A Study on the nonlinear relationship between two-way FDI and industrial structure in China

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Abstract: This paper further studied the relationship between Chinese two-way FDI and its industrial structure effect by using the Nonlinear Granger Causal Test. It shows that, the one-way nonlinear Granger relationship does exist from FDI to the industrial structure. Meanwhile, it also exists that the one-way nonlinear relationship from Chinese OFDI to the upgrade of industrial structure, with an obvious time-lag. This phenomenon illustrates that the industrial structure effect from OFDI will be prominent increasingly, while not obvious at present.

1. Introduction

Dunning (1986) pointed that the net OFDI (OFDI minus FDI) in one country will change along a certain path with the improvement of economy and per capita GNP. Based on the study of Dunning, Cantwell and Tolentino (1987) came up with the theory of industrial structural upgrading caused by technological innovation, they attributed the upgrade of industrial structure in developing countries to the stable increase of technology, which is closely related to enterprises’ use of FDI and OFDI. So are there any causal relationships between two-way FDI and industrial structure? And how to use this law to promote Chinese industrial structure upgrading, which is what we pay attention to.

Chinese economy has continued a rapid growth in average of nearly 9% for 34 years since Opening-up, which is rarely seen all over the world. While accomplishing great achievements, the industrialization process in China has arrived at a diversion. Chinese per capita GDP in 2012 has arrived to $6028, according to the classical theory of industrial structure, once the per capita GDP in one country surpass to $6000, it has basically achieved industrialization. In terms of the industrial structure, in 1978, the production value in the primary industry, secondary industry and tertiary industry respectively accounts for 28.2%, 47.9%, 23.9%, while the number changed to 10.01%, 45.36%, 44.63%. The proportion of primary industry in the domestic economy has decreased sharply, the secondary industry held its original level, and the tertiary industry has shown an increase trend, which is slightly lower compared with the secondary industry. Regardless of the per capita GDP or the three industrial structures, China has gone into an important period of the industrial structure transformation.

At the same time, Chinese Opening-up to the outside world has also entered into a new historical stage, of which the stream of capital etc. has transformed from the one-way flow as major to both the double-way and one-way flow pay equal attentions. In 1982, the quantity of Chinese using FDI was 430 million dollars, while the outflow of OFDI was only 44 million dollars. By 2012, the quantity of Chinese FDI has arrived to 121.08 billion dollars, which accounted for 8.96% of the global, OFDI reached to 84.22 billion dollars, accounting for 6.1%. FDI is as 1.43 times as the quantity of OFDI, between which the gap decreased significantly. Considering of the developing phase in China and the gigantic flow quantity of FDI and OFDI, and the condition of FDI’s slowing growth and OFDI ‘s increasing growth, it
is necessary to study further about the relationship between two-way FDI and the upgrade of industrial structure, and then explore the causal relation between them.

2. Index selecting instructions and data source

The evaluation index to measure a country’s industrial structure level can be divided into two sorts: (1) Measuring the respective proportional relation among various industries to reflect their developing degree, that is according to the Petty-Clark Law, using the percentage of product value in secondary and tertiary industries as the evaluating standard of industrial structure upgrade, such as Chuihui Gan etc. (2011). (2) Regarding the product of proportion of productive output in respective sectors and labor productivity as the measure of industrial structural upgrading level, such as Xinmin Tian etc. (2012), Yonghui Han etc. (2016). This paper adopted Yonghui Han’s method which improved basing standard index mentioned above, as showed in equation (1).

\[ H = \sum_{i=1}^{n} \left( \frac{Y_i}{Y_t} \right) \left( \frac{LP_i}{LP_t} \right) \]  

In the equation (1), \( Y_t \) means the total output of industrial sector \( i \) during the period of \( t \), \( LP_t \) is the labor productivity of sector \( i \) in the time \( t \), \( LP_t \) is sector \( i \) ’s labor productivity after accomplishing industrialization, the terminal choice refer to Chenery et al. (1986), and \( n \) illustrates the total number of industrial sectors. The data used to measure the industrial structure level was selected from China Statistical Yearbook, The assembly of New China’s Statistical Data For 60 Years, The Statistical Yearbook of Chinese Labor.

