

Ridge Regression Analysis on the Influential Factors of FDI in Jiangsu Province

ANALYSES DE RIDGE REGRESSION SUR LES FACTEURS INFLUENTS DE FDI DANS LA PROVINCE DU JIANGSU

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Abstract: As Chinese eastern coastal developed areas, through the use of foreign capital, Jiangsu Province has not only promoted economic growth rapidly, enhanced the regional comprehensive competitiveness, promoted employment, but also created a new famous mode of economic development called Sunan. Based on the qualitative analysis of factors affecting the inflow of foreign capital in Jiangsu, the paper establish a mathematical model between the FDI and major economic indicators in Jiangsu, in accordance with its own characteristics. And then taken 1992-2006 time-series data for the background, the paper use the method of ridge regression to analysis the influential factors of FDI in Jiangsu.

Key words: foreign direct investment, ridge regression, factors, Jiangsu

Résumé: En tant qu'une région développée dans la côte-est de la Chine, grâce à l'usage du capital étranger, la province du Jiangsu a non seulement eu une croissance économique rapide, augmenté la compétitivité générale, créé des emplois mais aussi inventé un nouveau modèle du développement économique qu'on appelle Sunan. En se basant sur les analyses qualitatives des facteurs affectant l'afflux du capital étranger dans la province de Jiangsu, l'article établit un modèle mathématique entre le FDI et les principaux indicateurs économiques dans la Province, conformément à ses caractéristiques appropriées. Et puis, en employant les données de la période de l'année 1992 à 2006 comme l'arrière-plan, l'article utilise la méthode d'analyse de ridge régression pour étudier les facteurs influents de FDI dans la province de Jiangsu.

Mots-Clés: investissements directs étrangers, ridge régression, facteurs, Jiangsu

1. INTRODUCTION

Jiangsu is one of the most effective provinces of the development of the open economy in China. And its

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scale and the amount of introducing foreign capital maintains the leading position for many years. In 2007, The new foreign-funded enterprises registered 5,986. The registration agreement foreign capital was 435.8 billion U.S. dollars which was increased of 12.4% than last year and the actual one was 218.9 billion U.S. dollars which was increased of 25.6%. The amount of the actual foreign direct investment in 2007 was over passing the total foreign investment in 2004. All these is due to the unique geographical advantages, solid industrial base, huge market capacity, strong science and technology, education, research, better infrastructure system and friendly foreign investment policies and so on which provide a good external environment for the inflow of foreign capita in Jiangsu. This article studies the influential factors of FDI in Jiangsu mainly from the empirical perspective.

2. LITERATURE REVIEW

Overall, there are mainly two empirical methods for many Chinese scholars studying the influential factors of FDI: one is field surveys and questionnaires; another is the economic measurement methods. For example, Li Xiaojian (1996) through the questionnaire study found that among 55 Hong Kong enterprises investment in the Chinese mainland, 46 enterprises took "reduce production costs" as the most important investment motive and 8 enterprises took " enter Chinese market "as the main motivation. Sun Zhaoming, Zhang Shaojiang and Gao Xiangmei(2006) used cointegration analysis and Granger test of the economic measurement method to study the influential factors of FDI in China. And it founded that the size of the domestic market, labor costs and exchange rates is the main impact factors of FDI inflows which have shown the same direction changes. Particularly, the size of the domestic market is the main reason for attracting foreign investment; labor advantages are the second factor. The third is the exchange rate.

To sum up, although there already are a large number of theoretical and empirical researches on the influential factors of FDI, today the academic community does not form a unified theory. From the existing research results, the past two or three decades, among domestic empirical researches, except for some scholars using the questionnaire method, most using economic measurement methods to find and identify influential factors. The data are often adopt cross-section data or time-series one and the methods are often the ordinary least squares and principal component. On the basis of predecessor's researches, the paper uses ridge regression method to study the factors affecting the FDI with time-series data according to the characteristics of Jiangsu Province.

3. VARIABLE SELECTION AND ANALYSIS

Market, infrastructure, cost, the extent of opening up and so on is the main factors affecting FDI. These factors in different regions may be the same and also may be diametrically opposed while the same factors in different regions may be a lot of different. In this section, reference to the relevant research experiences, considering the actual situation in Jiangsu Province, from the perspective of data available, scientific and representative, six statistical indexes are chosen as Table 1.

