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Empirical Study on the Relationship between FDI and Economic Growth in Shanghai

***[1]Zhen Yu, [2]Hong-jiang Li**

*[1]Zhen Yu, school of business, university of shanghai for science and technology, Shanghai, China.
[2]Hong-jiang Li, school of business, university of shanghai for science and technology, Shanghai, China.

Email: *[1]yuzhensharon@sina.com
[2]lhjmoye@126.com

Abstract–The study analyzes the relationship between FDI and economic growth based on the data of GDP and actual absorption of FDI in Shanghai from 1981 to 2011. The cointegration analysis on them indicates that FDI and economic growth indeed has a long-term and stable equilibrium relationship. The Granger causality test further suggests that real value of actual absorption of FDI Granger-causes the real GDP, but actual absorption of FDI don't Granger-cause real GDP. However, the error correction model built afterwards supports that the short–term changes of the real value of the actual absorption of FDI has almost no influence on the real GDP.

Key words–FDI; Economic growth; Cointegration analysis; Granger causality test; Error correction model

1. Introduction

Economic growth has long been one of the most crucial subjects in the macro economy. Economic growth refers to the expansion of potential productivity of the products and services that a certain economic system provides to its people, or in other words, the outward expansion of the production-possibility curve. The main accounting indicator is Gross Domestic Product (GDP). Capital element is one of the main driving forces of the economic growth, while FDI is one of the key components of capital elements in an open economic system. Therefore, it becomes especially necessary to do some research on the relationship between FDI and economic growth in an open economic system.

As for Shanghai, it is of even more special practical significance to do researches on the relationship between FDI and economic growth for the following reasons. Firstly, although the GDP per capita of Shanghai has long been in the first place among the mainland provinces, municipalities and autonomous regions in China, people's living standard still has a relatively large gap compared with those cosmopolitan metropolis such as New York, London and Tokyo and so on. Secondly, similar to the overall conditions of the Chinese continent, Shanghai also faces lots of social and economic problems such as unemployment, social security and environmental pollution and so on. The last but not the least, in recent years, Shanghai is committed to building itself as China's economic, financial, trade and shipping center. To solve all the these problems and achieve all these objectives, the large amount of capital, advanced technologies and management experiences that may brought by FDI , are still critical impetus, moreover, the sustained and healthy economic growth is also an important guarantee for that. All in all, if we can obtain something useful from the research on the relationship between FDI and economic growth, then it will add more advantages to the further development of Shanghai.

A large number of studies have been conducted to identify the relationship between FDI and economic growth, but no consensus has emerged.

Owing to different method and data being used, the literature on the relationship between FDI and economic growth can be classified into five groups.

The first group emphasizes positive contributions of FDI on economic growth (e.g., Romer, 1986; Coe & Helpman, 1995; Balasubramanyam, Salisu & Sapsford, 1996; Campos & inoshita, 2002; Durham, 2004). For example, Balasubramanyam et al. (1996) employs a new growth theory framework to examine the role FDI played in the economic growth of developing countries with different trade policy regimes. They demonstrate empirically that FDI has a positive and significant effect on economic growth by using annual average data on a cross-section of 46 developing countries from 1970 to 1985. Campos and Kinoshita (2002) examine the effect of FDI on economic growth for 25 central and eastern European and former Soviet Union economies. Their results indicate that FDI had a significant positive effect on the selected countries' economic growth. Durham (2004) examines the effects of FDI on economic growth using data on 80 countries from 1979 through 1998. His empirical results suggest that the FDI effect on the absorptive capacity of the host country, particularly with respect to financial and institutional development.

In contrast, the second group holds the opinion of positive contributions of economic growth on FDI (e.g., Cardoso & Fishbowl, 1989; Howdy, 1995). For example, by examining the data in Latin America, Cardoso and Fishbowl (1989) point out that economic growth is the main reason of FDI. In order to test the hypothesis that FDI can improve the host's production efficiency, Howdy (1995) selects the data of five typical countries (Mexico, Brazil, Chile, Singapore and Zambia) with a large influx of FDI, then reaches the conclusion: FDI does not help improve the host country's production efficiency, in the contrary, the host country's production efficiency and the existing factor endowments do attract large inflows of FDI.

