DISTRIBUTION ABOUT REGIONAL DISPARITIES OF THE US LABOR MARKET: STATISTICAL ANALYSIS OF GEOGRAPHIC AGGLOMERATION BY EMPLOYMENT STATUS

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Abstract

The paper analyzes the regional disparities brought by each employment status concerning the civilian noninstitutional population 16 years of age and over especially focusing on the regional agglomeration. Specifically, it investigates the characteristics of spatial autocorrelations or geographical clusters based on the statistics of the regional specialization. Thus it definitely investigates the degree of agglomeration based on each specialization state, not the original data from the statistics of each labor category such as the number of the unemployed persons or the simple unemployment rates. The method is based on the share and rate calculations which would be almost equivalent to the well-known Location Quotient technique. With respect to the geographical agglomeration, some interesting regional characteristics of the working population have been found by mainly an exploratory way. From some results, several states such as North Dakota, South Dakota, and Nebraska indicate specific regional features which are very different from the other states, and those features often have a surprisingly persistent trend. Usually the influence of the significant socioeconomic shocks is exchanged or is absorbed in some specifically related regions. Then it spreads around and disperses to further distant areas during a sufficient amount of time, and finally its geographical distribution map is properly modified or changed. In addition, some results suggest the significant relationship between the geographical clustering process and the equilibrium or disequilibrium phenomenon based on the regional specialization of the labor force; it also suggests an important relevance to the existing economic theories.
Keywords: regional disparities, regional specialization, spatial dependence and agglomeration
JEL classification: J20, J21, R12, R23

1. Introduction

1.1. Theoretical background about regional disparities of unemployment

The study of regional changes of the labor market is one of the most fundamental topics in all regional studies including regional science, and other related fields. In particular, regional disparities with respect to unemployment issues have been a popular research theme since 1960s. The remarkable achievement of this subject in the early days is by Thirlwall (1966), and afterwards Brechling (1967), Gordon (1979, 1980, 1985), Elias (1978, 1979, 1980), Bell (1981), Marston (1985), and other numerous studies followed. With respect to theoretical standpoints on the issues of unemployment rates, the "equilibrium theory" and the "disequilibrium theory" are well known: They argue about whether the values of regional unemployment data ultimately converge to a certain equilibrium point or not (Marston 1985, and others). Usually equilibrium theorists have a theoretical scenario: After big shocks of business fluctuations, the substantial effects by them would remain for a considerably long period and spread widely throughout regions (Blackley 1989; Veder and Gallaway 1996; Aragon et al. 2003, and others). This remaining ripple effect is a cause of areal persistence of unemployment rates, and it induces a specific rate sometimes called the natural ratio of unemployment which would be a targeting equilibrium point. Most of the existing literature of local unemployment disparities is based on the hypothesis of a stable equilibrium of labor markets (Cracolici and Nijkamp 2007). On the other hand, based on the fact that the differentials of the rates tend to be lost during a certain suitable time, the disequilibrium approach generally assumes a relatively short period. In that sense, this theory is built on the thought that the levels of unemployment rates are always variable and moving, and they never converge on a specific rate in nature.

There are several reasons why disequilibrium phenomena occur. As an example, the speed of adjustment for relieving the fluctuation of unemployment rates is a key role. Any failure or collapse of this process would cause a serious problem such as high unemployment rates and/or low economic growth in many areas. Aragon et al. (2003) indicated that there were four factors that significantly influence and/or even dominate the spatial patterns of unemployment; those are migrations, labor force participation, business locations, and wages. Of course, although there are many other factors that would affect regional structures of unemployment, these four elements are essential, and particularly the first two also directly influence the changes of the working-age population. However, in the real world, it is difficult to identify the equilibrium or disequilibrium state accurately since the labor environment of each region is always changing and thus the actual condition of unemployment is also fluctuating. Then as an alternative idea, the existence of multiple equilibrium points was suggested by Fujita, Krugman, and Venables (1999); it claims that such equilibrium or disequilibrium is tentative or local one, not global one, thus the idea seems to be quite a natural solution of this argument.

