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New Firm Survival and Human Capital

by

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Research into Economic Systems
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Number of Pages: 39

The *Papers on Entrepreneurship, Growth and Public Policy* are edited by the
Group Entrepreneurship, Growth and Public Policy, MPI Jena.
For editorial correspondence,
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ISSN 1613-8333
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April 2004

Acknowledgements

This research was supported by the National Science Foundation under Grant # SES – 0080316. The analysis was carried out at the Center for Economic Studies (CES), U. S. Bureau of the Census Washington D. C. under the project title, “Evaluation of New Service Firm Entries in the SSEL and Analysis of Regional Differences in their Entry Rates.” Research results and conclusions expressed are those of the authors and do not necessarily indicate concurrence by the Bureau of the Census or the Center for Economic Studies. We would like to thank seminar participants at the Uddevalla Symposium June 12-14, 2003, Uddevalla, Sweden, and anonymous reviewers for valuable comments. All errors and omissions are our responsibility.

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

Key Words: Business Survival, Spillovers, Entrepreneurship, Human Capital, Regions

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1. Introduction

Human capital is sometimes viewed as the primary variable that influences economic development (Lucas, 1988). Thus various measures of human capital have been central to much of the large literature on the impact of individual characteristics on business survival and success of young small business owners (Van Praag, 2003). 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. The results of such studies have not been consistent (see Storey, 1994).

These inconsistent prior findings on the impact of human capital are puzzling, but they may be explained by several factors. First, most of these studies use data covering only self-employed workers, meaning that most of the businesses do not have employees. Many of these businesses represent the career choices of the self-employed workers, who had no ambitions to hire other employees and grow their businesses. Their variation in education is thus related to their chosen careers, rather than to their business success, since they never intended to grow. These studies therefore may suffer from sample selection bias since they are dealing primarily with small business (or individual self-employed workers), rather than with entrepreneurship (Lazear 2002).

Second, the unit of analysis may be wrong. Looking at individuals as the unit of analysis may not fully account for the endogenous human capital spillover

effects of education. While formal education itself does not usually provide either the skills or the inspiration to start a new business or to survive, education trains individuals to rationally assess information. A workforce with high average educational qualifications and managerial experience should have more success at starting new firms. While location may not play a specific role in the survival of individual firms, in fact the new sociology suggests that characteristics of regions and networks may be more important for growth and survival of entrepreneurial firms than individual characteristics of potential entrepreneurs (Thornton and Flynn, 2003).

The purpose of this paper is to examine the relationship between 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 effects. Section 2 presents the data and discusses measurement of formation rates for surviving new firms and short-lived new firms. Section 3 examines how and why formation and survival rates vary across geographic regions. Section 4 presents the empirical model, and the basic results are in section 5. Our conclusions are briefly discussed in the final section, where we observe that the extent of human capital already in a region has a significant effect on the new firm formation rate, but it seems to impact nearly equally on the rates of formation of surviving firms and of short-lived firms. The service firm formation rate is even more sensitive to the prior intensity (establishments per thousand people) of the local service sector. The greater this intensity is, the more probable are the relevant knowledge spillovers, and the

more likely that the resulting new ideas will lead to new firm formations. But once again, we were surprised to find that this relationship was marginally stronger for short-lived new firms than for those that survived.

2. MEASUREMENT OF NEW FIRM FORMATION AND SURVIVAL

The Data

This study uses a new database that the Bureau of the Census has constructed for study of entry, survival, and growth 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.¹ 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.²

The Unit of Observation

Although the LEEM data support analysis at the firm level, our interest was in the analysis of regional variations within the United States. Therefore, after considerable preliminary analysis of the data at the firm level, the scope and definitions of the relevant regional data were carefully defined and the firm-level data were aggregated to create regional data.

The choice of geographic unit for previous studies of firm formation and survival has frequently been determined more by the availability of any relevant data than by optimal choice of unit for testing of a theory. A wide variety of economic data are available for various politically defined units in the United States, including states, counties, cities, and towns. However, such units have boundaries that rarely represent the borders of functional economic areas.

