Papers in Evolutionary Economic Geography

05.13

Diversity, stability and regional growth in the U.S. (1975-2002)

Jürgen Essletzbichler

Utrecht University
Urban & Regional research centre Utrecht

http://econ.geog.uu.nl/peeg/peeg.html

Diversity, stability and regional growth in the U.S. (1975-2002)

Jürgen Essletzbichler
Department of Geography
University College London
26 Bedford Way
London, WC1H 0AP
e-mail: j.essletzbichler@geog.ucl.ac.uk

INTRODUCTION

The recent years witnessed important changes in economic governance systems represented as a scalar shift of economic and political power from national states to supra-national entities and sub-national entities such as cities and regions (Brenner 1998, 2004, Jessop 1990, 1994, Scott 1998). Cities, regions and city-regions are increasingly forced into direct competition with each other that prompts regional policy makers to actively design and shape regional economic development (Harvey 1989, Leitner and Sheppard 1998). Baden-Württemberg, the Third Italy and Silicon Valley exemplify the paradigmatic model of economic development that other regions attempt to emulate (Bartik 1996). Regional policies are designed to attract clusters of functionally related industries with high growth potential although the value of cluster based policies is not uncontested (Begg 2002, Boschma 2004, Hudson 1999, Lovering 1999, Kitson et al. 2004, Martin and Sunley 2003). Duranton and Puga (2000: 533) caution that many of these policies seem to "lack a clear rationale or even to be based on common misconceptions". The value of industrial specialization for regional economic development is uncertain as theoretical and empirical work on specialization and diversity of cities suggests (Baldwin et al. 2003, Black and Henderson 1998, Duranton and Puga 2000, 2001, Feldman and Audretsch 1999, Henderson 1997, Henderson et al. 1995). In particular, there appears to be a tradeoff between growth and stability of regional economies that is largely ignored by policy makers (Baldwin and Brown 2004).

This chapter examines the relationship between diversity, growth and stability of regional production systems. Empirical work by regional scientists and new geographical economists yields ambiguous results. While Kort (1981) and Baldwin and Brown (2004) find strong evidence for a positive relationship between stability and diversity and a negative relationship between employment growth and diversity, Attaran (1986) and Smith (1990) contest these findings. Overall, the review by Dissart (2003) suggests that more diversity leads to more stability and less growth in unemployment. The regional science literature is strongly focused on the identification of empirical relationships, while the theoretical links are not fully developed (Chandra 2003, Conroy 1974, 1975, Siegel et al. 1995). New geographical economists examine the theoretical and empirical relationship between diversity and economic growth (Brakman et al. 2001, Glaeser et al. 1992, Henderson 1997, Krugman 1991). Some of these researchers are influenced by the ideas of Alfred Marshall (1890) and Jane Jacobs (1969) linking variety (technological and/or industrial) to external economies, efficiency of regional production systems and economic growth (Henderson 2003). Conclusions from both areas of research have potentially important policy implications. Should regional policy makers stimulate or curtail the production of diversity to foster regional economic growth? Should policy makers focus on generating conditions for high rates of economic growth or should they focus on minimizing growth rate fluctuations?

The existing work has developed important theoretical arguments to understand the relationship between diversity and growth (Henderson 1988, Glaeser et al. 1992, Quigley 1998), but the relationship between diversity and stability has been under-theorized. In part, this might be explained by the influence of neoclassical economics on regional science and new geographical economics focusing on market competition as the only allocation mechanism. Although formulated at the level of the firm these concepts have been scaled up to the regional and national levels (Porter 1990, 1998). What is often overlooked is the fact that firm competition is based on very different principles than regional competition. While firms have to maximize profits to stay in business, regions cannot go bankrupt (Krugman 1994). Furthermore, regional policy makers are responsible to different interests in the region including the provision of technical and social infrastructures and social services. Only if it is assumed that increased "regional efficiency" translates into welfare gains for everybody can the exclusive focus on economic growth be justified. Instead of using economic growth as a vehicle to achieve other goals such as equity or sustainability, higher rates of economic growth become the policy target. This exclusive focus on growth might be problematic if it leads to a reduction in technological, industrial, social and institutional diversity in the region. Because growth rates are maximized if less efficient routines, technologies, skills and industries are eliminated this is likely to be the case. A lack of diversity might reduce the adaptive potential of the region to future change.

This chapter addresses explicitly the trade-off between regional employment growth and regional economic stability drawing on insights from evolutionary theory and ecological economics. Evolutionary theories highlight the importance of diversity as fuel for the selection process (Nelson 1995). Selection winnows on existing variation and, given a stable selection environment and no introduction of new diversity, will assure that only the most efficient entities survive. In reality, new diversity is added through innovation and firm entry and coupled with a continually changing environment, efficiency and optimality criteria are perpetually redefined. Perfect adaptation towards a global optimum is therefore impossible (Hodgson 1993, 1997). Applications in evolutionary economics focus primarily on the impact of firm diversity in populations of competing firms on population (e.g. industry) averages. In this work Fisher's principle is employed stating that the rate of change is proportional to the variance in efficiency characteristics (e.g. profit rates, unit costs or productivity levels) (Metcalfe 1994, 1998). Recent work suggests that intra-population dynamics has to be linked to inter-population dynamics and include selection processes at various analytical scales such as the firm, industry, region and nation (Andersen 2004, Gowdy 1992).

Moving the focal level to the regional scale complicates the analysis considerably. Ecological economists and evolutionary biologists have long argued that a trade-off between adaptive efficiency and the adaptability (the ability to adapt to environmental changes) of ecosystems exists (Levins and Lewontin 1985, Gould and Lewontin 1979, Vrba and Gould 1986). Like ecosystems, regions might be confronted with an explicit trade-off between adaptation and flexible adaptivity/resilience. Adaptation refers to the optimal adjustment to current environmental circumstances. Adaptation is achieved through enhanced efficiency of individual agents (e.g. through innovation and imitation) and the elimination of redundant features such as undesired skills, inefficient technologies, industries, organizations and institutions. While boosting current efficiency levels (and rates of economic growth), lower levels of diversity decrease the likelihood of pre-adaptive features and the potential to react to changing environmental conditions ushered in by technological paradigm shifts, exogenous shocks or changes in the institutional environment (Holling 1973, 2001). However, there are limits on the extent of diversity. Without commonalities between different entities, no synergies arise, and certain efficiency thresholds necessary for the economic survival of regions might never be reached.

In this chapter, the theoretical arguments from evolutionary theory and ecological economics are summarized to put the trade-off between regional economic diversity and regional economic growth on stronger theoretical foundations. For this purpose, section 2 reviews work by evolutionary theorists and ecological economists and their emphasis on the relationship between diversity, growth and stability. Section 3 presents a simple empirical model that links regional economic diversity to stability and growth and Section 4 concludes this chapter.

DIVERSITY, STABILITY AND GROWTH

The case for diverse regional production systems hinges on the premise that diversity reduces volatility[1] (or enhances stability). Stability is seen as a positive property of regional production systems for two reasons: First, high levels of volatility are often coupled with higher rates of unemployment, because contracting economies destroy jobs and release workers and because it takes time to match workers to new jobs. Second, high volatility complicates planning decisions to provide adequate investment in technical and social infrastructures (Baldwin and Brown 2004, Schoening and Sweeney 1992). The maintenance of diversity is therefore useful from a policy point of view. However, diversity will not only affect stability but also regional efficiency by stimulating or constraining innovation, technology spillovers and supplier-customer interaction (Jacobs 1969). Whether or not diversity will generate external economies through spillovers is likely to depend on the exact mix of industries, firms, workers, organizations and institutional practices in a region.
Too much diversity might stifle the formation of spillovers through a lack of synergies. Too little diversity results in increasing specialization and makes the region vulnerable to changes in technological paradigms, demand and supply shocks.

