Manufacturing Transition in Local Economies: A Regional Adjustment Model[1]

Jason P. Brown[1,†] Dayton M. Lambert[2], and Raymond J.G.M. Florax[3,4]

[1] USDA, Economic Research Service
1800 M St. NW, Washington, D.C. 20036–5831
E-mail: jbrown@ers.usda.gov

[2] Dept. of Agricultural and Resource Economics, University of Tennessee
2621 Morgan Hall, Knoxville, Tennessee 37996–4518
E-mail: dmlambert@tennessee.edu

[3] Dept. of Agricultural Economics, Purdue University
403 W. State Street, West Lafayette, IN 47907–2056
E-mail: rflorax@purdue.edu

[4] Dept. of Spatial Economics, VU University Amsterdam
De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands

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Abstract

This paper addresses changes in capital formation by testing the importance of location factors with respect to the rate of establishment births and deaths in U.S. manufacturing, 2000–2004. A theoretical concept called “localized creative destruction” is tested as a mechanism to explain the dynamics impacting the spatial distribution of manufacturing establishment birth and death rates. While no support of this process was found, results identify a convergence process occurring where counties with high initial birth/death rates have smaller changes in firm birth and death rates. The interpretation is that counties become more equally competitive in terms of firm formation dynamics in lieu of successful counties increasing their lead in the short run. This is potentially relevant to policymakers and economic development practitioners who are concerned with business retention and the impact of new manufacturing establishments on their existing base.

Key words: location determinants, manufacturing, adjustment models
JEL Codes: L60, R11, R12

1. INTRODUCTION

The United States economy has experienced four recessions since the 1980s, including the most recent one which began in the fourth quarter of 2007. Over the same period, but especially in the 1990’s, rural areas in the United States struggled as manufacturing investment flowed back to urban areas, drawn by better access to skilled labor, business services, and product and input markets. The impact of this trend was magnified by the 2001 recession, when rural areas in particular suffered from this spatial realignment because of their higher relative shares of manufacturing employment as compared to metropolitan areas (WILKERSON, 2001). Increased global integration of product markets has also heightened competition in domestic manufacturing, eroding the competitive advantage of rural areas once typified by lower labor costs (MCGRANAHAN, 2002). The spatial concentration of manufacturing investment in urban areas has also increased because of the growing importance of a skilled workforce, supply-chain logistics, and lower costs arising from (external) scale economies. These events have translated into changes in the capital stock of manufacturing as well as in the spatial distribution of capital stock. While the causality of these events is difficult to untangle, changes in technology sets used in production as well as changes in product markets constitute important drivers of reallocation trends.

Research documents that technological and industrial renewal occurs through a simultaneous process of micro-evolutionary changes in technology and discontinuous technological innovations (BAUM, 1996). As Schumpeter observed, technological innovation and technology adoption may also be driven by birth (market entry) and death (exit) of manufacturing establishments via a process of "creative destruction" (SCHUMPETER, 1942, p. 83).[2] The extent to which exiting firms are replaced by new establishments is also influenced by local and regional economic and demographic determinants. The industrial organization literature documents many examples of firm behavior with respect to entry-exit dynamics even within narrowly defined industries (BARTELSMAN *et al*., 2003). Firms continuously enter and exit markets. Among entering firms, many fail to survive during the first few years, while others prosper. Even during good times, the number of firms in a sector may decrease, while in other locations or sectors firm recruitment increases. Consequently, changes in employment following plant opening and closing are as important as changes due to firm expansion or contraction of surviving firms (HAMERMESH, 1993). These dynamics may have important implications for local business attraction and retention strategies pursued by policymakers.

[2] The terms "entry" and "exit" are synonymous with birth and death in the theoretical and empirical industrial organization literature (HOPENHAYM, 1992; ERICSON and PAKES, 1995; PAKES and ERICSON, 1998; BALDWIN and GORECKI, 1991; JOHNSON and PARKER, 1996; REYNOLDS *et al*., 1995; LOVE, 1996; FOTOPOULOS and SPENCE, 1998). Our convention is that the dynamic process of establishment birth and may be viewed as creative destruction.

This paper investigates the relative importance of location determinants related to birth and death of manufacturing establishments in the U.S., during the time period 2000–2004. Although the spatial and temporal dynamics of birth and death processes are obviously related, the causal direction is difficult to discern as birth/death occurs simultaneously. Establishment birth and death are therefore hypothesized to be endogenous. In addition, the possibility of a heterogeneous response to location factors impacting birth and death across space cannot be ruled out *a priori*. This paper follows PE'ER and VERTINSKY (2008) testing for a localized process of creative destruction, in a novel way allowing for spatial spillovers between counties. Simultaneously allowing for spatial heterogeneity and localized spillovers provides a richer context for explaining the spatial distribution of manufacturing establishment birth and death. Understanding why firms choose specific locations and the resulting spatial and temporal dynamics driving firm birth and death may help policymakers better understand the process of regional growth and renewal. This information is useful in light of economic development policies designed to attract or retain manufacturing investment (MALECKI, 2004; HART, 2008).

2. BACKGROUND

An obvious and very pervasive empirical regularity occurring in the study of birth and death rates of establishments is their high correlation (DUNNE *et al*., 1988; CABLE and SCHWALBACH, 1991; BRUCE *et al*., 2007; BOSMA *et al*., 2008). Schumpeter's theory of creative destruction is often cited to motivate and explain this general phenomenon. Schumpeter maintained that the vitality of an economic engine in a capitalist society depends on the formation of new goods and services, new methods of production or transportation, new forms of industrial organization, and new product and input markets. Schumpeter emphasized that firm formation by entrepreneurs is crucial for revolutionizing "… the pattern of production by exploiting an invention or, more generally, an untried technological possibility for producing a new commodity or producing an old one in a new way …" (SCHUMPETER, 1942, p. 132). The process of creative destruction and ensuing churn results from the creation of value through product innovation, provision of new services, and the formation of organizations that inevitably cause displacement or diminish the value of incumbent products, services, and organizations.

Theoretical and empirical studies following Schumpeter's idea provided the context for understanding the recent empirical evidence explaining the creative destruction process observed in firm birth and death (DIXIT, 1992; ERICSON and PAKES, 1995; SHAPIRO and KHEMANI, 1987; DUNNE *et al*., 1988; LOVE, 1996; BERNARD and JENSEN, 2007). Firm entry creates a competitive environment where production costs are minimized. Firm birth and death are indicative of free market entry and exit, absent market power. New firms also increase the extent to which product and process innovation occurs (LOVE, 1996). More generally, the birth and death of firms brings about the reallocation of resources to their most efficient use as economic conditions change over time. There are well-established theoretical links between firm birth and death, and the empirical evidence suggests that spatial variations in the two phenomena are highly correlated (EVANS and SIEGFRIED, 1992; LOVE, 1996; FOTOPOULOS and SPENCE, 1998; BRUCE *et al*., 2007). A healthy birth rate of firms is frequently regarded as a positive indicator of vitality and growth (LOVE, 1996), and in a Schumpeterian sense firm death is often seen as an important catalyst by which resources are redistributed. Therefore, a large and significant correlation between firm entry and firm exit—sometimes also labeled "turnover"—is indicative of a "creative destruction" process hypothesized to promote economic growth (AGARWAL *et al*., 2007).

The industrial organization literature dealing with firm entry and exit typically rallies around a common hypothesis that firm births are caused by firm deaths. Replacement and resource release are two reasons for this relationship, found in literature. The replacement argument is used by, for instance, AUSTIN and ROSENBAUM (1990) and EVANS and SIEGFRIED (1992) to describe the patterns of birth and death in U.S. manufacturing. New firms may locate where firms died as they are drawn to cheap and available physical assets left by departing firms. This notion is referred to as the "release hypothesis" (STOREY and JONES, 1987). Some assets, such as machinery, are immobile. Other assets, such as skilled workers who prefer to stay in the same location, are partially immobile. Resource immobility presents opportunities for new firms as prices fall to clear factor markets. Firm death also facilitates the emergence of new organizations that are not constrained by their external relationships and internal routines and procedures. The empirical research to date does not provide clear evidence of the underlying processes of birth and death in manufacturing industries. Moreover, the literature points to two different hypotheses regarding the large positive correlation between birth and death in the manufacturing industry. The first hypothesis suggests that firm birth and death occur simultaneously, with feedback between the two processes. High levels of birth may lead to the displacement of existing firms by new entrants, and hence lead to death of existing firms. Concurrently, however, high levels of firm death may create room for firms to emerge. The second hypothesis is that of natural churning, which states that higher industry turbulence in terms of birth and death is due to underlying business conditions. Firm birth and death may be highly positively correlated over time and across industries, but the causal link may not be identifiable as the concept of churning is broader than that of the displacement-vacuum effect, which amounts to exit in order to make room for entry (FOTOPOULOS and SPENCE, 1998).

