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Abstract

Motivated by differences in new-firm survival across regions, this paper explores the impact of regional human capital on new-firm survival rates. New-firm survival is interpreted through formation rates of surviving versus closed firms in the service sector. By incorporating knowledge spillovers through a geographical variation model for Labor Market Areas, we empirically test the relationship between regional human capital stocks and new-firm survival. The expected positive relationship between regional human capital and new-firm survival is supported for the period 1993-1995, but is not as strong for the recession period 1990-1992. Controlling for human capital, the new-firm survival rate is negatively related to service sector specialization and positively related to all industry intensity, suggesting that city size and diversity may be an important determinant of new-firm survival in both periods.

JEL Classification: R1, L80, J24, M13, O3

Key Words: New-Firm Survival, Human Capital, Knowledge Spillovers, Entrepreneurship, Labor Market Area

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1. INTRODUCTION

The variation in new-firm survival did not receive much attention in the literature until the 1980s (Lin and Huang, 2006). In recent years, new-firm survival has received increasing academic attention and many recent studies have focused on its determinants. Following the empirical studies in the 1950s and 1960s that focused on the relationship between the growth rate and firm size by making use of firm-level data, many studies have addressed firm-level factors affecting the new-firm survival rate. In addition to firm level heterogeneity, to explain the empirical evidence related to firm survival, economists have also relied on models that emphasize market selection. Therefore, based on the previous studies on firm survival, factors affecting the survival rate of a newborn firm can be classified into three categories: firm-, industry-, and location-specific factors. Among those three-categories, the role of human capital and location factors, with various measures, has been explored in the new-firm survival literature. However, the measures of human capital have typically focused on the impact of individual characteristics (i.e. characteristics of firm owners, managers, or entrepreneurs) (Van Praag, 2003). The location-specific human capital, or the aggregate human capital at the regional level, has not been analyzed for firm survival (Acs and Armington, 2006).

The results of previous studies[1] that focus on individual-specific human capital levels have not been consistent (see Storey, 1994). Most studies have focused on the self-employed who often are less educated then the general population especially after professionals is removed from the data. These inconsistent prior findings on the impact of human capital are puzzling, but they may be better explained by the disparities of regional human capital stock. Regional human capital stocks have been found to be important for new-firm formation and might therefore also play a role firm dynamics. The impact of regional human capital agglomeration on new-firm survival is unclear from previously published analyses. On the one hand, according to agglomeration theory, regions with higher levels of educational attainment are expected to have higher formation rates of surviving firms; on the other hand, there is evidence that regions with poor education levels are not necessarily associated with lower new-firm survival. In addition, knowledge spillover debates are seldom addressed in the literature related to new-firm survival or human capital.

This paper is designed to bridge this gap in the literature and explore the relationship between location-specific human capital and new-firm survival at the regional level by incorporating not only the level of schooling, but also knowledge spillover effects (Lucas, 1988), while controlling for other regional effects. The following sections will exhibit the details of this research design. Section 2 reviews the new-firm survival literature and controversies on knowledge spillover in more details and explains why the regional level of human capital is important for explaining differences in new-firm survival rates. Section 3 presents the data and discusses the measurement of new-firm survival rates. Section 4 presents the empirical model, and the results are carefully discussed in section 5. The final section concludes this paper, where we observe that the extent of human capital already in a region has a significant effect on the new-firm survival rate, and knowledge spillovers play an important role in the survival of new-firms.

2. LITERATURE REVIEW

While an extensive literature exists on new-firm survival, few studies examine new-firm survival rate differences across regional economies. Audretsch (1991) started this exploration. Through empirical studies of the variation in ten-year survival rates of 11,000 manufacturing firms established in 1976, Audretsch found that new-firm survival was promoted by higher small-firm innovative activity and was reduced by that the presence of substantial scale economies and high capital-labor ratios in an area. Following Audretsch (1991), many other researches have examined New-firm survival, though not necessarily in the setting of regional economic development. This section reviews the literature related to firm survival through the following three perspectives: mostly addressed determinants for new-firm survival, human capital factors, and location factors. In addition, closely related to regional human capital, this section also reviews the debate on whether knowledge transfers within specialized industries or across diverse industries.

2.1 Mostly Addressed Determinants for New-firm Survival

Most of the new-firm survival literature focuses on factors affecting new-firm survival, particularly for manufacturing firms. The determinants addressed in previous literature for new-firm survival include firm-, industry-, and location-specific factors. The firm-specific factors include firm size (Mata, et. al, 1995), post-entry performance (Audretsch and Mahmoon, 1995; Cooper, et. al, 1997), hybrid organizational forms (Shane, 1996), the timing of entry (Klepper, 2002), organizational capital (i.e. firm capacity to adapt to changes), relational capital (i.e. development of productive business networks) (Peña, 2002), and the development of firm-specific assets through advertising and investing in R&D (Esteve-Pe′rez and Man˜ez-Castillejo, 2006). The industry-specific factors include the stage of the market development in the cycle from birth to maturity (Agarwal and Gort, 1996), technology and the stage of the industry life cycle (Agarwal and Audretsch, 2001), and industry-specific capital, market, and technological regime (Lin and Huang 2006). The location-specific factors include geographical concentration or agglomeration (Leone et al., 1975; Sorenson and Audia, 2000), scale economies (Audretsch, 1995), the quality of the local labor market and business climate (Ciccone and Hall, 1996), and institutional legitimacy (Shane and Foo, 1999).

2.2 Human Capital and New-firm Survival

In addition to the above-mentioned factors affecting new-firm survival, human capital has been considered an important intangible asset for new-firm survival (Peña, 2002), but this role of human capital is controversial. Human capital relevant to enhancing the new-firm-survival rate is typically measured by entrepreneurs' (or firm founders' or owners') level of education (or years of schooling) (Hay and Ross, 1989; Bruderl et al, 1992; Storey, 1994; Bates, 1995; Van Praag, 1996; and Peña, 2002), prior experience in management positions (Cooper et al., 1989; Stuart and Abetti, 1990, and Peña, 2002), industry-specific experience (Bruderl et al., 1992), previous startup experiences (Doutriaux and Simyar, 1987; Dyke et al., 1992), ambition (Stigter, 1998) and motivation for success (Keasy et al., 1991), preparation for the start-ups (Bruderl et al.,1992; Schutjens and Wever, 2000), and time spent on the firms[2] (Peña, 2002).