State and county level business data collected by the federal government are generally comparable across all the states, but most states are composed of multiple, diverse economic areas. Therefore analyses of state-level economic data usually suffer from aggregation problems due to the diversity within states. On the other hand, many integrated local economic areas cross both state and county boundaries, and both workers and businesses often flow freely back and forth across these boundaries, so the economic behavior of agents within a given

state or county may be significantly affected by unmeasured influences from adjacent areas in other states or counties.

Although local government units (cities and towns) generally collect some economic data, they are rarely comparable across areas, because these data are frequently dependent on local tax laws. The city has the advantage of being a smaller geographic unit, within which there is reasonably integrated economic and social activity, with potential for knowledge spillovers. However, city boundaries are often quite arbitrary relative to the local patterns of economic activity, and their relatively small size means that their local economies may be substantially influenced by their suburbs.³

The most common politically defined unit for approximating local economic areas is the Metropolitan Statistical Area (MSA). These are multi-county units that are defined for large and medium-sized cities, including all of the densely populated counties surrounding each city. This geographic unit does a better job of ensuring that people both live and work within the boundaries of the unit. However, 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.

The geographic unit of analysis chosen for this study, Labor Market Areas (LMAs)⁴, substantially avoids all of the problems associated with the units discussed above. These 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 LMA's 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.⁵

The Sector of Inquiry

This paper focuses on the service sector of the U.S. economy. Why do we feel that the service sector is preferable to manufacturing for analysis of new firm formation? 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 are started by, and employ, workers with a wide variety of skills, and 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 sectors. Third, new firm formation rates are much higher in the service sector than in the manufacturing sector (Acs and Armington, 2002). 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. While some of these new firms merely replace older establishments that have closed, many others serve new markets, provide new services, or apply innovative techniques to compete with older businesses.

The Firm Formation Rates for Surviving and Short-lived Firms

Firm formation rates 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 1992.⁶ 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.⁷ These have been termed 'surviving' and 'short-lived' new firms, for the purposes of this study.⁸

New firm formations 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.⁹ '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.¹⁰ 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

most¹¹ 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 is just one-fourth of their average.

3. WHY DO FIRM FORMATION AND SURVIVAL RATES VARY LOCALLY?

Much of the recent research on new firm formation and growth has focused on the role of innovation in economic competitiveness. Acs and Armington (2004) address this issue in terms of human capital, spillovers, and agglomeration effects, specifically for service firm formations of various types. 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 rates of survival of innovation-based new firms.

Does the level of human capital in a region have a different impact on the region's rate of successful new firm formation than on its rate of unsuccessful firm formation? Can we identify any factors that contribute more to the formation of firms that fail within their first three years, than to firms that survive their first three years? This is an important question because new firm formation is generally not an end in itself, but is promoted for its contribution to economic growth. 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). What we know from the industrial organization literature is that small scale, de novo entrants have a relatively short life expectancy. That is, new firm formation appears to be much easier than the continuing survival of a new business. While the traditional literature has focused on entry barriers, it is difficult to reconcile the theoretically high entry barrier concept with the actual high entry rates. If, however, barriers to entry are thought of as obstacles that prevent firms from surviving long in the market, then the data present less of a puzzle. Audretsch (1995) found that indeed scale economies and product differentiation do constitute barriers to survival, but these can be overcome when firms innovate and learn how to survive.

Recently a growing literature has sought the determinants of local variation in rates of new firm formation and survival, and has identified a number of factors that contribute to these differences (Keeble and Walker, 1994). Two conflicting hypotheses can be put forward with regard to the role of the education level of the entrepreneur in influencing business survival. One argues that education provides a basis for intellectual development, which the entrepreneur requires to be in business successfully, and that higher levels of education provide the individual with greater confidence in dealing with customers and suppliers. In short, this approach says that education 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 strain 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, which is also when higher rates of new firm formation and failure result from the successes and failures of their learning experiences.

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 growth and survival of entrepreneurial firms than individual initiative (Thornton, 1999, and Littunen, 2000).

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 formation, survival, and growth 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 formations and growth. 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 activity. Variation in local new firm formation rates should be positively related to local educational attainment rates. We would expect that the formation rate of surviving businesses would be more sensitive to differences in the local educational attainment rates than the formation rate for short-lived businesses. Thus higher shares of college graduates in the local population should lead to higher firm birth rates generally, but particularly for surviving firms.

