put the Most People to Work. New York, The Free Press.

Blair, J. P. and R. Premus (1987). "Major factors in Industrial Location: A review." Economic Development Quarterly **1**: 72-85.

Bolton, R. (1992). "Place prosperity vs. people prosperity revisited: An old issue with a new angle." Urban Studies **29**(2): 185-203.

Breschi, S. and F. Lissoni (2001). "Localized knowledge spillovers vs. innovative milieu: Knowledge "tacitness" reconsidered." Papers in Regional Science **80**: 255-273.

Brown, C., J. Hamilton and J. Medoff (1990). Employers Large and Small. Cambridge, MA, Harvard University Press.

Brüderl, J., P. Preisendorfer and R. Ziegler (1992). "Survival chances of newly founded business organizations." American Sociological Review **57**(2): 227-242.

Brüderl, J. and R. Schussler (1990). "Organizational mortality: The liabilities of newness and adolescence." Administrative Sciences Quarterly **35**(3): 530-547.

Buss, T. F. and X. Lin (1990). "Business survival in rural America: A three state study." Growth and Change **Summer**: 1-8.

Carlino, G. A. (1978). Economies of Scale in Manufacturing Location. Boston, Martinus Nijhoff Social Science Division.

Carlino, G. A. (1979). "Increasing returns to scale in metropolitan manufacturing." Journal of Regional Science **19**(3): 363-372.

Carlino, G. A. (1980). "Contrasts in agglomeration: New York and Pittsburgh reconsidered." Urban Studies **17**: 343-351.

Carlino, G. A. (1985). "Declining city productivity and the growth of rural regions: A test of alternative explainations." Journal of Urban Economics **18**: 11-27.

Carlsson, B. (1996). Small business, flexible technology and industrial dynamics. In Small Business in the Modern Economy. P. H. Admiraal (Ed.). Oxford, UK, Blackwell.

Caves, R. E. and M. E. Porter (1976). Barriers to Exit. In Essays on Industrial Organization in Honor of Joe S. Bain. R. Masson and P.D. Qualls. (Eds.). Cambridge, MA, Ballinger.

Caves, R. E. and M. E. Porter (1977). "From entry barriers to mobility barriers." Quarterly Journal of Economics **91**: 241-261.

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

Ciccone, A. (2002). "Agglomeration effects in Europe." European Economic Review **46**: 213-227.

Ciccone, A. and R. E. Hall (1996). "Productivity and the density of economic activity." American Economic Review **86**: 54-70.

Coase, R. H. (1937 [2002]). The nature of the firm. In Alternative Theories of the Firm. R. N. Langlois, T. F. Yu and P. Robertson (Eds.). Cheltenham, U.K. and Northampton, Mass., Elgar Reference Collection. International Library of Critical Writings in Economics, vol. 154. **1:** 85-104.

Cohen, W. M., R. R. Nelson and J. P. Walsh (2002). "Links and impacts: The influence of public research on industrial R&D." Management Science **48**(1): 1-23.

Cox, D. R. (1972). "Regression models and life tables (with discussion)." Journal of the Royal Statistical Society **B 34**: 187-220.

Czamanski, S. and L. Ablas (1979). "Identification of industrial clusters and complexes: a comparison of methods and findings." Urban Studies **16**: 61-80.

David, P. (1999). "Krugman's economic geography of development: NEGs, POGs, and naked models in space." International Regional Science Review **22**(2): 162-172.

de Lucio, J. J., J. A. Herce and A. Goicolea (2002). "The effects of externalities on productivity growth in Spanish industry." Regional Science and Urban Economics **32**: 241-258.

Devereux, M. P., R. Griffith and H. Simpson (2004). "The geographic distribution of production activity in the UK." Regional Science and Urban Economics **2004**: 533-564.

Diggle, P. J. and A. G. Chetwynd (1991). "Second-order analysis of spatial clustering for in homogenous populations." Biometrics **47**(September): 1155-1163.

Doms, M., T. Dunne and M. J. Roberts (1995). "The role of technology use in the survival and growth of manufacturing plants." International Journal of Industrial Organization **13**: 523-542.

Drucker, J. M. and H. A. Goldstein (forthcoming). "Assessing the regional economic development impacts of universities: A review of current approaches." International Regional Science Review.

