ISSN : 0974 - 7435 Volume 10 Issue 24

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(24), 2014 [15847-15854]

County export trade in Jiangsu province: A spatial correlation analysis

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ABSTRACT

Export trade is taken as an economic activity with strong demonstration effect and spillover effect, and spatial correlation should exist in export trade in adjacent geographical locations. This paper applies SLM and SEM models to make an econometric analysis on the spatial correlation of county export trade in Jiangsu province by spatial panel data. The empirical results are shown as follows: firstly, from the angle of county export trade in an adjacent area, the county export trade in Jiangsu province is not featured by spatial correlation; secondly, on the whole, there is spatial correlation in county export trade in Jiangsu province which is promoted by the whole export trade in surrounding areas, and export trade in counties and cities with larger areas or economic scales is significantly featured by spatial correlation; thirdly, regional differentials in county export trade in Jiangsu province, which are owing to spatial distances to a certain extent, are strengthened by the spillover effect and radiation effect of the trade among developed areas.

KEYWORDS

County; Foreign trade; Export dependence; Spatial correlation; Jiangsu.

INTRODUCTION

Since 1949, China has adjusted its regional development strategy three times. The first stage (1949-1978) is known as Balanced Development, whose major objective was to seek an absolutely balanced development. The second stage (1979-1991) was unbalanced Development with a major objective of preferentially developing regions with special advantages. The third stage (1992-present) is known as Coordinated Development, whose major objectives are to promote the development of underdeveloped regions and reduce regional disparities[1].

It is universally acknowledged that China's recent economic growth still involves distinct spatial patterns, which is not only in terms of the disparity across the 30 provinces especially between eastern area and western area, but also refers to the different county economic levels in a province. Export trade in county economy also display the same characteristic, especially in the eastern area such as Jiangsu province, Zhejiang province and Guangdong province, whose export-oriented economy accounts for the large proportion in the whole economy. The differences of export trade in county economics almost reflect the regional export trade disparity. Developed areas of the county's export trade are more concentrated in one area. Previous experiences showed the further from the concentrated area, the lower the export trade level of a county. For instance, the export trade level in northern and central Jiangsu province is obviously lower than that in southern Jiangsu province. Thus, it is necessary to analyze the unbalanced county export trade development. Most of the time, the empirical cross-sectional methods have been used are identical to the methods used in interregional studies. Nevertheless, at the regional scale, spatial effects and particularly spatial autocorrelation are determining for the analysis of unbalanced county export trade levels. Several factors, like trade between regions, technology and knowledge diffusion and more generally regional externalities and spillovers lead to geographically dependent regions: there are spatial interactions between regions and the geographical location plays an important role[2].

It has been more than thirty years since Jean Paelinck and Leo Klaassen published a small volume entitled *Spatial Econometrics* which arguably was the first comprehensive attempt at outlining the field of spatial econometrics and its distinct methodology[3]. Then, this new emerging approach has been increasingly been applied in a wide range of empirical investigations in many traditional fields of economics, including international economics[4], labor economics[5], public economics[6], and agricultural and environmental economics[7]. Gallo's research of the spatial distribution of regional per capita GDP in Europe over 1980-1995 using Exploratory Spatial Data Analysis (ESDA) highlights the importance of spatial interactions and geographical locations in regional growth and convergence issues[2]. Aroca's paper employs spatial econometric tools to investigate how the process of convergence/divergence has mapped spatially and whether it makes sense to talk about spatial regions in Mexico[8]. Interestingly, China's recent economic growth at a provincial level has been analyzed using non-parametric and Bayesian spatial econometric methods that allow for locally linear spatial variation in the relationships being analyzed[9]. However, to our knowledge, there is no published study involving Chinese county export trade data that reply on spatial econometric methods.

In the present study, the spatial correlation of county export trade was analyzed using the export trade data of Jiangsu province, which is one of the most developed provinces and also one of the most regional development unbalanced provinces in China.