However, there are also studies that have found no convincing evidence of significant relationship between such personal characteristics and new-firm survival or failure (Wicker et al., 1989). Keeble and Walker (1994) discuss two conflicting hypotheses about the role of entrepreneurs' education level in influencing business survival. One argues that education provides a basis for intellectual development and therefore is an essential constituent of the human capital needed for business success. The converse argument is that business ownership is not an intellectual activity. Instead, entrepreneurship is an opportunity for the less academically successful to earn higher incomes. It may even be that individuals with high academic attainments are likely to be insufficiently challenged by the many mundane tasks associated with business ownership. A third train of thought focuses on the differences in quality of human capital needed as a new product or service evolves through a typical industry life cycle, with better educated employees needed during the development phase. Similarly, Storey (1994) cites empirical evidence from seventeen studies, of which nine found no relationship between education and survival, while the other eight showed some form of positive relationship at the individual level to firm survival.

While the educational level of entrepreneurs may not play a specific role in the survival of individual firms, the general consensus is that education more broadly influences the overall probability of survival of new firms in a region. In fact the new sociology suggests that characteristics of regions and local networks may be more important for survival of entrepreneurial firms than individual initiative (Thornton, 1999, and Littunen, 2000).

2.3 Why Location Matters to New-Firm Survival Rates

Much of the recent research on new-firm formation and growth has focused on the role of innovation in economic competitiveness. Feldman (2000) provides a good summary of this line of analysis, but she does not dwell on the factors that might account for regional differences in the successful application of innovative ideas, which results in differing survival rates of innovation-based new firms. Acs and Armington (2004b) address this issue in terms of human capital, spillovers, and agglomeration effects, specifically for service firm formations.

Does the level of human capital stock in a region have a different impact on the region's rate of new-firm success than on its rate of new-firm failure? Can we identify any factors that contribute more to the formation of surviving firms than to the formation of closed firms within their fist three years? This is an important question because the new firms that fail quickly contribute little to a local economy beyond temporary disruption.

While there has been very little research on firm survival differences at the regional level, it has been examined carefully in the context of industrial organization studies (see, for example, Geroski 1995). Audretsch (1995) found that indeed scale economies and product differentiation constitute barriers to survival, but these can be overcome when firms innovate and learn how to survive.

Region or location matters to new-firm survival because it offers the resource base and the cultural environment necessary for a firm to maintain its growth. According to firm incubation theory, larger agglomerations tend to provide a more favorable breeding ground for firm success and this successful experience may spread to nearby locations (Leone et al., 1975). Peña (2004)'s measure of the relative number of local business incubation centers in the study of new-firm growth evidenced this argument. The agglomeration effects that contribute to new-firm survival can come both from demand effects associated with increased local population, income, and business activity, and from supply factors related to the quality of the local labor market and business climate (Ciccone and Hall, 1996). Among areas with broadly similar regional demand and business climate characteristics, there are further differences in rates of new-firm survival that are associated with the specific qualities of their human capital, and the propensity of locally available knowledge to spill over and stimulate innovative activities that culminate in new-firm success. More educated populations provide more human capital, embodied in their general and specific skills, for implementing new ideas for creating and growing new businesses. They also create an environment rich in local knowledge spillovers, which support another mechanism by which new-firm start-ups are initiated and sustained.

Thus, regions that are richer in educated people should have more start-up activities. We would expect that surviving businesses would be more sensitive to differences in the local educational attainment rates than short-lived businesses. Higher shares of college graduates in the local population should lead to higher firm birth rates of surviving firms. These externalities of human capital agglomeration may also spill over to influence those with lower education levels. In the 1990s, many service businesses were started using relatively unskilled labor for services such as building cleaning, security, detective, and secretarial services.

However, although agglomeration has been purported to enhance chances for new-firm survival, there is also evidence that geographic concentration serves as a constraint to new-firm survival. Through social and spatial models of competition, Sorenson and Audia (2000) found that geographic concentration contributed to firm failure, instead of success, and the current distribution of production placed important constraints on entrepreneurial activities. Also, although there is rather convincing evidence at the individual level that, ceteris paribus, educational attainment levels are positively associated with new business formation (Evans and Leighton, 1990; Bates, 1997), it has not been tested whether higher regional average educational attainment rates lead more strongly to higher formation rates for surviving firms than for short-lived firms. Kangasharju and Pekkala (2000) found that in Finland the more educated self-employed tended to have higher failure rates during growth periods and lower failure rates in recessions, apparently because the better educated are more likely to choose jobs with existing firms when they are easily available during growth periods. This leads to a credible contrary hypothesis when regions are the unit of analysis. Regions with a high proportion of the workforce that has both high educational qualifications and managerial experience may be more likely to provide greater opportunities for individuals to obtain secure and rewarding employment with large firms, without having to take the risk of becoming an entrepreneur themselves.

2.4 Debates on Knowledge Spillovers: Specialization or Diversity?

Historically, agglomeration has contributed to the flourishing of many metropolises through natural geographical advantages, convenient market or product accesses, and knowledge spillovers. However, although the New Economic Geography has indicated the agglomeration effect due to market size, transportation cost, and firm level increasing returns, neoclassical urban system theory indicates that agglomeration may not always result in positive externalities (Krugman 1996). Diseconomies of city scales occur as well as agglomeration economies.

Along with agglomeration theories, the importance of industry localizations has been noted. With the assumption of knowledge externalities within the same industry, Loesch (1954)'s location theory indicated the important of industry localization; Arrow (1962) suggests the concept of sticky knowledge; Romer (1986, 1990), Lucas (1993), and Krugman (1991) believe that concentration of industry within geographical regions facilitates knowledge spillover across firms and externality within geographical boundary results in increasing returns. Focusing on spillovers between firms within industry, the Marshall-Arrow-Romer (MAR) model purports that geographical specialization absorbs knowledge spillovers between firms. According to theories of dynamic externalities, cities grow because of people's interaction and knowledge sharing. Knowledge spillovers are externalities. Cities grow better than rural areas because cities provide greater proximity between people, which facilitates their more frequent interaction and knowledge spillovers. Therefore, proximity in cities enlarges knowledge externalities. The geographical specialization emphasized in the MAR model is assumed within industry, not across industries. Porter (1990) mirrors this perspective of the MAR theory. Similar to the MAR model, Porter (1990) argues that knowledge spillovers in specialized, geographically concentrated industries stimulate growth. The MAR theory and Porter both agree that the most important technological externalities occur within industry and that regional specialization is good for growth (Glaeser et al., 1992).

Unlike the MAR theory and Porter, Jacobs (1969) believes that the most important knowledge transfers come from outside the core industry. Instead of geographical specialization, Jacobs (1969) indicates that variety of industries and knowledge transfer across geographically proximate industries enhances innovation and growth. For Jacobs (1969), exchange of complementary knowledge across diverse industries yields greater returns because it allows for new economic knowledge-inter-industry spillover.