Despite the mechanisms connecting birth to death, the potential effect of death on birth is not immediately evident. In this paper, a local creative destruction process is hypothesized to explain the spatial distribution of the birth and death of manufacturing establishments. The next section describes the econometric model used to empirically test this process in manufacturing establishment birth-death in the United States, 2000–2004.

3. CONCEPTUAL MODEL

This paper applies a regional adjustment model commonly used to understand population-employment dynamics (CARLINO and MILLS, 1987) to disentangle firm birth-death events. The regional adjustment model used here explains firm birth and death as an adjustment toward some unknown future state of spatial equilibrium of the geographical distribution of establishments expressed as:

(1a) $\dot{B}_i = (B_{i,t} - B_{i,t_0}) = \lambda_B (B^* - B_{i,t_0}),$

(1b) $\dot{D}_i = (D_{i,t} - D_{i,t_0}) = \lambda_D (D^* - D_{i,t_0}),$

where B^* and D^* are equilibrium birth and death rates, and λ_B and λ_D are speed-of-adjustment parameters. In equilibrium, all manufacturing firms would be distributed across space in such a way that their profits were maximized with respect to location. Given that this steady state is unlikely for any discernable time period, researchers routinely describe the spatial economy as being in a state of partial equilibrium (CARRUTHERS and MULLIGAN, 2007).[3] This constant

[3] The case of partial equilibrium has been made several times in the literature to describe the dynamics of people-job adjustment processes. We extend this concept to the adjustment of the spatial distribution of establishments via birth and death.

adjustment process in terms of firms entering and exiting markets lends itself well to the interpretation of the spatial and temporal dynamics as a process of local creative destruction.

The process of constant adjustment is often illustrated in regional adjustment models by a system of two simultaneous equations (STEINNES and FISHER, 1974; CARLINO and MILLS, 1987; BOARNET, 1994a,b; CLARK and MURPHY, 1996; CARRUTHERS and VIAS, 2005; CARRUTHERS and MULLIGAN, 2007). The adjustment model used here replaces population and employment (growth) with the birth and death (rates) of establishments. Following CARRUTHERS and VIAS (2005) and CARRUTHERS and MULIGAN (2007) the adjustment process is depicted by the following the structural set of equations:

(2a) $\dot{B}_i = (B_{i,t} - B_{i,t_0}) = \alpha_0 + \alpha_1 D_{i,t} + \alpha_2 B_{i,t_0} + X^B_{i,t_0}\theta_B + u^B_i$,

(2b) $\dot{D}_i = (D_{i,t} - D_{i,t_0}) = \gamma_0 + \gamma_1 B_{i,t} + \gamma_2 D_{i,t_0} + X^D_{i,t_0}\theta_D + u^D_i$,

where i indexes regions, t indexes time with t_0 referring to the initial time period, θ_B and θ_D are vectors of estimable parameters from location factors hypothesized to impact birth and death of manufacturing establishments, and the error terms u_i^B and u_i^D are assumed to be independently and identically distributed (i.i.d.) with $\mathrm{cov}(u^B, u^D) \neq 0$. Endogenous variables $D_{i,t}$ and $B_{i,t}$ appear in the birth and death equations, respectively.[4] To attend to the potential endogeneity of firm birth and death, equations (2a) and (2b) may be estimated with instrumental variables (IV) conditional on the variables controlling for local factors impacting the spatial distribution of birth and death rates, X_{i,t_0}.

[4] An alternative specification would be to replace $D_{i,t}$ and $B_{i,t}$ with D_{i,t_0} and B_{i,t_0} in equations 2a and 2b. However, the reduced form specification would require a transformation of the coefficients in order to test the creative destruction hypothesis. As a result, we use the structural equations which allow us to test our hypothesis directly.

The present framework allows for the incorporation of a conceptual model of location determinants established in previous research (BARTIK, 1989; WOODWARD, 1992; HENDERSON and MCNAMARA, 1997; LAMBERT *et al*., 2006a,b) as well as for properly accounting for the potential links between birth and death. Location determinants are hypothesized to affect birth and death in two ways: via firm birth and death in the previous period, and via the stock of firms in each region. Given that manufacturing activity is concentrated in certain parts of the U.S., it seems quite reasonable to assume that an underlying spatial process may help explain the spatial distribution of capital formation. Specifically, firm location decisions may be co-determined across space and time. Spatial effects are generally grouped into two categories: spatial dependence and spatial heterogeneity (DE GRAAFF et al., 2001; ANSELIN, 2002). Spatial dependence is commonly modeled using an endogenous, spatially lagged dependent variable or spatially autocorrelated error terms, with only the former having a useful substantive interpretation (ANSELIN, 1988). Spatial regimes, in which coefficients are allowed to vary over a discrete disjoint grouping of specific regions, allows for spatially heterogeneous responses to factors hypothesized to determine the spatial distribution of manufacturing birth and death rates.

4. ECONOMETRIC MODEL AND SPECIFICATION

Global and local spillovers may also be used to model how a particular county's birth and death rates are impacted by changes in the location factors of neighboring counties (FLORAX and FOLMER, 1992). These terms may carry important policy implications depending on the intensity and direction of spillover effects. Local spillovers are incorporated by including cross-regressive terms WX in the regression, where W is an $(n \times n)$ spatial weights matrix containing information about regional neighbors and X is an $(n \times k)$ matrix of explanatory variables. The elements in W are typically row-standardized so that the elements of each row sum to one. Neighborhood criteria are often based on distance or commonly shared borders between spatial units (ANSELIN, 2002). The interpretation in the present context is that firm birth and death rates in a particular county are a function of the weighted average of the adjustment in birth and death rates of neighboring counties (Wy), local determinants (X), as well as the weighted average of the local determinants in neighboring counties (WX).

The present analysis is based on a cross-sectional regional adjustment model to explain establishment births and deaths between 2000 and 2004, where the year 2000 is used as the base year. We specify a general model that allows for spatial spillovers in the endogenous variables, exogenous variables, and disturbances. A first-order queen contiguity matrix was chosen for the definition of the spatial weights needed to test for spatial dependence and to construct the cross-regressive terms WX. These terms are interpreted as the local weighted averages of location factors in neighboring counties. Moreover, the presence or absence of cities may have additional impacts on location choice beyond urbanization and agglomeration economies. Dummy variables are included in the model to identify counties belonging to metropolitan and micropolitan statistical areas (MSA) as defined by the U.S. Office of Management and Budget (U.S. CENSUS BUREAU, 2008). Counties not belonging to these two groups are classified as "non-core".[5] These classifications allow heterogeneous response of factors hypothesized to influence the distribution of establishment births and deaths. Let r index region type, where r = 1, 2 or 3 representing metropolitan, micropolitan, and non-core regions. The partial adjustment equations are specified using the spatial autoregressive model of the first order SARAR(1,1)

[5] There are 3,078 U.S. counties included in this analysis of which 1,061 are metropolitan, 665 are micropolitan, and 1,352 are non-core.

(KELEJIAN and PRUCHA, 2007), which incorporates a spatially lagged dependent variable as well as spatially correlated errors. The general moments estimation procedure is robust to unspecified forms of heteroskedasticity, and facilitates consistent and efficient estimation of the autoregressive parameters. Details of the estimation procedure in the case where the first stage involves a linear spatial autoregressive lag model are explained in detail in ARRAIZ et al. (2008). The model allows for spatial spillovers in endogenous variables, exogenous variables, and disturbances, which in matrix notation, reads as:

$$\text{(3a) } \dot{B}_i = \rho_1 W\dot{B}_i + \alpha_{0,r} + \alpha_{1,r} D_{i,t} + \alpha_{2,r} B_{i,t_0} + X_{i,t_0}\theta_{B,r} + \gamma_{1,r} WD_{i,t} + \gamma_{2,r} WB_{i,t_0} + WX_{i,t_0}\gamma_{B,r} + u_i^B,$$
$$\text{(3b) } \dot{D}_i = \rho_2 W\dot{D}_i + \delta_{0,r} + \delta_{1,r} B_{i,t} + \delta_{2,r} D_{i,t_0} + X_{i,t_0}\theta_{D,r} + \tau_{1,r} WB_{i,t} + \tau_{2,r} WD_{i,t_0} + WX_{i,t_0}\gamma_{D,r} + u_i^D,$$

where, $u_i^B = u_i^B W\lambda_1 + \varepsilon_i^B$ and $u_i^D = u_i^D W\lambda_2 + \varepsilon_i^D$ assuming ε_i^B and ε_i^D are independently, but not necessarily identically distributed error terms and *i* indexes spatial units, i.e. counties. Equations (3a) and (3b) each have endogenous spatial lags of the dependent variables and potentially endogenous variables corresponding with $D_{i,t}$ and $B_{i,t}$, and the cross-regressive terms $WD_{i,t}$ and $WB_{i,t}$.[6] Next is a discussion of the testable hypotheses using equations (2a,b) and (3a,b), which are listed in Table 1.