The third group views that there are positive interactions between FDI and economic growth (e.g., Feng, 2003; Zhang, 2005). For example, Based on the panel data of 28 provinces, autonomous regions and municipalities directly under the Central Government (except Chongqing, Tibet and Hainan) in the mainland of China from 1984 to 2002, Zhang (2005) starts from horizontal and vertical angles, and takes advantage of unrelated regression method, finally reaches the conclusion that there is a positive correlation between FDI and regional economic growth.

The fourth group argues that there is no direct relationship between FDI and economic growth. For example, Carkovic and Levine (2002) tried to assess the relationship between FDI and economic growth for 72 countries. Their results indicated that for both developed and developing economies, FDI inflows did not exert any independent influence on economic growth.

While the last group indicates that FDI can do harm to economic growth. For example, Alfaro et al. (2002) indicated that FDI had a negative effect on growth, confirming the hypothesis that insufficiently developed financial markets and institutions can diminish the positive effects of FDI. Right here, we extract FDI and GDP data of Shanghai from 1981 to 2011, to explore the relationship between FDI and economic growth in Shanghai.

2. Methodology

2.1. Unit root tests

In this study, we have done Stationary Tests to the time series such as LNRGDP (natural logarithm of real GDP) and LNRFDI (natural logarithm of real value of actual absorption of FDI).The main method for Stationary Test is Unit Root Test, while the extensive method for Unit Root Tests is ADF (Augment Dickey-Fuller) Test.

Take the LNRGDP time series as an example, the ADF test is completed through the following three models.

Model 1: $\Delta \mathrm{LNRGDP}_t = \delta \mathrm{LNRGDP}_{t-1} + \sum_{i=1}^{n} \beta_i \mathrm{LNRGDP}_{t-i} + \varepsilon_t$

Model 2: $\Delta \mathrm{LNRGDP}_t = \alpha + \delta \mathrm{LNRGDP}_{t-1} + \sum_{i=1}^{n} \beta_i \mathrm{LNRGDP}_{t-i} + \varepsilon_t$

Model 3: $\Delta \mathrm{LNRGDP}_t = \alpha + \beta t + \delta \mathrm{LNRGDP}_{t-1} + \sum_{i=1}^{n} \beta_i \mathrm{LNRGDP}_{t-i} + \varepsilon_t$

The variable t in model 3 represents time trend. Model 2 has an additional constant item α compared with model 1, and model 3 has an additional item βt that represents time trend. The null hypotheses of the three models are all $\delta=0$, which means there only exists one unit root. In the actual inspection, it often conducts in the sequence of model 3, 2, 1 rather than the adverse sequence. The inspection stops right after the test refuses the null hypothesis, or in other words, accepts that the tested series is stationary. Otherwise, it will continue the inspection until it finishes the test to model 1.

For other time series such as LNRFDI, the models used in the ADF tests are similar to the above analysis.

2.2. Cointegration analysis

If we can prove that LNGDP and LNRFDI are both integrated of 1 variable, we can do Cointegration Regression to them. One of the methods for cointegration test is two-step test or in other words EG Test which was put forward by Engle and Granger in 1987.

Assume that LNRGDP and LNRFDI have the following relation:

$$\mathrm{LNRGDP}_t = \alpha_0 + \alpha_1 \mathrm{LNRFDI}_t + \varepsilon_t \quad (1)$$

Step 1: use OLS (Ordinary Least Square) to estimate the equation (1) and calculate the non-equilibrium error $\hat{e}_t$;

Step 2: use ADF Test to inspect the Single Integrity of $\hat{e}_t$. If $\hat{e}_t$ is a stationary series, we believe that LNRGDP_t and LNRFDI_t are (1, 1) order cointegration; if $\hat{e}_t$ is a series of single integration of order one, we believe that LNRGDP_t and LNRFDI_t are (2, 1) order cointegration.