Duncan, C. and K. Jones (2000). "Using multilevel models to model heterogeneity: Potential and pitfalls." Geographical Analysis **32**(4): 279-305.

Dumais, G., G. Ellison and E. L. Glaeser (1997). "Geographic concentration as a dynamic process." NBER working paper 6270.

Dumais, G., G. Ellison and E. L. Glaeser (2002). "Geographic concentration as a dynamic process." Review of Economics and Statistics **84**(2): 193-204.

Dunne, P. and A. Hughes (1994). "Age, size, growth and survival: UK companies in the 1980's." Journal of Industrial Economics **XLII**(2): 115-140.

Dunne, T., M. J. Roberts and L. Samuelson (1989). "The growth and failure of U.S. manufacturing plants." Quarterly Journal of Economics: 671-698.

Dunne, T. and L. Samuelson (1988). "Patterns of firm entry and exit in US manufacturing industries." Rand Journal of Economics **XIX**: 48-71.

Duranton, G. and H. G. Overman (2004). "Testing for localisation using micro-geographic data." working paper.

Duranton, G. and D. Puga (2000). "Diversity and specialization in cities: Why, where and when does it matter?" Urban Studies **37**: 533-552.

Duranton, G. and D. Puga (2004). Micro-foundations of urban agglomeration economies. In Handbook of Urban and Regional Economics. J.V. Henderson and J. Thisse (Eds.). **4**.

Eaton, B. C. and R. G. Lipsey (1980). "Exit barriers are entry barriers: The durability of capital as a barrier to entry." Bell Journal of Economics **11**(2): 721-729.

Eisinger, P. (1995). "State economic development in the 1990's: Politics and policy learning." Economic Development Quarterly **9**(2): 146-158.

Ellison, G. and E. L. Glaeser (1997). "Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach." Journal of Political Economy **105**: 889-927.

Ellison, G. and E. L. Glaeser (1999). "The Geographic Concentration of Industry: Does Natural Advantage Explain Agglomeration." American Economic Review **89**(2): 311-316.

Ericson, R. and A. Pakes (1995). "Markov-Perfect industry dynamics: A framework for empirical work." Review of Economic Studies **62**(1): 53-82.

Ettlinger, N. (1994). "The localization of development in comparative perspective." Economic Geography **70**(2): 144-166.

Evans, A. W. (1986). "Comparisons of agglomeration: Or what Chinitz really said." Urban Studies **23**: 387-389.

Evans, D. S. (1987). "The relationship between firm growth, size, and age: Estimates for 100 manufacturing industries." Journal of Industrial Economics **XXXV**(4): 567-581.

Evans, L. B. and J. J. Siegfried (1992). Entry and exit in United States manufacturing industries from 1977 to 1982. In Empirical Studies in Industrial Organization: Essays in honor of Leonard W. Weiss. D. B. Audretsch and J. J. Siegfried (Eds.), Norwell, MA, Kluwer Academic Publishers**:** 253-73.

Feldman, M. P. (1994a). "Knowledge complementary and innovation." Small Business Economics **6**(5): 363-372.

Feldman, M. P. (1994b). "The university and economic development: The case of Johns Hopkins University and Baltimore." Economic Development Quarterly **8**(1): 67-76.

Feldman, M. P. (2001). "The entrepreneurial event revisited: Firm formation in a regional context." Industrial and Corporate Change **10**(4): 861-891.

Feldman, M. and D. Audretsch (1999). "Innovation in cities: Science-based diversity, specialization and localized competition." European Economic Review **43**: 409-429.

Feser, E. J. (1998a). "Enterprises, external economies, and economic development." Journal of Planning Literature **12**(3): 283-302.

Feser, E. J. (1998b). Old and new theories of industrial clusters. Clusters and Regional Specialization. M. Steiner. London, Pion**:** 19-40.

Feser, E. J. (2001a). Agglomeration, enterprise size, and productivity. In Theories of Endogenous Regional Growth. B. Johansson, C. Karlsson and R. Stough (Eds.). Heidelberg & New York, Springer**:** 231-51.

Feser, E. J. (2001b). "A flexible test for agglomeration economies in two US manufacturing industries." Regional Science and Urban Economics **31**: 1-19.

Feser, E. J. (2002). "Tracing the sources of local external economies." Urban Studies **39**(13): 2485-2506.

