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SPECIAL ISSUE PAPER

Economic vulnerability in US metropolitan areas

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Abstract

This paper examines various aspects of recent employment vulnerability in US metropolitan areas. Based on the three decades preceding COVID-19, an estimate is made of the volatility (sensitivity) in each area's unemployment rate, relative to the national rate, and this reflects the area's *overall* employment vulnerability to external events. Using the Brechling–Thirlwall time-series approach, the monthly change in each area's unemployment rate is first compared to the monthly change in the nation's unemployment rate. Regression analysis is then used to tie the volatility seen in those metropolitan unemployment rates to various initial conditions: degree of specialization in primary (+), manufacturing (+), and government (−) activities; initial unemployment (+); human-created (−) and natural amenities (+); real wages (−); self-employment (−); and the presence of major colleges or universities (−). An alternative specification reassesses these estimates after including the volatility of unemployment rates across the nation's various states. A short discussion then addresses the issue of vulnerability in *specific* activities. Selecting four industries that were identified "at risk" during early COVID events, ranked employment specialization indices (*LQ*s) are correlated with ranked volatility estimates of unemployment rates. In the more advanced economies, metropolitan areas typically specialize in, and trade across, different industries, but this specialization can create overall employment vulnerability.

JEL Classification J21 · R12 · R23

1 Introduction

Analyzing the nature and extent of regional economic growth continues to be a dominant topic of research in economic geography and the related social sciences (Karlsson et al. 2015; Capello and Nijkamp 2019). In recent times, three aspects of

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this research have become increasingly prominent. First, there is a widespread belief that planners, policymakers, and leaders should learn to construct and implement endogenous growth strategies (Stimson et al. 2019). These self-sustainable strategies should begin with a realistic assessment of the core competencies that are currently available to each region. However, many regions will never enjoy self-sustainable growth, either because they are too small or too specialized, or badly lacking in human capital or physical infrastructure (Stimson et al. 2009). Second, there is growing recognition that regions can only compete by becoming more creative and innovative (Moretti 2012; Jackson and Schaeffer 2017). Here, the research on regional knowledge production functions (RKPFs) highlights the key roles played by industrial laboratories, university facilities, and STEM jobs in the so-called New Economy (Varga and Horváth 2015). Other studies have clarified that the various information and knowledge transfers between agents are now determined more by occupations than by industries (Michaels et al. 2018). But innovation can also be viewed as a region-wide learning process where entrepreneurs successfully bring more "local" products and practices to the market (Cerisola 2019). Third, there is growing interest in gauging the sustainability, vulnerability, and resilience of regional economies. But to date, a lot of this research has been self-selective—often targeting "at risk" industries or "declining" regions—and has not yet revealed the general economic vulnerability of metropolitan areas, either to internal uncertainties or external disruptions. In truth, much more hard evidence is needed to clarify how sensitive regional unemployment shifts are to national or international events (Armstrong and Taylor 1993). Only then will planners and policymakers fully realize that some regions are much more, and others much less, vulnerable to disruptive changes. However, all three of these perspectives realize that the fortunes of every metropolitan economy rest on attracting and nurturing human capital that in turn can take advantage of social networks, knowledge spillovers, and other local externalities (Shearmur et al. 2016). Here, the role of natural- and human-created amenities is seen to be increasingly important in attempts to widen or deepen the region's pool of skilled and educated workers (Marans and Stimson. 2011; Mulligan et al. 2019).

The analysis of this paper addresses the monthly changes in unemployment rates across 381 US standard metropolitan statistical areas during the three pre-COVID decades stretching between 1990 and 2020. All these areas currently have populations that exceed 50,000 although many were sub-metropolitan, or micropolitan, back in 1990 (U.S. Census Bureau 2021). As discussed below, these metropolitan areas, based on county units, represent the labor markets of the nation's major cities. The analysis uses the BLS time series for unemployment rates, and the *sensitivity* of metropolitan rates, in comparison with the national rates, is estimated across some 360 months using ordinary least-squares regression (U.S. Bureau of Labor Statistics 2020a). Using the Brechling–Thirlwall approach (see below), more widely known in the UK, the first-order difference in each area's unemployment rate is compared to the first-order difference in the nation's unemployment rate. Some metropolitan areas, in part due to their locations and in part due to their histories and ever-evolving industrial profiles, always exhibit more volatility in their unemployment rates than other areas. The degree of this volatility can be linked, in part, to various initial conditions of the metropolitan areas in 1990. Specialization (or over-representation) in primary or manufacturing industries is shown to have a positive impact and specialization in government activities a negative impact on the subsequent volatility seen in metropolitan unemployment rates. Similar effects are seen for self-employment (−), natural amenities (+), human-created amenities (−), real wages (−), the initial unemployment rate (+), and the importance of colleges and universities (−). Together, the results suggest that certain key activities can be chosen as public-policy instruments for dampening monthly changes in unemployment rates. An alternative estimation, which includes the corresponding monthly changes in unemployment rates at the state level, indicates that per capita patent production (−) and overall industrial diversity (+) can also affect the volatility in unemployment rates experienced across US metropolitan areas. The analysis considers a wide variety of economic circumstances that prevail before a lengthy study period and is not designed to gauge those factors that might drive employment growth or decline over much shorter periods (Kreston and Wójcik 2018). Moreover, lead and lag effects, whether of the spatial or industrial variety, are not examined at this time (Park and Hewings 2012).

The paper concludes with a short discussion of economic vulnerability at the level of *individual* industries, where the notion of "riskiness" has recently become commonplace. Here, the results are taken from the analysis of four different activities—amusement, health care, real estate, and retailing. In all four cases, each metropolitan area's single-industry degree of specialization is determined by a location quotient computed for 2018, and the ranks of these *LQ*s are compared to the ranks calculated for the 30 years of volatility in the various unemployment rates. As expected, all four correlations are positive and three of these are also highly significant. The results show that different metropolitan areas can be equally vulnerable to disruptions or downturns even though those areas specialize in different "at risk" activities.

2 Relevant literature

2.1 Background

Most studies of regional growth have depended on the use of multipliers that, until recently, were determined either by the economic (export) base or the input–output framework (Isard 1960). But, as the debate between the colleagues North (1955) and Tiebout (1956) demonstrates, there were differences from the outset about the interpretation and application of the economic base model. Tiebout, who was more concerned with the Keynesian effects of exports on the growth of regional economies, saw the economic base as being one aspect of the short-term theory of income determination. He elaborated many of these ideas later when he showed how leakages (from taxes, commuting, etc.) will diminish the expansionary effects of the multipliers that are created by local or regional rounds of expenditures (Tiebout 1962). His approach remains very useful for understanding the employment trajectories and growth prospects of those open economies that are either small or highly specialized. North, on the other hand, saw the region's export base as being a potential barrier to its continued economic growth, as older, sunset industries were always disappearing and newer, sunrise industries were always appearing. So, he stressed that open regional economies must learn to continually "reinvent" themselves to thrive over the long term. Like Blumenfeld (1955), he also emphasized the key role of ancillary services in making this ongoing transformation a success. Such activities as legal services, corporate accounting, and transportation repairs might grow up around a narrow export base, but, eventually, those service industries could become the attractors or incubators for other industries arising in the region's "new" export base. At the same time, it became recognized that non-earnings income (unemployment insurance, pensions, etc.) could play an important role in the region's evolving economic base, especially with household members becoming more mobile and living longer (Mulligan and Gibson 1984). Subsequent studies showed that the effects of this non-earnings income can differ a lot from one region to the next. Although input–output studies do provide industry-specific multipliers, of both the employment and income variety, that approach is also restricted to linear relationships, and all the internal transactions can be traced back to exogenous forces. Consequently, and unfortunately, input–output analysis has become widely viewed as being only a more detailed version of economic base analysis.