2.3. Error correction model

Assume that the long-term equilibrium relationship between LNRGDP and LNRFDI are as equation 1 shows, as LNRGDP and LNRFDI in the real economy rarely have opportunities to be at the equilibrium point, so what we actually see in reality is the short-term or non-equilibrium relations between LNRGDP and LNRFDI. Assume that they have the following (1, 1) order Distributed-lag form:

$$\mathrm{LNRGDP}_t = \beta_0 + \beta_1 \mathrm{LNRFDI}_t + \beta_2 \mathrm{LNRFDI}_{t-1} + \delta \mathrm{LNRGDP}_{t-1} + \varepsilon_t \quad (2)$$

This model shows that the value of LNRGDP at the period of t, not only relates to the changes of LNRFDI, but also the value of LNRGDP and LNRGDP at the period of $t-1$.

As the variables studied maybe un-stationary, so we can not directly use the the method of OLS. Do some appropriate deformation of the equation (2), we can get the following equation:

ΔLNRGDP$_t$=β_0+$\beta_1\Delta$ LNRFDI$_t$+(β_1+β_2)* LNRFDI $_{t-1}$-(1-δ)LNRGDP $_{t-1}$ +ε_t

$$=\beta_1\Delta\text{LNRFDI}_t-(1-\delta)(\text{LNRGDP}_{t-1}-\frac{\beta_0}{1-\delta}-\frac{\beta_1+\beta_2}{1-\delta}\text{LNRFDI}_{t-1})+\varepsilon_t$$

or ΔLNRGDP$_t$=$\beta_1\Delta$LNRFDI $_t$-λ(LNRGDP $_{t-1}$ -α_0-α_1LNRFDI $_{t-1}$)+ ε_t (3)

in which λ=(1-δ) , α_0= $F=\frac{(RSS_R-RSS_U)/\text{m}}{RSS_U/(n-k)}$,

$$\alpha_1=\frac{\beta_1+\beta_2}{1-\delta}$$

if the parameters α_0、α_1 in the equation (3) are considered equal to the corresponding parameters in the equation 1, the item in the brackets of equation (3) is exactly the non-equilibrium model of the t-1 period. Therefore, the equation (3) indicates that the changes of LNRGDP is determined by the changes of LNRFDI and the degree of non-equilibrium of the former period. At the same time, equation (3) has made up for the deficiencies of the simple differential, because the equation has the degree of non-equilibrium of the former period that is represented by the horizontal value of LNRFDI and LNRGDP, besides, the value of LNRGDP has corrected the degree of non-equilibrium of the former period.Therefore, equation (3) is called as First-order Error Correction Model.

We can also put the equation as the following form:

ΔLNRGDP$_t$=$\beta_1\Delta$LNRFDI $_t$-λecm_{t-1}+ ε_t (4)

in which the *ecm* represents the item of error correction.

One of the methods to establish the error correction model is the Engle-Granger two-step test method:

Step 1: use the OLS method to do cointegration regression to the variables to test the cointegration relationship between them, and also to estimate the long-term equilibrium parameters;

Step 2：if there does exist the cointegration relationship, then add the residul gotten from the first step to the error correction model as a non-equilibrium error term , and then, use the OLS method to estimate the correspongding parameters.

2.4. Granger test of causality

For the two variables of LNRGDP and LNRFDI, Granger Test of Causality requires to estimate the following regression:

$$\text{LNRGDP}_t=\sum_{i=1}^{m}\alpha_i\text{LNRFDI}_{t-i}+\sum_{i=1}^{m}\beta_i\text{LNRGDP}_{t-i}+\varepsilon_{1t} \quad (5)$$

$$\text{LNRFDI}_t=\sum_{i=1}^{m}\lambda_i\text{LNRGDP}_{t-i}+\sum_{i=1}^{m}\delta_i\text{LNRFDI}_{t-i}+\varepsilon_{2t} \quad (6)$$

It will probably have four different results:

(1)LNFFDI has unidirectional impact on LNRGDP, it is indicated from the fact that the parameters before each lagged item of the LNRGDP in the equation (6) are not all zero as a whole,while he parameters before each lagged item of the LNRGDP in the equation (5) are all zero as a whole;

(2)LNRGDP has unidirectional impact on LNFFDI, it is indicated from the fact that the parameters before each lagged item of the LNRGDP in the equation (6) are not all zero as a whole,while he parameters before each lagged item of the LNRGDP in the equation (5) are all zero as a whole;

(3)There are bidirectional impact between LNRGDP and LNRFDI, it is indicated from the fact that the parameters before each lagged item of LNRGDP and LNRFDI are not all zero as a whole;

(4)There are not any impact between LNRGDP and LNRFDI , it is indicated from the fact that the parameters before each lagged item of LNRGDP and LNRFDI are all zero as a whole.