Current market-driven policies largely based on Ricardo's theory of comparative advantages drive the formation of trade-areas and the globalization process. The erosion of national boundaries is likely to result in increasing regional specialization. This might increase overall efficiency (at the supra-national or global level) but at the expense of increased vulnerability at the sub-national or regional level. Unfortunately a theoretical discussion of these inter-temporal and inter-spatial trade-offs is largely absent from economic geography. A substantial body of literature theorizing these trade-offs however, is emerging in evolutionary theory, ecological economics and complex systems analysis (Giampietro and Mayumi 1997, Holling 2001, 2004, Rammel and Van den Bergh 2002, Ulanowicz 1997). In the following, the arguments emerging from this literature are summarized. Although there are limitations to the transferability of knowledge and concepts from the physical and biological sciences to the social realm, some of the conclusions from this literature pertain to all complex, adaptive systems (Giampietro and Mayumi 1997). The review of this literature is not expected to generate a series of testable hypothesis but a series of general principles on the relationship between diversity, stability and growth of regional production systems that can be explored through empirical work.

Evolutionary theory, diversity and stability

Diversity and Selection

Evolution is driven by the creation and destruction of diversity. Diversity is expressed as variation at the genetic level, as biodiversity at the level of ecosystems, as technological diversity at the level of industries, as industrial and institutional diversity at the level of regions and countries. In biological systems, diversity is created by random mutation. In socio-economic systems, diversity is generated primarily by the processes of innovation and plant entry (Dosi and Nelson 1994, Essletzbichler and Rigby 2005a, b, Hodgson 1993, Nelson 1995, Nelson and Winter 1982, Rigby and Essletzbichler 1997, 2006, Saviotti and

[1] Volatility is interpreted as opposite of stability and will be measured as the variance in annual rates of employment change.

Metcalfe 1991, Saviotti 1991, 1996). Reduction of diversity is driven by imitation and selection. Selection rewards those species, firms, regions or countries that are best adapted to narrow conditions at the moment. In this sense, selection operates as short-term adaptive force (Rammel and Staudinger 2002). Adaptation is interpreted as "*temporary* feature providing a benefit over its alternatives under specific environmental conditions…" (Rammel and van den Bergh 2003: 123, own emphasis). This view on adaptation has a number of important implications relating to questions of optimality, efficiency, equilibrium and causal relationships.

Without going into details about debates on adaptationism in evolutionary biology (see for instance Gould and Lewontin 1979, Depew and Weber 1995), a few clarifications need to be made in the context of this contribution. Spencer interpreted selection as a process that guaranteed the "survival of the fittest". In this view selection is regarded as (global) optimization process. This reading of selection entails a closed universe, one that can be described by a unique and optimal equilibrium configuration towards which the system gravitates. Natural selection is the mechanism that assures that this state will be reached eventually. In equilibrium, only those traits, species and populations survive that are perfectly adapted to environmental conditions describing this equilibrium. In equilibrium a global optimum is reached. This view of evolution was adopted by neoclassical economists who interpreted competitive markets as selection environments that assured that only firms with optimal technologies and organizational routines survived. Because inefficiency was only considered a transitory phenomena, diversity in firm behavior could be ignored and firms be treated *as if* they were profit maximizers (Friedman 1953). During the movement towards global optimum, diversity becomes eliminated (see Vromen 1995).

In the absence of changing environmental conditions and creation of new diversity, selection would indeed reduce variation until only the profit-maximizers would survive (Alchian 1950, Metcalfe and Gibbons 1986, Iwai 1984a, b, Jovanovic 1982, Metcalfe 1994, 1998). In reality, firms are confronted with moving targets in form of shifting fitness landscapes, continuous introduction of new diversity in form of innovation and technological change, random shocks and non-linear feedback mechanisms and complex patterns of interactions whose outcomes cannot be predicted ex ante. In this environment of uncertainty and unpredictability, optimization must be understood as local and myopic (Nelson 1995). In that sense it might be better talk about "survival of the fitter or sufficiently fit" (van den Bergh 2003) or "survival of the fitting" (Boulding 1981). According to this view, selection does not entirely eliminate diversity. Although the persistence of diversity might be undesirable from a neoclassical point of view, the rejection of the existence of a global optimum makes diversity in form of redundant, sub-optimal and inefficient technologies, skills, firms and industries not only acceptable but a necessary condition for long-term survival of firms and regions.

Diversity, optimality and stability

As in regional science, the exact relationship between diversity and stability is still debated in ecological theory (Rammel and Staudinger 2002, Holling et al. 2001). In ecology, diversity is negatively related to stability "if species diversity reflects a diversity in functional entities in an ecosystem with minimum redundancy" (Rammel and Staudinger 2002: 5). Translated to economic geography, this case would describe a region with a diversity of sectors whose technological inputs and demand are highly correlated, i.e. whose input-output structures are almost identical. In this case, the existing industrial diversity would not protect the region from demand shocks and/or shifts in technological paradigms (Frenken et al. 2005, Wagner and Deller 1998).

Independent of the specific expression of diversity, the rejection of the assumption of a global optimum complicates definitions of efficiency[2] suggesting that current regional policies based on some notion of economic and social efficiency are driven by the "ideology of efficiency" (Bromley 1990) and not derived from solid theoretical foundations. In the presence of shifting adaptive landscapes and moving equilibria, the focus on efficiency (in the 'maximum power' sense) entails a prioritization of short-term adaptation/optimization that comes, potentially, at the expense of long-term stability. "If optimality exists it will be temporary, because through evolution, selection, and innovation it is easily transformed into maladaptive traits. Under such conditions, diversity is a key element of long term stability and even survival" (Rammel and van den Bergh 2003: 127).

Diversity, enhanced adaptive flexibility and "evolutionary potential"

One of the main arguments to maintain diversity is its role as "repertoire of alternative options" that increases the probability that pre-adaptations to altered conditions exist. This is referred to as "evolutionary potential" (Rammel and van den Bergh 2003: 127). While selection operates as short-term adaptive force that reduces diversity to narrow and temporally adapted features, selection does not guarantee survival in the long-run (Matutinovic 2001). Diversity persists because of imperfect adaptation and the counter-acting influence of other sorting mechanisms. Selection rewards those individuals or firms that are relatively more efficient (generally characterized by lower input-output ratios) but a firm's competitive position is also improved by exaptation and exogenous shocks (Gowdy 1992). For instance, exaptation could refer to an increase in efficiency of suppliers of a firm A that translates into lower costs of inputs and in turn a lower input-output ratio of firm A. This improvement of efficiency is achieved without any actual technological or organizational changes by firm A. Exogenous shocks, such as a rise in energy prices, can influence firm A's efficiency through a shift in relative prices of input factors. Firms that use relatively small amounts of energy will improve their efficiency relative to firms that use larger amounts of energy (for an empirical example see Berman and Bui 2001). Selection is thus only one of many sorting mechanisms that drive evolution. Exaptation and exogenous shocks might stimulate diversity, because these sorting mechanisms might reward relatively "inefficient" firms. Diversity might therefore be as much an evolutionary outcome as specialization. Within bounds, regions should therefore embrace rather than eliminate redundancy.

In ecology, redundancy of agents (and pathways) stands for ecosystem overhead. Ulanowitz (1997) argues that "ecosystem overhead evolves: (1) as a response to the opportunity for the complete use of available resources (efficiency in the 'second law' sense); (2) to prevent system brittleness; (3) to preserve its adaptive response and creativity; and (4) to preserve its reliability" (Matutinovic 2002: 434). Similarly, there are good reasons for economic systems

[2] Ecology offers three different notions of efficiency: "(1) 'first law' efficiency, or simply the fraction of energy input that appears as output; (2) efficiency in the 'second law' sense where resources are being used more thoroughly by a diverse set of agents, having different single-use efficiencies (the most efficient agent is the one that effects the most complete use of the available resource, regardless of the rate of use); (3) efficiency in the 'maximum power' sense, where an agent uses a resource to provide either the quickest return or the greatest rate of output" (Matutinovic 2002: 433). Economics prioritizes definition (3). From a 'maximum power' efficiency perspective, less efficient firms are considered redundant. 'Second law' efficiency is generally absent from economic policy discourse although it might be desirable from an equity point of view.

to embrace overhead or redundancy. From an evolutionary point of view, firms, institutions, regions and countries are likely to be forced into a trade-off between realizing short-term profits (adaptation to current conditions to achieve a local optima) and long-term flexibility to enhance the adaptive potential and the ability to react to technological paradigm shifts, exogenous shocks and industrial shifts (Schütz 1999). Mayumi and Giampietro (2001: 13) suggest that long-term (regional) competitiveness is achieved through "increases in efficiency [..] by amplifying the most performing activities, *without* eliminating completely the obsolete ones". From a regional point of view this entails a strengthening of existing well-performing sectors (probably clusters) but without completely eliminating those firms and sectors that appear less efficient and redundant at present. This view also resonates with arguments made by innovation system researchers (Lundvall and Johnson 1994, Edquist 1997).