Lazear (2002) has contributed insights into one mechanism that contributes to the higher firm formation rates in the presence of higher levels of individuals with a 'career' life-mode and a college education. Because their dominant value is the advancement of their career, although they are most likely to be working in large hierarchical private or public sector organizations, they will start their own businesses if this becomes the best way in which to benefit from their skills, knowledge and expertise. These businesses are often technologically advanced, innovative and with good marketing capabilities.

In fact, the 1990's saw an increase in the incidence of highly educated individuals starting new businesses, especially in the technologically advanced

sectors of the economy, like computers, biotechnology, and internet-dependent businesses. However, there was also an increase in startups of many service businesses using relatively unskilled labor for services such as building cleaning, security, detective, and secretarial services. These may be started by career-oriented individuals who have recognized opportunities or developed new ideas to allow them to compete favorably in these markets, based on their own experiences or on spillovers from others.

However, 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 and Bates 1997), there has been little testing of the hypothesis that higher average educational attainment leads more strongly to higher formation rates for surviving firms than for short-lived firms. Kangasharju and Pekkala (2000) found that in Finland the higher educated self-employed tended to have higher failure rates during growth periods, and lower ones in recessions, apparently because the better educated are more likely to choose jobs with other firms when they are easily available during growth periods. This leads to a credible contrary hypothesis when regions are the unit of analysis. LMAs with a high proportion of the workforce having 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.

Prior analysis of the service sector (Acs and Armington, 2002) has shown that service firm formations also are higher in regions with relatively high shares of high-school dropouts. However, it seems likely that the new firms associated with higher dropout ratios would have much greater probabilities of failure, so we expect that the short-lived firm formation rate will be much more sensitive to the dropout rate than the formation rate of surviving firms.

Furthermore, areas that already have relatively intense development of service businesses have been found to have higher levels of new service firm formations, resulting in large part from spillovers of relevant specialized knowledge. Formal education itself does not usually provide either the skills or the inspiration to start a new business. But higher education trains individuals to rationally assess information, and to seek new ideas. Therefore more educated people are more likely to acquire useful local knowledge spillovers from others who are involved in research or in managing some service business. Some of these new firm formations may be based on unsophisticated imitation of others, and this would tend to result in more short-lived businesses.

4. EMPIRICAL MODEL

The data for this study were constructed to facilitate analysis of the relationships between local differences in new firm formation rates 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.¹² 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.

New firm formation 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:

$$(1) \text{ New Firm Formation Rate}_{L,t+3} = \alpha_L + \beta \text{ Human Capital}_{L,t} + \delta [X]_{L,t} + e_{L,t}$$

where X is a vector of control variables, the subscript L indexes LMAs, t refers to time and e is stochastic disturbance. The conditioning information set is a vector of exogenous population and business variables specific to each labor market area L .

Independent Variables

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,¹³ 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 1990.¹⁴ 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 2004) 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.

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.

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 the rates at which new firms are formed. Summary statistics are provided in Table 1 for all of the regional socio-economic variables that are discussed above and below. Generally there is little theory to support or explain differences in the impact of these control variables on surviving formations versus short-lived formations.

Population growth represents the average annual rate of change in the local population in the previous period.¹⁵ 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 were 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. Audretsch and Fritsch (1994) and Armington and Acs (2002) have used this measure with sometimes conflicting results -- it is not clear whether the relative impact of local differences in unemployment rates is negative or positive. The effect may differ by industry, according to whether the activity is more capital-intensive or labor-intensive. The local relative impact of unemployment on new firm formation rates may also be sensitive to whether the national economy is expanding or contracting.

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.

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).

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, 2002).

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.¹⁶

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 .15 with firm formation rates, and our model views the regional difference in income levels more as an effect of differences in formation rates and prices, and a cause of

differences in educational attainment (correlated .68 with College and -.53 with High-school dropout).

5. EMPIRICAL RESULTS

We test whether the human capital factors that we have used to help explain local differences in formation rates of service firms relate differently to formation rates of successful businesses than to formation rates of businesses that close within three years. More specifically, we hypothesize that the formation rates for successful businesses are more strongly positively related to the local levels of higher educational attainment (share of college degrees) and potential for knowledge spillovers from similar businesses (intensity of service establishments), and less strongly positive for share of high-school dropouts than the formation rates for businesses that close quickly.