The Granger Test of Causality is completed by constraint F test. As to the null hypothesis that LNRFDI is not the Granger cause of LNRGDP, if the calculated value of F test is bigger than the correspongding critical value of F distribution $F_\alpha(m, n\text{-}k)$under the given confidence level α, then the assumption is refused and it comes to the conclusion that LNRFDI is the Granger cause of LNRGDP. The judges of the other three test results are similar to the first result.

3. The empirical analysis of the relationship between FDI and economic growth

3.1. Explaination of the data

The paper adopts the data of FDI and GDP of Shanghai from 1981 to 2011, in which the FDI is the actual absorption of FDI. The sources of the data include *Statistical Yearbook of Shanghai* and *Economic and Social Development Statistical Bulletin of Shanghai in 2011*, as the actual aborsorption of FDI are all accounted in dollar, we exchanges the dollars to RMB at the correspongding exchange rate from1981 to 2011 so that it can be consistent with the unit of GDP. Besides ,to eliminate the influence to the stability of the data brought by the flutuations of the price level,we use the data in 1981 as the base period, and then use the CPI of each year to deflate the FDI time series and GDP series, thus the nominal values are converted into the actual values and we record them in turn as RFDI and RGDP. At last, we adopt the natural logarithm of all the real value of FDI and GDP and record them in turn as LNRFDI and LNRGDP.

3.2. Analysis of correlation

Enter the data of LNRGDP and LNRFDI of Shanghai from 1981 to 2011 to the econometric software EVIEWS6.0, then we can check the correlation matrix between LNRGDP and LNRFDI, as the following form show:

Table 1. Correlation matrix between LNRGDP and LNRFDI

	LNRGDP	LNRFDI
LNRGDP	1.0000	0.7905
LNRFDI	0.7905	1.0000

Through the form, we can indicate that the correlation coefficient of the two time series is relatively high. As a result, we can guess that there may exist good traits of the cointegration and Granger causality between LNRGDP and LNRFDI .we have to do single integration test to the data of time series and their differences because the prerequisite for the cointegration analysis is that the data to be examined must be single integrated.

3.3. Stationarity test

3.3.1. Graphic test

The time trend path of LNRGDP and LNRFDI is shown in the figure 1, as stationary time series data on the graph is often manifested in a process of constant fluctuation around its mean value, so we can come to the preliminary judgment that LNRGDP and LNRFDI are both non-stationary.

3.3.2. Unit root test

As for the stationary test to time series data, intuitive graphical test method is just preliminary and cursory inspection, unit root tests are more in-depth and accurate. ADF test is widely used in the unit root tests.

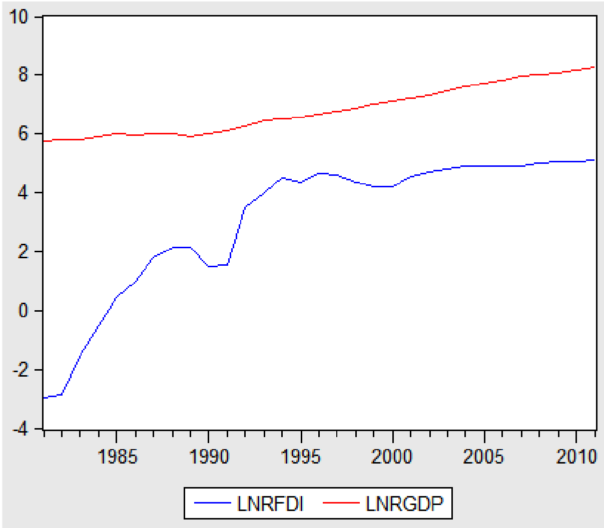

Figure 1. Time trend path of LNRGDP and LNRFDI

Firstly do the test to LNRGDP using the model 3,2,1 in the ADF test program with the econometric software EVIEWS6.0, take a 5% confidence level,the result is shown in the table 2, analysis indicates that the LNRGDP is non-stationary series; secondly, we do test to D(LNRGDP) which is the first-order differential of LNRGDP, also take a 5% confidence level, the result is shown in the table 2, analysis shows that D(LNRGDP) is stationary time series. Therefore, D(LNRGDP) is integrated of 1 variable.