4. DATA COLLECTION AND MODEL IDENTIFIED

Because the year of 1992 is the new starting point for Jiangsu Province , even China to use foreign capital, the data is acquainted from the start of 1992. By which, we can not only exclude the more ambiguous policies variables and raise the feasibility of analysis, but also improve the practical guiding significance of the results. Take the actual foreign direct investment in every year as dependent variable,

units set million; then data collect results as Table 2:

Table 1. Indicators matrix affecting FDI in Jiangsu

Variable	Indicators	Variables	Units
The size of the market	Regional GDP	GDP	Billion Yuan
Infrastructure	The number of investment completion of transport, posts and telecommunications industry	Infr	Billion Yuan
Labor costs	average wage workers in post	Wage	Yuan
The quality of labor force	the proportion of college students of every 10000 people	Reso	%
Open degree	dependence on foreign trade	Open	%
Industry gathering	Town resident population the proportion of the total population	Indu	%

Table 2. 1992-2006 the original data table of the influential factors of FDI in Jiangsu

Year	FDI	GDP	Infr	Wage	Reso	Open	Indu
1992	350032	2136.02	30.27	2800	22.10	17.97	23.78
1993	392359	2998.16	36.39	3615	25.90	17.54	24.02
1994	425683	4057.39	52.94	4974	28.70	24.98	24.68
1995	478058	5155.25	88.08	5943	29.50	26.37	27.30
1996	530653	6004.21	104.52	6603	31.00	28.65	27.32
1997	623015	6680.34	119.12	7108	33.40	29.31	29.85
1998	665201	7199.95	172.27	8256	38.00	30.39	31.50
1999	639915	7697.82	197.20	9171	49.80	33.62	34.90
2000	642358	8582.73	201.76	10299	64.80	44.02	41.50
2001	712201	9511.91	249.92	11842	84.00	44.69	42.60
2002	1036615	10631.75	265.89	13509	100.60	54.73	44.70
2003	1580214	12460.83	374.29	15712	120.00	75.50	46.77
2004	1213800	15512.00	474.58	18202	138.10	91.13	48.18
2005	1318000	18305.66	535.30	20957	155.20	102.00	50.50
2006	1743100	21645.08	564.65	23782	173.00	104.59	51.90

The above data are all get from *Jiangsu Province Statistical Yearbook*. In order to make a preliminary understanding of the relationship between the FDI and other variables, plot graphics are drawn. In the Following section if no special note, all results and graphics are calculated and drawn by software Spss11.5