We adopted the actual number of flow from 1982 to 2012 in China selected from United Nations conference on trade and development statistics to reflect FDI and OFDI.

3. The non-linear Granger analysis

3.1 Augmented Dickey-Fuller Test (ADF)

Firstly we took the Augmented Dickey-Fuller Test (ADF) for variables, whose result are shown in table 1, from that we can see every variables have their own unity roots, but their first order difference refused the null hypothesis of there exist roots of unity or accept the stable sequence in the 5% level.

| Variate | ADF | PP  | DF-GLS | KPSS | Roots of unity |
|---------|-----|-----|--------|------|----------------|
| OFDI    | -1.96 | -3.52 | -1.65 | 0.73 | Exist          |
| FDI     | -0.93 | -2.11 | -1.17 | 3.26 | Exist          |
| H       | 0.93  | 0.87 | -0.56 | 31.64 | Exist          |
| \( \Delta \)OFDI | -0.83*** | -6.13*** | -6.15*** | 0.04*** | No exist       |
| \( \Delta \)FDI | -9.11*** | -7.72*** | -3.54*** | 0.32*** | No exist       |
| \( \Delta \)H  | -5.28*** | -5.43*** | -1.92** | 0.04** | No exist       |

Annotation : numbers in chart reflect the corresponding statistical magnitude , ***、** and * mean the significant level of 1% , 5% and 10%.

3.2 Non-linear Test

Before we begin to study the nonlinear relationship between FDI, OFDI and industrial structure level, we need to investigate is there existing the dynamic variation trend between the industrial structural upgrading level and international investment through the nonlinear test. In the view of this, we adopted the VAR model to estimate the interactional relationship between FDI, OFDI and industrial structural level, to wipe out its linear elements. And used three test methods including BDS, RESET, McLeod Li to make a Non-linear Test of the residual sequences of linear part. As is shown in table 2, no matter which test methods we use, the majority of statistical magnitudes obviously refused the linear null hypothesis. From here we can conclude that in the process of interaction between FDI, OFDI and industrial
structural upgrading, it reflects obvious nonlinear dynamic variation trend due to the impact of international financial crisis, the restraint of institution, the periodic fluctuation of economy, and the improvement of technology so on.

### Table 2. Non-linear Test

|                | BDS Test | McLeod-Li Test | RESET Test | BDS Test | McLeod-Li Test | RESET Test |
|----------------|----------|----------------|------------|----------|----------------|------------|
| FDI’s regression residual based on the VAR system | 3.193*** | 13.453**       | 6.278**    | 2.601**  | 15.905**       | 5.839*     |
| (0.000)       | (0.041)  | (0.044)        |            | (0.013)  | (0.019)        | (0.069)    |
| OFDI’s regression residual based on the VAR system |          |                |            |          |                |            |
| Industrial structural level’s regression residual based on the VAR system | 5.372*** | 36.453***      | 0.240      | 1.781*   | 1.280          | 7.839**    |
| (0.000)       | (0.000)  | (0.887)        |            | (0.084)  | (0.999)        | (0.025)    |

Annot: (1) ***、** and * respectively means to refuse the nonlinear null hypothesis on the significant level of 1%、5% and 10%.

3.3 Nonlinear Granger causal test

With the development of nonlinear theory, it has been proved that traditional Granger Test cannot check out the nonlinear causal relationship between factors, and further generate obvious deviations (Hiemstra and Jones, 1994; Zhuo et al, 2009). In view of that, to further analyze the nonlinear relationship between FDI, OFDI and the industrial structural level, we adapted the test method put by Hiemstra and Jones (1994), to test the interactional relationship between them. No difference with the study of Diks (2008) and Zihui Yang(2010), we tested the linear factors wiped through VAR, and listed the 1-8 phases’ conclusion based on the common Lag Intervals for Endogenous in table 3.

