The Analysis on Co-integration Testing of Foreign Direct Investment and Economic Growth in Liaoning Province

Lianting Gao and Shuying Jin

School of Economy and Management, Shenyang Aerospace University, Shenyang,, China

Abstract—Based on the theory of co-integration test, this paper analyzes the quantitative relation between Foreign Direct Investment(FDI) and economic growth in Liaoning province. The result shows that there exists long-term steady equilibrium relation between FDI and economic growth in Liaoning province. FDI in Liaoning province contributes to economic growth. In the future, Liaoning province should strengthen absorbing more FDI, and advance the level of opening.

Keywords-Foreign direct investment ;co-integration; Unit-root testing

1. Introduction

Over the years, with the rising of production cost in the south-east coastal region, foreign direct investment (FDI) arises the trend of "going north". Via superior geographic location, good infrastructure and human capital etc, Liaoning becomes one of the hot spots of FDI "going north". The amount of FDI grows constantly. In 1985, FDI in actual use was 15.69 million U.S. dollar, and in 2008 reaching 12019.25 million U.S. dollar, which grew by 765 times.

TABLE I THE AMOUNT OF FDI FROM 1985-2008

Unit :10 thousand U.S dollar

	1985	**1990**	**1995**	**2000**	**2001**	**2002**
FDI	1569	24831	140405	255219	311293	391561
	2003	2004	2005	2006	2007	2008
FDI	558262	540679	359042	598554	909673	1201925

Data resource：Liaoning Statisticss. Yearbook 2009

Now, Liaoning has absorbed the capital of more than 70 countries and regions around the world, and the main capital resources are from Asia-Pacific countries and regions, such Hong Kong, Japan, South Korea, and the U.S.A. etc. In 2008, FDI in actual use coming from Hong Kong, South Korea, Japan, and the U.S.A. were 5320.55 million U.S. dollar, 1622.23 million U.S. dollar, 984.8 million U.S. dollar, and 675.48 million U.S. dollar respectively, which occupied 72% of the total sum of FDI in actual use. The main forms of FDI in Liaoning are Sino-foreign joint ventures and exclusively foreign-owned enterprises, but the amount of cooperative enterprises and joint stock companies invested by FDI is little. FDI in Liaoning province concentrates upon the secondary and tertiary industry, the proportion of the primary industry is very low. In 2008, the proportion of the secondary and tertiary industry of FDI in Liaoning province was 47% and 51% respectively. The distribution of FDI in Liaoning province differs greatly, and about 90% of FDI concentrates in Shenyang city and Dalian city.

E-mail address: liantinggao@163.com

After more than thirty years of development since reform and opening, FDI has become one power of promoting economic growth of Liaoning province, affecting the present and future of Liaoning province. As one input of capital, FDI not only increases the capital formation of Liaoning province, but also promotes economic growth of Liaoning province. In addition, FDI has made great contribution to foreign trade, tax revenue, employment, talent training, etc.

2. Data Source and Disposal

In order to validate the relation between FDI and economic growth in Liaoning province, this paper makes model test by the co-integration theory with data of Liaoning province from 2000-2008, which showed the development of FDI in Liaoning since the 21st century. GDP data of Liaoning are from each year' Liaoning Stas. Yearbook. FDI data come from Liaoning Stas. Yearbook of the past years. It takes the logarithm form of GDP and FDI in order to eliminate the change trend and heteroscedasticy, expressed by LNFDI and LNGDP.[1]

3. Co-Integration Testing

3.1. Onarity Testing of Serials

In order to avoid "imitative regression" of regression results, time serials must be stable. If a time serial is stable, then its mean value, variance and autocovariance (lagged of all kind) remain unchanged no matter measured at any time. This kind of time serial has the trend of returning to mean value, and the fluctuation arounding its mean value has roughly constant amplitude of vibration. Time serials of economics are not stable usually. One simplest and visual method of judging if the time serial is stable or not is to observe the line graph of this time serial. By observing line graphs of LNFDI and LNGDP, FDI and GDP go up with time in the research period, which shows that the mean values of LNFDI and LNGDP have changed. It states probably that LNFDI and LNGDP are not stable. The ocular feeling is the starting point of stationarity testing, and more normative stationarity testing is the following ADF testing.
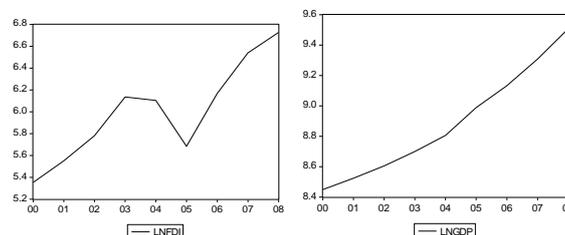

Figure 1 Line Graph of LNFDI and LNGDP

3.2. Unit-root Testing(ADF testing)

The premise to analyze time serial with co-integration theory is that two serials are the same rank integrations. The method of judging the integration rank of time serials is unit-root testing, including DF testing and ADF testing, and DF testing is one special case of ADF testing. [2]ADF testing is familiar in practice, so this paper adopts ADF testing. With Eviews3.1 software, it makes ADF unit-root testing on time serials of LNGDP and LNFDI of Liaoning province, and the results showed in the table below:

TABLE II UNIT-ROOT TESTING RESULTS OF LNFDI AND LNGDP

Variables	ADF statistics	Critical point	Testing form （c,t,k）	Conclusion
LNFDI	-2.6504	-3.6280（10%）	（c，t，1）	uneven
LNGDP	-0.3591	-3.5486（10%）	（c，t，0）	uneven
△LNFDI	-1.6963	-1.6458（10%）	（0，0，1）	even
△LNGDP	-3.6375	-3.6280（10%）	（c，t，0）	even

Note ：In the table above, △ indicates 1st difference, c, t and k indicates constant term, time trend term, and lagged ranks separately; ADF statistics is t value of estimated coefficients

In the above table, c, t and k represent constant term, time trend term, and lagged ranks in suitable equation separately. By testing, we find time serials LNFDI and LNGDP are uneven before unchanged. After 1st rank difference, t condition value of ADF testing value is remarkable at the level of 10%. Therefore, LNFDI and LNGDP time serials are 1st rank integration, and meet co-integration testing term of two variables. Perhaps there exists co-integration between two sides.

3.3.　C　Co-integration Testing

The premise of co-integration relation is that two time serials meet the term of same integration, which shows there exists a kind of equilibrium relation in the long run between two sides.[3] In order to test two sides x_t and y_t is co-integration or not, Engle and Granger put forward two-steps testing method, called EG testing.

According to the above method, we make certain there exists co-integration relation between LNFDI and LNGDP in Liaoning province. Firstly, we verified that LNGDP and LNFDI of Liaoning province is 1st rank integration, and makes regression analysis using LNGDP to LNFDI. [4]The equation as follows:

$$LNGDP_t = b_0 + b_1 LNFDI_t + e_t$$

$\hat{b}_0$ and $\hat{b}_1$ indicate estimation value of regression coefficients, and residual estimation value is $\hat{e}_t$.

$$\hat{e}_t = LNGDP_t - LNG\hat{D}P_t$$

Secondly, we test the evenness of residual serial. If $\hat{e}_t$ is even serial, there exists co-integration relation between LNGDP and LNFDI. According to the above method, based on data from 2000 to 2008 and Eviews software, we get the regression results of Liaoning province as follows:

$LNGDP_i$=4.648220+0.706565 LNFDI$_t$
　　　(5.164663) (4.726126)

R^2=0.761387, adjust R^2=0.727300, F=22.33626, P=0.0021, and its residual serial is e_t =. LNGDP$_t$-4.648220-0.706565 LNFDI$_t$ .The value of the brackets in the above equation shows T testing value, and the following same.

Then according to EG testing method, we need to test the evenness of residual serial in order to verify there exists co-integration between LNGDP and LNFDI, so make unit-root testing. The result as followings in Table 3. ADF statistics value of $\hat{e}$ is -1.797927,less than critical value -1.6382 at the marked level of 10%, so residual serial is even,which shows there exists a long-term equilibrium between LNGDP and LNFDI in Liaoning province.

TABLE III UNIT-ROOT　TESTING　RESULTS OF RESIDUAL SERIAL

ADF Test Statistic	-1.797927	1%　Critical Value*	-2.9677
		5%　Critical Value	-1.9890
		10% Critical Value	-1.6382

4.　Conclusion

This paper makes co-integration testing about the relation between FDI and GDP in Liaoning province by the co-integration theory, and the result shows that there exists a long-term even equilibrium between FDI and GDP in Liaoning province. FDI influences economic growth in Liaoning province by some action channels, for example capital formation, trade, employment, technology spill over and so on. Result of co-integration testing shows function elasticity of FDI on economic growth in Liaoning province is 0.71, which shows that FDI increases by one unit, and GDP increases by o.70 unit. From the results, FDI has promoted the economic growth in Liaoning province. In fact, GDP and FDI in Liaoning province have formed good mutual promotion relation..

FDI is one resource of promoting economic growth of Liaoning province. [5]In the future, Liaoning should take more measures to absorb FDI. Firstly, try to improve investment environment. Based on improved hard environment, make use of superial terms of soft environment to absorb FDI. Secondly, guiding investment direction to improve investment quality and benefit. Guide FDI to invest in tertiary industry which is beneficial to upgrading of industrial structure. Guide foreign businessmen to increase investment on technology-intensive industry. Thirdly, coordinate regional distribution of FDI in Liaoning province. In order to reduce the gap of economic development among regions, we should exert the comparative advantages of big cities and coastal cities continuously, meanwhile speed up the step of utilizing FDI of north-western region of Liaoning. Fourthly, enhance the employment effect of FDI. The direct driving force of FDI to the employment of Liaoning is obvious, and in each year FDI enterprises absorb a large number of labor forces. On the whole, the relative proportion of employment is not high. Purchasing civil intermediate products of FDI enterprises is one main channel of forming indirect employment, so strengthen the relevancy degree between foreign enterprises and local enterprises to increase indirect employment. At last, deal with internal capital and foreign capital correctly. Avoid foreign capital cuts down the development room of internal-funded enterprises when utilizing foreign capital according to development needs. The influence degree of foreign capital to economic development depends on the technology spillover of foreign-funded enterprises to domestically-funded enterprises. Combining with technological absorptive capacity or potency of domestically-funded enterprises, Assessing technology level of foreign-funded enterprises and importing items selectively is more meaningful.

5. References

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