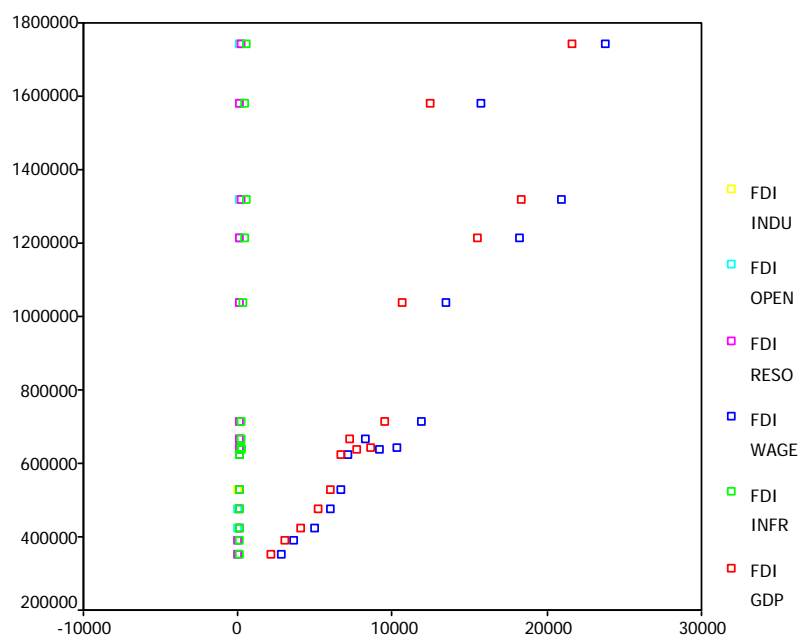


Figure 1. The plot graphics of influential factors of FDI in Jiangsu

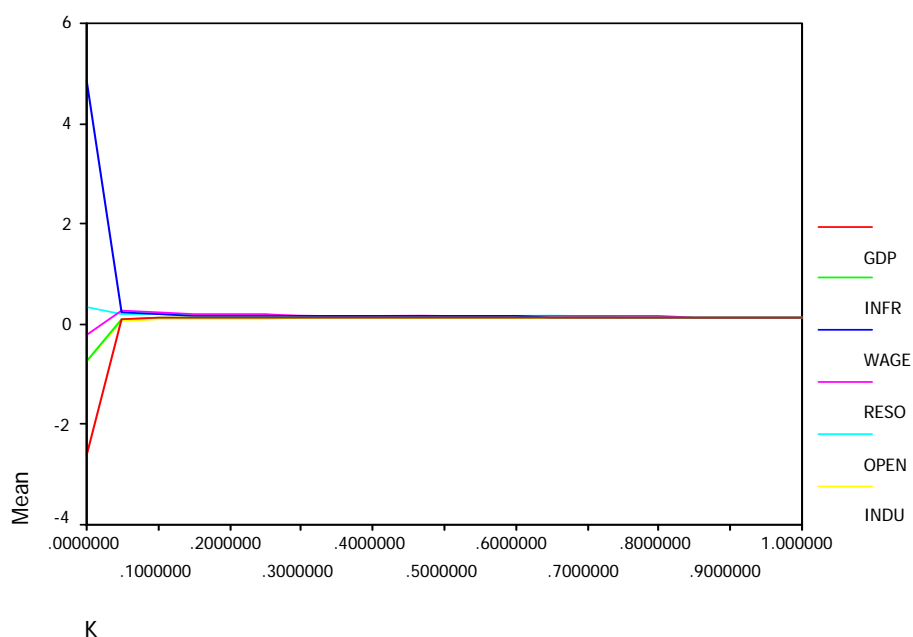


Figure 2 Ridge trace charts

It can be seen from figure 1 that the linear relationship between FDI and other variables are remarkable significantly which meet the linear hypothesis of multiple linear regression parameters, so the model is established as the following:

$$FDI = \alpha + \beta_1 GDP + \beta_2 Infr + \beta_3 Wage + \beta_4 Reso + \beta_5 Open + \beta_6 Indu + \varepsilon_t (t = 1992 \dots 2006;)$$

α is the intercept and ε_i is the disturbance of the random.

5. RIDGE REGRESSION ANALYSES ON THE INFLUENTIAL FACTORS OF FDI IN JIANGSU PROVINCE

5.1 Colinearity Diagnosis

For time-series data, variables are often characteristics with the same reduction and increasing with the changes, so there inevitably are the problems of colinearity or similar line in the model. Variance inflation factor (VIF) is the common statistics variable that testing multicollinearity. It calculated by the formula: $VIF_i = (1 - R_i^2)^{-1}$, among which, R_i^2 is the goodness-of-fit of x_i to the remaining variables. Generally speaking, when the $VIF > 20$, it can be judged existing multicollinearity in the model. So the value VIF of each variance must be calculated firstly in order to diagnose colinearity.

Table 3. The colinearity diagnosis form based on the VIF value

variances	GDP	INFR	WAGE	RESO	OPEN	INDU
VIF	394.337	128.5041	992.9219	105.5172	95.80981	40.55364
T value	0.002536	0.007782	0.001007	0.009477	0.010437	0.024659

From table 3, it can be seen that variance inflation factors of every variance are all far greater than 20 which indicate that there are serious multicollinearity. Then put all the variables into the equation, the adjusted coefficient of the regression model is 0.861 which shows that it is goodness-of-fit and $F = 15.475$ which shows the model passes the test. However, when takes significant test to every variable coefficients, the all variable coefficients are not significant, obviously too small to validate fatherly that the presence of multicollinearity in the regression model.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.960(a)	.921	.861	165973.37513

A Predictors: (Constant), INDU, OPEN, GDP, RESO, INFR, WAGE

When there is multicollinearity, the regression model established by traditional ordinary least squares (OLS) and the regression variable coefficients have poor stability which will due to the unreliable forecasting results, even get the opposite conclusions. But if remove those highly relevant variables simply, it will lose a lot of useful information samples, which can not fully reflect the impact of the dependent variable information. In light of these problems, this paper use ridge regression method to analyze. It is a a partial estimate regression method which devoted to the analysis of colinearity data.