Contrary to biological systems, socio-economic systems actively produce diversity. This means that the diversity-selection feedback works much faster in social systems and hence, any reduction in diversity might be translated more rapidly into adaptability problems. Furthermore, economic systems are often characterized by increasing returns based on internal and external economies, cumulative technological change, learning and network externalities and complementary production factors that can result in path-dependent evolution and lock-in. Diversity helps to break lock-in and path-dependence (Arthur 1994, Grabher 1993, Grabher and Stark 1997). Diversity at the level of the region refers to diversity in labor (skills), firms, industrial sectors, organizations and institutional environments but also the network connections between local and non-local agents (Grabher and Stark 1997, Granovetter 1973, Matutinovic 2002). Diversity can thus be seen as a risk-minimizing strategy similar to portfolios in business economics (Chandra 2003).

The theoretical arguments on the relationships between diversity, stability and resilience are rather general and biology, ecology, and complex adaptive systems theory have yet to solve the exact linkages between them. Despite these shortcomings, the theoretical arguments put forward demonstrate that a narrow policy focus on regional efficiency is problematic. Strategies to maximize efficiency in the short-term might pose problems for economic prosperity over longer time horizons and hence, prioritize implicitly the needs of current generations at the expense of future generations. To complicate matters further, the impact of economic policies will not only lead to conflicting outcomes at various temporal but also at various spatial scales. Competition between regions might yield positive economic returns for some regions, but also result in the unnecessary duplication of infrastructure, services, and organizations that appear wasteful from the perspective of the national state (Harvey 1989, Hubbard and Hall 1998). On the other hand, regional specialization might result in positive region-specific externalities that maximize wealth at the national level at the expense of intra-regional diversity (Krugman 1991, Fujita et al. 1995, Neary 2001). Nations might manage risks by maintaining a portfolio of specialized regions similar to assets of companies. Decline in some regions will be compensated by growth in other regions. In this case, the national scale receives priority over the regional scale where the average well-being of national citizens will increase at the expense of declining welfare in declining regions. If these inter-temporal and inter-spatial trade-offs do indeed exist, the trade-offs at various temporal and spatial scales have to be made explicit in regional policy templates rather than hidden behind the assumption that free markets will lead to a (global) welfare optimum.

While evolutionary theory provides us with interesting insights into the trade-off between diversity, stability and growth, the exact relationship between technological and industrial diversity and economic growth and stability have been insufficiently developed so far. The relationship between diversity and economic growth has been addressed extensively by new geographical economists (this literature cannot be discussed in this essay but for overviews on the new geographical economics see Martin (1999), Sheppard (2000a, b), Neary (2001), Duranton and Puga (2004), Frenken et al. (2005), Robert-Nicoud (2005) and for an empirical attempt to disentangle the effects of urbanization and localization economies on metropolitan labor productivity see Rigby and Essletzbichler (2002)) while regional scientists applied portfolio theory to examine the empirical relationship between diversity and stability.

Industrial diversity and portfolio theory

In business economics and industrial organization, the concept of portfolio refers to the valuation of the collection of a company's assets to examine the impact of product diversity on corporate profitability growth. The basic underlying principle is that diversity of assets reduces risk. Ideally a company diversifies into technologically related industries/products in order to maximize economies of scope, but also industries that are characterized by unrelated demand in order protect overall sales from demand shocks in individual product markets. This reasoning has a striking similarity to the arguments by Giampietro and Mayumi (1997) on the behavior of complex adaptive systems. Although regions cannot go bankrupt in the same way as corporations do, regions expand and contract over the business cycle. Regional contraction manifests itself through plant closures, low entry rates and a shrinking employment base. Once a negative cumulative cycle is set in motion it is often hard to switch to a new path of regional economic growth, attract businesses and jobs. In severe cases of economic decline, regions are confronted with very fast rates of employment decline. This is particularly the case if the economic base is dependent on a few companies and/or industrial sectors. If individual plants are closed down because of structural problems occurring in this sector, related industries follow rapidly and whole areas can be transformed into ghost towns in a short period of time. Detroit in the United States, Liverpool in the UK, Ivanovo in Russia and Halle in Germany are examples of these unfolding processes (Oswalt 2004). Although the region does not go bankrupt in the same sense as firms do, capital has to be scrapped, workers laid off and, in the case of prolonged crisis, have to move to other regions.

In most circumstances, not all sectors of an economy decline at the same time or at equal rates. Borrowing from portfolio theory, it is therefore possible to think of regional diversification as a strategy to reduce the risk of economic decline. Developing a portfolio of industries whose demand is largely uncorrelated might be a useful strategy of regions to avoid big fluctuations in rates of economic growth and to shield them in part from economic decline during recessions (Baldwin and Brown 2004). Clearly these arguments are rather abstract and require refinement. The same levels of regional diversity might result from very different industry-mixes, some of them might be more favorable than others. Even if the levels of regional diversity remain constant, the underlying industry mix of regions might change over time. And finally, what are the appropriate temporal and spatial scales to examine the evolution of regions? Diversity might be useful for the long-run at the expense of short run economic growth. Regional economic specialization might yield high levels of efficiency that benefit actors at the regional and national scales and that maintain industrial diversity at the national scale.

Frenken et al (2005) describe new geographical economics and portfolio approaches as static because variety at a single point in time relates to regional growth. Boschma and Lambooy (1999) argue that urbanization economies and Jacobs externalities are more important during the emergence of new industries and technological paradigms when industries have not yet generated their specific skills, supplier and institutional requirements, but that localization economies might become more important once these factors are created (see also Boschma and Frenken 2003). This literature is important as it brings a dynamic perspective to the literature and demonstrates how industrial and technological diversity influence regional growth at various stages of industry life cycles, but regions are somehow considered as containers in which industrial evolution unfolds. Instead of following a single industry (or cluster) through time and space, it is possible to start with regions and examine the relationship between the distribution of characteristics within regions and the changes in regional aggregates such as growth, productivity, profitability, and stability. This avenue is pursued in the following empirical analysis: Regions are conceptualized as assembles of industries and the distribution of employment among these industries (indicating regional industrial diversity/concentration) is expected to exert an influence on changes in regional economic growth and stability.

EMPIRICAL ANALYSIS

The empirical part of this essay is based on employment data from the US county business patterns (1975-2002). The goal of the analysis is the establishment of a negative statistical relationship between economic growth and stability and a positive relationship between industrial diversity and economic stability at the level of the economic areas of the Bureau of Economic Analysis (BEA) through the application of spatial econometric techniques. In order to measure the impact of industrial diversity on regional volatility, it is necessary to control for the influence of additional explanatory variables. The choice of variables is informed by the theoretical discussion and empirical work in regional science (e.g. Baldwin and Brown 2004). Regional stability/volatility is measured as the variance of annual regional employment growth rates. According to Baldwin and Brown (2004) the variance will be influenced by the diversity of a region's industrial structure, the variance of its industries' growth rates and the covariance between those growth rates. The correlates of volatility are chosen from a set of structural characteristics of regions. The names, definitions and expected signs of these variables are summarized in Table 1.

The simplest and most widely used measure of diversity is probably the Herfindahl index (Baldwin and Brown 2004, Chandra 2003, Duranton and Puga 2000). Experimentation with entropy measures of diversity did not change the conclusions of the paper. The Herfindahl index H of a BEA region r is measured as

$$H_r = \sum_i s_{ir}^2 \qquad (1)$$

where $s_{ir} = E_{ir} / \sum_i E_{ir}$ and E_{ir} refers to employment in sector i in BEA region r. The index varies between 1 (all employment is concentrated in one sector) and 1/n (employment is distributed equally among all sectors). A higher value indicates greater concentration of employment in fewer sectors (lower diversity), while a lower value indicates a more even distribution of employment across sectors (higher diversity). The index has been constructed for the base year (1975) using the 1972 SIC[3]-3-digit system. Based on the theoretical discussion on diversity and volatility, a positive relationship between the level of

[3] Standard Industrial Classification

concentration (a high Herfindahl index) and volatility (high variance of annual growth rates) is expected.