The simple least squares estimations of the parameter values for both formation rates for both time periods, using all 394 LMAs as our units of observation, are shown in Table 3. We present standardized beta coefficients¹⁷, so that each parameter indicates the sensitivity of survival rate variation to normalized variation in the corresponding independent variable. The t-ratios shown for each were calculated from the simple estimated standard errors. These were also calculated with a correction for heteroscedasticity, and these results 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.

As expected, the estimated parameters for all of the human capital variables were positive, and they were significant at the .05 level 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 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. However, the earlier period failed to support this hypothesis. Could it be that higher shares of college degrees lead during recessions 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.

The positive and statistically significant coefficient for high-school dropouts as a share of the non-college adult population is at first surprising -- however it is consistent with our earlier results for the whole economy (Armington and Acs, 2002). There we suggested that after controlling for the proportion of adults with college degrees,¹⁸ the additional effect of a greater share of less educated

workers is to facilitate the survival process by providing cheap labor for the new firms. Even the most sophisticated businesses need some workers who are less educated to do the manual labor. Thus, the relationship between educational attainment and new firm start-ups at the regional level may be U-shaped, with both low levels and high levels of education conducive to firm formation and growth.

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.”

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 establishments¹⁹ 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.

The coefficient on the intensity of service establishments is also slightly higher for new formations that close quickly than for those that survive 3 years. This relationship is consistent over both of our available time periods. This might suggest that the knowledge spillovers and networking that are facilitated by greater intensity of similar businesses are more important to the formation of businesses that fail quickly. Or it might 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.

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 remain negative for the growth period and positive for the recession period. It appears that during that recession, areas with higher unemployment rates contributed to higher rates of formation of both surviving and closing businesses. But the coefficient on unemployment for surviving new businesses in the growth period is not statistically significantly different from zero, while that for closed formations is strongly negative and significant.

Furthermore, once we control for the intensity of service establishments, the additional intensity of all establishments is negatively related to formation of

short-lived service firms, but virtually unrelated to formation of surviving firms. This suggests that survivals are facilitated by spillovers from clusters of similar or related establishments, but that a relatively high intensity of other types of establishments actually discourages the formation of short-lived new service firms. Crowding, in general, does not lead to higher rates of surviving service firm formations. It may 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. These results are interesting because they shed additional light on the debate between diversity and specialization (Glaeser et al, 1992 Jacobs, 1969). They provide evidence that spillovers have important positive effects on formations within broad industry sectors, but do not play an important positive role across sectors. These results are consistent with Acs, FitzRoy and Smith (2002) who found no spillovers across unrelated industries.

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 formation rate, both within cities and within countries, is the educational attainment of the labor force. The higher the average share of adults with college degrees in an area, the higher the area's expected firm formation rate. However, we found that this factor did not contribute 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 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.

In addition to the positive impact of higher proportions of adults with college degrees on rates of new firm formation, we also found an additional positive impact of higher proportions of high school dropouts among the non-

college-educated portion of the adult population. This impact was somewhat stronger for formation of short-lived firms than for surviving firms.

Our results also suggest that 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. Crowding, or greater density of unrelated businesses, may therefore lead to lower overall rates of new firm formation, but higher rates of survival of the new firms. Further research is needed to sort out the consequences of these results for intelligent policies to encourage more successful new firm formation, and to overcome any important negative factors discouraging local growth.

REFERENCES

Acs, Z. J. and C. Armington, 1998, 'Longitudinal Establishment and Enterprise Microdata (LEEM) Documentation', *Center for Economic Studies*, U. S. Bureau of the Census, Washington D. C. CES 98-9.

Acs, Z. J. and C. Armington, 1999, 'Measures of Job Flow Dynamics in the U. S.', *Center for Economic Studies*, U. S. Bureau of the Census, Washington D. C. CES 99-1.

Acs, Z. J. and C. Armington, 2002, "Endogenous Growth and Entrepreneurial Activity in Cities, *Regional Studies*, forthcoming.

Acs, Z. J. and C. Armington, 2004, "The Impact of Geographic Differences in Human Capital on Service Firm formation Rates," *Journal of Urban Economics*, forthcoming.