1.2. **Research motive**

Although many achievements for regional disparities of unemployment based on especially economics or related approaches have been already done as mentioned above, however, the further geographical studies such as spatial patterns and dependency by multi-disciplinary perspectives are few. Most previous work is on macroscopic or even abstract viewpoints. To fill such gaps, thus the approach used in this paper depends on more microscopic approach by region, and it would have more geographical aspects based on demographics than the existing literature.

In addition, the paper treats not only the phenomena of unemployment but also the phenomena derived from the entire labor structure of the civilian non-institutional population 16 years of age and over. It is very important to analyze such dynamic mechanism to identify the regional disparities of the entire structure of the labor market. Also the approach of this paper is able to give further comprehensive explanations of the changes of the labor force state by region since the method directly using the share ratios of employment statuses instead of unemployment rates is much effective for the multi-faceted treatment of mutual comparisons of the data about population. Thus from that point of view, one of the aims of the paper is to characterize the agglomeration process of the regional specialization of the unemployed persons compared with the other categories including the employed persons. However, unfortunately the work based on such approach is hardly known so far. Therefore it would be able to suggest a new direction to this field.

In addition, the previous work which investigated the regional agglomeration tendency about specialization areas of the working population classified by the status categories is also hardly known. Actually the analysis of spatial agglomeration based on the regional specialization is definitely necessary to identify the geographical distribution state of such specialization areas and especially the spatial clustering process.

In order to draw a right knowledge and conclusion as exact as possible, many kinds of statistics and indicators are used by combining them each other. The paper is structured as follows: The next Section 2 presents about the methods and data. Section 3 shows the main results accompanied by some brief explanations of LISA and so on for evaluating spatial dependency and agglomeration. Finally some concluding remarks and a brief discussion are made in Section 4.

2. Methods and data

2.1. Methodology

One of the most commonly used measures of specialization is the Location Quotient (Billings and Johnson 2012). It has been used for the data of various regional studies to analyze the degree of concentration regarding the economic or geographical matters since the study of the measurement of industrial localization (Hoover 1936). Thereafter, for example, the employment Location Quotient (Hoover-Balassa coefficient), or the standardized location quotient (O'Donoghue and Gleave 2004) was introduced as a further improved version. Thus that technique generally has high flexibility to the applications of many research areas. The method used here is generally called the rate-share analysis which would derive from this well-known Location Quotient technique. That was firstly advocated by J. Takahashi, and has been already used for over a couple of decades at the fields of regional science, civil engineering, regional planning, management science, and others especially in Japan. The main principles of the rate-share analysis are based on the share rate calculations of each row and column as shown on the table below. The first step is to compute the share-ratio of each target category; for instance, "New York" as the region item, or "Employed" as the sector item against the total sum of each row and column. IAS (index of areal specialization) used here is important to investigate the degree of areal specialization of each region in each sector; that is essentially based on the same technique as the Location Quotient. In addition, IAG (index of areal gain) is the simple ratio of any two estimated IAS values. Clearly this method is for showing share rates and their growth rates. Thus the rate–share analysis would be considered as an application of the traditional Location Quotient.

On one hand, although sometimes the Herfindahl-Hirschman Index is used for measuring regional specialization, however, it is originally for a tool to determine whether a monopoly exists, not for a tool to detect regional specialization from a geographical view point. Similarly the Krugman Index and many other related indices are not necessarily fit for some specific geographical analysis. In that sense, using the applied location quotient technique is generally considered to be more natural way to evaluate the geographic characteristics of regional specialization than the above indices. As an example, Goschin et al. (2009) introduced the "coefficient of absolute structural changes" to measure the change of the regional shares between any two different periods of time. However, the above-mentioned IAG is much simpler than that. Also it is able to evaluate appropriately the changes of the regional specialization since much more direct statistical interpretation is possible. For more details, see Ishii et al (2002), Billings and Johnson (2012), or other related references.

Table 1. Data matrix for region and sector.