The above main controversy underlines a secondary debate between local competition and local monopoly. The MAR model predicts that local specialization and monopoly are better for growth than local competition because through monopoly innovators internalize the externalities (Romer, 1990). On the one hand, industry specialization facilitates ideas to be quickly disseminated among neighboring firms of the same industry through spying, imitation, and rapid inter-firm movement of highly skilled labor; on the other hand, monopoly reduces imitation from neighboring firms, protects property rights, and thus raises their pace of innovation and growth.

For the debate on local competition or monopoly, Porter (1990) diverts his view from the MAR theory. Porter (1990) predicts that local competition, rather than local monopoly, fosters the pursuits and rapid adaptation of innovation (Glaeser et al. 1992). Although Porter (1990) has also identified the situation that local competition accelerates imitation, he notices that competition also pushes firms for further innovation. To survive the fierce competition, firms have to continuously innovate with sustainable new ideas and form their own core competence.

As a result, ruthless competition between local competitors leads to rapid adaptation of the innovations and therefore generates industry growth.

After reviewing these above debates, Glaeser et al. (1992) have empirically tested Jacobs's diversity versus specialization hypothesis. Through measuring employment, Glaeser et al. (1992) find that industries grow slower in cities where they are more heavily over-represented and industries grow faster when the rest of the city is less specialized. This result is consistent with Jacob's view that city diversity promotes growth as knowledge transfers across industries.

Following Glaeser et al. (1992), Feldman and Audretsch (1999) further empirically test this argument on diversity versus specialization. In addition to adopting Glaeser et al. (1992)'s measurements, Feldman and Audretsch (1999) add the variable, science-based related industries, to test the innovation of clustering industries. They find that complementary industries sharing the same base of scientific knowledge tend to locate together in geographical space for both the location of production and the location of innovation and that a strong presence of complementary industries sharing a common science base, not specialized industries or localized competition, is particularly conductive to innovative activity.

3. MEASUREMENT OF NEW-FIRM FORMATION AND SURVIVAL

3.1 The Data

This study uses a new database that the Bureau of the Census has constructed for study of survival in different types of businesses. The Longitudinal Establishment and Enterprise Microdata (LEEM) file has multiple years of annual data for every U.S. private sector (non-farm) business with employees.[3] The current LEEM file facilitates tracking employment, payroll, and firm affiliation and (employment) size for the more than eleven million establishments that existed at some time during 1989 through 1998. This database was constructed by the Bureau of the Census from the microdata underlying the aggregate data published annually in Census' County Business Patterns, and it facilitates tracking establishments over time, even when they change ownership and identification numbers.

The basic unit of the LEEM data is a business establishment (location or plant). An establishment is a single physical location where business is conducted or where services or industrial operations are performed. For each year of each establishment's existence, these microdata provide its employment, location (state, county, and metropolitan area), primary industry, and start year, as well as identifying the firm (or enterprise) to which the establishment belongs, and the total employment of that firm. A firm (enterprise or company) is the largest aggregation (across all industries) of business establishments under common ownership or control.[4]

3.2 The Unit of Observation

The geographic unit of analysis chosen for this study, Labor Market Areas (LMAs)[5], substantially avoids all of the problems associated with the units used in previous studies. State and city boundaries are often quite arbitrary relative to the local patterns of economic activity, and their adjacent areas may substantially influence their local economies. The Metropolitan Statistical Area (MSA) approximates local economic areas, but it is based primarily on the densities of residential population, without regard for the location of businesses. In addition, MSAs are periodically redefined to keep pace with changing urban population patterns, and they exclude large areas of the country whose local economies are not centered on large cities. In this paper, the LMAs are aggregations of the 3,141 US counties into 394 geographical regions based on the predominant commuting patterns (journey-to-work) between them. Each LMA contains at least one central city, along with the surrounding counties that constitute both its labor supply and its local consumer and business market. Many of the 394 LMAs cut across state boundaries to better define regionally integrated areas of local economic activity. The LMA unit of observation has the advantage of including both the employment location and the residence location of the population and labor force within the same area. Being based on counties, a wide variety of data collected at the county or Zip-code level can be aggregated to construct LMA-level data. Finally, the 394 LMAs together cover the whole country, so that their data can be aggregated to U.S. totals, and all areas are represented. [6]

3.3 The Sector of Inquiry

This paper focuses on the service sector of the U.S. economy for four reasons. First, the service sector has been growing much faster than other sectors, increasing its share of private employment from 28.3% in 1990 to 32.8% in 1998. Second, service businesses tend to be more labor-intensive than capital-intensive so that area differences in human capital may have a stronger impact on the service sector than on more capital-intensive manufacturing sectors. Third, new-firm formation rates are much higher in the service sector than in the manufacturing sector (Acs and Armington, 2004a). Indeed, cities with high concentrations of manufacturing have typically been the slowest growing cities over the past twenty years. Finally, much of the growth in service jobs has been in new firms.

3.4 The New-Firm Survival Rates

The firm survival rate at year t is typically measured by the fraction of the total number of firms that survived for at least t years (see, for example, Agarwal and Audretsch, 2001). Among those, the new-firm survival rate at year t is defined as the fraction of the total number of newly established firms that were still in existence after t years (Lin and Huang, 2006; Audretsch, 1991). Sometimes, such as in Evans (1987) and Cressy (1996), the same concept of firm survival rate is actually interpreted as the probability of survival. In a logit or probit model, the binary variable for new-firm survival is often coded as 1 if a firm is existent for both the beginning year and year *t* and as 0 if a firm disappears in the dataset for year *t*. Occasionally, the firm survival rate is indirectly referred to through the firm exit rate. Dunne et al. (1989) clarified the relationship between firm survival rate and exit rate—the firm exit or failure rate equals to 1 minus firm survival rate. Keeble and Walker (1994) used VAT deregistration rates in UK stock as a broad surrogate index of small business deaths and closures and thus inferred some conclusions relevant to firm survival.

To clearly compare surviving firms versus short-lived firms, in this paper, we define the new-firm survival rate as the odds of survival, i.e. the new-firm survival rate is the formation rate of surviving firms divided by the formation rate of firms that closed by the end of their first three years. This measurement of new-firm survival, together with the comparison between the estimated parameters for surviving versus closed firms, can not only examine whether a certain factor leads to higher new-firm survival rates, it can also identify factors contributing to higher formation rates of both successful and closed firms.