A paradigm shift began once it was recognized that some economies could achieve self-sustainable or endogenous growth. Early research carried out by economists like Lucas (1988) and Romer (1990), who extended the ideas of Solow (1956) and others, clarified the key roles played by size and variety in generating external economies. One claim here was that research and development, involving the deliberate investment of (largely private) agencies in the creation of knowledge, could generate inventions that would eventually spur on growth in the regional economy through subsequent commercial applications. In fact, much of this early research, which now rests on stylized facts, supposed that investments in knowledge creation would continue for as long as private returns outpaced private costs (Warsh 2006). Later research showed how other factors, including attributes tied to location, generated externalities that would be highly valued at the regional or local level (Brakman et al. 2001; Fujita and Thisse 2002). At the same time more attention in economics and political science was turning to the role of governance, contracts, and social capital in facilitating regional and national growth (Williamson 1985; North 1990).

2.2 Endogenous growth

Useful observations about the endogenous growth of regions have also come from other disciplines, including geography and policy studies, although this research has been more descriptive and prescriptive than that seen in economics (Stimson et al. 2019). Here, analysts have emphasized that sustainable growth must not only address economic considerations but environmental, governmental, and social goals as well (Wolfe and Gertler 2016; Irwin et al. 2017). This stream of ideas has often included the thoughts of Roger Stough who wrote widely, both singly and collaboratively, about the importance of private and public leadership (Stimson et al. 2006, 2009; Stough 2019). Here, it is recognized that regions must make informed decisions to enhance their productivity once it is realized that central (federal) governments often fail to efficiently allocate scarce resources; moreover, those same central governments rarely provide strong governance or inspire leadership (Button and Stough 2000; Lakshmanan and Button 2019; Stimson et al. 2019). Measuring the progress made in a region's sustainable performance is not at all straightforward but one approach involves examining the competitive component of shift-share analysis (Haynes and Dinc 1997; Mulligan and Molin 2004). In many ways, this "soft" approach takes Porter's work as a starting point and attempts to identify those core competencies that will maintain or enhance productivity growth (Porter 1990, 1998).

However, in truth, these competencies stretch across the entire socioeconomic domain and include imaginative and non-corrupt governance; reliable and transparent credit markets; social adaptability and tolerance; an openness to both invention and innovation; a fair sense of intergenerational equity; the maintenance of human and social capital; and the adoption of both smart and strategic infrastructures (Florida 2005; North 2005; Shearmur et al. 2016; Irwin et al. 2017). Also, a calculus for overall well-being should be devised so that stakeholders engaged in regional development can accurately determine the benefits from adopting new practices and products or evaluate the gains from tapping into new markets (Storper et al. 2015; Wolfe and Gertler 2016). Here, the research of Roberto Camagni (2019) has been especially influential across Europe in making the case for regional (territorial) economies becoming more aware of their local assets, past growth paths, and future possibilities, and then using this knowledge to create or redirect regional development strategies.

Partly due to the highly technical aspects of the endogenous growth literature, at least in economics, most measures of metropolitan performance in regional science have remained narrowly conceived, if not outright deficient. Although the BEA has recently introduced an index of metropolitan performance based on the GNP concept, this new measure still suffers from all the criticisms targeting those approaches that are confined to income accounts (U.S. Bureau of Economic Analysis 2020). Hee, again the Europeans have done most of the pioneering work in providing alternative perspectives and they have devised various performance measures that address happiness or satisfaction; subjective perceptions and objective indicators of well-being; socioeconomic inequality and intergenerational equity; and the nature of work (Glatzer et al. 2015; D'Ambrosio 2018; Macekura 2020).

2.3 Creativity and innovation

The discussions of creativity, invention, and innovation in the post-Schumpeter era have addressed a variety of issues including: the nature of ideation and knowledge creation; the differences between linear (closed) and nonlinear (open) models of innovation; the role of patent protection; and the general attitude of society regarding risk-taking (Bathelt et al. 2017). Much of the early research, being focused on manufacturing, addressed those tangible products and production processes that tended to be invented and then adopted by businesses in a series of stages. But with the more intangible outputs of the New Economy, this perspective was seen to be overly restrictive, if not misleading. Soon analysts recognized the key role that producer services often play in the innovation process, while others saw the importance of geographic clusters in knowledge sharing and adaptation (Porter 2012). In fact, innovation is now understood to be open, non-sequential, and multidimensional. Furthermore, there is now much more appreciation of the role of personalized networks in knowledge creation. These networks serve to connect private and public actors, both within and between firms and among regions, and clearly affect the short-run exchange of data, ideas, and funding, as well as the long-run spatial sorting of people and businesses. Patent production is sometimes examined to gauge the volume of local or regional knowledge creation, while citation analysis can shed light on the geographic fields of influence for these new ideas and innovations (Mulligan et al. 2014). And, as already pointed out, some observers now claim that regional economies only thrive when they provide creative and innovative milieux for information exchange and transcoding, and both explicit and implicit cooperation among actors (Camagni 2019).

Furthermore, cultural heritage—including archaeological sites, monuments, museums, and the like—is now recognized to comprise a public good where local and regional traditions are non-excludable and, in the absence of rivalry, all parties can benefit from their consumption (Cerisola 2019). Such heritage is not only a tangible good but one that has both aesthetic and emotional value, especially to local peoples. Cultural heritage not only attracts visitors; it can also lead to the appearance of different cultural industries, and even clusters, which will serve to attract more skilled workers. Not surprisingly, this heritage is becoming increasingly commodified to promote place-based products—a practice that can even assist in the regeneration of some lagging regions. Nevertheless, measuring place-bound creativity remains a challenge for those analysts trying to identify a testable variable for their models. Moreover, industry-wide measures of creativity often include too many non-creative activities, while, alternatively, occupation-wide measures often include too many non-creative workers (Markusen 2004).