Insert TABLE 1 about here

Employment levels and growth rates are also expected to relate to volatility. Although it is expected that total regional employment is correlated with diversity and hence, the effect of employment size subsumed by the effect of diversity on volatility, Malizia and Ke (1993) argue that larger regions are more stable than smaller regions and that size (measured as total employment) might have a positive effect on regional stability independent of the effect of diversity. The impact of size on volatility will also depend on the geographic concentration of markets for products. If firms in larger regions sell a larger share of their product in local markets than the growth rates of a region's industries are more likely to be correlated because they will be dependent on the same market and subject to the same economic shocks. In this case, larger regions will be more volatile than smaller regions even if they are characterized by similar levels of industrial diversity. The relationship between size and volatility is therefore ambiguous.

Malizia and Ke (1993) found a U-shaped relationship between growth and volatility suggesting that regions that have concentrations in fast-growing industries have higher growth rates, while regions with concentrations in fast-declining industries have lower growth rates. On the other hand, more diverse regions are characterized by more stability and average growth rates. The U-shaped relationship between growth and volatility has been confirmed by Baldwin and Brown (2004) for Canadian census regions and manufacturing industries. Contrary to the U-shaped relationship detected by Malizia and Ke (1993) and Baldwin and Brown (2004), a linear (positive) relationship between growth and volatility for BEA regions was discovered (see Figure 2). The squared growth rate was thus omitted from the set of independent variables.

The average plant size in a region is expected to exert a positive influence on regional economic stability because smaller plants are generally newer and more likely to exit the industry than larger plants (Baldwin et al. 1998, Davis et al. 1996). Furthermore, large firms tend to produce a variety of commodities and are thus less vulnerable to market fluctuations affecting a particular product. Product variety tends to be lower in smaller firms which will decrease their ability to adapt to market fluctuations affecting a specific product. Hence, we would expect a negative relationship between average plant size and volatility. The negative correlation coefficient between average plant size and stability confirm this relationship (see Table 4).

Baldwin and Brown (2004) add export shares and the share of employment in different types of industries (e.g. resource based) as explanatory variables. Unfortunately, export data are not available for BEA regions but the share of regional employment in resourced based industries was included. It can be expected that regions with a high share of resource based industries such as mining, agriculture and forestry, logging, lumber, and petroleum, are characterized by higher volatility in growth rates, because resource based economies are often influenced by global (i.e. exogenous) price fluctuations. A positive relationship between the share of resource based industries and volatility is expected.

The data used in this analysis are based on county business patterns from 1975 to 2002. The data have been aggregated to the level of BEA regions because they are probably closest to functional economic regions in the US (similar to labor market regions or travel to work areas in Europe) (Johnson and Kort 2004). County business patterns provide employment, establishment and wage data for SIC-4-digit industries between 1975 and 1986. For many counties, actual figures have been suppressed and replaced by employment size classes. Because of the large number of undisclosed information (in particular for smaller counties) and in order to reduce measurement error, county employment at the SIC-4-digit level have been aggregated to SIC-3-digit employment and the diversity measures have been calculated at the SIC-3-digit level. If information for individual counties was not reported at the SIC-3-digit level, the average value of the employment size class (e.g. 10 for employment size class 0-19) was used to impute the missing information. Because counties were then aggregated to the new BEA regions, measurement error will be relatively small and is unlikely to influence the results. Changes in county and BEA definitions have been considered in order to keep the geography constant over the whole period. Overall, the dataset spans 27 years and includes the 177 BEA areas of the continental United States.

Insert FIGURE 1 about here, TABLE 2 about here

Figure 1 maps the key variables volatility, diversity and growth for the 177 BEA areas. Growth and volatility are measured over the whole period 1975-2002 while diversity is measured for the base year, 1975. Table 2 lists the top 10 and bottom 10 cities with respect to stability, diversity and growth. Figure 1 and Table 2 reveal the following geographic pattern. The regions characterized by the highest levels of stability tend to be concentrated in the Mid-Atlantic region including areas such as Philadelphia, New York and Rochester, while among the most volatile are many of the resource based economies of Oregon, Texas and Wyoming. The most diverse regions are those surrounding large urban areas such as New York, Philadelphia, Dallas, Chicago, Atlanta or Memphis while the more specialized areas tend to be either resource based economies or those focusing on tourism such as Las Vegas or Reno. The fastest growing regions are located in Florida and the Southwest of the country and include retirement areas and high-tech centers. The slowest growing regions are found in the old manufacturing heartland and include regions such as Buffalo, Cleveland and Pittsburgh. Although some regions score high/low on several variables, others do not follow a clear pattern. Figure 2 plots the relationship between volatility on the vertical axis and growth/diversity on the horizontal axes. Both relationships are positive and significant at the 0.0001 level.

Insert FIGURE 2 about here

Descriptive statistics of all dependent and independent variables as well as the logarithmic values are presented in Table 3, while the raw correlation coefficients are presented in Table 4. Table 3 highlights considerable variation in diversity, growth and stability, although the variation is considerably smaller than for Canadian Census regions (Baldwin and Brown 2004). The correlation coefficients reveal that most of the independent variables are correlated with stability. Table 4 indicates that specialized regions and those characterized by higher rates of economic growth, smaller employment size and smaller average plant size tend to be more stable (i.e. have lower variances of growth rates). Also of interest is the positive relationship between growth and diversity: Specialized regions appear to grow more rapidly but are also characterized by higher volatility. Table 3 suggests the presence of extreme outliers with respect to the dependent and independent variables that might drive overall results. Hence, the natural logarithms of the variables are taken to remove the effect of those outliers. Table 4 suggests that the linear relationships between the logged variables tend to become stronger.

Insert TABLE 3 about here, TABLE 4 about here

The basic regression model estimated may be written as

$$y = X\beta + \varepsilon \qquad (2)$$

where y is a Nx1 vector of observations on the dependent variable, X is a NxK matrix of observations on K independent variables, β is a Kx1 vector of regression coefficients, and ε is a Nx1 vector of errors assumed to be normally and independently distributed. As discussed above, the dependent variable is the variance of regional growth rates (VARGROWTH) and the independent variables are HERF75, GROWTH, EMP75, PLSIZE75 and R75. Figure 1 suggests considerable spatial autocorrelation in the dependent variable. Employing spatial contiguity weights, a Moran's I value of 0.3348 (significant at the 0.001 level) suggests the presence of strong spatial autocorrelation of the independent variable. In the presence of spatial autocorrelation, OLS estimates may be inconsistent (Anselin 1988, Anselin and Rey 1991).

Spatial dependence is of two basic forms, error dependence and lag dependence. In the spatial error model the errors can no longer be assumed independent and identically distributed and the regression model takes the following form

$$y = X\beta + \lambda W\varepsilon + \tau \qquad (3)$$

where λ is the spatial autoregression coefficient, W is a NxN matrix of spatial weights representing the geography of the observational units (BEA's), and τ is a Nx1 vector of errors assumed to possess the usual properties. In this form, spatial dependence influences the error term only and it has been shown to influence the power of tests for heteroscedasticity and the structural stability of regression coefficients. In the spatial lag model, the standard regression equation may be rewritten as

$$y = \gamma Wy + X\beta + \tau \qquad (4)$$

where γ is the spatial autoregression coefficient. In this form, the value of the dependent variable at a particular location is jointly determined by its values at other locations and ordinary least squares estimation is no longer consistent (Anselin and Rey 1991).