Firm formation rates of both surviving and closed firms are calculated for each of the 394 LMAs, based on the number of new-firm formations during each of two recent time periods -- 1993 through 1995, and 1990 through 1992.[7] New firms were separated into those that still had employees 3 years after they first hired any employees, and those deemed to be closed, because they no longer had any employees 3 years later.[8] These have been termed 'surviving' and 'short-lived' new firms, for the purposes of this study.[9]

New firms include both new single-unit firms with less than 500 employees, and the primary locations of new multi-unit firms with less than 500 employees, firm wide. Those new firms that had 500 or more employees in their first year of activity appear to be primarily offshoots of existing companies.[10] 'Single unit firm formations in year *t*' are identified on the LEEM as non-affiliated establishments with a reported Census start-year of *t* or *t-1* that had no employment in March of year *t-1*, and had positive employment below 500 in March of year *t*. This avoids inclusion of either new firms that have not yet actually hired an employee, or firms recovering from temporary inactivity.[11] The Census 'start-year' is the year that the establishment first reported any payroll and therefore entered the Census business register. We have also included most[12] of the relatively few multi-unit firms (1500 to 6000 per year) that appeared to start up with less than 500 employees in multiple locations in their first year.

Because the Labor Market Areas vary greatly in size, the absolute numbers of new firms must be standardized by some measure of the LMA size before it is meaningful to compare them across areas. Firm formation rates are calculated as the number of new firms, either surviving or short-lived, per thousand members of the labor force in the LMA in the prior year. This labor force basis derives from the theory of entrepreneurial choice proposed by Evans and Jovanovic (1989). Each worker in the LMA chooses whether to be an employee of an existing business, or to become an entrepreneur and form a new firm. This approach implicitly assumes that the entrepreneur starts the new business in the same labor market where he or she previously worked or sought employment.

Table 1 includes summary statistics for these firm formation rates for new-firms surviving three years, and for those that were short-lived (closing within three year of their formation), for all service firms with employees that were formed during two periods – between

1990 and 1992 and between 1993 and 1995. The annual average number of surviving new firms was about 0.8 per thousand-labor force, accounting for about 63 percent of all new service firm formations. In other words, nearly two-thirds of the new service firms survived at least three years, while the other third closed before their third year. This ratio was little different for the 1990 to 1992 period, which encompassed a small recession, and the 1993 to 1995 period, with its recovery and rapid growth. Note also that the formation rates for short-lived firms are consistently more variable across regions than those of surviving firms. The standard deviation of the short-lived firm formation rates is one-third of their average rate, while the standard deviation of the formation rates of surviving firms in just one-fourth of their average.

4. EMPIRICAL MODEL

The data for this study were constructed to facilitate analysis of the relationships between local differences in new-firm survival and various characteristics of economic areas, including the human capital. These data are not suitable for distinguishing the impact of the different characteristics of the individuals starting new firms, the firms themselves, or the regional economy, on the survival probabilities of new firms in the region. But these data are suited to our more limited goal -- to test whether the human capital factors that we have previously used to help explain local differences in formation rates of service firms relate differently to formation rates of surviving firms, in contrast to formation rates of firms that close within three years.[13] More specifically, we hypothesize that the formation rates for successful businesses are more strongly related to our human capital variables than the formation rates for businesses that close quickly. This would mean that regional human capital is positively associated to new-firm survival.

New-firm survival should be positively associated with higher levels of local human capital (including relevant knowledge spillovers), and we would expect formation of surviving firms to be much more sensitive to these human capital variables than formation of short-lived firms, using the following model:

(1) Formation of Surviving Firms $_{Lt+3} = \alpha_L + ß$ Human Capital $_{L\,t} + \delta\,[X]_{\,Lt} + e_{\,L,}$

(2) Formation of Short-lived Firms $_{Lt+3} = \alpha'_L + ß'$ Human Capital $_{L\,t} + \delta'\,[X]_{\,Lt} + e'_{\,L;}$

(3) New–firm Survival Rate = Formation of Surviving Firms/ Formation of Short-lived Firms;

where X is a vector of control variables, the subscript $_L$ indexes LMAs, t refers to time and e is stochastic disturbance. [14] The conditioning information set is a vector of exogenous population and business variables specific to each labor market area L. Equation (1) measures variables of surviving firms and equation (2) measures variables of short-lived firms.

4.1 The Key Independent Variable—Human Capital

To measure the level of human capital in each local economy we use two measures of educational attainment in each region, and a measure of the relative intensity of businesses in the same sector. The share of *college graduates* is defined as the number of adults with college degrees in 1990 divided by the total number of adults. This is a proxy measure that covers both technical skills needed in the economy, for example engineers and scientists, and skills needed to start and build a business, like finance and marketing and complex reasoning.

In 1990, an average of 16 percent of the adult (at least 25 years old) population of the U.S. had a college degree,[15] but this varied from a low of 6 percent to a high of 32 percent across LMAs. Its simple correlation with the new service firm formation rates in LMAs is 0.29 and it has been found to be positively related to the birth rate, even after controlling for other important factors (Glaeser et al, 1995; Rauch, 1993; Simon and Nardinelli, 1996 and 2002). We expect it to be more strongly related to the formation rate of surviving businesses than to the formation rate of short-lived firms. Prior U. S. empirical work has presented rather convincing evidence at the individual level that, ceteris paribus, *educational attainment* levels are positively associated with new business formation (Evans and Leighton, 1990 and Bates 1997).

The second measure of educational attainment that we use is the *high-school dropout* rate, defined as the percentage of adults (population 25 years or older) without college degrees who also do not have high-school degrees in 1990.[16] This high school dropout rate should be a good proxy for the proportion of unskilled and semi-skilled labor in the LMA. Nationally, 33 percent of non-college adults were high-school dropouts in 1990, and this varied from 17 to 60 percent across LMAs. We have found in previous work (e.g. Acs and Armington 2004b) that, at least for the nineties, in multi-variate regression analysis the high-school dropout rate is pretty consistently positively related to the firm formation rate. While many high-school dropouts are employed in some of the personal and business service activities, few of them have the skills to start and manage a new firm themselves. In fact, the simple correlation between the high-school dropout rate and the new service firm formation rate is –0.19. It may be that the limited employment opportunities for high-school dropouts will lead more of them to start businesses themselves in order to support themselves and their peers. However, such new businesses are more likely to be under-capitalized, badly managed, and/or non-competitive, leading to higher rates of formation of non-surviving, or short-lived, firms. We therefore anticipate that the positive relationship of high-school dropout rates to firm formation rates will be stronger for new firms that are short-lived.

4.2 Knowledge Spillovers

Knowledge spillovers from people involved in related activities are another potential factor contributing to the rate of new-firm formation. Some prior studies have attempted to assess the potential for positive effects from spillovers using population density, or establishment density, the number of units per square mile. Such measures, however, are more indicative of physical crowding than of communication opportunities. We expect the quantity of potentially useful knowledge spillovers to be a function of the number of similar business establishments, relative to the population of the economic area. *Service-industry intensity* is defined as the number of service establishments in the region divided by the region's population in thousands. The greater the number of establishments relative to the population, the more spillovers should be facilitated due to density of establishments (Ciccone and Hall, 1996). Conversely, areas dominated by a few large businesses are less likely to have spillover of knowledge that stimulates new-firm formation. It is not clear whether this relationship should be stronger for surviving new firms or for short-lived new firms.