5.2 Ridge Regression Analysis

Ridge regression analysis method is proposed by A·E·Horel in 1962, which is a special linear method used in unified diagnosis and treatment colinearity problem. The regression model is:

$$Y = X\beta + U$$

The least-squares estimation of parameters is:

$$\hat{\beta} = (X'X)^{-1}X'Y$$

If there is strong collinearity existing in the interpretation of variables, that is $|X'X| \approx 0$, then, $E[(\hat{\beta} - \beta)(\hat{\beta} - \beta)'] = \sigma^2(X'X)^{-1}$ will be increased with it that will disadvantage for the parameters estimation. So, supposed a positive constant matrix add to $X'X$, that is $\lambda I (\lambda > 0)$, I is units matrix. The structure of $(X'X + \lambda I)^{-1}$ made the possibility of $|X'X + \lambda I| \approx 0$ is smaller than $|X'X| \approx 0$. Through which avoids the variance incensement of $\hat{\beta}$ caused by $|X'X| \approx 0$, so ridge regression estimation $\hat{\beta}(\lambda) = (X'X + \lambda I)^{-1}X'Y$ is called the ridge regression estimation of β . λ is ridge regression estimation parameter and it get value usually in $(0 \cdot 1)$.

Table 4. Ridge regression coefficient estimation and the corresponding λ value

λ	RSQ	GDP	INFR	WAGE	RESO	OPEN	INDU
.000	0.9210	-2.6224	-0.7327	4.8447	-0.2008	0.3514	-0.7421
.050	0.8950	0.1097	0.0808	0.2191	0.2750	0.2079	0.0511
.100	0.8930	0.1322	0.1168	0.1865	0.2261	0.1929	0.0822
.150	0.8920	0.1394	0.1290	0.1753	0.2049	0.1836	0.0972
.200	0.8910	0.1424	0.1346	0.1692	0.1926	0.1772	0.1059
.250	0.8910	0.1437	0.1375	0.1651	0.1844	0.1724	0.1115
.300	0.8900	0.1441	0.1390	0.1620	0.1783	0.1685	0.1153
.350	0.8890	0.1441	0.1398	0.1595	0.1736	0.1653	0.1179
.400	0.8880	0.1437	0.1400	0.1572	0.1697	0.1625	0.1198
.450	0.8870	0.1432	0.1400	0.1553	0.1664	0.1601	0.1210
.500	0.8860	0.1426	0.1397	0.1535	0.1635	0.1578	0.1219
.550	0.8850	0.1419	0.1393	0.1519	0.1610	0.1558	0.1225
.600	0.8840	0.1411	0.1388	0.1503	0.1586	0.1539	0.1228
.650	0.8820	0.1403	0.1382	0.1488	0.1565	0.1522	0.1230
.700	0.8810	0.1394	0.1376	0.1474	0.1546	0.1505	0.1230
.750	0.8800	0.1385	0.1369	0.1461	0.1527	0.1489	0.1229
.800	0.8780	0.1377	0.1361	0.1448	0.1510	0.1474	0.1227
.850	0.8770	0.1368	0.1354	0.1435	0.1493	0.1460	0.1224
.900	0.8750	0.1359	0.1346	0.1423	0.1478	0.1446	0.1221
.950	0.8740	0.1350	0.1338	0.1411	0.1463	0.1433	0.1217
1.00	0.8720	0.1341	0.1330	0.1400	0.1449	0.1420	0.1213

When $\lambda=0$, then $\hat{\beta}(\lambda) = \hat{\beta}$, at this time, the model is the ordinary least squares one. When $\beta \rightarrow \infty$, all the value of estimated coefficients are prone to zero. The key issue of ridge regression analysis is the determination of constant λ . Because ridge regression is a partial estimate, λ value should not be too large. Generally speaking, when hope to retain information as much as possible; people should try to maximize the λ value. So we can observe the different λ value when the regression equation changes, and then take the minimum λ value which makes the equation stability basically. Table 4 shows the different λ value under the different ridge estimated mode, it can be seen that regression coefficients is to stable with the λ ridge parameters incensement.

When $\lambda = 0.35$, regression coefficient start moving toward stability, so $\lambda = 0.35$ is accepted, the corresponding fitting equation is:

$$FDI=0.1441GDP +0.1398INFR +0.1595WAGE +0.1736RESO +0.1653OPEN +0.1179INDU$$

Here is no constant term, but this is not what we care about. Figure 2 is the ridge trace map which shows that when near $\lambda = 0.35$, three ridge traces become smooth; this is further evidence of previous conclusions.