4.1 Hypotheses

An appropriate set of instruments is needed to test for creative destruction (endogeneity of birth and death, H_0: $\alpha_1 = \delta_1 = 0$) in equations (3a) and (3b). One possible underlying process of

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[6] Equations (3a) and (3b) are similar to those of a spatial Durbin model (SDM). However, a distinction is made here from the SDM due to the presence of the spatially autoregressive errors. In addition, the typical nonlinear restriction on the parameters applicable in the spatial Durbin model are not implemented here.

changes in establishment birth/death rates is the change in population dynamics in the previous decade at the county level. People may leave one area to take a job in another, frequently indicated as "jobs follow people" (CARLINO and MILLS, 1987; HOOGSTRA *et al.*, 2010). We use the change (in logs) of population density from 1980 and 1990 and the log of the population growth rate from 1969 to 2000 as instruments for $D_{i,t}$ and $B_{i,t}$. Local creative destruction (H_0: $\gamma_1 = \tau_1 = 0$) is tested using the spatial lag of the instrument set. Globally, the adjustment process of birth/death rates may be impacted by death/birth rates in a particular county. However, they may also be impacted locally by the weighted average of neighboring death/birth rates. The distinction between the testing of a global or localized creative destruction process. Tests for endogeneity are performed using the Durbin-Wu-Hausman statistic (DURBIN, 1954; WU, 1973; HAUSMAN, 1978).

Local spatial spillovers in the adjustment process are tested by the hypotheses H_0: $\gamma_1 = \gamma_2 = \gamma_B = 0$ and H_0: $\tau_1 = \tau_2 = \tau_D = 0$ in equations (3a) and (3b), respectively. These hypotheses indicate whether neighboring activity and demographics impact own-county adjustment in establishment birth and death rates. Wald tests are used to test for the restriction that the cross-regressive terms are jointly equal to zero. Rejection of the null hypothesis suggests…

Factors influencing the firm birth-death adjustment process may vary in importance across space. These factors are allowed to vary by county according to metropolitan, micropolitan, or noncore characteristics as defined by the U.S. Office of Management and Budget (U.S. Census Bureau, 2003). Wald statistics test for the restriction that H_0: $\beta = \beta_r$ in both equations. Rejection of the null hypothesis suggests that the influence of factors impacting the adjustment is different across metro, micro or non-core regimes.

The birth and death adjustment processes may be impacted by adjustment processes in neighboring counties and by spatially correlated omitted variables, which may arise from economic linkages across counties. To determine this, tests for spatial dependence in the presence of the endogenous regressors ($D_{i,t}$, $B_{i,t}$, $WD_{i,t}$, $WB_{i,t}$) were conducted using a Lagrange Multiplier (LM) tests suggested by ANSELIN and KELEJIAN (1997).[7] The additional set of instruments used for Wy was WWX, which is consistent with KELEJIAN and PRUCHA'S (2007) use of X, WX, and WWX to instrument Wy. The results for these tests are obviously conditional in the sense that they depend on the exogenously and *a priori* determined specification of the spatial weights matrix. As a robustness check, five different specifications of the weights matrix were used based upon variations of contiguity, *k*-nearest neighbors, inverse distance with a cut-off so that each spatial unit has at least one neighbor, and *k*-nearest neighbors incorporating inverse distance. Wald tests were also used to test the independent (H_0: $\rho_1 = 0$, $\lambda_1 = 0$; $\rho_2 = 0$, $\lambda_2 = 0$) and joint restrictions (H_0: $\rho_1 = \lambda_1 = 0$; $\rho_2 = \lambda_2 = 0$) of significant autoregressive processes in the dependent variables and disturbance terms.

To address the simultaneity of adjustment in establishment birth and death rates, we test whether the correlation between ε_i^B and ε_i^D is equal to zero. It is possible that unmodeled factors impact birth and death adjustment processes in the same manner. The null hypothesis H_0: $\mathrm{CORR}(\varepsilon_i^B, \varepsilon_i^D) = 0$ is tested using Breusch and Pagan's (1979) LM statistic. Rejection of the null hypothesis indicates that estimating the system allowing for correlation between the disturbances will increase the efficiency of the standard errors.

[7] Anselin and Kelejian (1997) show that a test for spatial error autocorrelation in models with non-spatial endogenous regressors can be based on the standard LM-error test using the residuals obtained from IV estimation. Our search of the literature reveals a need for a modified LM-lag test based upon the residuals from IV estimation and a modified LM-error test using IV residuals from models containing both spatial and non-spatial endogenous regressors.

<< Insert Table 1 >>

5. DATA SOURCES AND LOCAL DETERMININANTS

County level manufacturing data are from the U.S. Census Bureau's Dynamic Firm Data Series, which is compiled as part of Statistics of U.S. Businesses (U.S. CENSUS BUREAU, 2008). Counts of single-unit establishment births and deaths in 2000 and 2004 are used to compare the importance of location factors influencing birth and death over the 2000–2004 period. The counts of births and deaths are converted to birth and death rates, reported in percentage terms, by dividing by the stock of manufacturing establishments in 2000 and 2004. This variable construct is known as the ecological approach because it considers the amount of entry relative to the size of existing businesses (AUDRETSCH and FRITSCH, 1994; FRITSCH, 1997). Using birth and death data defined as rates may also mitigate the problem of heteroskedasticity caused by differences in the size of the areal units (STOREY and JONES, 1987; AUDRETSCH and FRITSCH, 1992; LOVE, 1996; FOTOPOULOS and SPENCE, 1998).[8]

<< Insert Figure 1 >>

The frequency distribution of single-unit establishment birth and death rates across U.S. counties in 2004 is shown in Figure 1. The frequencies are listed for all counties and by county type: metropolitan, micropolitan, and non-core (U.S. CENSUS BUREAU, 2008). The *z*-axis, labeled "Frequency", has been truncated to 100 in order to better show the distribution of birth and death rates at lower frequencies. Approximately 57% of all U.S. counties reported birth and death rates lower than 10% of the manufacturing stock. The distribution for metropolitan and micropolitan counties is similar. Non-core counties have more variation in birth and death rates,

[8] The modifiable areal unit problem would also be a much more persistent issue of concern if counts of births and deaths were used in place of rates (OPENSHAW and TAYLOR, 1981).

which is likely due to their lower absolute levels of manufacturing activity. Figure 1 shows a rather symmetric relationship between birth and death rates among all county types.

The location factors hypothesized to impact the spatial distribution of establishment birth and death rates are reported in Table 2. Agglomeration economies are important factors in firms' location decisions (COUGHLIN *et al*., 1991; WOODWARD, 1992; AUDRETSCH and FRITSCH, 1999; ARMINGTON and ACS, 2002; DE GROOT *et al*., 2007). Agglomeration is measured in the year 2000 with the percentage of manufacturing establishments with less than 10 employees, manufacturing's share of employment in a county, percentage of manufacturing establishments with more than 100 employees, and total business establishment density scaled by county area. The first two measures are proxies for local agglomeration economies. The third and fourth measures are intended to capture economies of scale internal to the firm and urbanization economies, respectively. All four measures are hypothesized to have a positive impact on firm location choice, and thus result in a higher incidence of birth in a county. Their effect on establishment death is unknown *a priori*. Sector-specific employment data are from the U.S. Department of Transportation commuting patterns compiled by the Research and Innovation Technology Administration (RITA). Total firm density and percentage of manufacturing establishments with less than 10 and more than 100 employees are calculated from the annual County Business Patterns files.