Feser, E. J., K. Koo, H. C. Renski and S. Sweeney (2001). "Incorporating spatial analysis in applied industry cluster studies." working paper.

Feser, E. J. and S. H. Sweeney (2000). "A test for the coincident economic and spatial clustering of business enterprises." Journal of Geographic Systems **2**: 349-373.

Feser, E. J. and S. H. Sweeney (2002). Theory, methods and a cross-metropolitan comparison of business clustering. In Industrial Location Economics. P. McCann (Ed.). Cheltenham, UK, Edward Elgar.

Feser, E. J. and S. H. Sweeney (forthcoming). "On the state of the geography in the US BLS Covered Wages and Employment (ES-202) series." International Regional Science Review.

Feser, E. J., S. H. Sweeney and H. C. Renski (2005). "A descriptive analysis of discrete US industrial complexes." Journal of Regional Science **45**(2): 395-419.

Figueiredo, O., P. Guimarães and D. Woodward (2002). "Home-field advantage: Location decisions of Portuguese entrepreneurs." Journal of Urban Economics **52**: 341-361.

Fischer, M. M. and A. Varga (2003). "Spatial knowledge spillovers and university research: Evidence from Austria." Annuals of Regional Science **37**: 303-322.

Fogarty, M. S. and G. G. Garofalo (1988). "Urban spatial structure and productivity growth in the manufacturing sector of cities." Journal of Urban Economics **23**: 60-70.

Fotheringham, A. S. and C. Brunsdon (1999). "Local forms of spatial analysis." Geographic Analysis **31**(4): 340 - 358.

Fotopoulos, G. and H. Louri (2000). "Location and survival of new entry." Small Business Economics **14**: 311-321.

Fotopoulos, G. and N. Spence (1999). "Spatial variations in new manufacturing plant openings: Some empirical evidence from Greece." Regional Studies **33**(3): 219-229.

Fritsch, M. (1997). "New firms and regional employment change." Small Business Economics **9**: 437-448.

Fritsch, M. and P. Mueller (2004). "Effects of new business formation on regional development over time." Regional Studies **38**(8): 961-975.

Fugita, M. and J.-F. Thisse (2002). Economics of Agglomeration: Cities, Industrial Location, and Regional Growth. Cambridge, Cambridge University Press.

Gabe, T. M. (2005). "Industry agglomeration and investment in rural businesses." Review of Agricultural Economics **27**(1): 89-103.

Galbraith, J. K. (1956). American Capitalism. Boston, Houghton Mifflin.

Geroski, P. A. (1989). "Entry, innovation and productivity growth." Review of Economics and Statistics **71**(4): 572-578.

Geroski, P. A. (1995). "What do we know about entry?" International Journal of Industrial Organization **13**: 421-440.

Gilmour, J. J. (1974). External economies of scale, industrial linkages and decision making in manufacturing. In Spatial Perspectives on Industrial Decision-Making. I. Hamilton (Ed.). London, John Wiky & Sons.

Gittell, R. and J. Sohl (2005). "Technology centers during the economic downturn: What have we learned?" Entrepreneurship and Regional Development **17**(4): 293-312.

Glaeser, E. L., H. D. Kallal, J. A. Scheinkman and A. Shkeifer (1992). "Growth in cities." The Journal of Political Economy **100**(6): 1126-1152.

Gold, B. (1981). "Changing perspectives on size, scale, and returns: An interpretive survey." Journal of Economic Literature **19**: 5-33.

Goldstein, G. S. and T. J. Gronberg (1984). "Economies of scope and economies of agglomeration." Journal of Urban Economics **16**: 91-104.

Goldstein, H. (1994). "Multilevel cross-classified models." Sociological Methods & Research **22**: 364-75.

Goldstein, H. (2003). Multilevel Statistical Models. London, Hodder Arnold.

Goldstein, H. A. and J. M. Drucker (2006). "The economic development impacts of Universities on regions: Do size and distance matter?" Economic Development Quarterly **20**(1): 22-43.

Goldstein, H. A., G. Maier and M. I. Luger (1995). The University as an instrument for economic and business development: U.S. and European comparison. In Emerging Patterns of Social Demand and University Reform: Through a Glass Darkly. D. Dill and B. Sporn (Eds.). Oxford, UK, Pergamon**:** 105-133.