METHODS

Spatial econometric models

We employed the spatial econometric model to analyze the spatial effects of county export trade in the Jiangsu Province. Spatial econometrics is a subfield of econometrics that deals with the treatment of spatial interaction (spatial autocorrelation) and spatial structure (spatial heterogeneity) in regression models for cross-sectional and panel data[10]. When a value observed in one location depends on the

values observed at neighboring locations, there is a spatial dependence. And spatial data may show spatial dependence in the variables and error terms. There are two primary types of spatial dependence:

(a) Spatial lag model (SLM)

In the spatial lag form the spatial dependence is similar to having a lagged dependent variable as an explanatory variable and, thus, is often called a spatial autoregression. Using standard notation, such a regression can be expressed as:

$$y=\rho Wy + X\beta + \varepsilon \quad \textbf{(1)}$$

where y is a n×1 vector of observations on dependent variable, W is the pre-specified n× n matrix of spatial weights, ρ is a spatial autocorrelation coefficient (when W is row-standardized) and is assumed to lie between -1 and +1, X is a n × k matrix of explanatory variables, β is a k ×1 vector of parameters to be estimated, and ε is a n×1 vector of error terms.

The coefficient ρ measures how neighboring observations affect the dependent variable. In our study, we explore whether export trade in a county is directly affected by export trade in neighboring regions. The effect is independent of the effects of exogenous variables. If equation (1) is the correct model, then ignoring the spatial autocorrelation term means that a significant explanatory variable has been omitted. The consequence is that the estimates of β are biased and all statistical inferences are invalid[11].

(b) Spatial error model (SEM)

The other form of spatial dependence is represented by a spatial error model. A spatial error model, often called a spatial autocorrelation model, can be expressed as:

$$y=X\beta+\varepsilon$$

$$\varepsilon=\lambda W\varepsilon+ u \quad \textbf{(2)}$$

Where λ is a spatial autoregressive coefficient and is assumed to lie between -1 and +1 and u is an n element vector of error terms. Other notations are as previously defined. The coefficient λ measures how neighboring observations affect the dependent variable, but the interpretation differs from that of a spatial lag model. In the spatial error model, a shock in neighboring counties spills over to a degree depending on the value of λ through the error term. If the spatial autocorrelation represented by equation (3) is erroneously ignored, then similar to the spatial lag case, standard statistical inferences are invalid; however, in contrast, the parameter estimates are unbiased[11].

Spatial weight matrix

When we are studying spatial interrelationships distributed over a set of areal units, the spatial structure of units might be defined as the spatial contiguity which is treated as a n × n spatial weights matrix W with binary variable[12]. The binary weight is represented as follows:

$$w_{ij} = \begin{cases} 1 & \text{if area i and j are contiguous;} \\ 0 & \text{otherwise.} \end{cases} \quad \textbf{(3)}$$

The binary spatial weight matrix W is a symmetric form. If the W is row-standardized:

$$w_{ij}^{*} = \frac{w_{ij}}{\sum_{j \in J} w_{ij}}$$

Where J is the set which includes all areal units that are not contiguous with i. The w_{ij}^{*} is satisfying non-negative $w_{ij}^{*} \geq 0$ and $\sum_{j \in J} w_{ij}^{*} = 1$ (for all i=1, …, n).

Application

(a) Data source

Data in this study was taken from the Jiangsu statistical yearbook from 2001 to 2008, including the statistical information of 52 counties in 13 cities. In general, according to economic development, geographical location and culture tradition, Jiangsu province could be divided into three territories: Nanjing, Suzhou, Wuxi, Changzhou and Zhenjiang city with higher economic level was known as 'South Jiangsu'; Yangzhou, Taizhou and Nantong with moderate economic level was called 'Central Jiangsu'; Xuzhou, Lianyungang, Suqian, Yancheng and Huaian with lower economic level was referred to 'North Jiangsu'. The geographic adjacency of all these 52 counties was from the administrative map of Jiangsu province drawn by Jiangsu Administration of Surveying, Mapping and Geoinformation.

(b) Variables

The variables for the analysis were selected based on influence factors of export trade and spatial factors, then spatial panel data was used for econometric analysis. As the present study focused on the influence factors of export trade in the counties of Jiangsu province, we regarded the dependent variable as export dependence (exp_gdp), which was defined as the ration of exports to Gross Domestic Product (GDP). A detailed description of the variables to be used was presented in TABLE 1.