TABLE 5 about here

The results of the linear model are presented under Model (1) in Table 5. Specialized and faster growing regions and those with higher shares of resource-based industries are characterized by more volatility in growth rates. All relationships are significant at the 0.01 level. The average plant size is negatively related to volatility, supporting the theoretical arguments discussed above. The relationship is significant at the 0.1 level only. The size of the region is positively related to volatility lending some support to Fujita et al.'s (1999) argument that the demand for products in large regions is more likely to be correlated exacerbating demand shocks. However, Table 4 revealed high correlations between regional size and most other independent variables suggesting that the size effects might have been picked up by other variables (e.g. HERF75). Furthermore, Table 5 shows that the positive relationship between EMP75 and VARGROWTH is not statistically significant. In addition to the parameter estimates and t-values, a set of diagnostic statistics have been added. An adjusted R-square value of 0.515 indicates a relatively good fit of the original model. However, tests on heteroscedasticity and spatial dependence reveal that both are present in the model. Heteroscedasticity could have been the result of correlated spatial errors. However, even after correcting for spatial lags/errors, heteroscedasticity posed a problem. The scatterplots depicted in Figure 2 seemed to suggest that the variance of volatility increases with both, higher rates of growth and diversity, and that no single variable could be easily identified to cause heteroscedasticity. Gujarati (2003) suggests that the log-transformation of variables often helps to eliminate heteroscedasticity.

Model versions (2)-(4) present the results for the log-linear models. The fact that parameter estimates can be interpreted as elasticities is an added advantage of the log-linear model. Model (2) presents the results for the OLS estimates without correction for spatial dependence. The signs of the parameter estimates for the log-linear version do not change, although the parameter estimate for average plant size is now significant at the 0.05 level and the adjusted R-square value indicates a moderately worse model fit. On the other hand, the Breusch-Pagan and Koenker-Bassett tests reveal no heteroscedasticity, while spatial dependence is still present in the models. Lagrange multiplier tests suggest the presence of both, spatial lag and spatial error. Model (3) provides the results for the spatial lag model. The model results are based on maximum likelihood estimation and the values in parentheses are z- rather than t-values. The signs of the parameter estimates are consistent with those of Models (1) and (2). The negative estimate for the size of plants is no longer significant, but all the goodness-of-fit measures indicate a clear improvement from model version (2). Furthermore, the parameter estimate for the spatially lagged dependent variable is positive and significant at the 0.01 level. The results suggest that volatility of growth in a region is also influenced by volatility of growth in the neighboring regions. The results for the spatial error model (Model (4)) are similar to the results of the spatial lag model. The estimate for average plant size is significant again at 0.1 level and the goodness-of-fit statistics suggest an almost identical performance when compared to the spatial lag model. The spatial lag parameter, λ, is also positive and significant at the 0.01 level.

Anselin (1988, 1992) advises to use to use performance indicators such as the log-likelihood, AIC, or SC criteria to inform model selection. Because the performance indicators for both models are almost identical no obvious choice for the "best" model emerges. Because the parameter estimates are very similar and since the purpose of the model is not predication but the establishment of statistical relationships between variables, this does not pose a major predicament. Independent of the exact model specification, a comparison of the elasticities suggest that a change in diversity has the highest impact on change in regional economic stability, followed by a change in average growth rate and the change in share of resource based industries (keeping in mind that the impact of average plant size is barely significant). The results confirm the work by other researchers and highlight the importance of industrial diversity for regional economic stability.

CONCLUSION

This chapter employed evolutionary theory to develop arguments on the trade-off between short-term adaptation and long-term adaptability. At present, little thought is given to the potentially negative impacts of cluster based regional policies predicated on the spatial concentration of functionally integrated sectors. The concentration of economic activity in a few economic areas is likely to boost short-term productivity growth and profit rates through the exploitation of externalities based on the local skill base, knowledge spillovers, traded and untraded interdependencies. The negative side of specialization is a decline in adaptive flexibility, the ability to react to continually changing economic environments.

The essay examined the relationship between stability, growth and diversity for 177 BEA areas over the period 1975-2002 using employment data from county business patterns. The analysis revealed a strong positive relationship between diversity and stability on the one hand, and growth and instability, on the other. While these results confirm work in other countries and provide some credibility to evolutionary theories of regional economic change, it is important not to overstate the results. Although regional economic stability is desirable because it facilitates planning for technical and social infrastructure and avoids the pitfalls of fast growth (congestion, rising house prices, environmental degradation, overinvestment in infrastructure), stability (small variances in growth rates) coupled with economic decline is problematic if the decline is rapid and investments have to be written off rapidly. In other words, from a policy point of view, it still has to be worked out what kind of regional stability is desirable keeping in mind the trade-off between growth and stability. Furthermore, the Herfindahl index provides a general measure of industrial diversity, but does not capture the degree of functional relation between sectors. Regions can contain a large number of different but functionally integrated economic sectors that react in similar fashion to demand shocks. The impact of diversity on stability will be influenced strongly by the degree of functional integration of sectors and hence, future work will have to pay more attention to this aspect of diversity (Frenken et al. 2005). However, based on insights from evolutionary theory and the empirical results, industrial, institutional, skill, technological and social diversity should be elevated to a general principle of regional economic development even at the cost of short-term welfare losses. This is imperative if we drop the assumptions of global optimality and equilibrium.

Acknowledgement: This research was partially funded by an Annual Grant of the University of Southampton (A2001/19). I would also like to thank Koen Frenken for valuable comments on an earlier draft of this chapter. The usual disclaimer applies.

REFERENCES:

Alchian, A. (1950). “Uncertainty, evolution and economic theory.” Journal of Political Economy **58**: 211-222.

Andersen, E. S. (2004). “Population Thinking and Evolutionary Economic Analysis: Exploring Marshall's Fable of Trees.” DRUID Working Paper **04-05**.

Anselin, L. (1988). Spatial Econometrics. Dortrecht, Kluwer Academic.

Anselin, L. and S. Rey (1991). “The performance of tests for spatial dependence in linear regression models.” Geographical Analysis **23**: 110-131.

Arthur, B. (1994). Increasing returns and path dependence in the economy. Ann Arbor, University of Michigan Press.

Attaran, M. (1986). "Industry diversity and economic performance in U.S. areas." Annals of Regional Science **20**: 44-54.

Baldwin, J. R. and W. M. Brown (2004). "Regional manufacturing employment volatility in Canada: The effects of specialization and trade." Papers in Regional Science **83**: 519-541.

Bartik, T. (1996). Strategies for economic development. In R. Aronson and E. Schwartz (eds). Management Policies in Local Government Finance. Washington DC, International City/County Management Association for the ICMA University**:** 287-311.

Begg, I., Ed. (2002). Urban Competitiveness. Bristol, The Policy Press.

Berman, E. and L. Bui (2001). "Environmental regulation and productivity: Evidence from oil refineries." Review of Economics and Statistics **83**: 498-510.

Black, D. and V. Henderson (2003). "Urban evolution in the US". Journal of Economic Geography 3: 343-372.

Boschma, R. A. (2004). "Competitiveness of regions from an evolutionary perspective." Regional Studies **38**: 1001-1014.

Boschma, R. A. and J. G. Lambooy (1999). "Evolutionary economics and economic geography." Journal of Evolutionary Economics **9**: 411-429.

Boschma, R. A. and K. Frenken (2003). "Evolutionary economics and industry location." Review of Regional Research **23**: 183-200.

Boulding, K. (1981). Evolutionary Economics. Beverly Hills, Sage Publications.

Brakman, S., H. Garretsen, and C. van Marrewijk (2001). An Introduction to Geographical Economics. Cambridge, Cambridge University Press.

Brenner, N. (1998). "Global cities, glocal states: Global city formation and state territorial restructuring in contemporary Europe." Review of International Political Economy **5**: 1-37.

Brenner, N. (2004). New State Spaces. Oxford, Oxford University Press.

Bromley, D. (1990). "The ideology of efficiency: searching for a theory of policy analyses." Journal of Environmental Economics and Management **19**: 86-107.

Chandra, S. (2003). "Regional Economy size and the growth-instability frontier: Evidence from Europe." Journal of Regional Science **43**: 95-122.

Conroy, M. E. (1974). "Alternative strategies of regional industrial diversification." Journal of Regional Science **14**: 31-46.

Conroy, M. D. (1975). "The concept and measurement of regional industrial diversification." Southern Economic Journal **41**: 492-505.

Davis, S. J., J. C. Haltiwanger, et al. (1996). Job Creation and Destruction. Cambridge, MA and London, MIT Press.

Depew, D. and B. Weber (1995). Darwinism Evolving. Cambridge MA, MIT Press.

Dissart, J. C. (2003). "Regional economic diversity and regional economic stability: Research results and agenda." International Regional Science Review **26**: 423-446.