Market structure is often the most important factor in investment location decisions (BLAIR and PREMUS, 1987; CRONE, 1997). A county with more wealth and people increases the likelihood of being a demand center for goods and services. Demand markets may also harbor a relatively larger stock of creative individuals capable of solving difficult supply issues or combining old ideas in a novel way, which may stimulate establishment birth (WOJAN and

MCGRANAHAN, 2007). Median household income, population, and the share of workers in creative occupations are used to measure the market structure of a county (all measured in 2000).[9]

Labor is frequently cited as an important location factor impacting the spatial distribution of firms (COUGHLIN and SEGEV, 2000; GUIMARÃES *et al*., 2004). Labor availability and labor cost are measured by county unemployment rates (Bureau of Labor Statistics, BLS) and the average wage per job (from the BEA), respectively. A high unemployment rate is hypothesized to attract manufacturing investment, whereas a high average wage per job increases labor costs, which deters investment. Additionally, the availability of skilled labor is measured by the percentage of a county's population 25 years of age and older with an associate degree. Labor may also be sourced from neighboring counties. Net flows of wages per commuter between place of residence and place of work help identify counties that are labor sources or sinks.

Access and breadth of infrastructure are measured by density of public roads and miles of interstate highway with data from the U.S. Department of Transportation (DOT). Infrastructure quality is measured by per capita local government expenditures on highways (CENSUS of GOVERNMENTS, 1997). Available land is measured as the percentage of a county's total area in use as farmland, which is hypothesized to attract investment as the availability of land increases. Presumably, farmland may be converted to other uses following sufficient investment in infrastructure. This measure is calculated using a GIS database from ArcGIS 9.2 produced by ESRI. For some counties, farmland area was not disclosed due to the small number of farms. In

[9] Median household income and population are measured in thousands to avoid large differences in scaling between other covariates. The creative class share of employment was constructed by MCGRANAHAN and WOJAN (2007) and is available at http://www.ers.usda.gov/Data/CreativeClassCodes/.

those cases, the value was approximated by multiplying the number of farms by the average farm size measured in acres in that county.

Fiscal policy may impact the cost of conducting business in a region, yet supporting a favorable business climate, while generating sufficient revenue to provide the necessary public goods is often difficult for local governments (GABE and BELL, 2004). Firms may consider other locations if tax rates are perceived as too high. Taxes may deter manufacturing investment (WHEAT, 1986; BARTIK, 1989), but local spending may be attractive (GOETZ, 1997). Government expenditures on education and highways on a per capita basis measure the level of public goods often provided by local governments.

<< Insert Table 2 >>

6. RESULTS

We model the regional adjustment in manufacturing establishment birth and death rates between 2000 and 2004 using 3,078 counties of the lower 48 United States. Several specification tests were performed to select the general models of given in equation (3a,b). Wald tests on the significance of local spatial spillovers (*WX*) were statistically significant in the birth equation ($W_{\gamma_B=0} = 318$, df =19) and death equation ($W_{\gamma_D=0} = 1251$, df = 19), using the queen first-order contiguity matrix as neighboring criteria. The eigenvalues of the weights matrix range between –1 and +1, which determines the appropriate bounds on the parameter space for the spatial autoregressive parameters. The average number of links in *W* is 5.8, with 0.19% of its elements non-zero. Tests on spatial heterogeneity failed to reject that location factors were same in importance across the county types. However, we maintained metropolitan and micropolitan counties as additional explanatory variables, with non-core omitted as the reference category assuming that only the constants are different between the three categories. Durbin-Wu-Hausman

(DWH) tests of $D_{i,t}$ and $B_{i,t}$, in equations (3a) and (3b) failed to reject exogeneity.[10] However, the DWH tests were rejected for spatially lagged birth and death, $WD_{i,t}$ and $WB_{i,t}$. Given the mixed results, we maintain the endogeneity of $D_{i,t}$ and $B_{i,t}$ on the basis of the theoretical argument rather than the empirical evidence. Using an a-spatial specification, first-stage F-tests as well as Sargan statistics for over-identification reveal that the population dynamics used to instrument birth and death rates appear to be appropriate (see bottom of Table 3). The LM-error tests for spatial dependence in the IV residuals rejected the absence of spatial error processes in the birth (LM = 51.78, df =1) and death (LM = 89.27, df =1) equations. Additionally, Wald tests for the joint significance of the auto-regressive processes were significant in the birth ($W_{\rho=\lambda=0}$ = 9.68, df = 2) and death ($W_{\rho=\lambda=0}$ = 7.54, df = 2) equations.[11]

Results from the SARAR models are reported in Table 3. The SARAR model is estimated using the R software, version 2.10.0.[12] Standard errors, reported in the last two columns, are robust against unspecified forms of heteroskedasticity. The second column of Table 2 shows the coefficients from the birth adjustment equation. Both spatial processes are statistically significant. The coefficient on death rate (DR04) has the expected sign, but is not statistically significant. This suggests that higher county establishment death rates did not lead to significantly higher birth rates over the sample period. The coefficient on initial establishment birth rate (BR00) suggests a convergence of birth rates from the initial period to the final period,

[10] The endogeneity tests as well as tests for instrumental variable performance (first stage F-tests and Sargan statistics) were conducted on sets of equations estimated via OLS omitting spatially lagged dependent variables and spatially correlated errors. This is an obvious limitation, but endogeneity tests in the presence of spatial dependence are not presently available.

[11] The Wald tests where implemented using the restrictions the $\rho = \lambda = 0$ in the birth and death equations from the SARAR model.

[12] R is available for download at http://r-project.org (R Development Core Team, 2009). The R-code used to implement this estimator was originally developed by Vanessa Daniel of the Dept. of Spatial Economics at the VU University Amsterdam and members of the SHaPE group in the Dept. of Agricultural Economics at Purdue University.

but the coefficient on neighboring birth rates ($W \times$ BR00) suggests a momentum affect in the adjustment process. Higher shares of manufacturing establishments with less than 10 employees (EMP<10) and urban agglomeration (ESTAB) are correlated with increases in the establishment birth rate between the two periods. However, higher wages per job (WAGE) and higher shares of farmland (FARML) are negatively correlated with the birth rate adjustment process.

The death rate adjustment results are in the third column of Table 3. Both spatial processes are also statistically significant in the death equation. The coefficient on birth rate (BR04) has the expected sign, but is not significant. Firm birth rates do not appear to have a direct impact on death rates. Taken together, there is no evidence of a creative destruction process in manufacturing establishments over the current sample period. The coefficient on initial establishment birth rate (DR00) also suggests a convergence of death rates from the initial period to the final period, but the coefficient on neighboring death rates ($W \times$ DR00) also suggests a momentum affect in the adjustment process. Higher shares of manufacturing establishments with less than 10 employees (EMP<10) are correlated with increases in the establishment death rate between the two periods. However, higher neighboring county shares ($W \times$ EMP<10) are negatively correlated with death rate adjustments. Metropolitan (METRO) and micropolitan (MICRO) counties have lower death rates compared to noncore counties. However, neighboring metro ($W \times$ METRO) and micropolitan ($W \times$ MICRO) counties are positively correlated with increases in establishment death rates compared to neighboring noncore counties. Additional complexity in interpreting these results arises from the spatial multiplier, $(I - \rho W)$, which moderates spatial decay between birth-death events between counties (discussed in the next section).

<< Insert Table 3>>

6.1 Single-Unit Manufacturing Establishment Birth and Death Rates

Results from a spatial lag process model must be interpreted carefully. One standard approach is to calculate the marginal effects of a change in an explanatory variable on the dependent variable. LESAGE and PACE (2009) decompose the marginal effects into direct, indirect, and total effects. The partial derivatives of the reduced form SARAR model in equations (3a, b) are:

$$(4)\ \frac{\partial y}{\partial x_k} = (I - \rho W)^{-1}[\beta_k + W \otimes \gamma_k].$$

where $\otimes$ is the element-wise (Hadamar) matrix product operator. The partial derivatives take the form of an *N* by *N* matrix of marginal effects. The impact on the dependent variable from a change in a covariate can be summarized in three ways (LESAGE and PACE, 2009). The first is the average total effect on a spatial unit. The row sums are the total effect on each observation from changing the *k*-th explanatory by one unit across all observations. Dividing the row sums by the sample size yields the average total effect. The second impact is referred to as the direct effect, which is the effect of changes in the *i*-th location of x_k on y_i including feedback effects on the *i*-th through spillovers to other locations. The average direct effect is measured by summing the trace of the *N* by *N* matrix in equation (4) and dividing by the sample size. The third impact is referred to as the indirect effect, which constitutes spillover effects of neighbors.