Region \ Sector	1	2	3	...	j	...	m	Total for Regions
1	x_{11}	x_{12}	x_{13}	...	x_{1j}	...	x_{1m}	$x_{1.}$
2	x_{21}	x_{22}	x_{23}	...	x_{2j}	...	x_{2m}	$x_{2.}$
3	x_{31}	x_{32}	x_{33}	...	x_{3j}	...	x_{3m}	$x_{3.}$
.	.	.	.	...	.	...	.	.
.	.	.	.	...	.	...	.	.
i	x_{i1}	x_{i2}	x_{i3}	...	x_{ij}	...	x_{im}	$x_{i.}$
.	.	.	.	...	.	...	.	.
.	.	.	.	...	.	...	.	.
n	x_{n1}	x_{n2}	x_{n3}	...	x_{nj}	...	x_{nm}	$x_{n.}$
Total for Sectors	$x_{.1}$	$x_{.2}$	$x_{.3}$	...	$x_{.j}$	...	$x_{.m}$	$x_{..}$

$$\left(X_{i.} = \sum_{j=1}^{m} X_{ij},\ X_{.j} = \sum_{i=1}^{n} X_{ij},\ X_{..} = \sum_{j=1}^{m} X_{.j} = \sum_{i=1}^{n} X_{i.},\ i = 1,2,3,\cdots,n,\ j = 1,2,3,\cdots,m. \right)$$

The calculation formulas and definitions of IAS and IAG are the following:

- $$IAS_{ij} = \frac{X_{ij}/X_{i.}}{X_{.j}/X_{..}} \tag{1}$$

where IAS_{ij} is the index of areal specialization of region i and sector j.

- $$IAG_{ij}^{st} = \frac{IAS_{ij}^{t}}{IAS_{ij}^{s}} \left(IAS_{ij}^{s} : IAS_{ij} \text{ at time} s, IAS_{ij}^{t} : IAS_{ij} \text{at time} t, s < t \right) \tag{2}$$

where IAS_{ij}^{st} is the index of areal gain of region i and sector j between time s and t.

The origin on the coordinate axis of IAS and IAG is (1, 1). If the value of IAS is greater than 1, it indicates the tendency of specialization. Similarly, if the value of IAG is greater than 1, it indicates the target category tends to increase. If the share rate of region i and sector j is equal to that of the entire regions and sector j, then the value of IAS is exactly 1. From the above equation of (2), the value of IAG becomes 1 when the two estimated values of IAS are exactly the same. The data points of IAS and IAG are divided into the four quadrants on a mathematical x-y plot:

- The first quadrant: the high values of IAS and the high values of IAG.
- The second quadrant: the low values of IAS and the high values of IAG.
- The third quadrant: the low values of IAS and the low values of IAG.
- The fourth quadrant: the high values of IAS and the low values of IAG.

To investigate the degree of the disparities specifically, some indices are introduced here. Based on the statistics of the rate-share analysis, RDC (Rate of divergence from the center) is a combined index for measuring the degree of the static and dynamic disparities between different two time periods, and it is defined as the following formulas:

- $$ADC_{as} = (IAS - 1) \times 100 \tag{3}$$

where ADC_{as} represents the average divergence from the center regarding IAS.

- $$ADC_{ag} = (IAG - 1) \times 100 \tag{4}$$

where ADC_{ag} represents the average divergence from the center regarding IAG.

- $$RDC = \sqrt{(IAS - 1)^2 + (IAG - 1)^2} \times 100 \tag{5}$$

where RDC represents the rate of divergence from the center.

2.2. <u>Data and notes</u>

The used data and the conditions are as follows: All analyses, used definitions and calculations are based on the labor statistics and the related reference literature from the US National Census 1991-2011 (see the References of the end of the paper for details). The entire population here corresponds to CNIP (Civilian Non-Institutional Population 16 years of age and over), and is divided into three categories: Employed (Employed persons), Unemployed (Unemployed persons), and Others (Out of Labor Force). Thus the number of CLF (Civilian Labor Force) is the sum of the numbers of Employed plus Unemployed. Also the number of CNIP is equal to the sum of the numbers of CLF plus Others.

Finally some frequently used abbreviations are listed up for convenience' sake:

IASER (IAS statistics of Employed), IASUR (IAS statistics of Unemployed), IASOR (IAS statistics of Others), RDCER (RDC statistics of Employed), RDCUR (RDC statistics of Unemployed), RDCOR (RDC statistics of Others), LM, LG (Local Moran's I statistics, Local G^* (Getis' G_i^*) statistics), IASURAVGLG (LG based on the averages of IASUR), IASURSDLG (LG based on the standard deviations of IASUR), and so forth.