2.4 Vulnerability and resiliency

Until recently the concept of urban vulnerability was pretty much tied to the notion of specialization or (lack of) diversification in the city economy. While North (1955) had emphasized the role of "residentiary industries" in maintaining economic growth, he also saw that these locally oriented activities, largely involving non-tradables, could dampen "the seasonality" of the city's overall employment. Later, Thompson (1965) revisited the issues of cyclical (short-term) and secular (long-term) stability in making the case for an optimal size to cities. Instability was seen to prevail in those places that specialized in the production of highly income- or price-elastic goods and services. So, by its very nature, a high degree of industrial specialization can lead directly to vulnerability (Glaeser et al. 1992; Duranton and Puga 2000). Consequently, if urban regions are to continue thriving, they must somehow reinvent themselves, either by making their export bases more competitive in price (or quality) or by constantly enhancing the skills of workers in their local (ancillary, producer) services. Consequently, the best prescription for reducing the economic vulnerability of city regions is to pursue those investment strategies and employment growth practices that are sustainable over the short term but flexible over the long term.

After the devastation wrought by Hurricanes Andrew (1992) and Katrina (2005) in the USA, and the later events of the Great Recession (2007–2009), many small- and medium-sized businesses (SMEs), and small- and medium-sized cities, were recognized to be severely affected, and this eventually brought the concept of resiliency to the forefront as a policy tool. Resilience has its origins in ecology and reflects the adaptability and flexibility of entities in the face of sometimes uncontrollable external events (Holling 1973). For the economies of regions, this dynamic adaptability depends on an array of factors, including the quality of local governance, the attitudes imbued in local history and culture, and the geographic allocation of scarce human capital (Williams and Vorley 2017). Resilience is believed to be high in those cities that have diverse industries, an abundance of entrepreneurs and skilled workers, and strong ties between private and public actors; on the other hand, resilience is thought to be low in other cities that are highly specialized, non-supportive of reskilling and entrepreneurship (as seen in rentier economies), and low in trust or interaction among key decision-makers. Some of the earliest research dealt with the prevention and mitigation (e.g., redundant infrastructure) of "natural" disasters but, more recently, research has turned to easing the overall economic pain following "human-created" disasters. But many scientists and policymakers have come to recognize that these disruptive events are becoming increasingly frequent, if not outright continuous, and most regional economies must implement mechanisms for steadily "bouncing forward" rather than continually "bouncing back." Not surprisingly, the approaches of evolutionary economics have come to replace those of equilibrium economics in the study of regional resilience (Nelson and Winter 1982; Cantner et al. 2000).

Rose (2017), for one, has undertaken important research on this topic and suggests that regional scientists should examine both static and dynamic types of economic resilience. The former recognizes that different metropolitan areas will have different abilities to function, let alone compete, after a disruptive event; the latter recognizes that different areas will exhibit somewhat different abilities to repair, reconstruct, and return to earlier performance levels. But, as Martin (2012), Martin and Sunley (2015), and others have pointed out, circumstances can arise where decision-makers might enhance resiliency not by nudging but by redirecting the trajectory of the regional economy. Here, the incentives provided for reinvention can be less costly over the long term than those encouraging the replication of past practices. A first step in this endeavor involves understanding how the economies of different metropolitan regions respond to various national and international events. More research, perhaps involving spatial simulations, could certainly clarify for planners how some urban morphologies are simply "smarter" than others in reducing the economic effects of damaged housing and decaying infrastructure. Other recent discussions of urban resiliency, along with appropriate case studies, can be found in Shearmur et al. (2016) and Irwin et al.

(2017). In any case, introducing the ideas of resilience and vulnerability into a region's competitive strategy is becoming an increasingly popular undertaking (Borsekova et al. 2021).

3 Unemployment

3.1 Background

Unemployment, which can be measured in various ways, continues to be one of the most widely used indicators of overall health in regional labor markets. Several multivariate studies, now somewhat dated, have suggested that unemployment strongly correlates with other socioeconomic conditions in metropolitan areas, including the quality of dwelling units and access to flexible transportation. In the USA, the BLS classifies a person as unemployed if she does not have a paid or unpaid job, is not available for work, or has not sought work in the previous four weeks. In some countries, like the UK, unemployment figures have been used since the Great Depression to designate areas that should be assisted with money or jobs programs issued from central governments. Here and elsewhere, much thinking has been devoted to the so-called regional problem and various explanations exist for why regional unemployment gaps remain so persistent. Armstrong and Taylor (1993) suggest there are two overarching issues that must be understood at the regional level. First, all regions are affected to some degree by national recessions and, alternatively, national expansionary periods, but these regions all share differently in the employment downturns that accompany recessionary events and the employment upturns that accompany expansionary events. Second, the regional patterns in unemployment appear to remain stable over very long periods of time. So, if the regional unemployment rate is high at some early point in time, it is likely to remain high at a later point in time (see below). These two findings reflect both the cyclical and the secular aspects of unemployment.

Consider the following relationship for the *i*th region at some fixed point in time:

$$u_i = 1 - \left[E_i/\left(E_i + U_i\right)\right] = 1/\left(1 + E_i/U_i\right) \quad (1)$$

where u_i is the region's unemployment rate, E_i is its employment, U_i is its unemployment, and $E_i + U_i$ is its entire labor force (Murphy and Hofler 1984). The two levels E_i and U_i usually refer only to the civilian labor force, so any region with large numbers of non-civilian workers, such as students or military personnel, might need adjustments made to this formula. Moreover, the attitudes toward hiring and firing are often very different in the public sector, so the composition of employment E_i must sometimes be adjusted: for example, layoffs can sometimes be delayed, or even muted, much easier in state and provincial capitals than in other metropolitan areas. Obviously, too, the area's unemployment rate depends on the methods, including sampling procedures, that are used to identify both E_i and U_i, and this can make international comparisons—such as those done by the Organization for Economic Co-operation and Development—very difficult to undertake (OECD 1989).

The multitude of factors affecting levels of employment and unemployment can affect either the demand for labor or the supply for labor, and unfold with varying time horizons, so it is difficult to assign expected signs or appropriate lags to shifts in some of the most important factors, including housing costs or non-earnings income. Not surprisingly, other measures of regional unemployment have appeared at times—including first-time rates and insured rates—but each of these has its own advantages and disadvantages (Burtless 1983).

3.2 Stability in the rates

One very notable aspect of US unemployment is the persistence of large differences in unemployment rates across the nation's metropolitan landscape (see below). Rappaport (2012) noted that these differences existed across the nation's 308 metropolitan areas during the 1990s, and he estimated that the correlation coefficient between the average (monthly adjusted) unemployment rate 1990–1999 and the average unemployment rate 2000–2007 was $r=0.872$. In fact, only a few of these metropolitan economies, including El Centro, CA, and Yuma, AZ, had unemployment rates that climbed two percent or more higher during the second decade, while only a handful of others, including Salinas, CA, and Idaho Falls, ID, had rates that fell two percent or more lower during the second decade. He attributed this remarkable persistence, where nearly all average unemployment rates moved up or down less than two percentage points during the entire decade, to different worker abilities (a matching issue), different labor market attributes (including housing costs), and moving costs. The first of these was believed to be the most important factor in this persistent dispersion, largely because current employment *growth* was determined to have only a weak relationship with the prior unemployment rate.