Table 2: Result of stationary test of LNRGDP and D(LNRGDP) time series

	Test model	T statistics	Critical value at confidence level 5%	Test result
LNRGDP	Model 3	-2.1789	-3.5742	non-stationary
	Model 2	0.6343	-2.9678	non-stationary
	Model 1	2.7766	-1.9529	non-stationary
D(LNRGDP)	Model 3	-3.2688	-3.5742	non-stationary
	Model 2	-3.1252	-2.9678	non-stationary

By the same method and programe, we can get the conclusion that LNRFDI is also integrated of 1 variable.

As a result, on the one hand, as LNRGDP and LNRFDI are both non-stationary time series, so we cannot directly do OLS estimation to them, or it may cause spurious regression problem. On the other hand, as the two time series are both single-integrated in first order, we can do cointegration analysis to them.

3.4. Cointegration analysis

It can be indicated from the result of unit root test that both LNRGDP and LNRFDI are non-stationary time series; however, non-stationary time series may become stationary through linear combination, and both of them can be single integrated in the same order, so we can commit cointegration analysis to LNRGDP and LNRFDI.

Now we use Engle-Granger two-step method to test whether there exists cointegration relation between LNRGDP and LNRFDI.

Step 1: according to the result of OLS estimation of the model 1 with the software EVIEWS6.0, we can get the linear regression model of LNRGDP and LNRFDI:

$LNRGDP_t$ =5.9816+0.2715$LNRFDI_t$ (7)
t statistics (39.4300) (6.9505)
p value of t 0.0000 0. 0000
R^2=0.6249 adjusted R^2=0.6120
D.W. = 0.0862 F = 48.3099

The value of D.W. in equation (7) is just 0.0862, which indicates that there may probably exist apparent first-order correlation. Furthermore, the *p* value of LM (1) gotten from the Lagrange Multiplier Test is 0.0000, at the 5% confidence level, this result refuses the null hypothesis, and suggests that (7) does exist first-order correlation. Because of this, we add two lagged variables $LNRFDI_{t-1}$ and $LNRGDP_{t-1}$to (6), and use OLS to estimate the new linear regression model:

$LNRGDP_t$ =0.0198+0.0377$LNRFDI_t$-0.0234$LNRFDI_{t-1}$+ 1.0014$LNRGDP_{t-1}$ (8)
p value of t 0.8638 0.0930 0.2492 0.0000
R^2=0.9967 adjusted R^2=0.9963
D.W.=1.4914 F=2625.853

The D.W.value is 1.4914 and furthermore, the *p* value of LM(1) gotten from the Lagrange Multiplier Test is 0.1382, at the 5% confidence level, this result suggests that equation (8) does not exist first-order correlation. However, the *p* value of t statistics of constant item and $LNRFDI_{t-1}$ are 0.8638 and 0.2492, under confidence level 5%, this indicates that the two items in the regression equation are not significant. Therefore, we eliminate these two items and estimate the following linear regression model:

$LNRGDP_t$ =0.0109$LNRFDI_t$+ 1.0068$LNRGDP_{t-1}$ (9)
p value of t 0.0337 0.0000
R^2=0.9965 adjusted R^2=0.9964 D.W.=1.3044

At the 5% confidence level, the *p* value of t statistics of $LNRFDI_t$ and $LNRGDP_{t-1}$ in equation (9) are in respect 0.0337 and 0.0000, which indicates that the equation does not exist first-order correlation. R-squared coefficient and adjusted R-squared coefficient both exceed 0.99 which suggests that the goodness-of-fit of the equation is very high. All these good traits shows that (9) is the good equation that reflects the long-term relation between LNRGDP and LNRFDI. We can furtherly get the non-equilibrium error $\hat{e}_t$.