For general reference literature for example, see Rogerson and Yamada (2009) for detailed formulas and definitions of statistics and indicators with respect to spatial dependence and agglomeration.

3. Results

3.1. Spatial dependence and agglomeration

Moran's I statistic

Moran's I static is an analogy of the well-known Pearson product-moment correlation coefficient. That is one of the global statistics, and studies the degree of any spatial dependence or agglomeration, which is calculated by the formula below:

- $$I = \frac{n}{\sum_{i}^{n}\sum_{j}^{n} w_{ij}} \frac{\sum_{i}^{n}\sum_{j}^{n} w_{ij}\left(x_i - \bar{x}\right)\left(x_j - \bar{x}\right)}{\sum_{i}^{n}\left(x_i - \bar{x}\right)^2} \qquad (6)$$

where n is the total number of regions, w_{ij} is the spatial weights for the regions i and j, x_{ij} is the observed data based on the regions i and j, and $\bar{x}_{ij}$ denotes the average of x_{ij}. In general, Moran's I value near +1 implies the state of clustering, and the one near -1 shows the state of dispersion. On the other hand, the value nearby 0 implies a kind of random state.

Local Moran's I statistic

Local Moran's I statistic is one of the local statistics, generally called as LISA (Local Indicators of Spatial Association), and is a local area version of Global Moran's I statistic: That means the values of Local Moran's I statistics are actually equivalent to the decomposition of the value of the corresponding Moran's I statistic. The formula for Local Moran's I statistic is given as

- $$I_i = \frac{n\left(x_i - \bar{x}\right)\sum_{j=1, j \neq i}^{n} w_{ij}\left(x_j - \bar{x}\right)\left(x_j - \bar{x}\right)}{\sum_{i}^{n}\left(x_i - \bar{x}\right)^2}. \qquad (7)$$

Moran scatter plot

Moran scatter plot depicts the distribution of the coordinate points of which x-axis is for Local Moran's I_i values, and y-axis is for the data of any observed variable. The interpretations for the four quadrants on Moran scatter plots are the following:

- The first quadrant: the data and their neighborhood both tend to have high values.
- The second quadrant: the data tend to have lower values than their neighborhood's values.
- The third quadrant: the data and their neighborhood both tend to have low values.
- The fourth quadrant: the data tend to have higher values than their neighborhood's values.

Local G* (Getis' Gi*) statistic

Local G^* statistic is also a Local statistic called LISA. The calculation formula is given by

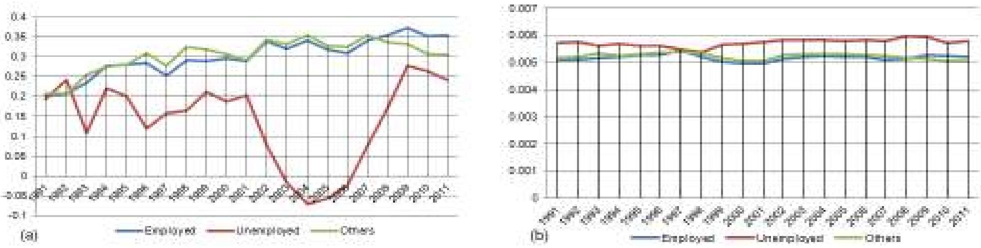
- $$G_i^*(d) = \frac{\sum_{j}^{n} w_{ij}(d)\, x_j - W_i^* \bar{x}}{s\sqrt{\left\{\left[n_i S_{1i}^* - W_i^{*2}\right]/(n-1)\right\}}} \qquad (8)$$

where s is the sample standard deviation of variable x_i (i=1,⋯, n), $w_{ij}(d)$ is the spatial weight which has the distance d from the observed points i and j, $W_i^* = \Sigma\, w_{ij}(d)$ and $S_{1i}^* = \Sigma\, \{w_{ij}(d)\}^2$. High positive values of Local G^* imply the clustering of high values, and the case of low values similarly indicates the clustering of low values.

As described above, we use several kinds of LISA statistics such as Local Moran and Local G^* (Getis' G_i^*) statistics to strictly check the degree of agglomeration and geographic concentration by region. For example, GIS maps, on which several statistics are overlaid, can derive relatively exact results for investigating the complicated phenomenon. It is also the same for the other graphics.