Goldstein, H. A. and C. S. Renault (2004). "Contributions of universities to regional economic development: A quasi-experimental approach." Regional Studies **38**(7): 733-746.

Gort, M. and S. Klepper (1982). "Time paths in the diffusion of product innovations." Economic Journal **92**: 630-653.

Granovetter, M. (1985). "Economic action and social structure: The problem of embeddedness." American Journal of Sociology **91**(3): 481-510.

Griliches, Z. (1979). "Issues in assessing the contribution of research and development to productivity growth." Bell Journal of Economics **10**(1): 92-116.

Griliches, Z. (1990). "Patent statistics as economic indicators: a survey." Journal of Economic Literature **28**: 1161-1707.

Griliches, Z. (1992). "The search for R&D spillovers." Scandinavian Journal of Economics **94**(0): 29-47.

Guo, G. and Z. Hongxin (2000). "Multilevel modeling for binary data." Annual Review of Sociology **26**: 441-62.

Guo, G. and G. Rodriguez (1992). "Estimating a multivariate proportional hazards model for clustered data using the EM algorithm, with an application to child survival in Guatemala." Journal of the American Statistical Association **87**(420): 969-976.

Haltiwanger, J. C. and C. J. Krizan (1999). Small business and job creation in the United States: The role of new and young businesses. In Are Small Firms Important? Their Role and Impact. Z. J. Acs (Ed.). Boston, Kluwer Academic**:** 99-110.

Hannan, M. T. and J. Freeman (1977). "The population ecology of organizations." American Journal of Sociology **82**: 929-54.

Hansen, E. R. (1990). "Agglomeration economies and industrial decentralization: the wage-productivity trade-off." Journal of Urban Economics **28**: 140-159.

Hanson, G. H. (2001). "Scale economies and the geographic concentration of industry." Journal of Economic Geography **1**(3): 255-276.

Hanson, R. (1993). "Bidding for business: A second war between the states." Economic Development Quarterly **7**(2): 183-198.

Harrison, B. (1992). "Industrial districts: Old wine in new bottles?" Regional Studies **26**: 469-483.

Harrison, B. (1994). Lean and Mean: The Changing Landscape of Corporate Power in the Age of Flexibility. New York, Basic Books.

Harrison, B., M. R. Kelley and J. Gant (1996). "Innovative firm behavior and local milieu: exploring the intersection of agglomeration, firm effects, and technological change." Economic Geography **72/3**(July): 233-58.

Headd, B. (2003). "Redefining business success: Distinguishing between closing and failure." Small Business Economics **21**: 51-61.

Heckman, J. and B. Singer (1984). "A method for minimizing the impact of distributional assumptions in econometric models for duration data." Econometrica **52**(2): 271-320.

Heckman, J. J. (1979). "Sample selection bias as a specification error." Econometrica **47**: 161-196.

Helsley, R. W. and W. C. Strange (1990). "Agglomeration economies and matching in a system of cities." Regional Science and Urban Economics **16**: 91-104.

Henderson, J. V. (1974). "The sizes and types of cities." American Economic Review **64**(4): 640-56.

Henderson, J. V. (1986). "Efficiency of resource useage and city size." Journal of Urban Economics **19**: 47-70.

Henderson, J. V. (1997). "Externalities and industrial development." Journal of Urban Economics **42**: 449-470.

Henderson, J. V. (2003). "Marshall's scale economies." Journal of Urban Economics **53**: 1-28.

Henderson, J. V., A. Kunroco and T. Turner (1995). "Industrial development in cities." Journal of Political Economy **103**: 1067-1090.

Henry, M. S. and M. Drabenstott (1996). "A new micro view of the US rural economy." Economic Review: Federal Reserve Bank of Kansas City **Second Quarter**: 53-70.

Hirschman, A. O. (1958). The strategy of economic development. New Haven, CT, Yale University Press.

Holmes, T. J. (1999). "Localization of industry and vertical disintegration." Review of Economics and Statistics **81**(2): 314-325.

Holmes, T. J. and J. J. Stevens (2002). "Geographic concentration and establishment scale." Review of Economics and Statistics **84**(4): 682-690.

Hoover, E. M. (1937). Location Theory and the Shoe and Leather Industries. Cambridge, MA, Harvard University Press.

Hoover, E. M. and R. Vernon (1959). Anatomy of a Metropolis; The Changing Distribution of People and Jobs within the New York Metropolitan Region. Cambridge, Harvard University Press.