Dosi, G. and R. Nelson (1994). "An introduction to evolutionary theories in economics." Journal of Evolutionary Economics **4**: 153-172.

Duranton, G. and D. Puga (2000). "Diversity and specialization in cities: Why, where and when does it matter?" Urban Studies **37**: 533-555.

Duranton, G. and D. Puga (2001). Nursery cities: urban diversity, process innovation and the life-cycle of products. American Economic Review **91**: 1454-1477.

Duranton, G. and D. Puga (2004). Micro-foundations of urban agglomeration economies. In: V. Henderson, J.-F. Thisse (eds). Handbook of Regional and Urban Economics, vol. 4. Amsterdam, North-Holland: 2063-2117.

Edquist, C. (1997). Systems of Innovation - Technologies, Institutions and Organizations. London and Washington, Pinter.

Ellison, G. and E. Glaeser (1997). "Geographic concentration in US manufacturing industries: A dartboard approach." Journal of Political Economy **105**: 889-927.

Essletzbichler, J. and D. L. Rigby (2005a). "Technological evolution as creative destruction of process heterogeneity: Evidence from US plant level data." Economic Systems Research **17**: 25-45.

Essletzbichler, J. and D.L. Rigby (2005b). "Competition, variety and the geography of technology evolution." Tijdschrift voor Economische en Sociale Geografie **95**: 48-62.

Feldman, M. and D. Audretsch (1999). "Innovation in cities: Science-based diversity, specialization and localized competition." European Economic Review **43**: 409-429.

Frenken, K. (2004). Entropy statistics and information theory. In: H. Hanusch and A. Pyka (eds) The Elgar Companion to Neo-Schumpeterian Economics. Cheltenham, Edward Elgar.

Frenken, K., F. G. v. Ooort, T. Verburg and R. Boschma (2005). "Variety and regional economic growth in the Netherlands". Papers in Evolutionary Economic Geography. Utrecht, Utrecht University, Urban and Regional Research Center Utrecht. **5.02**.

Friedman, M. (1953). Essays in Positive Economics. Chicago, University of Chicago Press.

Fujita, M., P. Krugman, and A.J. Venebles (1999). The Spatial Economy: Cities, Regions and International Trade. Cambridge MA, MIT Press.

Giampietro, M. and K. Mayumi (1997). “A dynamic model of socioeconomics systems based on hierarchy theory and its application to sustainability.” Structural Change and Economic Dynamics **8**: 453-469.

Glaeser, E., H. Kallal, J. Schenkman and A Shleifer (1992). “Growth in cities.” Journal of Political Economy **100**: 1126-1152.

Gould, S. J. and R. C. Lewontin (1984). The spandrels of San Marco and the Panglossian paradigm: A critique of the adaptionist programme. In E. Sober (ed) Conceptual issues in evolutionary biology. Cambridge, MA and London, The MIT Press**:** 252-270.

Gowdy, J. M. (1992). “Higher selection processes in evolutionary economic change.” Journal of Evolutionary Economics **2**: 1-16.

Grabher, G. (1993). The weakness of strong ties - The lock-in of regional development in the Ruhr area. In: G. Grabher (ed) The embedded firm. New York and London, Routledge**:** 255-277.

Grabher, G. and D. Stark (1997). “Organizing diversity: Evolutionary theory, network analysis and postsocialism.” Regional Studies **31**: 533-544.

Granovetter, M. (1973). “The strengths of weak ties.” American Journal of Sociology **78**: 1360-1380.

Harvey, D. (1989). “From managerialism to entrepreneurialism: The transformation in urban governance in late capitalism.” Geografiska Annaler **71B**(1): 2-17.

Henderson, J. V. (1988). Urban Development: Theory, Fact and Ilusion. Oxford, Oxford University Press.

Henderson, J. V., A. Kuncoro and M. Turner (1995). “Industrial development in cities.” Journal of Political Economy **103**: 1067-1085.

Henderson, J. V. (1997). “Externalities and industrial development.” Journal of Urban Economics **42**: 449-470.

Henderson, J. V. (2003). “Marshall's scale economies.” Journal of Urban Economics **53**: 1-28.

Hodgson, G. (1993). Economics and Evolution. Cambridge, Polity Press.

Hodgson, G. (1997). Notes on reductionism and emergence. Available upon request from the author.

Holling, C. S. (1973). “Resilience and stability of ecological systems.” Annual Review of Ecology and Systematics **4**: 1-23.

Holling, C. S. (2001). “Understanding the complexity of economic, ecological, and social systems.” Ecosystems **4**: 390-405.

Holling, C. S. (2004). "From complex regions to complex worlds." Ecology and Society **9**(11).

Hubbard, P. and T. Hall (1998). The entrepreneurial city and the 'new urban politics'. In T. Hall and P. Hubbard (eds). The Entrepreneurial City. Geographies of Politics, Regime and Representation.. New York, John Wiley**:** 1-23.

Hudson, R. (1999). "The learning economy, the learning firm and the learning region: A sympathetic critique to learning." European Urban and Regional Studies **6**(1): 59-72.

Iwai, K. (1984). "Schumpeterian dynamics. An evolutionary model of innovation and imitation." Journal of Economic Behavior and Organization **5**: 577-598.

Iwai, K. (1984). "Schumpeterian dynamics II: Technological progress, firm growth and 'economic selection'." Journal of Economic Behavior and Organization **5**: 321-351.

Jacobs, J. (1969). The Economy of Cities. New York, Vintage.

Jessop, B. (1990). State Theory. University Park, PA, Pennsylvania State University Press.

Jessop, B. (1994). Post-Fordism and the state. In A. Amin (ed). Post-Fordism: A Reader.. Oxford, Blackwell**:** 251-279.

Johnson, K. P. and J. R. Kort (2004). "2003 Redefinition of the BEA Economic Areas." Survey of Current Business **November**: 68-75.

Jovanovic, B. (1982). "Selection and the evolution of industry." Econometrica **50**(3): 649-670.

Kitson, M., R. Martin, and P. Tyler (2004). "Regional Competitiveness: An Elusive yet Key Concept?" Regional Studies **38**: 991-999.

Kort, J. R. (1981). "Regional economic instability and industrial diversification in the U.S." Land Economics **57**: 596-608.

Krantz, R. (2002). "Employment in business services: a year of unprecedented decline." Monthly Labor Review **April**: 17-24.

Krugman, P. (1991). "Increasing returns and economic geography." Journal of Political Economy **99**: 483-499.

Krugman, P. (1994). "Competitiveness: A dangerous obsession." Foreign Affairs(March/April): 1-17.

Leitner, H. and E. Sheppard (1998). Economic uncertainty, inter-urban competition and the efficacy of entrepreneurialism. In T. Hall and P. Hubbard (ed). The Entrepreneurial City. Geographies of Politics, Regime and Representation. New York, John Wiley.

Levins, R. and R. Lewontin (1985). The Dialectical Biologist. Cambridge MA, Harvard University Press.

Lovering, J. (1999). "Theory led by policy: The inadequacies of the "New Regionalism" (illustrated from the case of Wales)." International Journal of Urban and Regional Research **23**: 379-395.

Lundvall, B.-A. and B. Johnson (1994). "The learning economy." Journal of Industry Studies **1**: 23-42.

Malizia, E. E. and S. Ke (1993). "The influence of economic diversity on unemployment and stability." Journal of Regional Science **33**: 221-235.

Marshall, A. (1920). The Principles of Economics. London, MacMillan.

Martin, R. (1999). "The new 'geographical turn' in economics: Some critical reflections." Cambridge Journal of Economics.

Martin, R. and P. Sunley (2003). "Deconstructing clusters: Chaotic concept or policy panacea?" Journal of Economic Geography **3**: 5-35.

Matutinovic, I. (2001). "The aspects and the role of diversity in socioeconomic systems: An evolutionary perspective." Ecological Economics **39**: 239-256.

Matutinovic, I. (2002). "Organizational patterns of economies: an ecological perspective." Ecological Economics **40**: 421-440.

Mayumi, K. and M. Giampietro (2001). The epistomological challenge of modelling sustainability: risk, uncertainty and ignorance. Frontiers I Conference, New Hall, Cambridge.