The following figures show some features of the Moran's I statistics from 1991 to 2011.

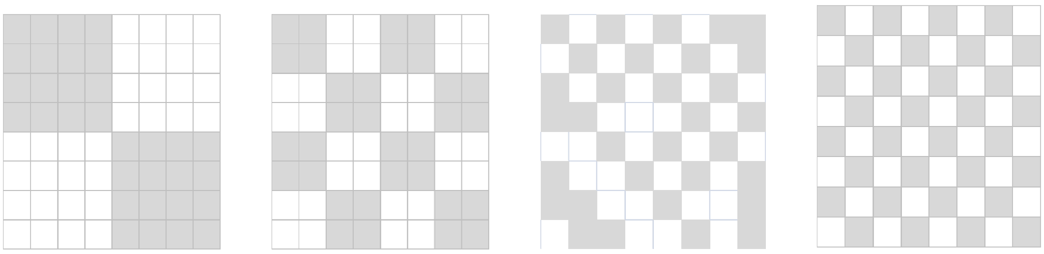
Figure 1. Moran's I statistics: (a) Value, (b) Variance.



From the outcome of variances, the Moran's I statistics of each employment status remain a comparatively narrow range and stay calm throughout the entire periods, which indicate some sort of stability of spatial dependence. The Moran's I statistics of Employed and Others constantly tend to increase from 1991 to 2011.

On the contrary, Unemployed, which hardly reacts to any change caused by Employed or Others, sometimes has experienced sharp fluctuations during the above period. In fact, the results of the randomized Moran's I tests around 1993, 1996, and 2002-2007 can not reject the null hypotheses by the significance level of 5%. On the other hand, regarding Employed and Others, there are no cases rejecting the null hypotheses even by the 5% level tests through the whole period. Thus, obviously there would be some essential changes of the regional characteristics of Unemployed from particularly the years of 2002 to 2007 plus the cases of 1993 and 1996. It implies that some causes weaken the process of clustering and strengthen the tendency of regional dispersion.

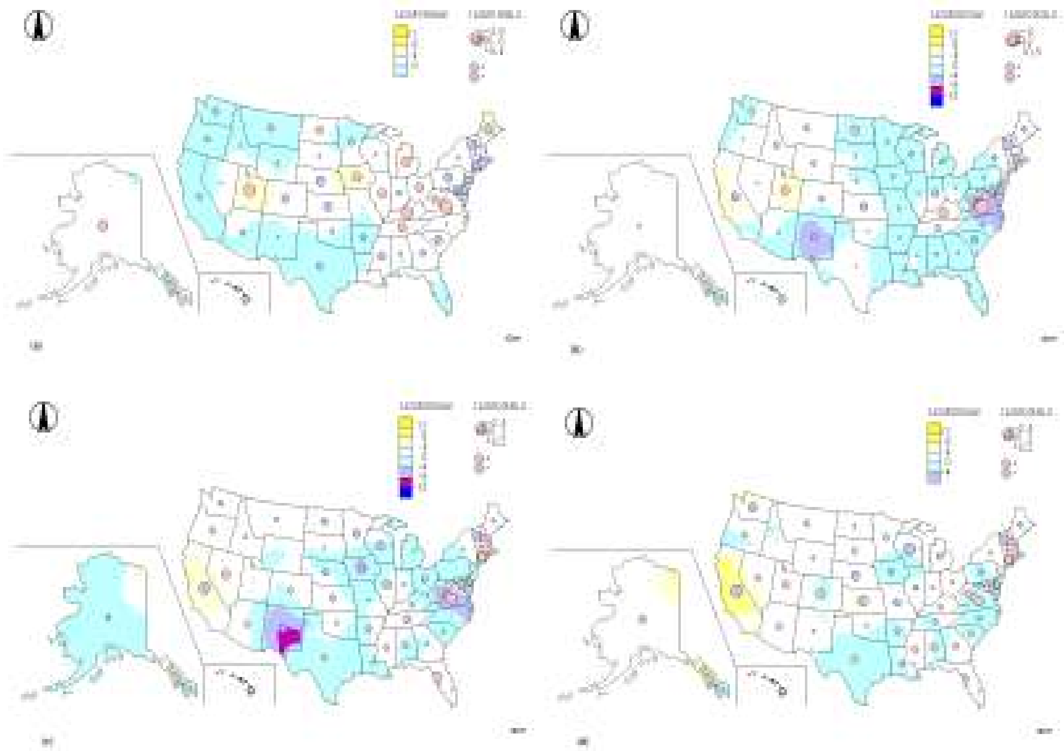
Figure 2. Spatial patterns in agglomeration process.