All-Industry intensity is the total number of private sector establishments in the region, divided by the region's population. This measure captures the general business intensity of an area, relative to its population density. It may also be thought of as the ratio of an area's business density (establishments per square mile) to its population density (people per square mile). The all-industry intensity variable serves to control for differences in crowding of businesses, relative to the population. Since we have already taken into consideration the local intensity of establishments in the service sector, we expect that the greater the density of all establishments, the lower the service firm formation rate will be (Acs, FitzRoy and Smith, 2002).

4.3 Regional Control Variables

The human capital variables whose impact we are analyzing are not the only explanation for differences among LMAs in new-firm survival rates. We control for differences in a number of other regional characteristics, which are commonly thought to influence survival rates. Summary statistics are provided in Table 1.

Population growth represents the average annual rate of change in the local population in the previous period.[17] Population growth captures the extent to which cities are relatively attractive to both migrants and immigrants, for living and for doing business. The growth in a region also increases local demand, causing subsequent proportional growth in businesses that market to that region's consumers or businesses. This growth might take place either by expansion of existing businesses, or by creation of new businesses. A growing population increases the demand for consumer services and should be positively related to business survival.

Income growth represents the average annual rate of increase of personal income per capita in the region over the prior two-year period, calculated using the same formula as for population. Income growth in excess of population growth captures local growth in labor productivity, and concomitant increases in local average quality of life. Two different mechanisms contribute to the expectation that areas with faster growing incomes would have higher rates of new-firm formation. The first is that areas with increases in disposable income will probably have greater demand for a wider range of income-elastic services. Secondly, this higher income growth enables potential new business founders to raise capital more easily at lower cost, thereby increasing the probability of finding the necessary capital to start a new business. Higher levels of either or both of these growth factors for the preceding period are expected to promote higher new-firm formation (Reynolds, 1994).

We control for agglomeration effects in each region by including the log of population as a control variable, because we expect proportional differences in population to impact the new-firm formation rates (rather than absolute value differences). Agglomeration effects are expected to have a positive impact on the survival rates. Lucas (1988) asserts that the only compelling reason for the existence of cities would be the presence of increasing returns to agglomeration of resources, which make these locations more productive. Population is highly correlated with the share of adults with college degrees, but the residuals when the estimated model excluded population was highly correlated with the size of the LMAs, providing evidence that the agglomeration effect contributes beyond the correlated effect of better education.

The *unemployment rate* is calculated for the two-year period prior to our start-up measurement period and expressed as the average number of unemployed divided by the labor force. The local unemployment rate has been traditionally used as a measure of local economic distress, which would suggest it serves primarily as an indicator of local business health, so that higher unemployment should be associated with fewer new-firm formations. In many studies of new-firm formation in the 1980s, there was a heavy emphasis on the possible positive explanatory power of unemployment (Evans and Leighton, 1990, Storey, 1991). Unemployment had then increased significantly in several countries and stayed at very high levels over an extended period. It was suggested that when workers were unemployed they might be more likely to start their own businesses. This activity, in turn, might reduce the unemployment rate as the resulting new-firms employ not only the owners, but also others. This effect of unemployment may dominate in the service industries, with its generally lower capital requirements.

Establishment size is a proxy for the broad structure of business in the region. It is measured for all private sector (non-agricultural production) industries together, as the region's employment divided by its total number of establishments. A local business structure with no dominant large firms may offer fewer barriers to entry of new firms. Furthermore, where small firms predominate in a geographical area there is a much broader population of business owners, and more individuals may visualize their own careers as leading to the founding of independent new firms. Thus the average size of area establishments should be negatively related to the new-firm formation rates, since larger average size indicates greater dominance by large firms or branch plants (Armington and Acs, 2004a).

Of course, some of these control variables may in fact be endogenous to, or at least correlated with, other variables. Table 2 shows the correlation coefficients among many of them, but the service industry data were not available publicly for this calculation, so Table 2 uses the all-industry firm formation rate, and does not include service industry intensity. Although income growth and population growth were measured for a previous two-year period, such regional differences are likely to persist over time, and future growth differences certainly result from current differences in formation rates. Therefore there is likely to be some endogeneity bias in the estimates for most of the variables, but numerous experiments with omitting some variables from the estimated models have provided considerable evidence that such endogeneity has not had a substantial impact on either the signs or the relative sizes of the estimated parameters. In fact, much of the economic geography literature today is concerned with cumulative growth mechanisms in which cause and effect are complexly interrelated. [18]

Because the economies of each Labor Market Area have considerable contact with adjacent LMA economies, and people are not restricted in their contacts, there will also be some spatial correlation that may impact our estimates, but we cannot even guess how that might affect our results. These effects are probably very small relative to the significant categories of influences that have been completely omitted, such as variations in availability of funds, and of transport and energy costs. Levels of regional per capita income are only correlated 0.15 with firm formation rates, and our model.

5. EMPIRICAL RESULTS

We test whether more regional human capital lead to a higher new-firm survival rate in a region within three years and whether knowledge spillovers within the service industry or across various sectors associate with a higher survival rate. More specifically, we hypothesize that the new-firm survival rates for successful businesses are more strongly positively related to the local levels of higher educational attainment (high share of college degrees and low share of high school dropouts) and potential for knowledge spillovers from similar businesses (intensity of service establishments).

The simple least squares estimations of the parameter values for new-firm survival rates and formation rates of both surviving and closed firms during both time periods, are shown in Table 3, using all 394 LMAs as our units of observation. We present standardized beta coefficients[19], so that each parameter indicates the sensitivity of survival variation to normalized variation in the corresponding independent variable. We also calculated t-ratios from the simple estimated standard errors and estimated the coefficients with a correction for heteroscedasticity. These results after correcting for heteroscedasticity were very similar to the uncorrected standard errors, so we conclude that it is not a serious problem. The estimated coefficients are generally consistent with our expectations, but with several important exceptions. The explanatory and control variables together explain about two-thirds of the regional differences in each of the new service firm formation rates.

5.1 Findings on Regional Human Capital

For the model of survival rates (shown in the last two columns in Table 3), the estimated parameters of human capital measures basically display our expected findings. To be more specific, except for that college-degree-share presents a weak negative impact (-0.02) on firm survival rate for the period of 1990-1992, high school dropout rates are negatively associated with firm survival rate for both periods and college-degree-share is positively related to firm survival rate for the period of 1993-1995. Therefore, our expectations on the relationship between regional human capital and new-firm survival rate are supported for the second period (growth period), but not as strongly supported for the first period (recession). Higher shares of college degrees during recessions might lead to higher rates of formation of new firms that fail, while during growth periods there is no such relationship? Further research is needed to resolve this question.