Step 2: use ADF test to check the single integration of $\hat{e}_t$. Do test to $\hat{e}_t$ series using model 3, 2, 1 in turn, the result is shown in table 3. Through the analysis of *p* value of t statistics, we can conclude that at the 5% confidence level, the test result of model 2 and model 1 indicates that $\hat{e}_t$ series itself is stationary, or in other words is integrated of 0 variable. Furthermore, we believe that there exists cointegration between LNFGDP and LNRFDI, and is in (1, 1) order, which indicates that the two series has long-term and stable equilibrium relationship. Equation (9) is the quantification of this relationship which suggests that RGDP will increase 0.0109% every time the RFDI increases 1% in the long-term.

Table 3. Result of Stationarity test to $\hat{e}_t$ series

	Test Mode	*p* value of t
$\hat{e}_t$	Model 3	0.0601
	Model 2	0.0029
	Model 1	0.0001

3.5. Granger test of causality

Cointegration analysis explains that there is a long-term and stable equilibrium relationship between LNRGDP and LNRFDI, but whether the relationship is causality is still open to inspection.

We take Granger causality test of LNRGDP and LNRFDI in EVIEWS6.0, The results are shown in table 4.The second column is the Null Hypothesis, and "—×—＞" stands for "the former variable does not Granger Cause the latter variable". The third , fourth and fifth column are respectively *p* value of Statistic F, AIC(Akaike Info Criterion) value of the test model and *p* value of LM(1) of Lagrange Multiplier Test of the test model under each lag length. Here we choose 2% as the confidence level, because we will lose half of the test conclusions if we choose 5%. Consider the test model aiming at the Null Hypothesis that "LNRFDI does not Granger Cause LNRGDP" under lag length of 8, its *p* value of LM (1) of Lagrange Multiplier Test is 0.0001. Under the confidence level of 2%, we determine that the test model has first-order autocorrelation. So does the test model aiming at the Null Hypothesis that "LNRGDP does not Granger Cause LNRFDI" under lag length of 9. Owing to their inspection failure, we ignore the two test models. Similarly, under the confidence level of 2%, the test models under lag length from 2 to 7 remain valid. Therefore further investigations are needed. From the angle of Akaike Info Criterion, when the lag length reaches to 5, AIC value of the test model aiming at the Null Hypothesis that "LNRGDP does not Granger Cause LNRFDI" is smaller than the test model aiming at the same Null Hypothesis under lag length from 2 to 4, and when the lag length reaches 6 and 7, the AIC value is still decreasing. On the other hand, when the lag length reaches 5, the AIC value of the test model aiming at the Null Hypothesis that "LNRFDI does not Granger Cause LNRGDP" reaches the minimum, and when the lag length reaches 6 and 7, the ACI value rebounds. So we determine that the test models under lag length of 6 and 7 are ineffective, we ignore both of them. Then after synthesizing the inspection from the angles of Lagrange Multiplier Test and Akaike Info Criterion, we believe that the test models under lag length of 5 are relatively more reasonable. In that case, under the confidence value of 2%, we refuse the Null Hypothesis that "LNRFDI does not Granger Cause LNRGDP", and accept the Null Hypothesis that "LNRGDP does not Granger Cause LNRFDI". In fact, accompanied with lag length changing from 2 to 5, the possibility of refusing the Null Hypothesis that "LNRFDI does not Granger Cause LNRGDP" is increasing, while the possibility of refusing the Null Hypothesis that "LNRGDP does not Granger Cause LNRFDI" is decreasing .That is to say, LNRFDI does Granger Cause LNRGDP, while LNRGDP does not Granger Cause LNRFDI. Therefore, we can get the conclusion that there is a one-way Granger Causality from LNRFDI to LNRGDP. In other words, it is the changes in FDI that result in the changes in GDP, and the reverse does not hold.

Then we will do some theoretical analysis based on the previous Granger causality test.