Howells, J. R. L. (2002). "Tacit knowledge, innovation and economic geography." Urban Studies **39**(5-6): 871-884.

Hubert Humphrey Institute of Public Affairs. (2004). Conference proceedings: Knowledge clusters and entrepreneurship in regional economic development, University of Minnesota.

Jacobs, J. (1969). The Economy of Cities. New York, Random House.

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

Jaffe, A. B., M. Trajtenberg and R. Henderson (1993). "Geographic localization of knowledge spillovers as evidenced by patent citations." Quarterly Journal of Economics **108**(3): 577-598.

Johnson, P. and J. Parker (1996). "Spatial variations in the determinants and effects of firm births and deaths." Regional Studies **30**(7): 679-88.

Jones, K. and C. Duncan (1996). People and places: The multilevel model as a general framework for the quantitative analysis of geographical data. Spatial Analysis: Modeling in a GIS Environment. P. Longley and M. Batty. Cambridge, Longman**:** 79-104.

Jovanovic, B. (1982). "Selection and the evolution of industry." Econometrica **50**(3): 649-670.

Keeble, D. and S. Walker (1994). "New firms, small firms and dead firms: Spatial patterns and determinants in the United Kingdom." Regional Studies **28**(4): 411-428.

Kelley, K. C. (1977). "Urban disamenities and the measure of economic welfare." Journal of Urban Economics **4**(4): 379-88.

Kiefer, N. M. (1988). "Economic duration data and hazard functions." Journal of Economic Literature **26**(2): 646-679.

Kim, S. (1990). "Labor heterogeneity, wage bargaining, and agglomeration economies." Journal of Urban Economics **28**: 160-177.

Kim, S. (1999). "Regions, resources and economic geography: Sources of U.S. regional comparative advantage, 1880-1987." Regional Science and Urban Economics **29**: 1-32.

Kirchoff, B. D., C. Armington, I. Hason and S. Newbert (2002). The Influence of R&D Expenditures on New Firm Formation and Economic Growth. Washington D.C., National Commission on Entrepreneurship.

Knaup, A. E. (2005). "Survival and longevity in the business employment dynamics data." Monthly Labor Review **May**: 2-8.

Koo, J. (2005a). "Agglomeration and spillovers in a simultaneous framework." Annals of Regional Science **39**(1): 35-47.

Koo, J. (2005b). "Knowledge-based industry clusters: Evidenced by geographic patterns in manufacturing." Urban Studies **42**(9): 1487-1505.

Koo, J. and S. Lall (2005). "Economic Geography: Real of Hype." working paper.

Krugman, P. (1991). Geography and Trade. Cambridge, M.A., MIT Press.

Leone, R. A. and R. Struyk (1976). "The incubator hypothesis: Evidence from 5 SMSAs." Urban Studies **13**: 325-331.

Lever, W. F. (1972). "Industrial movement, spatial association and functional linkages." Regional Studies **6**: 371-84.

Lucas, R. L. (1988). "On the mechanics of economic development." Journal of Monetary Economics **22**(1): 3-42.

Lucas, R. L. (1993). "Making a miracle." Econometrica **61**(2): 251-272.

Mahmood, T. (1992). "Does the rate of new plants vary between low and high-tech industries?" Small Business Economics **4**(3): 201-209.

Mahmood, T. (2000). "Survival of newly founded businesses: A log-logistic model approach." Small Business Economics **14**: 223-237.

Malecki (1992). "R&D Facilities and professional labour: Labour force dynamics in high technology." Regional Studies **26**(2): 123-136.

Malecki, E. J. (1990). "New firm formation in the USA: corporate structure, venture capital, and local environment." Entrepreneurship and Regional Development **2**: 247-65.

Malecki, E. J. (1994). "Entrepreneurship in regional and local development." International Regional Science Review **16**(1 & 2): 119-153.

Malmberg, A. and P. Maskell (1997). "Towards and explanation of regional specialization and industry agglomeration." European Planning Studies **5**(1): 25-42.

Marcon, E. and F. Puech (2003). "Evaluating the geographic concentration of industries using distance-based methods." Journal of Economic Geography **3**(4): 409.

Markusen, A. (1996). "Sticky places in slippery space: A typology of industrial districts." Economic Geography **72**(3): 293-313

Marshall, A. (1920 [1890]). Principles of Economics. London, Macmillan and Co.