For current purposes, Rappaport's findings were revisited over the 389 metropolitan areas that are now monitored (some 26% more than in 1990) by the BLS (2020a). Correlations could now be estimated across three instead of only two decades, and these were denoted as follows: period 1, 1990–2000; period 2, 2000–2010; and period 3, 2010–2020. Using the series of unadjusted unemployment figures given by the BLS for the month of January, the average unemployment rates for each decade were calculated. Indexing each of the decades by the three numbers shown above, the Pearson correlation coefficients for the average rates were estimated to be $r_{12}=0.866$, $r_{13}=0.820$, and $r_{23}=0.874$. So, there was remarkable stability evident during all three contiguous periods. These high values, based on even more (and mostly smaller) metropolitan areas and more points in time, not only reinforce Rappaport's findings, but they indicate that the general persistence or inertia in US regional unemployment rates has clearly extended for some time now. As seen in that earlier study most of the largest interdecadal shifts in unemployment rates occurred among the nation's smaller metropolitan regions: The greatest falls in those average rates (measured by absolute shifts in percentage rates) over 20 years were found in McAllen, TX (-11.98), Laredo, TX (−5.64), and Yakima, WA (−2.69), while the greatest rises were found in Hickory, NC (+3.58), Rockford, IL (+3.15), and Greensboro, NC (+3.03). Very few shifts fell outside the 3 percent threshold, even though these figures were not controlled by other factors as was done by Rappaport (2012). Nevertheless, these new findings suggest that the unemployment conditions substantially improved between 1990 and 2020 in those metropolitan regions located along the US–Mexico border and in the other regions scattered across the nation that continued to specialize in agricultural activities.

3.3 Volatility in the rates

One of the most revealing but least appreciated findings in the wide literature on spatial disparities in the USA is that the regional (metropolitan) unemployment rates *MTUN* vary substantially with the national unemployment rate *NTUN*. As a result, when a shift occurs in the national rate, the response in each regional economy tends to be somewhat different. In the UK, many studies have advocated use of the following version of the model:

$$MTUN = a + b\ NTUN + \lambda \text{ Time } + \varepsilon \tag{2}$$

where the coefficients a and b are region-specific estimates determined either by ordinary least-squares (OLS) regression or by a similar procedure (Armstrong and Taylor 1993). The slope estimate b is interpreted as an indicator of the long-term trend in the series of unemployment rates for a given region. When Eq. (2) is respecified as a double-logarithmic regression model, the new slope estimate represents the elasticity of the regional unemployment rate relative to the national unemployment rate, and this estimate will vary a lot from one metropolitan area to the next.

But of more interest in this paper is how the first-order differences in the regional unemployment rates change over time (Thirlwall 1966; Brechling 1967; Elhorst 2003). Here, the first-order differences $\Delta MTUN$ and $\Delta NTUN$ for each metropolitan area and the entire nation are calculated by adopting a one-month time lag. Now, the regression model takes on the following form:

$$\Delta MTUN = c + d\ \Delta NTUN + \varepsilon \tag{3}$$

where the time trend on the right-hand side of Eq. (2) is omitted. So here the slope estimate d in Eq. (3) indicates how the monthly change in a specific area's unemployment rate corresponds to the monthly change in the nation's unemployment rate. In the same way, different first-order effects for the unemployment rates of the District of Columbia and the 50 states can be estimated as follows:

$$\Delta STUN = e + f\ \Delta NTUN + \varepsilon \tag{4}$$

for each month of the 30 year period. Compared to the better-known UK studies, the time lag is now much shorter (one month versus one year), and the so-called bias problem is much less critical because of the many (relatively small) spatial observation units.

Of course, the full study period can always be divided up to examine the responses in regional unemployment rates over shorter periods, perhaps representing different parts of the business (trade) cycle or targeting the years just preceding or following key events or crises (Almeida et al. 2020). But these shorter sub-periods are not addressed in this paper as interest is confined to exposing the long-term effects of initial conditions on the varied responses of the metropolitan unemployment rates. In any case, most critics would still agree that the regression approach, often called the Brechling–Thirlwall model, sheds much useful light on the cyclical sensitivity of each region's unemployment rate. So, using Eq. (3), when the slope estimate $d > 1$, a metropolitan area's unemployment rate is more sensitive than average to a change in the unemployment rate at the national level; alternatively, when the slope estimate $d < 1$, the area's unemployment rate is less sensitive than average to a change in the unemployment rate at the national level. In many ways, then, the coefficient d can be interpreted much like an elasticity estimate. Seen from this general perspective, the sensitivity or volatility in each region's overall unemployment rate discloses the degree of vulnerability of that region's economy to small shifts in the nation's overall unemployment rate. This vulnerability is relatively high when d is greater than unity (elastic) and is relatively low when d is less than unity (inelastic). So, as an important first step toward understanding a region's economic vulnerability—at least in response to shifts in national unemployment—attempts should be made to determine how the slope estimate d in Eq. (3), or perhaps the slope estimate f in Eq. (4), varies with other initial attributes of the region, including such factors as its population size or density, the nature and degree of its industrial specialization, its various amenities, and perhaps its relative location (Elhorst 2003).

4 The data

4.1 Spatial units

As mentioned earlier, the conclusions of the paper are based on the study of metropolitan statistical areas (MSAs). These are county-based spatial units that are comprised of a central county and those (sufficiently large) surrounding counties that are highly integrated with (and usually adjacent to) that central county. Some metropolitan areas are comprised of a single central county, while others are comprised of five or more highly connected counties. County units are not always fully urbanized, especially in the nation's Southwest, where the counties can be very large in geographic extent. Moreover, these metropolitan areas are not space-filling across the entire national space economy. Metropolitan areas are preferred to urbanized areas because the boundaries of the former tend to be much more stable over time, although the criteria for including outlying counties have changed a bit through the years (Simmons and Bourne 1978). In any case, metropolitan areas are chosen to best capture the extent of (daily) labor markets, while urban areas, instead, are chosen to capture the smaller and more unstable continuously built-up parts of those labor markets (Cox 2022).

4.2 Initial conditions

A total of 17 variables were considered as initial conditions for two separate cases (families) of regression analysis. In the first case, the appropriate state-level differences in unemployment rates were not included, while, in the second case, those regional rate differences were introduced. Outside of these rate differences, all the other initial conditions were expressed as natural logarithms for the year 1990.