A **B** **C** **D**

As typical geographic surface patterns depicted by Moran's I statistics, the above stage A is a spatial pattern of considerably high agglomeration status, B or C is a middle stage which may imply moderate or slight correlation, and D is the perfect dispersion state. Just 2002 through 2007 would correspond to the period of the radical changes passing through such transition stages. That mechanism also would indicate the dissolution and reconstruction process of such geographical agglomeration system in a specific employment status such as jobless people. Generally working people tend to move to any region which has high economic power and many financial benefits. That is because such city provides more chances to get high salary jobs with various high-value-added amenities. Usually those many attractions in cities induce incentives to accelerate migrations and further changes the distribution of the working population. However it usually takes a sufficient amount of time and effort for changing regional characteristics or labor habits. That is one of the reasons the areal stickiness and the consistency of labor markets exist.

Figure 3. Selected maps by LISA (the year of 1999, 2003, 2006, and 2008).



From the LISA maps above, some findings and historical reviews are described as follows. Most of the 1990s was the era of low unemployment rates and high employment rates. Actually, it seemed that US economy had been moving along quite smoothly until the Russian crisis, the collapse of the ruble in August 1998. As a result, since the financial crisis including foreign exchange matters had a strong impact on the labor market, generally one would think that it might be one of the causes of the abrupt increase of the statistics concerning unemployment such as IASUR. Thus the end of the 1990s would be the period of the turning point of labor markets. The trend of uniformly decreasing unemployment rates was changed to the trend of increasing at that period: that would obviously indicate some kind of structural change of labor markets.

Regarding the annual Moran's I statistics, the comparatively low rates early in the 2000s were recorded, and then the sharp decline from 2001 to 2004 occurred, and the relatively high values of the dispersion rates were indicated during the period of 2004 to 2006. Also those periods correspond to the time when some "hot spots" newly broke out in the Northeast and extended into the coastal areas of the South and the West regions.

Compared to the 1999, the regional distribution of the Moran's I statistics in the beginning of the 2000s also explicitly changed. The above maps indicate the large variations in the distribution of "hot and/or cold spot" areas: they even give the impression of the partial reorganization of the labor structure in such areas. In fact, before 2000, there were more hot spots in especially inland and central areas in the U.S.A., however, afterwards they tended to spillover and disperse to more surrounding areas. If so, what on earth were the potential causes of these changes? Actually, these annual changes of LISA almost correspond to the variations of the average unemployment rates of the entire U.S.A. Namely, the large fluctuations of unemployment rates tend to widen the regional disparities, and remake the clustering process.

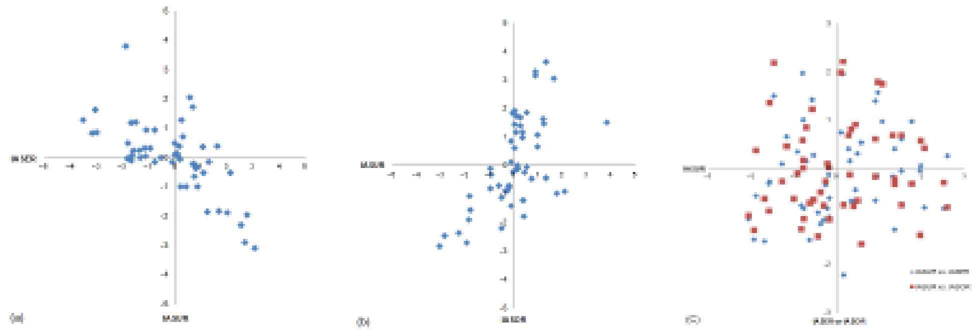
As already introduced by some arguments of the "equilibrium" or "disequilibrium" theory, some socioeconomic shocks trigger the sharp variations of IAS statistics and others, then somewhat rebound to a comparatively moderate level which becomes the next starting point to make a new trend. Since generally the regional characteristics are difficult to change quickly, it takes a significantly long time to transform them and usually shift to some transitional stages absorbing such remarkable changes.