Also as expected, the estimated parameters of the human capital variables were positive for formation rates of both surviving and closed firms, and they were significant at the 0.05 levels for all but the impact of college degree share on the formation of short-lived firms in 1993-95. Looking further at these coefficients on share of college degrees, we get the consistent findings as has been found from the model for survival rates. We note that for 1990-92 formations of both surviving and closed firms, the share of adults with college degrees has the expected positive relationship with both, but it is slightly stronger for short-lived firm formations than for surviving formation, contrary to expectations. In the 1993-95 period the share of college degrees showed a similar positive relationship to surviving formation rates, but virtually none to the formation rate of firms that closed within 3 years. This period therefore strongly supports our hypothesis that college-degree-share would be more strongly associated with surviving formations than with short-lived ones; or in another word, regional education attainment measured by college-degree-share is positively related to new-firm survival. However, the earlier period failed to support this hypothesis.

The coefficients for the share of high school dropouts are consistently stronger for closed formations than for surviving formations. This stronger association of dropout rates with failed formation rates suggests that people who start businesses without adequate education are more likely to fail. This supports the finding of Bates (1997, p.1). In that author's words,

> People most likely to pursue self-employment are highly educated and skilled, often possessing significant personal financial resources. Likewise, those lacking the requisite skills and capital, whether immigrants or otherwise, are unlikely to start small businesses. Among people who choose self-employment without appropriate education, skills and financial resources, business failure and self-employment exit rates are high.

5.2 Findings on Knowledge Spillovers

Interestingly, in terms of the debates on industry specialization or diversity, our findings on knowledge spillovers seem consistent with Jacobs (1969) theory and empirical findings by Glaeser et al. (1992) and Feldman and Audretsch (1999). As shown in the last two columns of Table 3, the intensity of service establishments presents a negative effect on the new-firm survival rate, while the intensity of all establishments is positively related to new-firm survival rate (though not statistically significant within 95% confidence interval).[20] This situation is consistent over both of our available time periods. This might suggest that knowledge spillovers and networking that are facilitated by greater intensity of similar businesses (such as the service industry) lead to a lower new-firm survival rates in cities without diversity.

Since we only compared intensity of service establishments to intensity of all industry establishments, we can only speculate the possibility of the advantage from establishment diversity over specialization in the sector of services; however, there might be another particular industry or industries, instead of all industry total that actually results in very high survival rates. The positive parameters on all industry establishments but negative parameters on service sector establishments might also indicate that the greater sensitivity for short-lived formations was associated with more imitative businesses being set up on the basis of insufficient knowledge, rather than use of spillovers to develop new businesses based on competitive innovations. Service industry might have the relative ease for establishments, which may relate to easier imitations and accordingly higher failure rates. It may also be that the presence of higher intensities of non-service firms serves to provide more attractive employment opportunities to the weaker potential entrepreneurs, reducing their tendency to form short-lived businesses of their own. Another possible explanation is that regions with higher intensity of service establishments may tend to be economic centers and have more fierce competition. This situation may result in higher failure rate. In addition, for city centers that have high intensity of services, particularly those oversized cities relative to their externalities according to Krugman (1996), the regional diseconomies would also result in higher firm failure rates. These results are interesting because they shed additional light on the debate between diversity and specialization (Jacobs, 1969; Glaeser et al, 1992; Feldman and Audretsch, 1999).

When testing the impact on new-firm survival rates, the parameters for intensity of all establishments are much bigger than others. This situation indicates that all establishment intensity has a much bigger impact on new-firm survival rates than other factors, including human capital. This situation means that all-industry establishment intensity not only contribute to firm survival, but also affect firm survival in a much bigger magnitude than the establishment intensity from only service sector. In other words, while higher intensity of all establishments slightly reduced formation rates it substantially increases the survival rate of new firms. This is in contrast to the relationship of the intensity of service establishments in the region where greater intensity contributes substantially to higher formation and slightly reduces the survival rate.

For the knowledge spillover effects on firm formations, all of the coefficients on intensity of service establishments are positive and statistically significant, suggesting that regions that already have a relatively strong supply of service establishments[21] will have higher rates of new-firm formation, as predicted by the theory of regional spillovers (Jovanovic and Rob, 1989). Indeed, this factor has the strongest relationship of any of our independent variables. The 0.54 value estimated for the standardized coefficient for surviving formation in 1993-95 indicates that a locality with a service establishment intensity that is one standard deviation more intense than the mean will be likely to have surviving firm formation rates that are 0.54 standard deviation higher than the mean.

5.3 Findings on Control Variables

Most of the variables controlling for other differences in regional characteristics show remarkably little difference in estimated coefficients for the surviving formations and the closed formations, and for the two time periods. However, the unemployment rate coefficients are noteworthy; they are positive for new-firm survival rate for both periods, although negative for the firm formation rates during the growth period, and positive for formations during the recession period. It appears that higher unemployment helps to maintain higher firm survival rates. For new-firm formations, during that recession, higher unemployment rates contributed to higher rates of formation of both surviving and closing businesses. But in the subsequent growth period the coefficient on unemployment for surviving new businesses is not statistically significantly different from zero, while that for closed formations is strongly negative and significant.

6. CONCLUSIONS

This paper sought to distinguish the impact of local differences in human capital on the local rates of formation of new service firms that survive at least 3 years from those that close within 3 years. For this investigation we used a model of geographic variation in new-firm formation rates, focusing on their relationship to local human capital and the potential for knowledge spillovers from existing similar businesses. The parameters of this model were estimated separately for surviving and closed new firms, using all new service firm formations in the United States during the mildly recessionary period from 1990 through 1992, and for the subsequent growth period from 1993 through 1995.

A key variable for the firm survival rate, both within cities and within countries, is the educational attainment of the labor force. The higher a region's high school dropout rates, the lower its new-firm survival rate; the higher the region's college degree share, the higher the region's new-firm survival rate for the period of 1993-1995, but not for the period of 1990-1992. Also, the higher the region's share of adults with college degrees, the higher the area's expected firm formation rate. Similar to the findings on the relationship between human capital and firm survival rate, we find that college degree share does not contribute significantly to the formation rate of short-lived businesses that started after the recession, during 1993-95.

Although the actual knowledge acquired with a college degree seldom suffices as the basis for a successful new business, the analytical methods learned in college facilitate both future acquisition of knowledge and openness to new ideas received as spillovers from other activities in the area. Indeed, after controlling for basic differences in the underlying rates of population growth, the strongest factor accounting for differences in new-firm formation rates was the local intensity of other related businesses in the area. Unfortunately, we found that this factor contributed somewhat more strongly to the formation of short-lived firms than to surviving firms. Nevertheless, these results suggest that higher education influences later growth through the increased discovery and implementation of innovative ideas, resulting in more new-firm formations.