One form of Macroeconomic Cobb-Douglas production function can be stated as $Y=AL^{\alpha}K^{\beta}\mu$, in which, Y stands for the total output, A stands for comprehensive technical level, L and K respectively stand for labor input and capital input, α and β stand for the coefficient of elasticity of the labor output and capital input, μ stands for random interference, $0<\mu<1$.

Under the framework of Cobb-Douglas production function $Y=AL^{\alpha}K^{\beta}\mu$, we argue that as a foreign capital force, FDI plays a significant role in promoting the capital factor, technical elements and labor factor of the received region.

Firstly, FDI, especially FDI in the form of capital inflow, can directly supplement the local capital stock. Secondly, FDI can create technology spillover effects. Take the manufacturing industry of Shanghai for example, according to the analysis of Huixian, Cai (2009), in the industries with lower export-oriented degree, when the capital of enterprises with foreign investment increases by every 1%, it will make the output of enterprises with domestic investment increase by 0.6915%. By contrast, in the industries with higher export-oriented degree, when the capital of enterprises with foreign investment increases by every 1%, it will make the output of enterprises with domestic investment increase by 0.5507%. That is to say, the lower the export-oriented degree of the industries is, the more obvious the technology spillover effects that the enterprises with foreign investment exert on the enterprises with domestic investment are. Lastly, FDI can enlarge domestic labor stock by increasing local employment. Huirong, Wang (2010) analyzes that from the respects of both direct and indirect effects, and concludes that FDI can not only directly increase local employment through foreign-funded enterprises, but also indirectly promote local employment by driving the development of its upstream and downstream enterprises. In summary, under the framework of Cobb-Douglas production function $Y=AL^{\alpha}K^{\beta}\mu$, FDI can play a catalytic role in A, L and K, and then promote the expansion of production and boost economic growth.

Table 4: Granger causality test of LNRGDP and LNRFDI

Lag Length	Null Hypothesis	*p* Value of F	AIC Value	*p* Value of LM(1)	Conclusion
2	LNRFDI—×—> LNRGDP	0.7462	-3.0245	0.7706	Accept
	LNRGDP—×—> LNRFDI	0.0127	0.8094	0.2557	Refuse
3	LNRFDI—×—> LNRGDP	0.0413	-3.1321	0.5310	Accept
	LNRGDP—×—> LNRFDI	0.0131	0.8072	0.7235	Refuse
4	LNRFDI—×—> LNRGDP	0.0467	-2.9690	0.0234	Accept
	LNRGDP—×—> LNRFDI	0.0579	0.9120	0.1903	Accept
5	LNRFDI—×—> LNRGDP	0.0175	-3.2582	0.6769	Refuse
	LNRGDP—×—> LNRFDI	0.0214	0.7861	0.0213	Accept
6	LNRFDI—×—> LNRGDP	0.3205	-3.0834	0.2328	
	LNRGDP—×—> LNRFDI	0.0104	0.5314	0.1205	
7	LNRFDI—×—> LNRGDP	0.1036	-3.1565	0.8108	
	LNRGDP—×—> LNRFDI	0.0837	0.5735	0.6654	
8	LNRFDI—×—> LNRGDP	0.3843	-2.9181	0.0001	
	LNRGDP—×—> LNRFDI	0.1594	0.4917	0.0455	
9	LNRFDI—×—> LNRGDP	0.0088	-3.7693	0.1046	
	LNRGDP—×—> LNRFDI	0.1342	-0.4406	0.0011	

3.6 Error correction model

The previous cointegration analysis indicates that there exists long-term equilibrium relationship between LNRFDI and LNRGDP, but in short-term, this relationship may be disturbed. According to the Granger Representation

Theorem that was put forward by Engle and Granger in 1987,if Y and X are co-integrated, then the short-term equlibrium relation between them can always find a Error Correction Model to express this relationship:

$$\Delta Y_t=\text{lagged}(\Delta Y,\Delta X_t)-\lambda\, ecm_{t-1}+\varepsilon_t\ ,\ 0<\lambda<1 \quad (10)$$

in which ecm_{t-1} is non-equilibrium error term or long-term equilibrium deviation, λ is short-term adjusted parameter. As a result, we can try to establish an error correction model to show the deviation of short-term fluctuations on its long-term trends. The preliminary result of the error correction model established by Engle-Granger two-step method is:

$\Delta LNRGDP_t = 0.0200\Delta LNRFDI_t + 0.9727\Delta LNRGDP_{t-1} - 0.6637ecm_{t-1}$ (11)

p value of t 0.2499 0.0000 0.0065

$R^2=0.2960$ adjusted $R^2=0.2419$ D.W.=1.8669

On the one hand, the p value of t statistics of $\Delta LNRFDI_t$ in equation (11) is 0.2499, at the 5% confidence level, it can not pass the test of variable significance which indicates that the explanatory power of $\Delta LNRFDI_t$ to $\Delta LNRGDP_t$ is not strong. On the other hand, the value of D.W. is 1.8669 and the p value of the LM(1) from the Lagrange Multiplier Test is 0.4396, which indicates that equation (11) does not exist autocorrelation in first-order, so there is no need to add lagged items of variable differential.Therefore, we get a new Error Correction Model after eliminating the item of $\Delta LNRFDI_t$:

$\Delta LNRGDP_t = 1.005\Delta LNRGDP_{t-1} - 0.6082ecm_{t-1}$ (12)

p value of t 0.0000 0.0104

$R^2=0.2585$ adjusted $R^2=0.2310$ D.W.=1.8719

The D.W. value in equation (12) indicates that it does not exist first-order autocorrelation, both $\Delta LNRGDP_{t-1}$ and ecm_{t-1} have passed the variable test of significance, and also the coefficient of ecm $_{t-1}$ is a negative number which conforms the principle of reverse correction, but the R-squared coefficient and adjusted R-squared coefficient both does not exceed 0.26, which suggests that the goodness-of – fit of the equation is very low. It furtherly indicates that the influence factors of the short-term fluctuations of LNRGDP are far from just $LNRGDP_{t-1}$ and ecm $_{t-1}$, there are still other factors waiting to be studied.

4. Conclusion

In this paper, we firstly have proved that time series LNRFDI and LNRGDP are both non-stationary, and also integrated of 1. Then through cointegration analysis, we find that there does exist long-term stationary equilibrium relationship between LNRFDI and LNRGDP: in the long-term, when RGDP increases by 0.0109% ,it will make RFDI increase by 1%. The Granger causality test further indicates that there exists LNRFID to LNRGDP one-way Granger causality between LNRFDI and LNRGDP, in other words, the changes of RFDI will cause the changes of RGDP, or it can be stated that FDI will promote economic growth. However, the Error Correction Model built afterwards shows that the short-term changes of LNRFDI rarely has any explanatory power to the short-term fluctuations of LNRGDP, the short-term fluctuations of LNRGDP are caused by other factors.

Therefore, it becomes a crucial proposition to find ways to attract larger and more qualified FDI to promote the economic growth of Shanghai. Through this study, we hold that Shanghai Municipal Government can make endeavors from the following aspects:

Firstly, based on the fact that Shanghai is building itself as the economic and trade center of the continent and international financial and shipping center, Shanghai should focus on the absorption efficiency type of FDI, seek all kinds of excellent factors of production and bring them to shanghai to conduct highly efficient integration, seek for a relatively high economic and social benefits.

Secondly, for the purpose of overall benefits, Shanghai should promote the absorption of FDI from the focus on quantity to the focus on quality; in respect to the introduction of technology, we should transform from the mold of focusing on the simple introduction of technology to the focus on the digestion and absorption and the afterward innovation; in terms of the absorption and good use of FDI, we should also pay great attention to the transformation from absorbing FDI through the advantage of market and resources to the reasonable integration and optimization of the internal and external resources in Shanghai.

Thirdly, conduct various kinds of investment activities and build a new system of attracting investment; broaden the channels of absorbing FDI, explore new ways of the utilization of foreign capital; strengthen the intensity of the use of FDI in the construction of infrastructure and promote the reform of the investment and financing system of urban infrastructure.

The last but not the least, Shanghai should focus on the improvement of the soft environment of the absorption of FDI, and gradually cultivate the innovative spirit and culture of a cosmopolitan modern metropolis [15-22].

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