3.2. Characteristics of Local G* statistics

The following graphs describe the local G^* statistics of IASER, IASUR, and IASOR. The figure (a) indicates downward-sloping tendency and the figure (b) shows a little upward trend instead. The former indicates that some hot spots of IASER correspond to the cold spots of IASUR, and shows that some cold spots of IASER correspond to the hot spots of IASUR conversely. On the other hand, the trend of the latter is opposite to that of the former.

The figure (c) is the pair plot of "IASUR vs. IASER" or "IASUR vs. IASOR" with respect to the standard deviations of the local G^* statistics from 1991 to 2011 by region. It shows that the extent of dispersions about two kinds of the pair plot is not so large, and also shows that there are few relationships of the standard deviations between IASUR and IASER or between IASUR and IASOR.

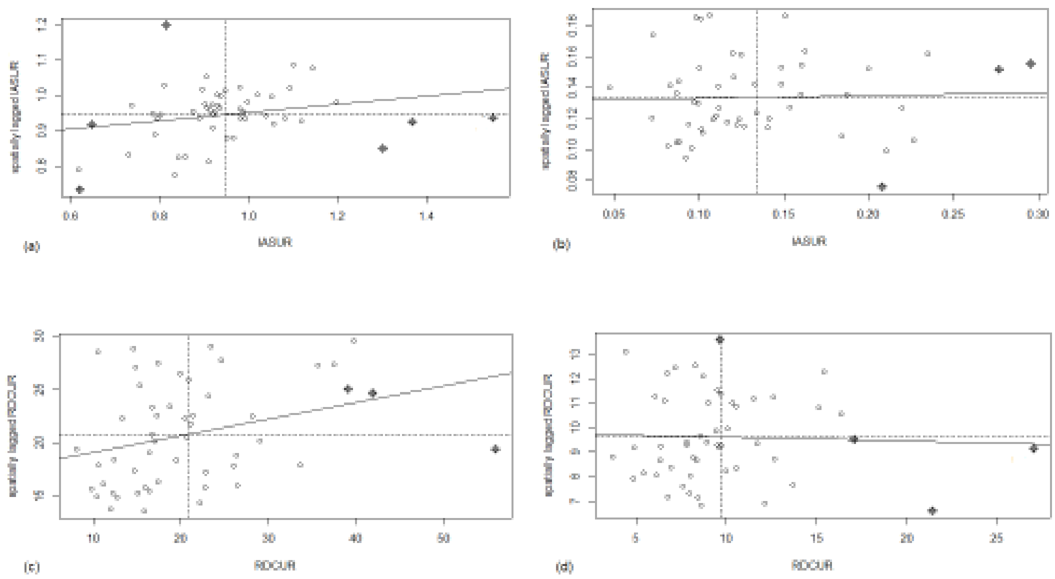
Figure 4. Related plots of *LG*: (a) Annual average, (b) Annual average, (c) Standard deviation.



3.3. Characteristics of Moran scatter plots

As the characteristics of the Moran scatter plots of IASUR and RDCUR selected from the list, some interesting findings are expressed in Figure 5.

Figure 5. Plots of *IASUR* and *RDCUR*:



(a) Annual average, (b) Standard deviation, (c) Annual average, (d) Standard deviation.

From the outcome of the Moran scatter plots, the total proportions of data plotted in the second quadrant and the third quadrant together are higher than those in the both of the first quadrant and the fourth quadrant. It implies relative superiority of the regions which include cold spot areas and have low levels of IAS or RDC. In addition, the trend of the standard deviations implies the superiority of cold spot areas: it indicates the spatial agglomeration of the regions that have comparatively small changes; thus it also shows the trend of such spatial dependency against time (see the figure (b), (d)).

3.4. Summary of LISA results of IAS and RDC statistics

The following is the list of main findings and some remarks from Figure 6.

・ Regarding the standard deviation of IASUR through1991 to 2011, the high value mostly concentrated in the coastal areas. Conversely, the low value is seen in the Northeast, and a part of the Midwest and the South regions.