Our results also suggest that knowledge spillovers within service establishments, instead of across sectors, tend to reduce new-firm survival rates. However, knowledge spillovers seem to function differently for firm formation rates. Successful new service firm formation is facilitated by spillovers from related establishments, but that a relatively high intensity of other types of establishments actually discourages the formation of short-lived firms. Industry specialization seems to limit new-firm survival rates while greater density of unrelated businesses, may lead to higher rates of survival of the new firms, but lower overall rates of new-firm formation. Further research is needed to sort out the consequences of these results for intelligent policies to enhance new-firm survival, encourage more successful new-firm formation, and to overcome any important negative factors discouraging local growth.

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Tables

Table 1: Summary Statistics on Dependent and Independent Variables
Observations are 394 Labor Market Areas, covering entire USA

	Mean	Std Dev.	Minimum	Maximum
Average Annual Service Firm Formations per 1000 labor force				
All firm formations				
1996-1998	1.269	0.371	0.662	3.276
1993-1995	1.275	0.352	0.688	3.327
1990-1992	1.233	0.337	0.692	2.785
Surviving at least 3 years				
1993-1995	0.804	0.205	0.454	2.174
1990-1992	0.786	0.196	0.428	1.808
Short-lived -closing within 3 years				
1993-1995	0.471	0.156	0.204	1.153
1990-1992	0.447	0.150	0.143	1.111
Independent variables				
Human Capital				
College Degree, % of adults, 1990	0.159	0.050	0.069	0.320
High-school Dropouts, % of non-college adults	0.329	0.082	0.167	0.598
Intensity of Serv Estab / Population (000), 1995	7.620	1.400	3.755	15.548
Regional characteristics				
Population Growth ratio, 1993-95 avg	1.010	0.010	0.989	1.059
Per capita Income Growth ratio, 1993-95 avg.	1.040	0.013	0.969	1.084
Log of population, 1995	12.801	0.940	11.543	16.542
Unemployment Rate, 1994-95 avg.	0.060	0.024	0.020	0.290
Avg. Employment per establ., all-industry, 1994	15.097	2.881	8.266	21.237
Intensity of Establ. / Popul. (000), all-ind., 1994	21.834	3.584	10.774	45.105

Table 2. Pearson correlation coefficients for all-industry firm formation and exogenous variables
(with * if significant at .01 level)

	College	HS dropout	Popul gro	Income gro	Popul ln	Unempl	Estab emp	Intensity
All-industry firm formation rate 1994-96	.311*	-.149*	.562*	-.043	.098	-.008	-.380*	.503*
College degree % of adults in 1990	1	-.586*	.199*	.061	.611*	-.337*	.188*	.398*
High-school dropout % of non-college adults		1	-.042	-.075	-.245*	.399*	.001	-.539*
Population growth 1993-96			1	-.098	.124	-.031	.049	.031
Per capita income growth 1993-96				1	.020	-.339*	.232*	.182*
Population (logarithm)					1	-.050	.474*	.041
Unemployment rate 1994-96						1	-.293*	-.398*
Avg employment per establishment							1	-.305*
Intensity of all estab/population								1

Table 3. Regression Coefficients for Survival Rates and Formation Rates ** of Surviving Service Firms (at least 3 years) and of Short-lived Service Firms (that close before 3 years)
(Significant at 0.05 unless starred*)

	1990-1992 Formations		1993-1995 Formations		1990-1992 Formations	1993-1995 Formations
	Survivors	Closed	Survivors	Closed	Survival rate	Survival rate
Adj R sqd	0.629	0.559	0.655	0.608	-	-
Human Capital						
College degree % of adults '90	0.17	0.19	0.14	0.04*	-0.02	0.10
High-school dropout % of non-college adults '90	0.09	0.19	0.18	0.23	-0.10	-0.05
Knowledge Spillover						
Intensity of service estab/population	0.42	0.50	0.54	0.65	-0.08	-0.11
Intensity of all estab/population	0.07*	-0.16*	-0.05*	-0.21	0.23	0.16
Regional Characteristics						
Population growth	0.38	0.42	0.41	0.51	-0.04	-0.10
Per capita income growth	0.14	0.12	0.19	0.17	0.02	0.02
Population (logarithm)	0.16	0.19	0.13	0.19	-0.03	-0.06
Unemployment rate	0.19	0.15	-0.04*	-0.16	0.04	0.12
Avg. size of all establ (employment)	-0.29	-0.35	-0.30	-0.35	0.06	0.05
n	394	394	394	394	394	394

** Formation rates are 3-year average annual firm formations per 1000 labor force in prior year

Undated exogenous variables represent prior year, or prior 2 year averages

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Endnotes

[1] Notable studies of self-employment have been carried out by Bates (1990), Blanchflower and Meyer (1994), Blanchflower and Oswald (1998), Evans and Leighton (1989) and Van Praag and Van Ophem (1995), with the goal of assessing the impact of human capital on the success or survival of these businesses.

[2] E.g. time, financial investment, and willingness to abandon previous jobs.

[3] The LEEM data cover all private sector businesses with employees, with the exception of those in agricultural production, railroads, and private households. This is the same universe that is covered in Census' annual County Business Patterns publications, but establishments with positive payroll during a year and no employment in March of that year are not counted for that year for this project. For further information on the LEEM, see Acs and Armington (1998).

[4] Establishments are owned by legal entities, which are typically corporations, partnerships, or sole proprietorships. Most firms are composed of only a single legal entity that operates a single establishment—their establishment data and firm data are identical, and they are referred to as "single unit" establishments or firms. The single unit businesses are frequently owner-operated. Only 4 percent of firms have more than one establishment, and they and their establishments are both described as multi-location or multi-unit.

[5] These LMA's are defined according to the specification of Tolbert and Sizer (1996) for the Department of Agriculture, using the Journey-to-Work data from the 1990 U.S. Census of Population. They are named according to the largest place within them in 1990. Some LMA's incorporate more than one MSA, while others separate some of the larger MSA's into more than one LMA, depending on the commuter patterns. A few smaller independent (usually rural) Commuting Zones have been appended to adjacent LMA's so that each LMA had a minimum of 100,000 population in 1990, which is necessary to avoid possible disclosure of confidential Census data that have been aggregated for LMA's. Alaska and Hawaii each are treated as a single integrated LMA, although they clearly have little mobility across their entire areas. See Reynolds 1994 for further discussion of LMAs.

[6] We code the location of each establishment according to its initially specified state and county in the LEEM. The few businesses that report operating statewide (county = 999), or are missing their county code, have been placed into the largest LMA in each state.