Metcalfe, S. and M. Gibbons (1986). "Technological variety and the process of competition." Economie Appliquée **39**: 493-520.

Metcalfe, S. (1994). "Competition, Fisher's principle and increasing returns in the selection process." Journal of Evolutionary Economics **4**: 327-346.

Metcalfe, S. (1998). Evolutionary Economics and Creative Destruction. London and New York, Routledge.

Neary, J. P. (2001). "On hypes and hyperbolas: introducing the new economic geography." Journal of Economic Literature **39**: 536-561.

Nelson, R. and S. Winter (1982). An Evolutionary Theory of Economic Growth. Cambridge, MA, Harvard University Press.

Nelson, R. R. (1995). "Recent evolutionary theorizing about economic change." Journal of Economic Literature **33**: 48-90.

Oswalt, P. (ed) (2004). Schrumpfende Städte. Städtischer Wandel im Zeichen von Postfordismus und Globalisierung. Hatje Canz Verlag.

Porter, M. (1990). The Competitive Advantage of Nations. New York, Free Press.

Porter, M. (1998). “Clusters and the new economics of competition.” Harvard Business Review(Nov/Dec): 77-98.

Quigley, J. M. (1998). “Urban diversity and economic growth.” Journal of Economic Perspectives **12**: 127-138.

Rammel, C. and M. Staudinger (2002). “Evolution, variability and sustainable development.” International Journal of Sustainable Development and Global Ecology **9**: 301-315.

Rammel, C. and J. C. J. M. van den Bergh (2003). “Evolutionary policies for sustainable development: Adaptive flexibility and risk minimizing.” Ecological Economics **47**: 121-133.

Rigby, D.L. and J. Essletzbichler (1997). “Evolution, process variety and regional trajectories of technological change in US manufacturing.” Economic Geography 73: 269-284.

Rigby, D. L. and J. Essletzbichler (2002). “Agglomeration economies and productivity differences in US cities.” Journal of Economic Geography **2**: 407-432.

Rigby, D.L. and J. Essletzbichler (2006): Technological variety, technological change and the geography of production techniques. Journal of Economic Geography **6**: Forthcoming.

Robert-Nicoud, F. (2005). “The structure of simple 'New Economic Geography' models (or, on identical twins).” Journal of Economic Geography **5**: 201-234.

Saviotti, P. P. and J. S. Metcalfe (1991). Present development and trends in evolutionary economics. In P. P. Saviotti and J. S. Metcalfe (eds) Evolutionary Theories of Economic and technological Change. Chur, Harwood Academic Publishers**:** 1-30.

Saviotti, P. P. (1996). Technological Evolution, Variety and the Economy. Cheltenham, Edward Elgar.

Schoening, N. C. and L. E. Sweeney (1992). “Proactive industrial development strategies and portfolio analysis.” Review of Regional Studies **22**: 227-238.

Schütz, J. (1999). “The value of systemic reasoning.” Ecological Economics **31**: 23-29.

Scott, A. J. (1998). Regions and the World Economy. Oxford and New York, Oxford University Press.

Sheppard, E. (2000). Geography or economics? Conceptions of space, time, interdependence and agency. In G. L. Clark, M. P. Feldman and M. S. Gertler (eds) The Oxford Handbook of Economic Geography. Oxford, Oxford University Press.

Sheppard, E. (2000). Competition in space and between places. In E. Sheppard and T. Barnes (eds). A Companion to Economic Geography. Oxford, Blackwell Publishers**:** 169-186.

Siegel, P. B., T. G. Johnson, and J. Allwang (1995). “A structural decomposition of regional economic instability: A conceptual framework.” Journal of Regional Science **35**: 457-470.

Smith, E. D. (1990). "Economic stability and economic growth in rural communities: Dimensions relevant to local employment creation strategy." Growth and Change **21**: 3-18.

Ulanowicz, R. E. (1997). Ecology, the Ascendent Perspective. New York, Columbia University Press.

Van den Bergh, J. C. J. M. (2004). Evolutionary thinking in environmental economics; Retrospect and prospect. In J. Foster and W. Hölzl (eds) Applied Evolutionary Economics and Complex Systems. Cheltenham, Edward Elgar.

Vrba, E. S. and S. J. Gould (1986). "The hierarchical expansion of sorting and selection: sorting and selection cannot be equated." Paleobiology **10**: 217-228.

Vromen, J. J. (1995). Economic Evolution - An Enquiry Into the Foundations of New Institutional Economics. London and New York, Routledge.

Wagner, J. E. and S. C. Deller (1998). "Measuring the effects of economic diversity on growth and stability." Land Economics **74**: 541-556.

TABLES AND FIGURES

Table 1: Correlates of Volatility

Variable name	Variable description	Hypothesized sign
HERF75	Herfindahl measure of diversity/specialization (1975)	+
GROWTH	Average annual compound rate of growth	+
SIZE75	Total employment in 1975	+/-
PLSIZE75	Average plant size (total employment per plant 1975)	-
R75	Percent of employment in resource based industries (SIC 12, 13, 14, 21, 24, 29)	+

Table 2: BEA area rankings by stability, diversity and growth

Rank	BEA Area	Stability	BEA Area	Diversity	BEA Area	Growth
1	Philadelphia, PA-NJ-DE-MD	0.0003942	Little Rock, AR	0.0103007	Las Vegas, NV	6.87
2	Lincoln, NE	0.0004523	Harrisburg, PA	0.0104357	Austin, TX	5.98
3	New York, NY-NJ-CT-PA	0.0004589	Jackson, MS	0.0105806	Sarasota, FL	5.42
4	Albany, NY	0.0005026	New York, NY-NJ-CT-PA	0.0107762	Phoenix, AZ	5.16
5	Dover, DE	0.0005044	Memphis, TN-MS-AR	0.0108033	Fayetteville, AR-MO	5.05
6	Richmond, VA	0.0005127	Atlanta, GA-AL	0.0108467	Bend, OR	5.01
7	Harrisburg, PA	0.000566	Philadelphia, PA-NJ-DE-MD	0.0112099	Flagstaff, AZ	4.94
8	Scranton, PA	0.0005689	Dallas-Fort Worth, TX	0.0114437	Sacramento, CA-NV	4.77
9	Omaha, NE-IA	0.0005821	Chicago, IL-IN-WI	0.0114459	Colorado Springs, CO	4.72
10	Rochester, NY	0.0006064	Columbia, SC	0.0115646	Orlando, FL	4.70
168	San Angelo, TX	0.0023583	Morgantown, WV	0.0344388	State College, PA	1.06
169	Pendleton, OR	0.0024352	Bend, OR	0.0345258	Waterloo, IA	1.02
170	Eugene, OR	0.0024807	Port Arthur, TX	0.035662	Springfield, IL	0.94
171	Sarasota, FL	0.0025731	Pueblo, CO	0.0372476	Erie, PA	0.90
172	Farmington, NM	0.0028575	Reno, NV	0.0376502	Buffalo, NY	0.89
173	Reno, NV	0.0031622	Odessa, TX	0.0415241	Odessa, TX	0.89
174	Odessa, TX	0.0034569	Flagstaff, AZ	0.0416221	Davenport, IA-IL	0.86
175	Lafayette, LA	0.0039636	Waterloo, IA	0.0693846	Cleveland, OH	0.80
176	Casper, WY	0.0039645	Gulfport, MS	0.0725675	Pittsburgh, PA	0.80
177	Bend, OR	0.0042717	Las Vegas, NV	0.0740087	Port Arthur, TX	0.76

Table 3: Basic Statistics of dependent and independent variables

Variables	n	Mean	Standard Deviation	Minimum	Maximum
VARGROWTH	177	12.56	6.38	3.94	42.72
HERF75	177	0.02	0.01	0.01	0.07
MGROWTH	177	2.53	1.09	0.76	6.87
EMP75	177	336866.00	680227.00	11288.00	6561322.00
PLSIZE75	177	12.71	2.89	7.56	19.80
R75	177	0.05	0.05	0.01	0.29

Variables	n	Mean	Standard Deviation	Minimum	Maximum
LOGVARGROWTH	177	2.43	0.43	1.37	3.75
LOGHERF75	177	-4.01	0.35	-4.58	-2.60
LOGMGROWTH	177	0.84	0.44	-0.27	1.93
LOGEMP75	177	11.91	1.19	9.33	15.70
LOGPLSIZE75	177	2.52	0.23	2.02	2.99
LOGR75	177	-3.36	0.88	-5.16	-1.25