At the outset, two factors were expected to be important determinants of the volatility seen in the metropolitan unemployment rates: population size *POPL* and the economy-wide diversity index *DIVE* of employment. The mean for population size was $M = 12.41$, and the standard deviation was $SD = 1.06$; the mean for overall job diversity was $M = 4.16$ and the standard deviation was $SD = 0.23$. As larger places usually tend to become increasingly diverse in their various industries (in part because non-tradables become more important), the volatility seen in unemployment rates was expected to decline with those higher populations. So small places like Hanford, CA, and Dalton, GA, were expected to exhibit much more volatility than large places like Philadelphia, PA, or Chicago, IL. Second, as in financial portfolios, those places that happened to specialize in one or only a few industries were expected to exhibit greater volatility in their unemployment rates. But surprisingly, neither relationship was borne out for the 30-year period 1990–2000. Although the Pearson correlation coefficient ($r = 0.103$) between prior population size and subsequent unemployment volatility was significant at the 0.10 level, the positive sign on the relationship was entirely unexpected (see below). Of course, this simple relationship might be overwhelmed by other factors in a more complex multivariate analysis. Early estimates of employment diversity could not be found for all 381 observations, but current estimates recently provided by Chmura (2021), adjusted so that greater diversity is represented by larger numbers in the interval between 0 and 100, indicate that the simple relationship ($r = -0.084$) between volatility in the unemployment rate and industrial diversity in jobs is nearly random. However, the general expectation that the industrial diversity of metropolitan areas climbs ($r = 0.722$) with increasing population size was clearly maintained.

The means and standard deviations for the other key variables, along with their expected signs, are as follows:

- *PRM%*: percentage of metropolitan employment in all primary industries; the expected sign is (+) given the export nature of these industries; $M = -0.06$, $SD = 0.61$ (BEA 2020)
- *MAN%*: percentage of employment in manufacturing; the expected sign is (+) given the largely export (tradable) nature of this industry; $M = 2.86$, $SD = 0.67$ (BEA 2020)
- *GOV%*: percentage of employment in all levels of government; the expected sign is (−) given that public hires tend to dampen economic downturns; $M = 2.78$, $SD = 0.42$ (BEA 2020)
- *PRO%*: percentage of total employment comprised of proprietary employment; the expected sign is (−) given the greater adaptability of small businesses that reflect self-employment; $M = 2.75$; $SD = 0.23$ (BEA 2020)

- *NATA*: natural amenities measured by *reversing* the sign on total (heating plus cooling) degree days; the expected sign is (+) as people prefer mild climates with high indices; M = -8.65; SD = 0.25 (Savageau and Boyer 1993)
- *HUMA*: human-created amenities measured by residuals calculated when average house values are regressed on average wages and natural amenities; the expected sign is (+) as people desire a better local ambience; M = 0; SD = 0.27 (Carruthers and Mulligan 2006)
- *WAGE*: real wage calculated as average wage divided by average house price (the inverse of an affordable housing index); the expected sign is (−) as people prefer areas with higher nominal wages and lower house prices; $M = -1.22$; $SD = 0.33$ (BEA 2020)
- *UNEM*: the annual non-adjusted unemployment rate for 1990; the expected sign is (+) because the unemployment rate is stable through time; $M = 1.72$, $SD = 0.33$ (BLS 2020a)
- *COLL*: a measure of the importance of colleges and universities determined by both the quality and size of the institutions; the expected sign is (−) because high student numbers diversify the economy and dampen economic downturns; $M = 3.50$; $SD = 1.12$ (Savageau and Boyer 1993)
- *PPAT*: the per capita patenting rate, representing technical expertise and creativity in the local economy; $M = -9.12$, $SD = 0.92$ (U.S. Patent and Trademark Office 2018)

The remaining 6 of the original 17 initial conditions were all (visibly) insignificant when the metropolitan volatility rates were estimated. These excluded variables were: total population, allowing for external economies (BEA 2020); a dummy for areas exceeding 0.50 million people, recognizing a size threshold effect (Brookings 2020a); the ratio between earned income and total income, representing variation in the role of non-earnings income (BEA 2020); the percent of the workforce in the prime working-age cohort 25–34, addressing changes in human capital over a worker's lifetime (BEA 2020); the percent of employment in professional services, representing the incidence of high-finance and high-tech workers (BEA 2020), and a location on a major body of water (Savageau and Boyer 1993).

The 11 included variables exhibited a significant amount of geographic variation across the nation, and this variation can be seen in Table 1. Here, the 381 metropolitan values have been transformed into standard scores where the national average in each instance is zero. Some thirty years ago, in 1990, specialization in manufacturing was very notable in the metropolitan economies of the Great Lakes (0.614) and New England (0.226) states but clearly was not so notable in the Far West (−0.632) and Rocky Mountain (−0.467) states. Government activities, on the other hand, were relatively less important in the metropolitan areas of New England and the Great Lakes than elsewhere. Self-employment (proprietary) rates were high in the Rocky Mountain (0.964) and Southwest (0.689) states but low in New England (−0.532) and the Great Lakes (−0.529) states. Natural amenities, which sort out locations by their cooling and heating energy needs (even neglecting regional differences in utility rates), needed to have their signs reversed for a correct interpretation, thereby making the Far West, Southeast, and Southwest more attractive than

Table 1 BEA regions: standard scores (means) for metropolitan attributes

Region	1	2	3	4	5	6	7	8
Name	NENG	MEST	SEST	SWST	GLAK	PLNS	RMNT	FWST
Number	15	41	121	39	59	33	22	51
PRM%	−0.188	−0.434	−0.001	0.112	−0.570	−0.318	−0.014	1.194
MAN%	0.226	0.158	0.165	−0.424	0.614	−0.211	−0.467	−0.632
GOV%	−0.532	−0.116	0.188	0.344	−0.511	0.066	0.176	0.011
PRO%	−0.100	−0.217	−0.356	0.689	−0.529	0.334	0.964	0.503
NATA	−0.874	−0.573	0.784	0.544	−0.905	−1.056	−1.072	0.634
HUMA	1.474	0.333	−0.411	−0.273	−0.597	−0.308	0.687	1.076
WAGE	−1.407	−0.238	0.169	0.413	0.815	0.374	−0.118	−1.246
UNRT	0.076	−0.135	−0.073	0.287	−0.041	−0.718	−0.050	0.573
COLL	0.254	−0.067	−0.121	0.214	0.110	0.297	0.020	−0.224
PPAT	0.707	0.268	−0.371	−0.447	0.700	−0.098	0.192	−0.028
DIVE	0.600	−0.017	0.104	−0.017	−0.239	0.207	0.193	−0.338
d	0.019	−0.377	0.209	−0.785	0.515	−1.012	−0.460	0.718
f	−0.037	−0.523	0.267	−0.854	0.645	−1.212	−0.490	0.701

All variables except slopes *d* and *f* are log transforms; signs on natural amenities and the diversity index have been reversed

the somewhat colder Rocky Mountain, Plains, and Great Lakes states. Evidently, back in 1990, human amenity rates were much higher in the large places of New England and the Far West than they were in the large places of the Southeast. Initial unemployment rates were low in the Plains and Mideast states but high in the Far West and Southwest. Colleges and universities were most prominent in New England and the Plains states, while their importance was much lower in the Southeast and Far West states. In the years before the rise of venture capital and Silicon Valley, most patenting activities had not yet moved to the Pacific coast so New England and the Great Lakes still prevailed in this activity. Finally, the metropolitan economies of New England and the Plains exhibited the most overall job diversity and those of the Far West and Great Lakes exhibited the most overall job specialization.