[7] In fact, formation rates were calculated for each annual period from 1990 through 1998, but these were found to be quite consistent in their rank ordering across LMA's, so averages of three years were used for this analysis. Using period averages serves both to smooth out irregularities and to minimize the possibility of disclosure problems with very small numbers of annual births for the smaller LMAs and subsectors.

Two considerations of timing of the firm birth rate data should be noted. While new firms enter the business register underlying the LEEM file on a nearly continuous basis, their employment data are reported only for a pay period in March of each year. Since we require positive employment before recognizing new firm, if a firm begins activity after March, we do not count its formation until the following year. Therefore, each specified year's firm formation counts actually represent firms that hired their first employees sometime between April of the prior year and March of the specified year, for an average of nine months lagged reporting (Acs and Armington, 1998). Further, Reynolds et al (1995) and others have shown that the time between an individual's decision to create a new firm and the start of the resulting economic activity averages about two years, and often longer.

[8] We would have preferred to track firms for 5 years before classifying them as survivors or short-lived, because the job loss from closures falls drastically after firms are 5 years old (see Acs and Armington 1999), but the available panel data and the timing of the business cycle dictated use of the shorter period.

[9] Most researchers have focused on the survival rate of existing businesses, but this project was limited to use of data on new service firms, and it is exploring the regional factors associated with differences in formation rates, so distinguishing surviving new firms from those that are short-lived facilitates the analysis of survival of new firms as a refinement of the analysis of differences in new-firm formations. While the explanatory models could be transformed to roughly represent all firm formation rates and survival rates for all new firms, this would clearly lose information, in comparison to our chosen approach, because the formation rates of short-lived firms are considerably more variable than those of firms that survive at least 3 years.

[10] Annually, there were less than 150 such large apparent births of single-unit firms, with an average of about 1500 employees each. About a third of these larger single unit firms were employee-leasing firms or employment agencies, while the remainder were widely distributed across industries. However, examination of the new firms with 100-499 employees in their first year showed that most seemed to be credible startups, frequently in industries that are associated with large business units, such as hotels and hospitals. Since this study is not concerned with the employment impact of startups, there is no danger of the bulk of the data on smaller startups being swamped by that of a few larger startups that might actually be offshoots of existing businesses. Therefore, the startups with 100 to 499 employees were included, if they qualified otherwise.

[11] About 400,000 new firms generally appear in the business register (with some positive annual payroll) the year before they have any March employment, and we postpone their 'birth' until their first year of reported employment. An average of 90,000 older firms each year have no employees in March, but recover some employees the following year.

[12] We limited multi-unit firm formations to those whose employment in their new primary location constituted at least a third of their total employment in the first year. This rule effectively eliminated the 600 to 1000 new firms each year which were apparently set up to manage existing locations -- relatively small new headquarters supervising large numbers of employees in mainly older branch locations which were newly acquired, or perhaps contributed by joint venture partners.

[13] While it would be preferable to distinguish the causes of short life – whether due to voluntary closure or to failure -- we are unable to identify or control for that in this paper (Headd, 2003).

[14] The survival rate is calculated by subtracting equation (2) from equation (1). Equation (1): LogX = aLogA + bLogB + ei. Equation (2): LogY= cLogC + dLogD + vi, where LogX and LogY measure the same variable, LogA and LogC measure the same variable, and LogB and LogD measure the same variable.

In fact, A = C and B = D, as the independent variables are specific to time and LMA, not to the duration of the newly formed firms. If we subtract (2) from (1), we get LogX-LogY=aLogA -cLogC + bLogB - dLogD + ei - vi, which is equal to Log(X/Y) = Log(A^a/C^c) + Log(B^b/D^d) + (ei - vi).

Because the independent variables are identical, the equation (1 and 2) reduces to Log (X/Y) = Log (A^(a-c)) + Log (B^(b-d)) + (ei-vi) from which we conclude that the coefficients of the ratio of surviving to short-lived formations could be calculated accurately from the difference in the estimated parameters in equation (3).

[15] This number has increased considerably since then, but more recent data on educational attainment from the 2000 Census of Population had not yet been released at the county level, which is needed to construct the LMA level data. We therefore implicitly assume that the relative levels between LMA's have remained similar.

[16] This formulation substantially reduces the strong negative correlation of dropout rates with college graduate rates that would result from using the same denominator for both educational attainment rates. The population of adults can be divided into those holding college degrees, those without college degrees who have high school degrees, and the high-school dropouts.

[17] This is calculated for each period from the ratio of, for instance for 1993-1995 firm formations, the 1992 population divided by 1990 population, and taking the square root of that two-year change ratio to calculate the annual change ratio. Since subtracting its mean value over all LMAs and dividing by its standard deviation standardize each variable, this ratio is the same as a rate of change.

[18] We have also abstained from considering local financial variables and regional knowledge factors such as research and development expenditures. The availability of adequate financial resources to fund new firms is an important determinant of new-firm formation, which we hope to take into account in subsequent research. Both university-based and industrial research and development activity may be probably important stimulants to regional new-firm formation rates, including those in services.

[19] These can be calculated from the ordinary coefficients, but it is more illuminating to view them as being estimated from standardized variables. In this case, rather than using the levels, ratios and percents whose means and deviations are shown in Table 1, we transform each variable by subtracting its mean value (calculated from all 394 LMA values) and then divide this adjusted value by the standard deviation of all 394 values. Each of these transformed variables has a mean of zero and a standard deviation of one, and each value represents the deviation of that particular LMA from the mean of that variable. Since the 394 LMAs constitute the universe at a point in time (rather than a sample of areas), it is apparent that the resulting standardized beta coefficients can be interpreted quite simply as measures of the impact of one standard deviation of the independent variable on the standardized dependent variable. For example, using standardized variables, if we estimate that $x = .1y + .5z$, then we can say that each standard deviation in the value of y is associated with 0.1 of a standard deviation of x, and each standard deviation of z is associated with half of a standard deviation of x. Obviously, it follows that x is five times more sensitive to z than to y.

[20] Traditional t-tests have limited significance in this analysis. We needs to keep in mind that we are not actually dealing with estimation of sample errors; we are actually dealing with descriptive statistics on the entire population at a point in time, and prepared to say that these relationships change over time. Clearly if the difference in the estimated coefficients is very small it indicates that with this set of explanatory variables we cannot systematically distinguish any important differences in survival ratios explained by the variables with the tiny differences. It is not really important whether a difference is .02 or zero or -.02, they are all tiny in terms of their impact on the dependent variable.

[21] When we tried replacing this measure of service establishment intensity with the share of employment in services, the estimates were much weaker, so we conclude that it is important that the local service sector have many establishments, rather than many employees with service experience.