TABLE 1: Variable description

Variable	Description
ave_fdi	Average foreign direct investment (FDI) in employees (Yuan)
imp_gdp	Import dependence, which is defined as ration of imports to GDP
LP	Labor productivity, which is defined as GDP produced by an hour of labor
fdi_inv	Ratio of FDI to overall investment
ssp	Sum of export dependence in adjacent areas of the studied area
ratio_ind2	The second industry proportion, which is defined as the ratio of the second industry output to GDP
ratio_ind3	The third industry proportion, which is defined as the ratio of the third industry output to GDP
inv_gdp	Ratio of investment to GDP
gov_gdp	Ratio of government Expenditures to GDP
Ipow	Industry power consumption (ten thousand kwh)

Moreover, in order to eliminate the influence of heteroscedasticity, the logarithms of ave_fdi, LP and Ipow were taken for the analysis in the research.

These data of 52 counties in 8 years are typical of panel data in that they are short and wide, consisting of a very large number of cross-sectional units observed over a small number of time periods. All these panel data were analyzed by the Spatial econometric toolbox of Matlab 7.0 (The MathWorks, Inc, Massachusetts, USA). Based on the explanatory variables and dependent variable described above, we modified the spatial lag model (1) and spatial error model (2) as follows:

$$\exp\_gdp_{it} = \rho\sum_{j\in J} w_{ij}\exp\_gdp_{it} + X\beta + \varepsilon_{it} \quad \textbf{(4)}$$

$$\exp\_gdp_{it} = X\beta+\varepsilon_{it}, \qquad \varepsilon_{it} = \rho\sum_{j\in J} w_{ij}\times\varepsilon_{it} + u_{it} \quad \textbf{(5)}$$

RESULTS AND DISSCUSSION

The economic data in 52 counties of Jiangsu province from 2001 to 2008 were analyzed based on spatial lag model (4) and spatial error model (5). The results according to random effects model (Form Ⅰ), spatial fixed effects model (Form Ⅱ), time fixed effects model (FormⅢ), and spatial and time fixed effects model were presented (FormⅣ) in TABLE 2.

TABLE 2: Estimation results for the SLM and SEM models

Form Variable	Form Ⅰ		Form Ⅱ		FormⅢ		FormⅣ	
	SLM	SEM	SLM	SEM	SLM	SEM	SLM	SEM
constant	0.007	0.009						
	(0.90)	(0.88)						
ln (ave_fdi)	0.169***	0.182***	0.024	0.031	0.152***	0.162***	0.029	0.034*
	(0.00)	(0.00)	(0.32)	(0.21)	(0.00)	(0.00)	(0.23)	(0.15)
imp_GDP	0.778***	0.739***	0.576***	0.576***	0.761***	0.723***	0.571***	0.570***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ln (LP)	0.005***	0.004*	0.013***	0.013***	0.007***	0.006***	0.014***	0.014***
	(0.05)	(0.10)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)
fdi_inv	-0.065***	-0.078***	-0.052**	-0.056**	-0.074**	-0.086**	-0.054**	-0.057**
	(0.03)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)
ssp	0.085***	0.061***	0.054**	0.081***	0.094***	0.073***	0.056***	0.083***
	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)
ratio_ind2	-0.079***	-0.055	0.007	0.004	-0.067	-0.034	0.012	0.008
	(0.32)	(0.48)	(0.95)	(0.97)	(0.40)	(0.67)	(0.91)	(0.94)
ratio_ind3	0.233	0.206	-0.209	-0.215	0.119	0.100	-0.200	-0.208
	(0.16)	(0.22)	(0.2)	(0.18)	(0.47)	(0.54)	(0.22)	(0.19)
inv_GDP	-0.011	-0.018	-0.021	-0.023	0.030	0.025	-0.009	-0.012
	(0.78)	(0.68)	(0.48)	(0.42)	(0.46)	(0.54)	(0.72)	(0.64)
gov_GDP	-0.370	-0.338*	-0.284	-0.229	-0.438**	-0.416**	-0.253	-0.199
	(0.11)	(0.14)	(0.13)	(0.21)	(0.04)	(0.05)	(0.14)	(0.23)
lnIpow	-0.003	-0.003	0.020**	0.016	-0.001	-0.002	0.017	0.013
	(0.61)	(0.59)	(0.08)	(0.14)	(0.81)	(0.75)	(0.11)	(0.19)
W	-0.08***		0.022		(0.00)		0.019	
	(0.00)		(0.64)		-0.08		0.61	
spatial autocorrelation		-0.047		-0.061		-0.072		-0.066
		(0.36)		(0.23)		(0.16)		(0.20)
Adjusted R-squared	0.894	0.888	0.970	0.965	0.888	0.883	0.964	0.965
Log likelihood	418.6	408.5	681.5	681.4	412.4	401.4	680.7	680.7

In parentheses is the estimated coefficient P value ; *, **, And *** indicate 10%, 5% and 1% significance level.