<< Insert Table 4 >>

Marginal effects calculated from the SARAR model are reported in Table 4. The standard errors of the direct, indirect, and total effects were estimated using a bootstrap procedure with

500 iterations.[13] We focus most of the discussion on total effects. Coefficients of the direct, indirect, and total effects of the initial period birth and death rates are negative and statistically significant. This suggests a convergence process that takes place between the two time periods. The interpretation is that counties with higher birth/death rates in a previous period will have lower birth/death rates in the future period as convergence occurs. The percentage of establishments with less than 10 employees (EMP<10) is positive and significant in the birth and death rate adjustment equations, which suggests that a low barrier to entry leads to more establishment births and is also a barrier to exit. Higher average wages (WAGE) have negative effects on manufacturing establishment birth rates, but have positive effects on establishment deaths. This illustrates the complexity that higher wages have on the dynamics of firm formation. Similarly, interstate transportation infrastructure (ISTATE) has positive effects in adjustment of birth rates and negative effects in adjustment of death rates. Such a result suggests that more infrastructure may lead to a growth in the overall number of manufacturing establishments. Next, we explore a policy experiment using the results of the SARAR model and the decomposition of its marginal effects.

6.2 Metropolitan Spillovers Impacting Manufacturing Establishment Birth and Death Rates

Policymakers and regional economic development practitioners may be interested in knowing how changes in metropolitan counties spillover to non-metropolitan counties. Spatial process models are capable of analyzing such situations. Spatial cluster analysis was conducted using Local Indicators of Spatial Association (LISA, Anselin, 1995) to determine if the pattern of

[13] The data generating process of the SARAR model was used to sample with replacement from the residuals of the IV model in order to reconstruct the dependent variable and re-estimate the SARAR model 500 times. Results of the bootstrapping were stored in matrices in order to calculate average direct, indirect, and total effects over the iterations.

spillovers between interconnected metro and non-metro counties demonstrated a greater likelihood of adjustment in firm dynamics relative to other counties.[14] We select the share of manufacturing establishments with less than 10 employees (EMP<10) to shock because it is a significant covariate in both the birth and death equations. Figure 2 shows how a 2% increase in the total effects of EMP<10 in metro counties spills over into non-metro counties, impacting the adjustment of (a) manufacturing establishment birth rates and (b) establishment death rates. Given that the coefficient on EMP<10 is similar in magnitude and sign in the birth and death equations, we expect to see a similar pattern in the spillovers from metro to non-metro counties. Figure 2a and 2b both show that significant spillovers attenuate to the immediate neighbors of metropolitan counties and quickly become insignificant thereafter. Non-metro counties in the Midwest and the South appear to capture the most from increases in small manufacturing establishment spillovers emanating from metropolitan counties as shown by the low-high LISA category of the map. This result may be due to the predominance of the manufacturing sector in those regions, but may be important for policymakers considering the impact that business formation policies have on the birth and death of manufacturing establishments.

<< Insert Figure 2 >>

7. CONCLUSIONS

This paper contributes to the empirical literature examining manufacturing establishment birth and death using a regional adjustment model and spatial econometrics. Localized creative destruction was tested as a mechanism to explain the adjustment of the spatial distribution of

[14] Lambert et al. (2006b) use a similar method for comparing food manufacturing clusters, but the clusters were based on location probabilities estimated by probit regression.

manufacturing establishment birth and death rates. The adjustment process of manufacturing establishments was measured for U.S. counties in the lower 48 states from 2000–2004. We estimate a set of birth and death equations using a generalized SARAR(1,1) model which allows for spatial spillovers in endogenous and exogenous regressors as well as in the disturbance terms.

Results indicate a kind of a "convergence" process occurring where counties with high initial birth/death rates have smaller percentage point changes in the growth of birth and death rates. This may be interpreted as counties becoming more equally competitive in terms of firm formation dynamics rather than that successful counties increasing their lead in the short run. This is potentially relevant to policymakers and economic development practitioners who are concerned with business retention and the impact of new manufacturing establishments on their existing base. Direct, indirect, and total effects from factors that are positively or negatively associated with adjustment in birth rates were also found to be positively or negatively associated with adjustment in death rates. This finding is consistent with previous literature suggesting that barriers to entry are also barriers to exit. Two exceptions include average wages per job and interstate highway infrastructure, which are both positively correlated with increases in establishment birth rates and negatively correlated with increases in death rates.

Cluster analysis of total marginal effects from a shock in the share of manufacturing establishments with less than 10 employees on firm formation dynamics shows that immediate neighbors of metropolitan counties in the Midwest and South are impacted the most. This may be important for policymakers considering the impact that business formation policies have on the birth and death of manufacturing establishments.

REFERENCES

ACS, Z.J. and ARMINGTON, C. (2004) Employment growth and entrepreneurial activity in cities, Regional Studies 38, 911-927.

ACS, Z.J. and MUELLER, P. (2008) Employment effects of business dynamics: mice, gazelles, and elephants, Small Business Economics 30, 85-100.

AGARWAL, R., AUDRETSCH, D. and SARKAR, M.B. (2007) The process of creative destruction : knowledge spillovers, entrepreneurship, and economic growth, Strategic Entrepreneurship Journal 1, 263-286.

ANSELIN, L. (1988) Spatial Econometrics: Methods and Models. London, Kluwer Academic Publishers.

ANSELIN, L. (1995) Local indicators of spatial association - LISA, Geographical Analysis 27, 93-115.

ANSELIN, L. (2002) Under the hood: issues in the specification and interpretation of spatial regression models, Agricultural Economics 17 (3), 247-267.

ANSELIN, L. and KELEJIAN, H.H. (1997) Testing for spatial error autocorrelation in the presence of endogenous regressors, International Regional Science Review 20(1&2), 153-182.

ARMINGTON, C. and ACS, Z.J. (2002) The determinants of regional variation in new firm formation, Regional Studies 36(1), 33-45.

ARRAIZ, I., DRUKKER, D.M., KELEJIAN, H.H., and PRUCHA, I.R. (2008) A spatial Cliff-Ord type model with heteroskedastic innovations: small and large sample results, CESIFO Working Paper no. 2485.

AUDRETSCH, D.B. (1990) Start-up size and establishment exit, Discussion Paper FS IV 90-8, Wissenschaftszentrum Berlin.

AUDRETSCH, D.B. and FRITSCH, M. (1992) Market dynamics and regional development in the Federal Republic of Germany, Discussion Paper FS IV 92-6,Wissenschaftszentrum Berlin.

AUDRETSCH, D.B. and FRITSCH, M. (1994) On the measurement of entry rates, Empirica 21, 105-113.

AUDRETSCH, D.B. and FRITSCH, M. (1999) The industry component of regional new firm formation processes, Review of Industrial Organization 15, 239-252.

AUSTIN, J.S. and ROSENBAUM, D.I. (1990) The determinants of entry and exit rates into U.S. manufacturing industries, Review of Industrial Organization 5(2), 211-23.

BALDWIN, J.R. and GORECKI, P.K. (1991) Firm entry and exit in the Canadian manufacturing sector, The Canadian Journal of Economics 24(2), 300-323.

BARTIK, T.J. (1989) Small business start–ups in the United States: estimates of the effects of characteristics of states, Southern Economic Journal 55(4), 1004-1018.

BARTELSMAN, E., SCARPETTA, S. and SCHIVARDI, F. (2003) Comparative analysis of firm demographics and survival: micro-level evidence for the OECD countries, OCED Economics Department, WP No. 348.

BAUM, J.A.C. (1996) Organizational ecology, in: CLEGG, S., HARDY, C., NORD, W. (Eds) Handbook of Organization Studies. Sage, London.

BERNARD, A.B. and JENSEN, J.B. (2007) Firm structure, multinationals, and manufacturing plant deaths, The Review of Economics and Statistics 89(2), 193-204.

BLAIR, J.P., PREMUS, R. (1987) Major factors in industrial location: a review, Economic Development Quarterly 1(1), 72–85.

BOARNET, M.G. (1994a) An empirical model of intermetropolitan population and employment growth, Papers in Regional Science 73, 135-52.

BOARNET, M.G. (1994b) The Monocentric model and employment location, Journal of Urban Economics 36, 79-97.

BOSMA, N., STAM, E. and SCHUTJENS, V. (2008) Creative destruction and regional productivity growth: evidence from the Dutch manufacturing and services industries. Papers in Evolutionary Economic Geography # 08.13, Utrecht University, Urban and Regional Research Center.

BRUCE, D., DESKINS, J.A. HILL, B.C. and RORK, J.C. (2007) Small business and state growth: an econometric investigation, Small Business Administration: Office of Advocacy. Report No. 292.

CABLE, J. and SCHWALBACH, J. (1991) International comparisons of entry and exit, in: GEROSKI, P. and SCHWALBACH, J. (Eds) Entry and Market Contestability: An International Comparison. Blackwell, Oxford.

CARLINO, G.A. and MILLS, E.S. (1987) The determinants of county growth, Journal of Regional Science 27, 39-54.