### Table 3. Nonlinear Granger causal test based on VAR linear filtering

| Lx=Ly | Null hypothesis : FDI is not the nonlinear Granger causal result of industrial structural level | Null hypothesis : Industrial structural level is not the nonlinear Granger causal result of FDI | Null hypothesis : OFDI is not the nonlinear Granger causal result of industrial structural level | Null hypothesis : Industrial structural level is not the nonlinear Granger causal result of OFDI |
|-------|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| H-J statistical magnitude | P value | H-J statistical magnitude | P value | H-J statistical magnitude | P value | H-J statistical magnitude | P value |
| 1 | -0.112 | 0.544 | 0.807 | 0.209 | -0.719 | 0.764 | -1.158 | 0.876 |
| 2 | 0.463 | 0.321 | -0.588 | 0.721 | -1.230 | 0.890 | 0.106 | 0.457 |
| 3 | 1.079 | 0.140 | -0.656 | 0.744 | -1.392 | 0.918 | 1.359 | 0.861 |
| 4 | 1.286 | 0.099* | -0.478 | 0.683 | -0.940 | 0.826 | 1.377 | 0.824 |
| 5 | 1.261 | 0.083* | -0.028 | 0.511 | -0.912 | 0.819 | 1.440 | 0.734 |
| 6 | 1.381 | 0.083* | 1.563 | 0.509 | -0.949 | 0.828 | 1.541 | 0.611 |
| 7 | 0.915 | 0.080* | 1.307 | 0.505 | -0.713 | 0.076* | 1.394 | 0.821 |
| 8 | 0.840 | 0.020** | 1.296 | 0.597 | 0.436 | 0.033** | 1.478 | 0.609 |

Annot: (1) Lx=Ly means the Lag Intervals for Endogenous of residual sequence; (2) ***、** and * respectively reflect the significant level of 1%、5%、10%.

The table 3 illustrates that, there exists the nonlinear Granger causal relationship from FDI to
industrial structure level, that is, Chinese FDI significantly and stably impact the industrial structural level in nonlinear. That is because FDI promoted the increase of intermediate goods’ sorts and aggravation of products’ competition through the Market Competition Effect, and thus increase the demand of capital elements in the departments of intermediate goods and final goods; and at the same time, FDI also promoted the demand of capital materials in the research and development department through Technology Spillover Effect (Lucas, 1990). The increase of capital accumulation brought from foreign investment also directly lead to the change of relative demand of capital elements in every department, in the common impact of various effects, the capital concentrated industries improved rapidly, and thus promoted the industrial structural level.

Table 3 also illustrates that there exists the nonlinear relationship between Chinese OFDI and upgrade of industrial structure, but this nonlinear relationship has obvious time lag. It shows the theory that OFDI promotes the upgrading of domestic industrial structure through Reverse Technology Spillovers, Learning By Actions needs a long period to be seen in China. The reasons are as follows, on one hand, strategic asset seeking OFDI accounts for a half among the total quantity of OFDI in China, and commonly, the strategic asset seeking OFDI, with a large scale of investment and long cycle of return, can hardly achieve the acceleration of industrial structure in a short time (Nisha Jia etc. 2016); on the other hand, the imbalance among Chinese regions and industry development, as well as the Reverse Spillover Effect produced by OFDI is also imbalance, which lead the counteract of the promoting effect OFDI to industrial structure. The characteristics of Chinese OFDI, as well as the discrepancy reflected in different districts and industries because of reverse spillover effect will lead an obvious lag in terms of its Nonlinear Granger influence to the upgrading of industrial structure.

4. Conclusion
This paper tried to figure out the nonlinear relationship between two-way FDI and industrial structure by using nonlinear Granger Test. The results showed that, the one-way nonlinear Granger relationship dose exist from FDI to the industrial structure. Meanwhile, it also exists that the one-way nonlinear relationship from Chinese OFDI to the upgrade of industrial structure, with an obvious time-lag.

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