・ The surrounding area of North Dakota, South Dakota, and Nebraska forms an especially high valued cluster, and that area is characterized by the combination of the cold spot areas of IASUR and the hot spot areas of IASER.

・ Oregon and Washington is another special clustering area which has the relatively high values of IASUR and the relatively low values of IASER; that fact may cause some potential labor problems at those areas.

・ Since Hawaii, Florida, Texas, Louisiana, and several other states have significantly high values of LG about IASUR, and low values of LG about IASER, that may bring a serious future problem of such labor shortages in those regions.

・ Northeast and some parts of the Midwest are the clustered areas of IASER of the relatively low values. Otherwise the other clustered areas of IASER are somewhat scattering.

・ With some exceptions, most regions mentioned above, plus Main, North Carolina, and some other states have the high positive LG values of the combination of the averages about IASUR and the standard deviations about IASUR: Thus regarding the annual averages of unemployed people in those areas, the high degree of agglomeration state of the remarkable specialization about unemployment throughout each region is clearly shown. By contrast, the other areas such as most inland areas have explicitly different patterns.

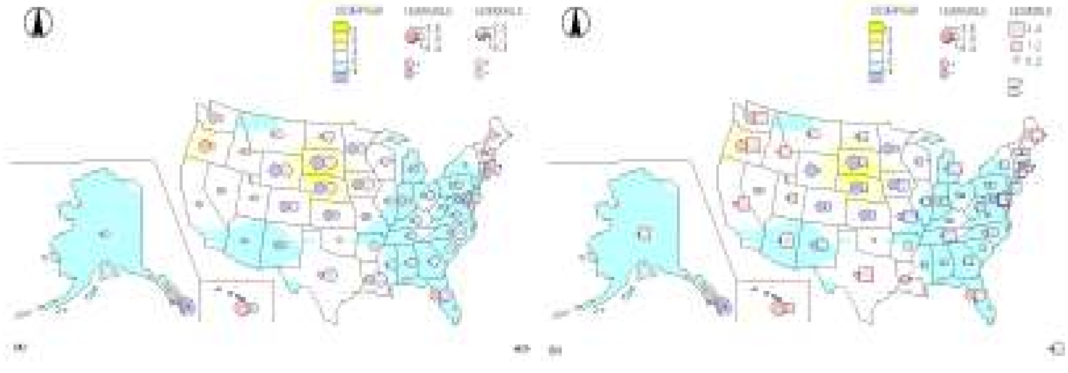
・ Florida and Louisiana and their surrounding areas are the hottest spots concerning the combination of IASOR and IASUR.

・ On the whole, mostly the Northeast, the South, and a part of the Midwest, and Hawaii have high values with respect to the combination of IASOR and IASUR.

・ The surrounding areas of especially North Dakota, South Dakota, and Nebraska have the strongest spatial dependence with respect to RDCUR and RDCER. Consequently, such areas show the widest inter-regional disparities about the ratios of the employed persons and the unemployed persons both.

・ Most parts of the Northeast and the South areas except for Main, North Carolina, and Florida tend to have the weak spatial dependencies or autocorrelations about RDCUR and RDCER in comparison with those of the other areas such as the Midwest or the Pacific.

Figure 6. LISA of some selected *IAS* and *RDC* (annual average, standard deviation).



4. Concluding remarks

Most labor statistics prove some kind of stability with respect to the regional gaps unless there is the considerable impact by large fluctuations. The influence of such shocks tends to be exchanged or absorbed between specific local areas and surrounding global areas. Afterwards, it spreads around and disperses to further distant areas during a sufficient amount of time, and thus the geographical distribution about the spatial dependence and agglomeration is significantly often repainted or transformed by the influence of such shocks in the final stage. Those phenomena would correspond to the economic situation such as equilibrium or disequilibrium state of the labor market, and simultaneously would bring about the remaking of the process of clustering regarding the geographical structure of regional labor mobility.

Regarding the geographical clustering process, thus the results of this paper would suggest the existence of the equilibrium and disequilibrium phenomena or the multiple equilibria as the same concepts in economics; an economic disequilibrium state also causes the geographic disequilibrium state. On one hand, an economic equilibrium state sometimes stabilizes geographical changes by controlling the mobility of the labor force. However, future empirical studies should continue scrutinizing the related arguments to obtain a much more determinate conclusion.

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