4.3 The Brechling–Thirlwall estimates

After computing the appropriate first differences in the regional and national series of unemployment rates, regression estimates for Eq. (3) were made for each of the 381 metropolitan areas. In each case, specific interest was focused on the size of the coefficient *d*, which indicated how the first difference in the unemployment rate for each metropolitan area responded to the first difference in the unemployment rate for the entire nation. As already mentioned, these coefficients were all positive and could be interpreted much like elasticities for the metropolitan unemployment rates.

The estimates of the "elasticities" for unemployment rates ranged between a low of 0.211 (Grand Island, NE) and a high of 1.904 (Redding, CA), and averaged 0.947

Table 2 Highest volatility rates for metropolitan unemployment

Rank	Region, state	Metro coeff	State coeff	BEA region
1	Redding, CA	1.904	1.337	8
2	Yuba City, CA	1.835	1.337	8
3	Elkhart, IN	1.822	1.188	5
4	Modesto, CA	1.744	1.337	8
5	Stockton, CA	1.721	1.337	8
6	El Centro, CA	1.706	1.337	8
7	Niles, MI	1.685	1.445	5
8	Flint, MI	1.649	1.445	5
9	Carson City, NV	1.623	1.509	8
10	Ocala, FL	1.615	1.271	3

Table 3 Lowest volatility rates for metropolitan unemployment

Rank	Region, state	Metro coeff	State coeff	BEA region
1	Grand Island, NE	0.211	0.291	6
2	Lincoln, NE	0.274	0.291	6
3	Bismarck, ND	0.292	0.263	6
4	Anchorage, AK	0.313	0.329	8
5	Fairbanks, AK	0.330	0.329	8
6	Houma, LA	0.331	0.526	3
7	Lafayette, LA	0.335	0.526	3
8	Las Cruces, NM	0.348	0.524	4
9	Omaha, NE	0.367	0.291	6
10	Fargo, ND	0.373	0.263	6

across the 381 county-based regions (outside of Puerto Rico) currently identified by the BEA. In other words, the unemployment rate of Redding was some nine times more sensitive to national rate changes than was the unemployment rate of Grand Island. These estimates ranged across the USA somewhat more than across the UK because many more regions were considered and the size differences between the smallest and largest economies were much greater (OECD 1989; Filippini 1998). Moreover, the US numbers were not adjusted for seasons and the many non-metropolitan (rural and micropolitan) county units were not included. In any case, column 3 in Table 2 shows the top ten and column 3 in Table 3 shows the bottom ten metropolitan economies in terms of their sensitivity to rate changes in national unemployment; in both instances, column 4 shows the corresponding regression estimates for the rate changes in unemployment for the appropriate states. In Table 2, most of the metropolitan regions are found in California but for the most part these are not large places; in fact, only Stockton is monitored in the Brookings list of the nation's one hundred largest economies. Several other places are found in the Midwest, where many metropolitan areas endured structural transformations and financial problems as the auto and truck industry contracted or relocated, and the appliance industries declined or even disappeared. Alternatively, in Table 3, all the designated metropolitan areas can be found in the more peripheral (or flyover) parts of the nation that are usually classified as being either resource- or farming-oriented. Again, most of these metropolitan regions are relatively small, although mid-size service centers like Lincoln and Omaha in Nebraska and Anchorage in Alaska are recognized. It is worth noting that in general the corresponding state elasticities for unemployment rates in column 4 of Table 3 are much lower than for the metropolitan economies listed earlier in Table 2.

Some further observations should be made about the nation's very largest metropolitan areas. New York City, NY (0.944), had a volatility estimate that approximated the national average, but the estimates for Los Angeles, CA (1.318), and Chicago, IL (1.163), were somewhat higher, and the estimates for Dallas, TX (0.827), and Houston, TX (0.655), were clearly lower, than the national average. Evidently metropolitan unemployment rates in Texas were much less sensitive to national trends than those in California, and, perhaps, some sort of endogeneity issue confuses the findings (and interpretation) here. Diversified regional centers like Denver, CO (0.977), and Atlanta, GA (1.153), were moderately more sensitive than average to national unemployment trends but Washington, DC (0.616), the nation's capital, clearly was not. Finally, tourist-oriented regions showed a remarkably wide distribution in the estimates for their unemployment rate elasticities, ranging from the highs seen in Las Vegas, NV (1.508), and Tampa, FL (1.309), to the global low seen in Honolulu, HI (0.400).

5 Results

5.1 Unemployment rates and volatility

The next step involved estimating the various effects for the array of initial conditions disclosed above. As mentioned earlier, a total of 17 initial conditions was first considered across the various metropolitan areas. But a preliminary investigation suggested that numerous variables were just not informative, so stepwise regression procedures were used to eliminate those variables and their effects. Stepwise procedures also made the models more manageable and reduced the degree of collinearity (not a serious problem) across the explanatory variables. In case (a), the F scores adopted for entry and exit were set "lower" at 0.075/0.15, and in case (b), the F scores were set "higher" at 0.025/0.05. So, in case (a) the estimates for volatility in the metropolitan unemployment rates were specified as:

$$\begin{aligned} d = \beta_0 + \beta_1 PRM\% + \beta_2 MAN\% + \beta_3 GOV\% + \beta_4 PRO\% + \beta_5 NATA \\ + \beta_6 HUMA + \beta_7 WAGE + \beta_8 UNRT + \beta_9 COLL \end{aligned} \tag{5}$$

where 9 of the 17 chosen initial conditions were found to be significant. In case (b), with the tighter entry and exit conditions, the college effect was dropped, but the other 8 initial conditions remained significant. Also, when the LHS values for

Table 4 Estimates of volatility in metropolitan unemployment rates 1990–2020

	Model 1 (a)	Model 1 (b)	Model 2 (a)	Model 2 (b)
CONSTANT	2.563 (3.46)	2.425 (3.28)	−0.756 (−3.27)	−0.264 (−2.07)
PRM%	0.066 (2.32)	0.070 (2.46)		
MAN%	0.139 (6.31)	0.139 (6.31)	0.056 (4.08)	0.057 (4.07))
GOV%	−0.167 (−4.63)	−0.175 (−4.89)	−0.146 (−6.51)	−0.165 (−7.51)
PRO%	−0.278 (−4.55)	−0.264 (−4.32)		
NATA	0.198 (2.91)	0.196 (2.88)		
HUMA	−0.257 (−2.43)	−0.283 (−2.66)		
WAGE	−0.382 (−4.12)	−0.390 (−4.21)	−0.082 (−3.13)	−0.088 (−3.30)
UNRT	0.315 (6.70)	0.330 (7.17)	0.171 (6.30)	0.166 (6.21)
COLL	−0.021 (−1.74)		−0.027 (−2.96)	
PPAT			−0.023 (−2.27)	−0.027 (−2.65)
DIVE			0.133 (2.98)	
f			0.899 (27.42)	0.894 (27.08)
F Ent/Ext	0.075/0.15	0.025/0.05	0.075/0.15	0.025/0.05
Adj Rsq	0.399	0.396	0.765	0.760
SEE	0.2534	0.2540	0.1583	0.1603
No of variables	9	8	8	6

$n = 381$; all initial conditions are log transforms; *t*-scores in parentheses; and model 2 includes state unemployment rates

d were transformed into logarithmic form, most of the RHS estimates in Eq. (5) shifted by at most 5 percent and all the same signs were retained.