Table 4: Correlation coefficients between dependent and independent variables (p-values in parentheses)

	VARGROWTH	HERF75	MGROWTH	EMP75	PLSIZE75	R75
VARGROWTH	1	0.44	0.31	-0.21	-0.39	0.60
		(0.0001)	(0.0001)	(0.0042)	(0.0001)	(0.0001)
HERF75	0.44	1	0.09	-0.22	-0.13	0.30
	(0.0001		(0.246)	(0.003)	(0.0796)	(0.0001)
MGROWTH	0.31	0.09	1	-0.15	-0.30	-0.03
	(0.0001)	(0.246)		(0.0514)	(0.0001)	(0.7212)
EMP75	-0.21	-0.22	-0.15	1	0.44	-0.23
	(0.0042)	(0.003)	(0.0514)		(0.0001)	(0.0018)
PLSIZE75	-0.39	-0.13	-0.30	0.44	1	-0.37
	(0.0001)	(0.0796)	(0.0001)	(0.0001)		(0.0001)
R75	0.60	0.30	-0.03	-0.23	-0.37	1
	(0.0001)	(0.0001)	(0.7212)	(0.0018)	(0.0001)	

	LOG VARGROWTH	LOG HERF75	LOG MGROWTH	LOG EMP75	LOG PLSIZE75	LOG R75
LOG VARGROWTH	1	0.50	0.29	-0.42	-0.42	0.48
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
LOGHERF75	0.50	1	-0.04	-0.49	-0.25	0.29
	(0.0001)		(0.6416)	(0.0001)	0.0007	(0.0001)
LOG MGROWTH	0.29	-0.04	1	-0.16	-0.30	0.07
	(0.0001)	(0.6416)		(0.0343)	(0.0001)	(0.3718)
LOGEMP75	-0.42	-0.49	-0.16	1	0.78	-0.48
	(0.0001)	(0.0001)	(0.0343)		(0.0001)	(0.0001)
LOGPLSIZE75	-0.42	-0.25	-0.30	0.78	1	-0.45
	(0.0001)	(0.0007)	(0.0001)	(0.0001)		(0.0001)
LOGR75	0.48	0.29	0.07	-0.48	-0.45	1
	(0.0001)	(0.0001)	(0.3718)	(0.0001)	(0.0001)	

Table 5: The determinants of volatility

Variables	Model 1 OLS	Model 2 OLS	Model 3 ML-SPATIAL LAG	Model 4 ML-SPATIAL ERROR
FORM	LINEAR	LOG-LINEAR	LOG-LINEAR	LOG-LINEAR
DEPENDENT VARIABLE =	VARGROWTH	LN VARGROWTH	LN VARGROWTH	LN VARGROWTH
Constant	4.87*	5.27**	3.87**	5.14**
	(2.05)	(14.03)	(8.41)	(12.76)
(LN)HERF75	182.09**	0.53**	0.44**	0.48**
	(4.70)	(6.39)	(8.41)	(5.85)
(LN)MGROWTH	1.60**	0.24**	0.16**	0.18**
	(4.90)	(4.15)	(2.89)	(2.93)
(LN)EMP75	4.54x10e7	0.05	0.02	0.04
	(0.81)	(1.25)	(0.44)	(1.01)
(LN)PLSIZE75	-0.25+	-0.38*	-0.21	-0.38+
	(-1.72)	(-2.06)	(-1.19)	(-1.89)
(LN)R75	58.94**	0.15**	0.11**	0.12**
	(8.30)	(4.75)	(3.52)	(3.57)
W_LNVARGROWTH			0.37**	
			(4.67)	
λ				0.43**
				(4.83)
R-Square (adj.)	0.515	0.462	0.539p	0.537p
Log-Likelihood	-512.161	-47.8736	-36.8477	-36.8319
AIC	1036.32	107.747	87.6953	85.6638
SC	1055.38	126.804	109.928	104.720
Diagnostics for Heteroscedasticity				
Breusch-Pagan	51.22**	2.58425	8.57	8.97
Koenker-Basset	14.79*	2.35506	-	-
Diagnostics for Spatial Dependence				
LM-ERROR	5.85*	21.76**	-	-
LM-LAG	5.51*	27.38**	-	-

Notes: OLS = Ordinary Least Squares; ML = Maximum Likelihood; **, *, +: significant at the 0.01, 0.05, 0.1 level; Spatial weights are based on queen spatial contiguity of BEA areas; p indicates a pseudo R-Square measure, because the standard R-Square is invalid in ML estimation. AIC = Akaike Information Criterion; SC = Schwartz Criterion.

Figure 1: Diversity, growth, volatility

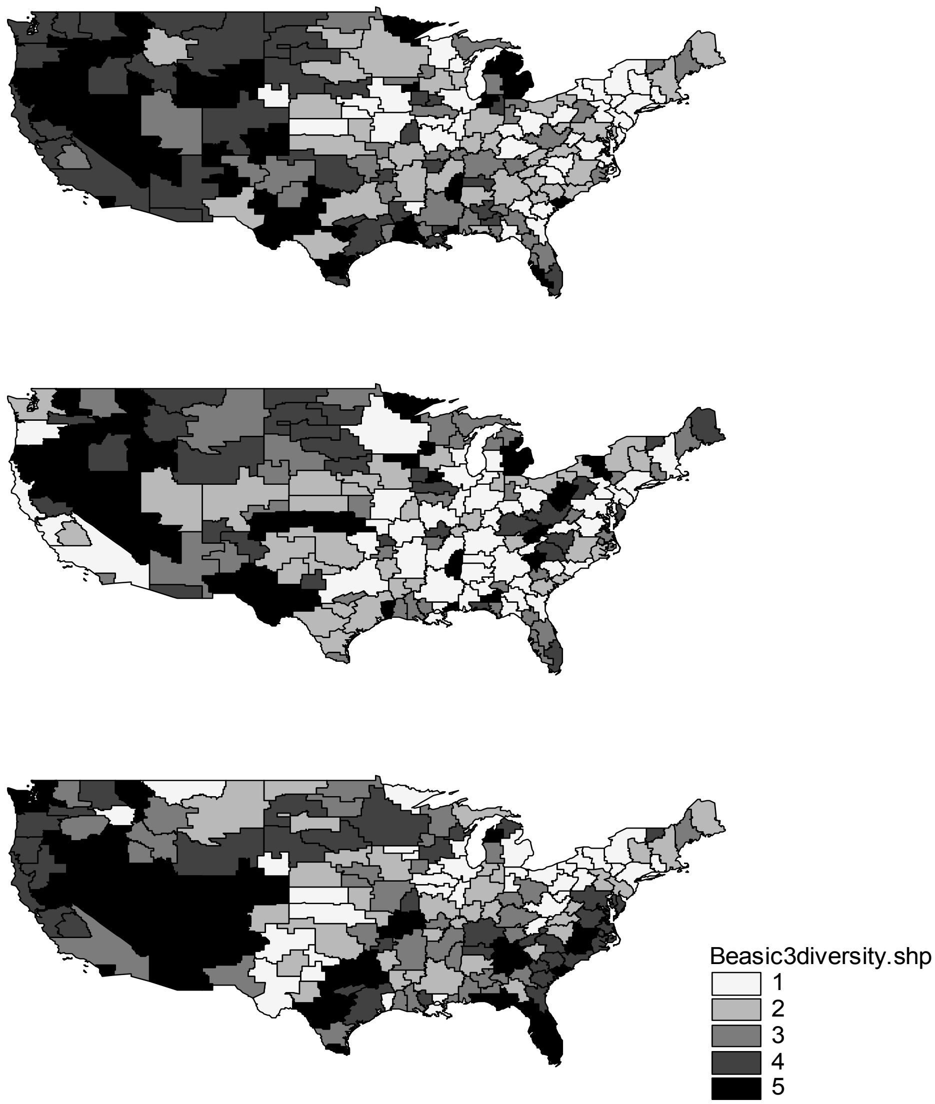

Figure 2: The relationship between volatility and growth/diversity