CARRUTHERS, J.I. and MULLIGAN, G.F. (2007) Land absorption in U.S. metropolitan areas: estimates and projections from regional adjustment models, Geographical Analysis 39, 78-104.

CARRUTHERS, J.I. and VIAS, A.C. (2005) Urban, suburban, and exurban sprawl in the Rocky Mountain West, Journal of Regional Science 45, 21-48.

CLARK, D.E. and MURPHY, C.A. (1996) Countywide employment and population growth: an analysis of the 1980s, Journal of Regional Science 36, 235-56.

COUGHLIN, C.C. and SEGEV, E. (2000) Location determinants of new foreign owned manufacturing plants, Journal of Regional Science 40, 323-351.

COUGHLIN, C.C., TERZA, J.V. and ARROMDEE, V. (1991) State characteristics and the location of foreign direct investment within the United States, The Review of Economics and Statistics 73, 675-683.

CRONE, T.M. (1997) Where have all the factory jobs gone - and why?, Business Review, Federal Reserve Bank of Philadelphia, May/June.

DE GRAAFF, T., FLORAX, R.J.G.M., NIJKAMP, P. and REGGIANI, A. (2001) A general misspecification test for spatial regression models: dependence, heterogeneity, and nonlinearity, Journal of Regional Science 41(2), 255-76.

DE GROOT, H.L.F., POOT, J. and SMIT, M.J. (2007) Agglomeration, innovation, and regional development: theoretical perspectives and meta-analysis, Tinbergen Institute Discussion Paper 079/3.

DIXIT, A. (1992) Investment and hysteresis, The Journal of Economic Perspectives 6(1), 107-32.

DUNNE, T., ROBERTS, M.J. and SAMUELSON, L. (1988) Patterns of firm entry and exit in U.S. manufacturing industries, RAND Journal of Economics 19(4), 495-515.

DURBIN, J. (1954) Errors in variables, Review of the International Statistical Institute. 22, 23-32.

ERICSON, R. and PAKES, A. (1995) Markov-perfect industry dynamics: a framework for empirical work, Review of Economic Studies 62, 53-82.

EVANS, L.B. and SIEGFRIED, J.J. (1992) Entry and exit in United States manufacturing industries from 1977 to 1982, in AUDRETSCH, D.B. and SIEGFRIED, J.J. (Eds) Empirical Studies in Industrial Organization: Essays in Honour of Leonard W. Weiss, pp. 253-73. Kluwer, Netherlands.

FIGUEIREDO, O., GUIMARÃES, P., and WOODWARD, D. (2002) Home–field advantage: location decisions of Portuguese entrepreneurs, Journal of Urban Economics 52, 341–61.

FLORAX, R.J.G.M., and FOLMER, H. (1992) Specification and estimation of spatial linear regression models: monte carlo evaluation of pre-test estimators, Regional Science and Urban Economics 22, 405-32.

FOTOPOULOS, G. and SPENCE, N. (1998) Entry and exit from manufacturing industries: symmetry, turbulence and simultaneity – some empirical evidence from Greek manufacturing industries, 1982 – 1988, Applied Economics 30, 245-62.

FRITSCH, M. (1997). New firms and regional employment change, Small Business Economics 9, 437-448.

GABE, T., and BELL , K.P. (2004) Tradeoffs between local taxes and government spending as determinants of business location, Journal of Regional Science 44(1), 21–41.

GEROSKI, P.A. (1995) What do we know about entry?, International Journal of Industrial Organization 13, 421-440.

GOETZ, S. (1997) State- and county-level determinants of food manufacturing establishment growth: 1987-1993, American Journal of Agricultural Economics 79(3), 838-50.

GUIMARÃES, P., FIGUEIREDO, O., WOODWARD, D. (2004) Industrial location modeling: extending the random utility framework, Journal of Regional Science 44(1), 1–20.

HALL, B.H. (1987) The relationship between firm size and firm growth in the US manufacturing sector, Journal of Industrial Economics 35, 583-605.

HAMERMESH D. S. (1993) Labor Demand. New Jersey: Princeton University Press.

HART, D.M. (2008) The politics of ‘entrepreneurial’ economic development policy of states in the U.S., Review of Policy Research 25(2), 149–68.

HAUSMAN, J.A. (1978) Specification tests in econometrics, Econometrica 46, 931-959.

HENDERSON, J.R. and MCNAMARA, K.T. (1997) Community attributes influencing local food processing growth in the U.S.Corn Belt, Canadian Journal of Agricultural Economics 45, 235-50.

HOOGSTRA, G.J., VAN DIJK and FLORAX, R.J.G.M. (2010) Determinants of variation in population-employment interaction findings: a quasi-experimental meta-analysis. Geographical Analysis. In press.

HOPENHAYM, H.A. (1992) Entry, exit, and firm dynamics in long run equilibrium, Econometrica 60(5), 1127-1150.

JOHNSON, P. and PARKER, S. (1996) Spatial variations in the determinants and effects of firm births and deaths, Regional Studies 30(7), 679-688.

JOVANOVIC, B. (1982) Selection and the evolution of industry, Econometrica 50, 649-70.

KANGASHARJU, A. and MOISIO, A. (1998) Births-deaths nexus of firms: estimating VAR with panel data, Small Business Economics 11, 303-313.

KELEJIAN, H.H. and PRUCHA, I.R. (2007) Specification and estimation of spatial autoregressive models with autoregressive and heteroskedastic disturbances, forthcoming in Journal of Econometrics.

LAMBERT, D.M., GARRET, M.I., MCNAMARA, K.T. (2006a) An application of spatial Poisson models to manufacturing investment location analysis, Journal of Agricultural and Applied Economics 38(1), 105–121.

LAMBERT, D.M., GARRET, M.I., MCNAMARA, K.T. (2006b) Food industry investment flows: implications for rural development, Review of Regional Studies 36(2), 140-162.

LAZEAR, EDWARD P. (2002) Entrepreneurship, National Bureau of Economic Research Working Paper 9109, August.

LOVE, J.H. (1996) Entry and exit: a county-level analysis, Applied Economics 28, 441-451.

MALECKI, E.J. (2004) Jockeying for position: what it means and why it matters to regional development policy when places compete, Regional Studies 38, 1101–20.

MCGRANAHAN, D.A. (2002) Local context and advanced technology use by small, independent manufacturers in rural areas, American Journal of Agricultural Economics 84(5), 1237-1245.

OPPENSHAW S., TAYLOR P.J. (1981) The modifiable areal unit problem. In: WRIGLEY N., BENNETT R.J., (Eds) Quantitative Geography. London, United Kingdom: Routledge and Kegan Paul.

PAKES, A. and ERICSON, R. (1998) Empirical iImplications of alternative models of firm dynamics, Journal of Economic Theory 79, 1-45.

PE’ER, A. and VERTINKSY, I. (2008) Firm exits as a determinant of new entry: is there evidence of local creative destruction?, Journal of Business Venturing 23, 280-306.

PHILIPS, B.D. and KIRKOFF, B.A. (1989) Formation, growth, and survival: small firm dynamics in the U.S. economy, Small Business Economics 1, 65-74.

REYNOLDS, P.D., MILLER, B. and MAKI, W.R. (1995) Explaining regional variation in business births and deaths: U.S. 1976-88, Small Business Economics 7, 389-407.

SCHUMPETER, J.A. (1942) Socialism and Democracy. New York: Harper.

SHAPIRO, D. and KHEMANI, R.S. (1987) The determinants of entry and exit reconsidered, International Journal of Industrial Organization 5, 15-26.

STEINNES, D.N. and FISHER,W.D. (1974) An econometric model of interurban location, Journal of Regional Science 14, 65-80.

STINCHCOMBE, A.L. (1965) Social structures and organizations. In: March, J.G. (Ed.) Handbook of Organizations, Rand McNally, Chicago.

STOREY, D.J. and JONES, A.M. (1987) New firm formation – A labour market approach to industrial entry, Scottish Journal of Political Economy 34, 37-51.

U.S. CENSUS BUREAU (2008) Metropolitan and micropolitan statistical areas, Available at: http://www.census.gov/population/www/metroareas/metrodef.html.

U.S. CENSUS BUREAU, Company Statistics Division (2008) Statistics of U.S. businesses: dynamic data. Available at: http://www.census.gov/csd/susb/susbdyn.htm. Accessed on 5/23/2008.

U.S. CENSUS BUREAU (1997) Census of Governments, Available at: http://www.census.gov/govs/www/cog97.html. Accessed on 10/21/2008.

U.S. CENSUS BUREAU (2003) Metropolitan and Micropolitan Statistical Areas. Available at: http://www.census.gov/population/www/metroareas/metrodef.html.