Following that a second set of estimates was generated that also accounted for the monthly differences in the unemployment rates across the various states. The additional state effects diminished the influence of several variables, including specialization in primary industries, the prominence of self-employment, and both types of amenities. Apparently, these 4 variables did not substantially affect matters *within* the various states of the nation. So now, in case (a), volatility in the new model was estimated as follows:

$$\begin{aligned} d = \beta_0 + \beta_1 MAN\% + \beta_2 GOV\% + \beta_3 WAGE + \beta_4 UNRT \\ + \beta_5 COLL + \beta_6 PPAT + \beta_7 DIVE + \beta_8 f \end{aligned} \tag{6}$$

where both per capita patenting rates and overall job diversity were now found to be significant. However, in case (b), with the tighter entry and exit conditions, both the college and job diversity effects became somewhat smaller, and the 8 variables shown in Eq. (5) were reduced to 6 significant variables. Again, transforming the values for *d* into logarithmic form changed matters very little.

These two sets of regression estimates are shown in Table 4. The pair of estimates for model 1 are given in the two left-hand columns, and the pair of estimates for model 2 are given in the two right-hand columns. Introducing the monthly state unemployment effects not only eliminated several initial conditions, as pointed out, but substantially enhanced the explanatory power of the regression approach.

The left-hand estimates reveal that the most important effects on the variation in metropolitan unemployment rates were due to differences in real wages, the initial unemployment rate, the degree of self-employment, and the incidence of human-created amenities. With a 1 percent rise in proprietary employment, the monthly volatility seen in the metropolitan unemployment rate fell approximately by 0.28 percent; alternatively, with a 1 percent rise in manufacturing specialization, this monthly volatility climbed approximately by 0.14 percent. It is notable that all the estimates had the anticipated signs.

Alternatively, the right-hand estimates indicate that—once the monthly state unemployment rates have been accounted for—the most important effects on the volatility of metropolitan unemployment rates were due to the initial unemployment rates, the degrees of specialization seen in government employment, and the overall degrees of job diversity evident in the various metropolitan economies. With a 1 percent increase in the percentage of government jobs, the monthly volatility of the unemployment rate fell by 0.15 percent in case (a) and by 0.17 percent in case (b). Surprisingly, again, higher levels of job diversity led to greater volatility in monthly unemployment rates (see above). Real wages and specialization in manufacturing both remained as significant variables, but their effects were much lower than those seen in model 1. As before, the dampening effect due to the presence of colleges and universities was only significant when the entry and exit conditions were relaxed.

5.2 Unemployment rates and employment growth rates

A few remarks should be made about the relationship between regional unemployment rates and the subsequent growth that occurred in regional employment numbers. Based on January's (unadjusted) unemployment rates for 1990, the Pearson correlation coefficients for the subsequent 1 and 5 year employment growth rates were − 0.239 and − 0.196, respectively; some twenty years later, in 2020, those coefficients had shifted only slightly to − 0.117 and − 0.171, respectively. So, employment growth was faster, both post-1990 and post-2010, in those metropolitan areas that initially had lower unemployment rates, a result that runs counter to any expectation that economic conditions would converge through time. Evidently many workers in lagging areas simply failed to become employed, perhaps because their skills failed to match the ever-changing needs of ascending industries (Moretti 2012). This finding is commonplace in studies of the so-called regional problem and raises some concerns about adopting unemployment rates except as descriptive measures of regional performance (Armstrong and Taylor 1993). So, in some regional econometric models, analysts prefer to interpret unemployment rates as outcomes without linking those rates back into the region's subsequent employment growth.

5.3 Unemployment rates and industrial specialization

In recent times, it has become fashionable, and sometimes useful, to identify the so-called riskiness of metropolitan economies. This practice became popular after the Great Recession but gained renewed popularity during the early months of the COVID-19 crisis. In one of the first statements made about the likely consequences of the pandemic, Brookings (2020b) generated an "at risk" ranking of the nation's metropolitan areas, ranging from the most to the least vulnerable in terms of jobs found in six specific industries: mining NAICS 21, transportation NAICS 48, employment services NAICS 5613, travel arrangements NAICS 5615, leisure NAICS 71, and hospitality NAICS 72. Here, the riskiest economies were found to be in the Texas oilpatch; well-known "sun and sand" seasonal resorts and retirement spots, including Hawaii; and destination amusement centers like Las Vegas and Orlando. The economies with lowest risk were found to be small agricultural areas in the Far West, college towns like Ann Arbor, MI, and Ithaca, NY, and larger central places like Spokane, WA, and Fresno, CA, that serviced extensive trade areas. Sometime later the Census Bureau revealed a ranking of all US counties based on 11 different factors and, while being very informative, the results were based on a mix of demographic, health, and social measures, and the report said little about the size or geography of risky employment across metropolitan America (U.S. Census Bureau 2020). Even other studies have attempted to link this industrial "riskiness" to the changes in commuting patterns brought on by the COVID-19 pandemic (BLS 2020b).

Given current purposes four specific industries were chosen for analysis: amusement, health care, retail trade, and real estate. In each case, the volatility estimated for the unemployment rate, as identified earlier, was compared to a year-specific degree of industrial specialization. The degree of this specialization was determined by location quotients, and *LQ*s were initially calculated for 2001, 2005, 2010, 2015, and 2018 (Isard 1960; Mulligan and Schmidt 2005). In each of the four cases, these rankings were all very similar, so the most recent figures, for 2018, were selected. The prior expectation was that highly specialized places would have changes in their unemployment rates that were more volatile than the nation's average change. The analysis and results were based on two comparative methodologies: first, Spearman rank-order correlations were determined between the rate volatility and location quotients across all 381 observations, and second, the ten metropolitan areas with the highest *LQ*s in each of the four industries were examined in more detail. Here, interest turned to the average ranked volatility where a large number, one greater than 190, indicated the area's unemployment rate was more volatile than the national average between 1990 and 2020.