Maskell, P. (2001). "Toward a knowledge-based theory of the geographic cluster." Industrial & Corporate Change **10**(4): 921-43.

Mason, C. (1991). Spatial variations in enterprise: The geography of new firm formation. In Deciphering the Enterprise Culture: Entrepreneurship, Petty Capitalism and the Restructuring of Britain. R. Burrows (Ed.). London and New York, Routledge**:** 74-106.

Mata, J. (1994). "Firm growth during infancy." Small Business Economics **4**: 125-131.

Mata, J. (1996). "Markets, entrepreneurs and the size of new firms." Economic Letters **52**: 89-94.

Mata, J. and P. Portugal (1994). "Life duration of new firms." Journal of Industrial Economics **27**: 227-245.

Mata, J. and P. Portugal (1999). Technology intensity, demand conditions, and the longevity of firms. In Innovation, industry evolution, and employment. D. B. Audretsch and A. R. Thurik (Eds.). Cambridge; New York and Melbourne, Cambridge University Press**:** 265-279.

Mata, J., P. Portugal and P. Guimarães (1995). "The survival of new plants: Start-up conditions and post-entry evolution." International Journal of Industrial Organization **13**: 459-481.

Maurel, F. and B. Sedillot (1999). "A measure of geographic concentration in french manufacturing industries." Regional Science and Urban Economics **29**: 575-604.

McCann, P. (1995). "Rethinking the economics of location and agglomeration." Urban Studies **32**: 563-577.

Meester, W. (2004). Locational Preferences of Entrepreneurs: Stated Preference in the Netherlands and Germany. Heidelberg and New York, Physica.

Minniti, M. (2005). "Entrepreneurship and network externalities." Journal of Economic Behavior and Organization **57**: 1-27.

Moomaw, R. L. (1981). "Productivity and city size: A critique of the evidence." Quarterly Journal of Economics **96**: 675-688.

Moomaw, R. L. (1983). "Spatial productivity variations in manufacturing: A critical survey of cross-sectional analyses." International Regional Science Review **8**: 1-22.

Moomaw, R. L. (1985). "Firm location and city size: Reduced productivity advantages as a factor in the decline of manufacturing in urban areas." Journal of Urban Economics **17**(1): 73-89.

Moomaw, R. L. (1988). "Agglomeration economies: localization or urbanization?" Urban Studies **25**: 150-61.

Moomaw, R. L. (1998). "Agglomeration economies: Are they exaggerated by industrial aggregation?" Regional Science and Urban Economics **28**: 199-211.

Nakamura, R. (1985). "Agglomeration economies in urban manufacturing industries: A case of Japanese cities." Journal of Urban Economics **17**: 108-124.

Nelson, R. and S. Winter (1982). An Evolutionary Theory of Economic Change. Cambridge, MA, Harvard University Press.

Norton, R. and J. Rees (1979). "The product cycle and the spatial decentralization of American manufacturing." Regional Studies **13**: 141-151.

O'Farrell, P. N. and D. M. W. N. Hitchens (1988). "Alternative theories of small-firm growth: A critical review." Environment and Planning A **20**(10): 1365 - 1383.

Ohlin, B. (1933). Interregional and international trade. Cambridge, MA, Harvard University Press.

Oughton, C. and G. Whittam (1997). "Competition and cooperation in the small firm sector." Scottish Journal of Political Economy **44**(1): 1-30.

Pakes, A. and R. Ericson (1998). "Empirical implications of alternative models of firm dynamics." Journal of Economic Theory **79**: 1-45.

Panzar, J. C. and R. D. Willig (1981). "Economies of scope." American Economic Review **71**: 268-272.

Parr, J. B. (2002a). "Agglomeration economies: ambiguities and confusions." Environment and Planning A **34**: 717-731.

Parr, J. B. (2002b). "Missing elements in the analysis of agglomeration economies." International Regional Science Review **25**: 151-168.

Parr, J. B. (2004). "Economies of scope and economies of agglomeration: The Goldstein-Gronberg contribution revisited." Annals of Regional Science **38**: 1-11.

Perroux, F. (1950). "Economic space: theory and applications." Quarterly Journal of Economics **64**: 89-104.