U.S. DEPARTMENT OF TRANSPORTATION (2000), Federal highway administration. highway statistics 2000. Available at: http://www.fhwa.dot.gov/ohim/hs00/re.htm. Accessed on 3/11/2008.

WHEAT, L. (1986) The determinants of 1963–77 regional manufacturing growth: why the South and West grow, Journal of Regional Science 26(4), 635 – 660.

WILKERSON, C. (2001) Trends in rural manufacturing. The Main Street Economist, Center for the Study of Rural America. Federal Reserve Bank of Kansas City.

WOJAN, T.R., MCGRANAHAN, D.A. (2007) Ambient returns: creative capital's contribution to local manufacturing competitiveness, Agricultural and Resource Economics Review 36(1), 133-148.

WOODWARD, D.P. (1992) Location determinants of Japanese manufacturing start–ups in the United States, Southern Economics Journal 58, 690 –708.

WU, D. (1973) Alternative tests of independence between stochastic regressors and disturbances, Econometrica 41-4, 733-749.

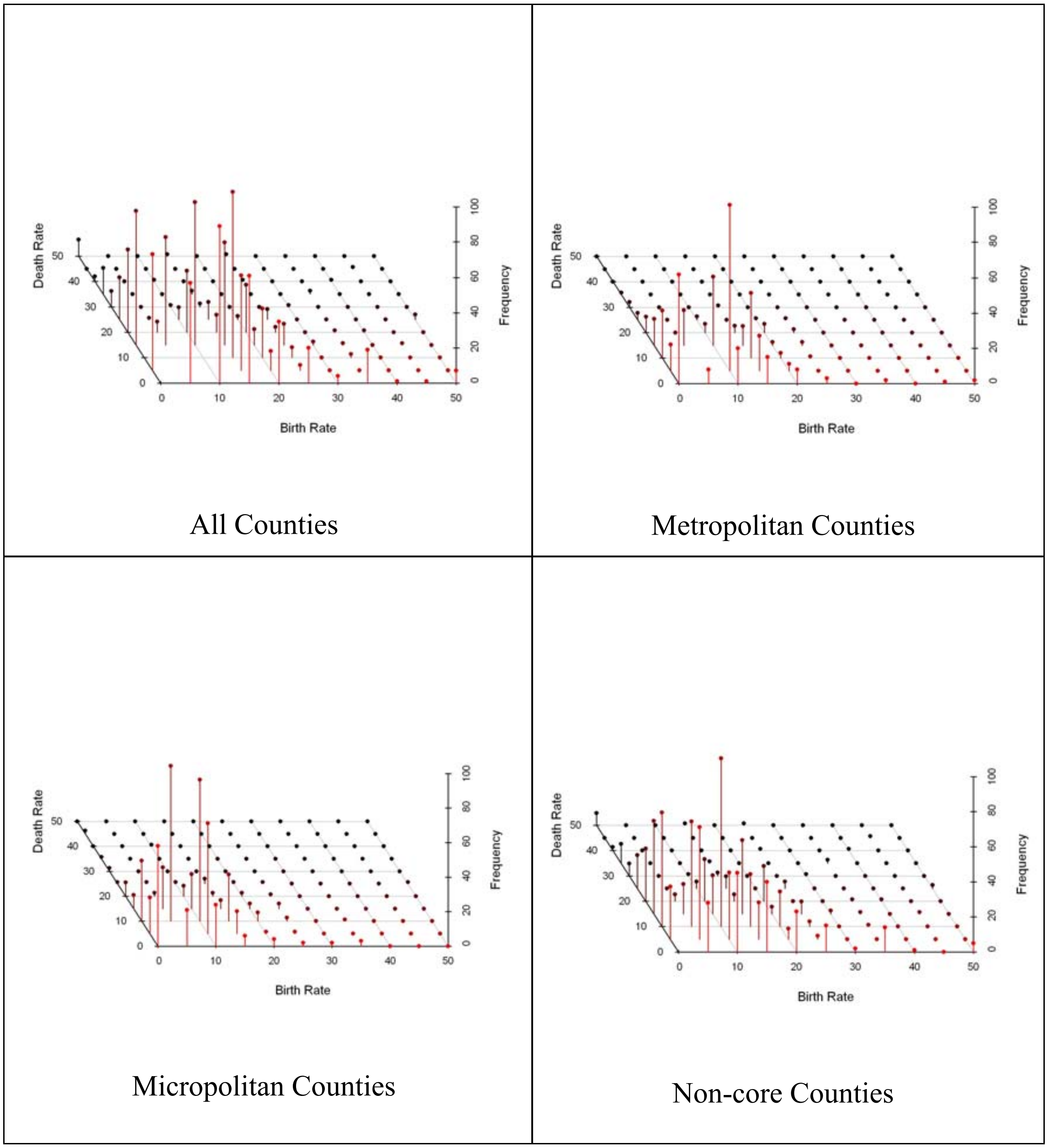
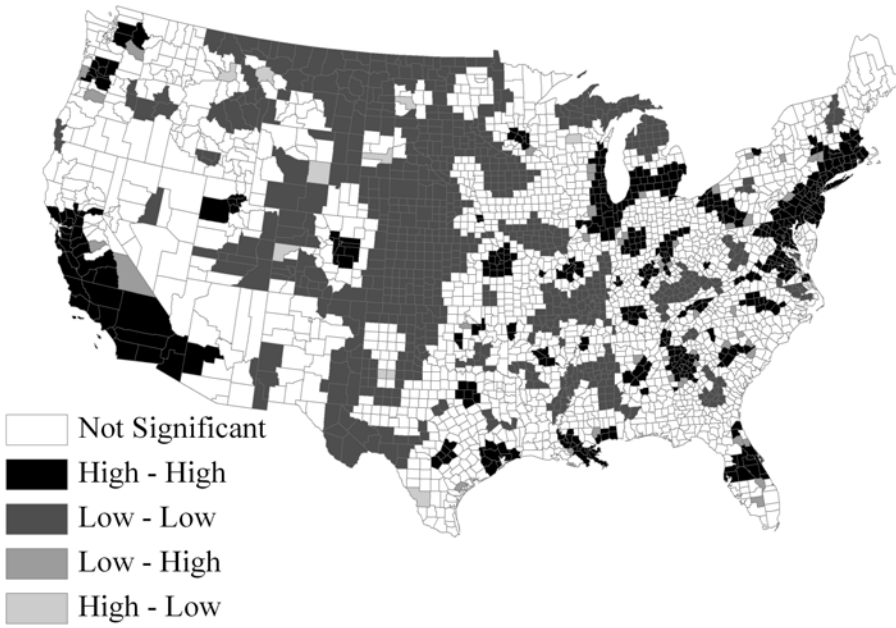
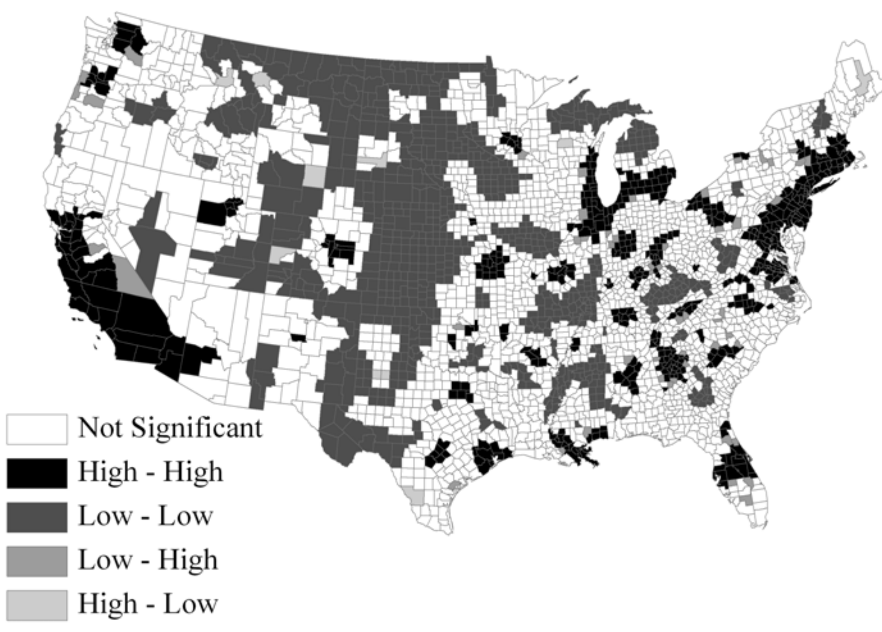