Regression model adjustment coefficient is $R^2=0.889$ which shows that the goodness-of-fit of the ridge regression model is good. All the variance inflation factor gets from the ridge regression model is less than 20 which shows that the model eliminates the problem of multicollinearity well and the regression coefficient can explain the economic phenomenon reasonably.

Table 5. The value of VIF when $\lambda = 0.35$

variances	GDP	INFR	WAGE	RESO	OPEN	INDU
VIF	0.1558	0.0889	0.0544	0.1268	0.1562	0.3883

6. CONCLUSION

6.1 FDI with the regional GDP

Empirical results show that the actual FDI flows and GDP have positive correlation significantly. One unit increment of GDP will increase 0.1441 units of the actual FDI inflow that indicate that one of the main goals of FDI in Jiangsu Province is the occupation of the huge local market. This is consistent with the status quo. FDI inflows and the growth of the GDP of Jiangsu Province are the complement and promotion for each other. FDI in Jiangsu Province made up for the severe shortage of construction funds, contributed to the sustained economic growth and promoted the evolution of the industrial structure and technological progress.

6.2 FDI with infrastructure

By empirical results, this indicator's symbol is positive which in line with expectations which means that the impact of infrastructure to FDI is positive. One unit increment of infrastructure will increase 0.1398 units of the actual FDI inflow. However, in the selected factors, the infrastructure index ranked fifth, which may be due to infrastructure construction in Jiangsu are relative perfect recent years with rapid economic growth, the hard investment environment are satisfied. Compared with human resources, opening degree, the size of the market and labor costs, it isn't the primary consideration factor. However, this does not mean that the investment environment is not to further expand to attract foreign investment

with the development of economic internationalization.

6.3 FDI with labor costs

The actual FDI flows and labor costs have positive correlation significantly; one unit increment of labor costs will increase 0.1595 units of FDI inflow. In previous studies, although unanimous conclusions haven't been reached, the majority of researches concluded that the two were negatively correlated. For the above result, there are many interpretations. Firstly, the paper selected the indicator of average wage in post to measure the cost of labor, on the one hand, the indicator can reflect the cost of labor, on the other hand it responses to the purchasing power of people to a certain extent. Secondly, there are currency expansion and other factors. With the combination of many factors, FDI and labor costs are positive correlation. But this is not denying the importance of labor costs, the cost of foreign investment is always an important factor to consider for investor.

6.4 FDI with human resources

Human resources factor is the most influential factor affecting FDI in Jiangsu Province, one unit increment of it will increase 0.1736 units of FDI inflow. 21 century, human resources are the most important resource. With the optimization and upgrading of industrial structure and economic development, foreign investment enterprises in our province have changed from traditional industries to high-tech industry, from labor-intensive industries to capital-intensive-based and technology-intensive one. A number of enterprises innovation centers, research and development centers, business technology center, post-doctoral workstations, and other enterprises research and development institutions have established. All these not only expand the scale of economy, improve the quality and efficiency of introducing foreign investment but also increase substantially the urgent desire for high-quality talent.

6.5 FDI with openness

FDI is a product of economic liberalization, so the relationship between the size of FDI and the regional economic openness is self-evident. One unit increment of it will increase 0.1653 units of FDI inflow which become the second important factor indicators affecting FDI. Long time, the degree of openness in Jiangsu Province remains relatively high, in 1992 dependence on foreign trade reached 17.97%, after that increases year by year, in 2005 and 2006, it is all more than 100% reached 102% and 104.5% respectively. The improvement of opening up shows the exchanges of trade in Jiangsu are active and trade barriers are gradually weakening, and the investment environment gradually improved. Openness in Jiangsu Province played an important role for attracting foreign investment and the results consistent with expectation and regression coefficient significantly.

6.6 FDI with industry gathering

The factors for each additional unit, the actual FDI inflows unit will increase 0.16530 units. This shows that industry gathering caused by urbanization have a strong attraction to the foreign investment. Jiangsu Province is a "economic zone" driven by the government and the development zone as the carrier of the role foreign investment has begun to appear, with the concentrated benefits become more prominent. At present, Jiangsu Province has 27 state-level development zones and 109 provincial-level development zones. The construction of the Suzhou Industrial Park as the representative of the various development zones of the cooperation of China and Singapore constitutes a stable safe and competitive investment environment with international standards and the management system and improving infrastructure, transparent policies and regulations norms, efficient service quality.

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