It is clear that the influence of ave_fdi on the export trade in random effects model and spatial effects model was significant. Meanwhile, the influence of imp_gdp on export trade in all these four models was significant. All these interesting outcomes indicated that the import trade and export trade were interdependent in Jiangsu county economy. It demonstrated that open economy would promote both the import and export trades in an area. Labor productivity is closely related to the export dependence. The regions with higher to the export dependence would have higher labor productivity, however, the level of labor productivity is the important source of region development gap, therefore, we can easily estimate that, the more extrovert economy of southern regions of Jiangsu has improved the labor productivity of local enterprises, it has also increased the gap from the economic development of the northern Jiangsu area. More opening regions have higher labor productivity, and this is the important characteristic of spatial economic development. The proportion between foreign direct investment (fdi) and total investment (INV) has a negative correlation relationship with the export dependence. This result is a little surprised but not difficult to understand: each county of southern regions of Jiangsu has large economic scale (southern regions of Jiangsu have the top 7 counties of the top 10 counties with strong economic of China in 2008), relative to FDI, the strength of the domestic investment is greater; however, there are faster development of trade export in the northern Jiangsu area and the middle Jiangsu area with smaller investment scale, but the cardinal number is relatively smaller and with larger foreign investment proportion, it leads to the export dependence of the county territory which has higher foreign investment proportion is not high. And industrial structure, the proportion of investment scale, government intervention and industrial electricity consumption and so on has unobvious effect on export trade of county territory.

There is obvious positive correlation relationship between the sum of the export dependence (ssp) of adjacent areas and the export dependence of the sample areas, and it is obvious that the export performance of adjoining areas have an impact on the regional export trade in geographic space, in a sense, the regions with larger export trade strength and higher degree of opening would lead to kinds of spillover effects on surrounding regions or positive externality of export. It needs to be stressed: the variable has reflected the effect from the overall export trade or overall space of the sample areas to explained variable. It indicates that, the regions with larger area, higher the export dependence of adjacent counties and more adjacent counties, its adjacent counties would have higher sum of the export dependence, and its own export dependence would also be larger.

The most important research purpose of this paper is discussion on whether there is spatial correlation of export trade in county region of Jiangsu. Based on it, we set a variable in the model that embodies foreign trade situation in geographic adjoining areas, this variable corresponds to adjacent weight matrix in spatial econometric model, it represents the overall spatial relationships in surrounding areas, the spatial dependency of export trade interdependence in county region economy of Jiangsu is tested by whether the overall space and spatial coefficients are significant or not. According to the estimation results of models in TABLE 2, we find that no matter various forms of SLM model or SEM model, the overall spatial correlation of counties and cities in Jiangsu is significant, the spatial dependency of a county region has a stake in the export trade of surrounding areas; In SLM and SEM model, the empirical results of unfixed effect form and time-fixed effect form show that there is a negative correlation on export trade between a region and the weighted space region, that is to say, the spatial correlation of export trade in a county and city and average export trade in adjoining areas is not obvious. So as a whole, export trade in county region of Jiangsu indeed existing spatial correlation, economical developed areas have positive driving effect on economically undeveloped areas. Yangtze River between South Jiangsu, Middle Jiangsu and North Jiangsu forms the spatial barrier objectively, which causes that Middle Jiangsu and North Jiangsu lag behind South Jiangsu, this paper uses spatial panel data to certify the “obvious” conclusion. With the improvement of transportation and other infrastructure, the radiation effects of Middle Jiangsu on South Jiangsu has begun to emerge, combined with the advantage of along the Yangtze River and industrial base in the middle Jiangsu area, the

development of county economy in the middle Jiangsu area is better than in the north Jiangsu area, It is particularly obvious in foreign trade. The export dependence of Jiangsu county area reflects the spatial correlation of the trade from characteristics which appears a decreasing trend from South Jiangsu, Middle Jiangsu to North Jiangsu in space. The interdependent relationship of the space formed the regional economy, especially the clubbable and reducing like wave development pattern of the trade export.