Acs, Z. J., F. FitzRoy, and I. Smith, 2002, 'High Technology Employment and R&D in Cities: Heterogeneity vs. Specialization', *Annals of Regional Science*, **36**(3), 373-386.

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. and M. Fritsch, 1994, 'The Geography of Firm Births in Germany', *Regional Studies* **28**(4) 359-365.

Audretsch D. B., 1995, 'Innovation, Growth and Survival', *International Journal of Industrial Organizations* **13**(4), 441-458.

Bates, T., 1997, 'Race, Self-employment, and Upward Mobility: An Illusive American Dream; Response to John Sibley Butler's Review Essay', *Small Business Economics* **12**(2), 189-190.

Bates, T., 1990, 'Entrepreneur Human Capital Inputs and Small Business Longevity,' *The Review of Economics and Statistics*, 4, 551-559.

Blanchflower, D. and B. Meyers, 1994, "A Longitudinal Analysis of the Young Self-employed in Australia and the United States," *Small Business Economics*, 6, 1-19.

Blanchflower, D and A. Oswald, 1998, "What Makes an Entrepreneur?," *Journal of Labor Economics*, 16(1), 26-60.

Ciccone, C. and R. E. Hall, 1996, 'Productivity and the Density of Economic Activity', *American Economic Review* **86**(1), 54-70.

Evans, D. and B. Jovanovic, 1989, 'Estimates of a Model of Entrepreneurial Choice Under Liquidity Constraints', *Journal of Political Economy* **95**, 657-74.

Evans, D. and L. S. Leighton, 1989, "Some Empirical Aspects of Entrepreneurship," *American Economic Review*, 79, 519-535.

Evans, D. and L. S. Leighton, 1990, 'Small Business Formation by Unemployed and Employed Workers', *Small Business Economics* **2**, 319-330.

Feldman, M. P., (2000) 'Location and Innovation: The New Economic Geography of Innovation, Spillovers, and Agglomeration', Ch. 19 in G.L. Clark, M. P. Feldman, and M. S. Gertler, Ed., *The Oxford Handbook of Economic Geography*, Oxford University Press.

Geroski, P., 1995, "What do we Know About Entry," *International Journal of Industrial Organization*, **13**(4), 413-614.

Glaeser E. L., H. Kallal, J. A. Scheinkman and A. Shleifer, 1992, 'Growth in Cities', *Journal of Political Economy* **100**(6), 1126-52.

Glaeser, E. L. J. A. Scheinkman and A. Shleifer, 1995, 'Economic Growth in a Cross-Section of Cities', *Journal of Monetary Economics* **36**(1), 117-43.

Headd, B., 2003, "Redefining Business Success: Distinguishing Between Closure and Failure," *Small Business Economics*, 21(1) 51-61.

Jacobs, J., 1969, *The Economy of Cities*, New York: Random House.

Jovanovic, B. and R. Rob, 1989, 'The Growth and Diffusion of Knowledge', *Review of Economic Studies* **56**, 569-582.

Kangasharju, A. and S Pekkala, 2002, 'The Role of Education in Self-Employment Success in Finland', *Growth and Change* **33**, 216-237.

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), 411-427.

Lazear, E. P., 2002, 'Entrepreneurship', *National Bureau of Economic Research*.

Littunen, H., 2000, 'Networks and Local Environmental Characteristics in the Survival of New Firms', *Small Business Economics* **15**(1), 59-71.

Lucas, R. E., 1988, 'On the Mechanics of Economic Development', *Journal of Monetary Economics* **22**, 3-42.

Rauch, J., 1993, 'Productivity Gains from Geographic Concentration of Human Capital: Evidence From the Cities', *Journal of Urban Economics* **34**, 380-400.

Reynolds, P. D., 1994, 'Autonomous Firm Dynamics and Economic Growth in the United States, 1986-1990', *Regional Studies* **28**(4), 429-442.

Reynolds, P. D., B. Miller and W. R. Maki, 1995, 'Explaining Regional Variation in Business Births and Deaths: U.S. 1976-88', *Small Business Economics* **7**(4), 387-407.