Significant expenditures in retail trade occurred across all the nation's metropolitan economies, and, in 2018, a total of some 16.7 million part- and full-time workers were engaged in retailing. Places like Grants Pass, OR ($LQ = 2.56$), Lake Havasu City, AZ ($LQ = 2.50$), and Punta Gorda, FL ($LQ = 2.22$), invariably appeared on the yearly lists compiled of those places with the highest retailing *LQ*s. In general, the metropolitan areas having the greatest specialization were either (seasonal) resort communities, interstate truck stops, or shopping-oriented cities often located along the US–Mexico border. Many of these places could be found along the nation's coasts or in either the Southeastern, Southwestern, or Rocky Mountain BEA regions. Alternatively, the places with the lowest employment specialization in retail trade included university towns like Ann Arbor, MI and Boulder, CO, high-tech centers like Durham-Chapel Hill, NC, and San Jose, CA, and wealthy residential areas like Napa, CA. The Spearman coefficient calculated across all areas in 2018 was $r = 0.129$ (significant at the 0.01 level), indicating that those metropolitan areas with specialization in retailing tended to exhibit higher amounts of volatility in their unemployment rates. Moreover, across the top-10 places specializing in retailing, the average volatility rank was 244.4, ranging between 93 and 359, indicating that the most specialized retail centers clearly had unemployment rates that were much more volatile than the national average.

By 2018, US workers in metropolitan areas were earning more in health care and related services than in retailing, and some 20.3 million workers were involved in this activity. Moreover, the two industries tended to colocate in space: The various year-specific Pearson correlation coefficients between the two distributions of location quotients only shifted between $r = 0.35$ and $r = 0.40$ during the period 2000–2018. After Rochester, MN ($LQ = 4.49$), home of the original Mayo Clinic, most of the areas specializing in health care were either resorts, often with mineral-rich waters like Hot Springs, AR ($LQ = 2.11$), or Homosassa Springs, FL, or regional medical centers, such as Cape Girardeau, MO ($LQ = 2.21$), and Tyler, TX, that were home to state-funded medical research facilities. Those metropolitan centers with deficiencies in health care, including Lawrence, KS, and College Station, TX, were often peripheral university cities lacking a teaching hospital. Very low *LQ*s in health care were also found in resource-based boom towns like Midland, TX, or seasonal resort communities, like Myrtle Beach, NC. Although they contained some of the nation's best known medical research centers, very large metropolitan areas like New York, Los Angeles, and Chicago tended to be found near the middle of the *LQ* distribution. The Spearman coefficient for all areas was $r = 0.197$ in 2018, indicating that those metropolitan areas specializing in health care clearly exhibited high amounts of volatility in their overall unemployment rates. But, surprisingly, across the top-10 health care economies the average volatility rank was only 180.8, ranging between 59 and 357, indicating that the most specialized health care centers had unemployment rates that were (marginally) less volatile than the national average.

As expected, the amusement industry exhibited somewhat more geographic variation and here the earnings-based location quotients of the top-10 amusement centers were all above 3.00. In 2001, four of the top-10 places were found in Florida but in 2018 this number had risen to six. Not surprisingly, Orlando ($LQ = 9.39$)—the home of Disneyworld—was ranked highest at each point in time. Many of the places with the highest *LQ*s were beach resorts although, at various times, recreation sites (Hilton Head, GA) and gambling centers (Michigan City, IN) performed strongly. Alternatively, many of the areas having low *LQ*s in amusement were found throughout the nation's Southeastern and Great Lakes regions. Across all 381 observations the rank-order coefficient, $r = 0.185$, between volatility and specialization was both positive and significant and, across the top-10 places specializing in amusement, the average volatility rank was 302.4, ranging between 84 and 362, indicating that highly specialized amusement centers clearly had unemployment rates that were much more volatile than the national average.

Real estate is an important industry to examine because it has such far-reaching input–output linkages to other activities, including building supplies, construction, and financial services. Several of the nation's highly specialized real estate centers also exhibited specialization in amusement activities, although the correlation coefficient for the two distributions of *LQ*s across all 381 areas was only modest ($r = 0.293$). The highest *LQ*s for real estate were usually found in those smaller metropolitan areas (except for Orlando, FL) where the cost-of-living was lower, and many of these areas, like Cape Coral ($LQ = 2.13$) and Naples ($LQ = 1.73$), were located either in or very near to Florida. In 2018, Hawaii had one metropolitan area highly specialized in real estate, as did the Texas oilpatch. In this industry, the rank-order coefficient between specialization and volatility was $r = 0.076$, while, across the top-10 places specializing in this activity, the average volatility rank was 214.2, ranging between 6 and 362, indicating that highly specialized real estate centers had unemployment rates that were somewhat (but not substantially) more volatile than the national average.

6 Conclusions

For more than a decade, analysts and practitioners alike have been interested in the related concepts of sustainability, vulnerability, and resilience. These terms have meant different things to different people, but all three concepts capture the interdependencies now seen in the economic, environmental, governmental, and social conditions existing within and between regions. Moreover, each concept has implications for strategic (endogenous) growth and for both creativity and innovation.

Using a variety of US data, the current paper has focused on the evolving relationship between differences in metropolitan unemployment rates and differences in national unemployment rates. The volatility of this relationship, seen across the three pre-COVID decades between 1990 and 2020, sheds light on the overall economic vulnerability of these metropolitan areas. Initial specialization in primary or manufacturing industries enhanced the regional volatility while initial specialization in government services dampened the regional volatility in unemployment rates. Those places rich in natural amenities experienced more volatility, while those places rich in human-created amenities (including local ambience) experienced less volatility. Clearly, those metropolitan areas with high degrees of self-employment experienced less volatility, although this effect was evidently due to differences in the state unemployment rates. Higher real wages—taken here to be nominal wages divided by average house prices in 1990—reduced the monthly volatility in unemployment rates during subsequent years. The pattern of unemployment rates persisted strongly over time so those areas that initially had high unemployment rates generally exhibited more volatility in those rates over the subsequent thirty years.

From a public policy perspective, it seems clear that, on a national basis, job vulnerability in metropolitan areas can be reduced by (i) attracting more government workers, (ii) increasing real wages, (iii) enhancing self-employment in local industries, (iv) upgrading human amenities, and (v) encouraging the presence of colleges and universities. There is also evidence given here that improvements in patenting activity can reduce this employment vulnerability. Given that this paper is dedicated to the memory of Roger Stough, some measure of governance or leadership across the metropolitan areas would also have been useful to consider.

In restricting the analysis to each area's total employment figures, the findings revealed the *overall* economic vulnerability of the nation's metropolitan areas over the long term. So, further attention was given to four *specific* "at risk" industries where, in each case, industrial specialization was expected to be correlated with the calculated index of overall vulnerability. In fact, this was largely found to be the case. But more research is needed, if such data are ever made more available, to reveal how specific unemployment rates varied through time for each of the major industry groups. Perhaps then the portfolio-based research on regional economies would prove valuable to revisit (Conroy 1974; Trendle 2006). Further study is also needed of those different sub-periods that reflect the ups and downs of the nation's business or trade cycle. Finally, endogeneity might be addressed by introducing a regional adjustment model to allow employment numbers and unemployment rates to interact with the ever-changing patterns seen across the USA in population numbers, real wages, and proprietary employment (Mulligan et al. 2019).

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