Peters, A. H. and P. S. Fisher (2004). "The failure of economic development incentives." Journal of the American Planning Association **70**(1): 27-37.

Phelps, N. A., R. J. Fallon and C. L. Williams (2001). "Small firms, borrowed size and the urban-rural shift." Regional Studies **35**(7): 613-624.

Piore, M. J. and C. F. Sabel (1984). The Second Industrial Divide: Possibilities for Prosperity. New York, Basic Books.

Pivetz, T. and H. Change (1998). Linking unemployment insurance wage records to ES-202 establishment microdata to improve accuracy of the BLS' Longitudinal Business Establishment Database. 1998 International Symposium on Linked Employer-Employee Data, Washington D.C.

Pivetz, T., M. Searson and J. Spletzer (2001). "Measuring job and establishment flows with BLS longitudinal microdata." Monthly Labor Review **April**: 13-20.

Porter, M. (1990). The Competitive Advantage of Nations. London, Macmillian.

Porter, M. E. (1979). "The structure within industries and companies' performance." Review of Economics and Statistics **61**: 214-227.

Porter, M. E. (1980). Competitive Strategy. New York, Free Press.

Porter, M. E., C. H. Ketels, K. Miller and R. T. Bryden (2004). Competitiveness in Rural U.S. Regions: Learning and Research Agenda. Cambridge, MA, Institute for Strategy and Competitiveness.

Pratten, C. F. (1991). The Competitiveness of Small Firms. Cambridge, UK, Cambridge University Press.

Prentice, R. L. and L. A. Gloeckler (1978). "Regression analysis of grouped survival data with application to breast cancer data." Biometrics **34**: 57-67.

Reynolds, P. (1994). "Autonomous firm dynamics and economic growth in the United States." Regional Studies **28**(4): 429-442.

Richardson, G. B. (1972). "The organisation of industry." Economic Journal **82**: 883-896.

Richardson, H. W. (1974). "Agglomeration potential: A generalization of the income potential concept." Journal of Regional Science **14**(3): 325-336.

Rigby, D. L. and J. Essletzbichler (2002). "Agglomeration economies and productivity differences in US cities." Journal of Economic Geography **2**(4): 407-432.

Robertson, K., L. Huff, G. Mikkelson, T. Pivetz and A. Winkler (1997). Improvements in record linkage processes for the Bureau of Labor Statistics' business establishment list. 1997 Record Linkage Workshop and Exposition, Office of Management and Budget.

Robinson, E. A. G. (1958). The Structure of Competitive Industry. Cambridge, Cambridge University Press.

Rocha, H. O. and R. Sternberg (2005). "Entrepreneurship: The role of clusters theoretical perspectives and empirical evidence from Germany." Small Business Economics **24**: 267-292.

Romer, P. (1986). "Increasing returns and long-run growth." Journal of Political Economy **94**: 1002-1037.

Romer, P. (1990). "Endogenous technological change." Journal of Political Economy **98**: S71-102.

Rosenbaum, D. I. and F. Lamort (1992). "Entry barriers, exit, and sunk costs: an analysis." Applied Economics **24**: 297-304.

Rosenthal, S. S. and W. C. Strange (2001). "The determinants of agglomeration." Journal of Urban Economics **50**: 191-229.

Rosenthal, S. S. and W. C. Strange (2003). "Geography, industrial organization and agglomeration." Review of Economics and Statistics **85**(2): 377-93.

Rosenthal, S. S. and W. C. Strange (2004). Evidence on the nature and sources of agglomeration economies. In Handbook of Urban and Regional Economics, Vol. 4. J.V. Henderson and J. Thisse (Eds.). Netherlands, Elsevier.

Sabel, C. (1989). Flexible specialization and the re-emergence of regional economies. In Reversing Manufacturing Decline? W. Hirst and V. Zeitlin (Eds.). Oxford**:** 17-70.

Saxenian, A. (1991). "The origins and dynamics of production networks in Silicon Valley." Research Policy **20**: 423-437.

Saxenian, A. (1994). Regional Advantage: Culture and Competition in Silicon Valley and Route 128. Cambridge, Harvard University Press.

Scherer, F. (1982). "Inter-industry technology flows and productivity growth." Review of Economics and Statistics **64**(4): 627-634.

Schmenner, R. W. (1982). Making Business Location Decisions. Englewood Cliffs, NJ, Prentice-Hall.