Figure 1. Frequency of Single-Unit Establishment Birth and Death Rates in U.S. Counties, in 2004



(a)



(b)

Figure 2. Spillovers from an Increase in Small Business Share of Manufacturing Establishments in Metropolitan Counties on (a) Adjustment of Birth Rates (b) Adjustment of Death Rates

Table 1. Model specification and hypotheses

Hypothesis	Restrictions	Degrees of Freedom	Test Statistic
Creative destruction	$\alpha_1 = 0$	1	Wald
	$\delta_1 = 0$	1	Wald
Local creative destruction	$\gamma_1 = 0$	1	Wald
	$\tau_1 = 0$	1	Wald
Local spatial spillovers	$\gamma_1 = \gamma_2 = \gamma_B = 0$	19	Wald
	$\tau_1 = \tau_2 = \tau_D = 0$	19	Wald
Slope homogeneity of metropolitan, micropolitan, and noncore counties	Birth: $\beta - \beta_r = 0$	74	Wald
	Death: $\beta - \beta_r = 0$	74	Wald
Spatial lag process	$\rho_1 = 0$	1	Wald
	$\rho_2 = 0$	1	Wald
Spatial error process	$\lambda_1 = 0$	1	Wald
	$\lambda_2 = 0$	1	Wald
Spatial lag and error processes	$\rho_1 = \lambda_1 = 0$	2	Wald
	$\rho_2 = \lambda_2 = 0$	2	Wald
Error correlation between birth-death equations	Corr(ε_i^B , ε_i^D) = 0	[n ×(n-1)] / 2	LM

Table 2. Descriptive Statistics Birth and Death Rate Model

Variables	Label	Average	Stdev
Manuf. share of employment (%)	EMP	15.19	10.35
Manuf. establishments with less than 10 emp.(%)	EMP<10	52.11	19.99
Manuf. establishments with more than 100 emp. (%)	EMP>100	11.05	9.93
Total establishment density (estab. per square mile)	ESTAB	5.21	59.98
Creative class share of employment	CCLASS	17.18	5.94
Median household income (1,000 $)	MHHI	32.01	87.41
Population (1,000)	POP	91.04	295.68
Average wage per job (1,000 $)	WAGE	24.69	5.59
Unemployment Rate (%)	UNEMP	4.32	1.64
Associate's Degree (% of population 25 years +)	SKILL	5.70	1.99
Public road density	ROAD	1.84	1.52
Interstate (miles)	ISTATE	14.68	25.23
Available land (% farm area/total area)	FARML	31.29	25.96
Highway per capita expenditures (100 $)	HWY	1.77	2.50
Education spending per capita (1,000 $)	EDUC	1.18	1.17
Metropolitan county	METRO	0.34	0.48
Micropolitan county	MICRO	0.22	0.41
Noncore county	NONCORE	0.44	0.50
Single-unit birth rate in 2000 (%)	BR00	6.44	8.75
Single-unit death rate in 2000 (%)	DR00	6.68	7.66
Single-unit birth rate in 2004 (%)	BR04	5.90	7.72
Single-unit death rate in 2004 (%)	DR04	6.45	8.21

N = 3,078

Table 3. SARAR Estimation of Establishment Birth and Death Rate Adjustment

Variable	Birth Equation	Death Equation	$S.E._{Birth}$	$S.E._{Death}$
Constant	–0.181	1.396	1.778	2.017
DR04	0.071	—	0.171	—
BR04	—	0.123	—	0.235
BR00	-0.988^{***}	—	0.039	—
DR00	—	-0.955^{***}	—	0.042
EMP<10	0.054^{***}	0.078^{***}	0.017	0.018
EMP>100	0.042	0.040	0.032	0.032
EMP	0.012	–0.038	0.027	0.028
ESTAB	0.003^{***}	–0.0001	0.001	0.001
CCLASS	0.063	0.016	0.057	0.059
MHHI	–0.010	–0.036	0.042	0.057
POP	–0.001	–0.0001	0.003	0.004
UNEMP	–0.263	0.251	0.182	0.255
SKILL	0.214	0.347^{*}	0.169	0.192
FLOW	0.023	0.005	0.015	0.012
WAGE	-0.105^{*}	0.020	0.056	0.073
EDUC	–0.035	0.264	0.176	0.167
HWY	–0.035	–0.152	0.108	0.097
ROAD	–0.110	0.035	0.101	0.200
ISTATE	0.009	–0.008	0.007	0.009
FARML	-0.036^{**}	–0.006	0.016	0.020
METRO	–0.523	-0.999^{**}	0.473	0.480
MICRO	–0.363	-0.713^{*}	0.425	0.393
$W \times$ DR04	0.093	—	0.211	—
$W \times$ BR04	—	0.265	—	0.247
$W \times$ BR00	0.511^{***}	—	0.190	—
$W \times$ DR00	—	0.713^{***}	—	0.173
$W \times$ EMP<10	–0.039	-0.093^{***}	0.034	0.036
$W \times$ EMP>100	–0.004	-0.090^{*}	0.051	0.048
$W \times$ EMP	–0.007	0.045	0.032	0.033
$W \times$ ESTAB	–0.001	–0.0001	0.002	0.002
$W \times$ CCLASS	0.062	–0.090	0.085	0.085
$W \times$ MHHI	0.046	0.012	0.053	0.067
$W \times$ POP	–0.003	0.002	0.006	0.008
$W \times$ UNEMP	0.424	–0.334	0.281	0.308
$W \times$ SKILL	–0.302	–0.337	0.205	0.209
$W \times$ FLOW	–0.012	–0.012	0.017	0.016
$W \times$ WAGE	–0.009	0.029	0.085	0.087
$W \times$ EDUC	0.136	–0.537	0.322	0.371
$W \times$ HWY	0.152	0.103	0.152	0.190
$W \times$ ROAD	–0.060	0.107	0.173	0.259
$W \times$ ISTATE	–0.010	0.014	0.011	0.015
$W \times$ FARML	0.034^{*}	0.008	0.018	0.023
$W \times$ METRO	0.402	1.613^{**}	0.854	0.807
$W \times$ MICRO	–0.051	1.375^{*}	0.765	0.747
ρ	0.496^{***}	0.779^{***}	0.193	0.156
λ	-0.245^{*}	-0.602^{***}	0.139	0.123
Corr(y,ŷ)	0.549	0.394		
First-Stage F	12.5^{***}	25.8^{***}		
Sargan Statistic	6.59	2.51		

Notes: ***, **, * represent statistical significance at the 1, 5, and 10% level, respectively.

Table 4. Marginal Effects from SARAR Model

	Birth Equation			Death Equation		
Variable	Direct	Indirect	Total Effect	Direct	Indirect	Total Effect
DR04	0.007	0.743	0.750	–	–	–
BR04	–	–	–	0.109***	1.012***	1.121***
BR00	–1.276***	–6.039	–7.315*	–	–	–
DR00	–	–	–	–1.328***	–3.699***	–5.027***
EMP<10	0.076***	0.331	0.406*	0.113***	0.286***	0.399***
EMP>100	0.057***	0.421	0.478*	0.057***	0.353***	0.410***
EMP	0.009**	–0.209	–0.200	–0.050***	–0.138***	–0.188***
ESTAB	0.004***	0.026	0.030*	0.0001	0.0001	0.0002
CCLASS	0.071***	0.279	0.350	0.037***	0.237***	0.274***
MHHI	–0.018***	0.117	0.099	–0.075***	–0.221***	–0.296***
POP	–0.001	0.023	0.022	0.0002	0.003	0.004
UNEMP	–0.369***	–1.025	–1.394	0.411***	1.023***	1.434***
SKILL	0.324***	1.367	1.691	0.552***	1.392***	1.944***
FLOW	0.030***	0.224	0.254	0.013***	0.034***	0.047***
WAGE	–0.126***	–0.454*	–0.580**	0.033***	0.077*	0.110**
EDUC	–0.054***	0.711	0.657	0.406***	1.012***	1.418***
HWY	–0.073***	–0.904	–0.976*	–0.259***	–0.666***	–0.925***
ROAD	–0.153***	–0.759*	–0.912	0.038***	0.079	0.117
ISTATE	0.012***	0.070	0.083**	–0.011***	–0.070***	–0.080***
FARML	–0.050***	–0.165	–0.215	–0.011***	–0.025***	–0.036***
METRO	–0. 643***	0.081	–0.562	–1.651***	–4.106***	–5.757***
MICRO	–0.440***	–1.458	–1.898*	–0.840***	–2.013***	–2.853***

Notes: ***, **, * represent statistical significance at the 1, 5, and 10% level, respectively. Standard errors are not reported to conserve space.