Simon, C. and C. Nardinelli, 1996, 'The Talk of the Town: Human Capital, Information and the Growth of English Cities, 1861-1961', *Explorations in Economic History* **33**(3), 384-413.

Simon, C. and C. Nardinelli, 2002, 'Human Capital and the Rise of American Cities, 1900-1990', *Regional Science and Urban Economics* **32**, 59-96.

Storey, D. J., 1991, 'The Birth of New Firms—Does Unemployment Matter? A Review of the Evidence', *Small Business Economics* **3**(3), 167-78.

Storey, D. J., 1994, *Understanding the Small Business Sector*, London: Routledge.

Tolbert, C. M. and M. Sizer, 1996, U. S. Commuting Zones and Labor market Areas: a 1990 update, Staff paper No. AGES-9614, Rural Economy Division, Economic Research Service, US Department of Agriculture, Washington, D. C.

Thornton, P. H., 1999, 'The Sociology of Entrepreneurship', *Annual Review of Sociology* **25**, 19-46.

Thornton, P., and K. Flynn, 2003, "Entrepreneurship, Networks and Geographies," in Z. Acs and D. Audretsch, *Handbook of Entrepreneurship Research*, Dordrecht: Kluwer Academic Publishers, 401-436.

Van Praag, C. M. and H. Van Ophem, 1995, "Determinants of Willingness and Opportunity to Start as an Entrepreneur," *Kyklos*, **48**, 513-540..

Van Praag, C. M., 2003, "Business Survival and Success of Young Small Business Owners," *Small Business Economics*, **21**(1), 1-17.

Table 1: Summary Statistics on Dependent and Independent Variables

Observations are 394 Labor Market Areas, covering entire USA

	<u>Mean</u>	<u>Std Dev.</u>	<u>Minimum</u>	<u>Maximum</u>
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 3. Regression Coefficients for Formation Rates of Surviving Service Firms (at least 3 years) and of Short-lived Service Firms (that close before 3 years)**

(standardized betas with t-ratios below, significant at .05 unless starred*)

	1993-1995 Formations		1990-1992 Formations	
	Survivors	Closed	Survivors	Closed
Adj R sqd	.655	.608	.629	.559
<u>Human Capital</u>				
College degree % of adults '90	0.14 2.50	0.04* 0.69	0.17 3.17	0.19 3.24
High-school dropout % of non-college adults '90	0.18 4.23	0.23 5.02	0.09 2.16	0.19 4.03
Intensity of service estab/population	0.54 5.01	0.65 5.68	0.42 3.84	0.50 4.20
<u>Regional Characteristics</u>				
Population growth	0.41 12.57	0.51 14.92	0.38 10.63	0.42 10.95
Per capita income growth	0.19 5.69	0.17 4.84	0.14 3.90	0.12 3.11
Population (logarithm)	0.13 2.67	0.19 3.56	0.16 3.20	0.19 3.61
Unemployment rate	-0.04* -0.99	-0.16 -3.67	0.19 4.40	0.15 3.16
Avg. size of all establ (employment)	-0.30 -7.39	-0.35 -8.01	-0.29 -6.57	-0.35 -7.23
Intensity of all estab/population	-0.05* -0.52	-0.21 -2.13	0.07* 0.76	-0.16* -1.55
n	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

Endnotes

¹ 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).

² 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.

³ For example, the city of Baltimore is smaller than the County of Baltimore, and many of the people that work in Baltimore city live outside the city limits. In addition, a large proportion of the people in adjacent counties work and shop in other parts of the urban agglomeration of which Baltimore is the center.

⁴ 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.

⁵ 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.

⁶ 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.

⁷ 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.

⁸ 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.

⁹ 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.

¹⁰ 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.

¹¹ 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.

¹² 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).

¹³ 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 among LMA's have remained similar.

¹⁴ This formulation substantially eliminates the strong negative 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.

¹⁵ 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 each variable is standardized by subtracting its mean value over all LMAs and dividing by its standard deviation, this ratio is the same as a rate of change.

¹⁶ 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.

¹⁷ 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 3, 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 .

¹⁸ When similar equations were estimated using only one of the two educational attainment variables at a time, the coefficients for each fell somewhat, but remained positive and significant, while the coefficients on all other variables remained substantially the same.

¹⁹ 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.