Scott, A. J. (1986). "Industrial organization and location: Division of labor, the firm and spatial process." Economic Geography **63**: 215-31.

Scott, A. J. (1988). Metropolis: From the division of labor to urban form. Berkeley, University of California Press.

Scott, A. J. (1992). "The role of large producers in industrial districts: A case study of high technology systems in Southern California." Regional Studies **26**: 265-275.

Segal, D. (1976). "Are there returns to scale in city size?" Review of Economics and Statistics **LVIII**: 339-50.

Shefer, D. (1973). "Localization economies in SMSAs: A production function analysis." Journal of Regional Science **13**: 55-64.

Singer, J. D. and J. B. Willett (1993). "It's about time: Using discrete-time survival analysis to study duration and the timing of events." Journal of Education Statistics **18**(2): 155-195.

Smith, A. (1976 [1776]). An Inquiry Into the Nature and Causes of the Wealth of Nations. Chicago, University of Chicago Press.

Sternberg, R. (1999). "Innovative Linkages and Proximity: Empirical results from recent surveys of small and medium sized firms in German regions." Regional Studies **33**(6): 529-540.

Stigler, G. L. (1951). "The division of labor is limited by the extent of the market." Journal of Political Economy **59**: 185-93.

Storper, M. (1992). "The limits to globalization: Technological districts and international trade." Economic Geography **68**: 60-93.

Streit, M. E. (1969). "Spatial association and economic linkages between industries." Journal of Regional Science **9**(2): 177-188.

Sutaria, V. (2001). The Dynamics of New Firms Formation. Burlington, VT, Ashgate.

Sutaria, V. and D. A. Hicks (2004). "New firm formation: Dynamics and determinants." Annals of Regional Science **2004**(38): 241-262.

Sviekauskas, L. (1975). "The productivity of cities." Quarterly Journal of Economics **89**: 393-413.

Sviekauskas, L. (1988). "Urban productivity: City size or industry size." Journal of Regional Science **28**: 185-202.

Sweeney, S. H. and E. J. Feser (1998). "Plant size and clustering of manufacturing activity." Geographical Analysis **30**(1): 45-64.

Sweeney, S. H. and E. J. Feser (2004). "Business location and spatial externalities: Tying concepts to measures." In Spatially Integrated Social Science. M.F. Goodchild and D.G. Janelle (Eds.). Oxford University Press, Oxford, UK.

Tödtling, F. and H. Wansenböck (2003). "Regional differences in structural characteristics of start-ups." Entrepreneurship and Regional Development **15**(4): 351-370.

Trussell, J. and T. Richards (1985). "Correcting for unmeasured heterogeneity in hazard models using the Heck-man-Singer procedure." Sociological Methodology **15**: 242-276.

Varga, A. (2000). "Local academic knowledge transfers and the concentration of economic activity." Journal of Regional Science **40**(2): 289-309.

Vernon, R. (1960). Metropolis 1985: Interpretation of the findings of the New York metropolitan region study. Cambridge, MA, Harvard University Press.

Viladecans-Marsal, E. (2004). "Agglomeration economies and industrial location: city-level evidence." Journal of Economic Geography **4**: 565-582.

von Thünen, J. H. (1966 [1826]). von Thünen's Isolated State. Oxford, Pergamon Press.

Wagner, J. (1994). "The post-entry performance of new small firms in German manufacturing industries." Journal of Industrial Economics **XLII**(2): 141-154.

Wagner, J. (1999). "The life history of cohorts of exits from German manufacturing." Small Business Economics **13**: 71-79.

Weber, A. (1929 [1909]). Theory of the Location of Industries. Chicago, University of Chicago Press.

Williamson, O. E. (1975). Markets and Hierarchies, Analysis and Antitrust Implications: A Study in the Economics of Internal Organization. New York, Free Press.

Williamson, O. E. (1981). "The modern corporation: Origins, evolutions, attributes." Journal of Economic Literature. **19**(4): 1537-1568.

Winter, S. G. (1984). "Schumpeterian competition in alternate technological regimes." Journal of Economic Behavior and Organization **5**: 287-320.

Woodward, D., O. Figueiredo and P. Guimarães (2004). "Beyond the Silicon Valley: University R&D and high-technology location." working paper.

Young, A. (1928). "Increasing returns and economic progress." Economic Journal **38**: 527-42.