CONCLUSION

The space characteristics of the export trade in Jiangsu county region is similar to Jiangsu regional economy development pattern, It generally formed a decreasing trend from south to north, South Jiangsu is one of the most advanced regions, Middle Jiangsu comes second, and North Jiangsu is the most backward. The particular geographical location is an important reason for the expansion of export trade in this region. The development of foreign trade obviously exists spillover effect in space, and this is an important reason for the development gap of regional trade. This paper confirms this view by verifying spatial correlation of the export trade in Jiangsu county region, the empirical results also indicate that the effects of sample area on the developed export trade in some neighbouring areas is limited. After the trade in these areas have developed, it can play a strong exemplary and leading role on the sample area. Based on further analysis of the estimation results of spatial econometric model, we can get the following conclusion:

Different forms of model has a great influence on the estimation results. In no-fixed effect form and time fixed effect form, there are more explained variables which have passed the significance test. Such as the labor average foreign direct investment has a positive effect on export trade; In the two forms of the SLM model, The export dependence of weighted space is negatively interrelated with the export dependence of study sample. It Suggests that it can not reflect the spatial correlation of foreign trade only from the county region export in an adjacent area, and it may even appear the characters of the bigger differences with the export trade of neighboring areas. Therefore, specific to a single county, There is no spatial dependence of the export trade of Jiangsu county areas.

There is a strong spatial correlation of Jiangsu county's export trade on the whole. The sum of the export dependence of all the neighboring counties and cities have a significantly positive role in promoting the exports to the region, the level of the export dependence of adjacent counties and cities and the number of the adjacent counties determine the total export dependence, and positively related to the export dependence of sample area. In Jiangsu county economy, the scale dependence is more obvious to the counties and cities with larger area or bigger economic scale. It is similar to the overall characteristics of the region economic development level decreasing from South of Jiangsu to North Jiangsu, the characteristics also have the same performance in foreign trade.

The foreign trade gap between Jiangsu County areas is largely from the spatial distance. There is a natural barrier of the Yangtze River between South Jiangsu and Middle Jiangsu & North Jiangsu, Objectively formed the barrier of space, it caused Middle Jiangsu & North Jiangsu far behind South Jiangsu. With the improvement of transportation and other infrastructure, the radiation effects of Middle Jiangsu on South Jiangsu has begun to emerge, added the advantage of along the Yangtze River and the historical industrial base, The county area economy development in Middle Jiangsu is better than North Jiangsu, It is particularly obvious in foreign trade. The characteristics of Jiangsu county area export dependency decreasing from South Jiangsu, Middle Jiangsu to North Jiangsu reflects that The space factor is an important reason of unbalanced development of foreign trade in Jiangsu region, the spillover and radiation effects of foreign trade in developed area will strengthen the regional disparity.

The key to narrow the gap between the county foreign trade and the gap of economic development is to narrow the distance in space between the areas. To take full advantage of the spillover and radiation effects brought by the foreign trade spatial correlation, Radiation effect and the spillover

effect of foreign trade to make full use of the spatial correlation which one of the most direct way is to shorten the "distance" of all counties and cities in Jiangsu, especially the distance between South Jiangsu, Middle Jiangsu and North Jiangsu. At present, with the improvement of infrastructure, more across the Yangtze River Bridge, high-speed railway, highway and modern information network and others can obviously shorten the distance in space, And the dissolution of barriers of various regional administrative, the deepening of regional economic integration is helpful to shorten the "psychological distance" of the area. But which should be reinforced is that the research object of this paper is the county's export trade, not including the urban economy, so it ignored the influence of the surrounding county's economy on a - level city urban economy. Because most of the urban economy (including foreign trade) is more developed than the counties and cities under his jurisdiction, and often have more greater space radiation effect and spillover effect on the surrounding counties and cities, So shorten the "distance" between the the city zone and the surrounding counties and cities has the same important significance, This can be accomplished through the integration of urban and rural areas and administrative division reform and other policies.

ACKNOWLEDGEMENTS

This work was supported by the National Social Science Foundation of China (Grant No. 13CJL065).

Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this article.

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