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Research on the relationship among financial development, foreign direct investment and industrial structure based on the panel smooth transition regression model

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ABSTRACT

The paper studies the non-linear impacts of financial development, foreign direct investment (FDI) and their interactions on the industrial structure based on the panel smooth transition regression (PSTR) model. The research results indicate that FDI exerts greater influence on the industrial structure against the background of financial development; as financial development enhances, the impact of FDI on the industrial structure is nonlinear, which gradually transforms from prevention to promotion; there is a substitution effect between financial development and FDI, which hampers the development of industrial structure.

KEYWORDS

Financial development; FDI; Industrial structure; PSTR model.

INTRODUCTION

Industrial restructuring has always been the focus of China's economic policies. Since the reform and opening up, foreign direct investment (FDI) plays a very important role in industrial structure optimization; meanwhile, with the establishment and improvement of the market economic system in China, financial resources play an increasingly larger part in resource allocation, and through allocating other resources, finance and financial development directly influence the industrial structure and industrial restructuring. Most of the existing related research only studied the impact of FDI and financial development on the industrial structure respectively; even if some literature mentioned the combined effects of FDI and financial development on the industrial structure, the focus is mainly about the mechanism of influence. For instance, Yin Xingshan etc. took the perspective of capital's screening functions, analyzed the different contributions of financial development and FDI respectively to the optimization of Ningbo's industrial structure; they believed that interest rate controls, inappropriate financial policies and unreasonable financial structure led to the result that the financial system cannot fully play its role in screening capital, thus limiting its function in the industrial structure optimization[1]. Xie Hanli analyzed systematically the mechanism of generating optimization effects on the industrial structure by financial development and FDI[2], but it has not been thoroughly studied on how FDI and financial development affect the industrial structure. Besides, existing studies suggest linear effects among various factors and ignore the threshold effect caused by China's regional economic differences.

Based on the above literature review, this paper takes the level of financial development as the conversion variable and uses the panel smooth transition (PSTR) model to study the impacts of financial development, FDI and their interaction on the industrial structure. Main characteristics and innovation of this paper are: 1. financial development is introduced in studying the impact of FDI on the industrial structure; 2. in the research of the process of industrial structure development, the substitution effect between financial development and FDI is also examined; 3. the PSTR model is employed to research the nonlinear features of the industrial structure development.

THEORETICAL HYPOTHESES AND MODEL SPECIFICATION

Theoretical hypotheses

Both FDI and financial development impact the industry structure by making production factors transfer among different industries, and there may be some interaction effects between them which influence the industrial restructuring. These features are determined by the dual function of financial resources which are not only under allocation but also can allocate other resources. There are two main ways of finance's influence on FDI's impact on the industrial structure: first, the key to the capital cumulative effect of FDI lies in how financial resource allocation plays the role of industry selection. The host country selects the source of FDI with the industry's development potential as a reference, focusing on developing the industrial sectors with comparative advantages, and giving priority to the pilot and radiation industries. The selection for FDI is the process of funds flowing and concentrating to high-quality industries; and during the process, the roles of policy selection mechanism and market selection mechanism should be well played. Policy selection refers to governments' direct or indirect intervention by means of credit tilt, different interest rates, capital market access restrictions and others, in order to achieve guidance on FDI and promote the optimization of FDI configuration among different industrial types. As for the market selection mechanism, it means through market competition, more and more financial resources flow to the industries or products with high marginal income. The government guides FDI mainly through the way of credit tilt. Through allocating credit resources, the government influences the direction of FDI to select industries and promotes industrial structure optimization. Second, the technology and knowledge spillover effects of FDI depend on the host country's own absorption capacity, in which financial market development is one of the most important elements. Financial development has played a critical role in promoting the technology spillover of FDI. Financial development supports the financing of intellectual property by means of indirect finance which is mainly dominated by bank credit and direct finance which mostly comes from the capital market; it also improves the effect of technology transfer in domestic technology enterprises, so that they can gradually get rid of dependence on the supply of FDI and achieve independent innovation. Wang Yongqi proved that financial development reduced the corporate financing costs, making it easy for entrepreneurs to get financial support while learning and acquiring foreign knowledge and technology, enabling diffusion and transfer of technology and access to technology spillovers[3]. Thus, in a country with developed financial markets, businesses and entrepreneurs can finance at a lower cost and achieve the absorption of foreign technology spillovers. Financial development ultimately promotes upgrading of the industrial structure by attracting FDI, providing financial services to foreign-funded enterprises, and transforming the potential spillover effects into practical productivity, Therefore, besides FDI, financial development can not be ignored while studying the impact on the industrial structure.

In addition, there may be some degree of substitutability between FDI and financial development when influencing the industrial restructuring. China's credit is mainly based on the institutional features of enterprises, rather than potential profit prospects of the investment projects. In such a selectively suppressive financial environment, on the one hand, FDI, with preferable sensitivity and decision-making ability, enjoys advantages of policy control as well as strong preference by domestic enterprises for its technical capabilities and management systems etc, so that the partners sought by FDI overlap with those favored by domestic commercial banks, especially the four major state-owned banks; on the other hand, with the opening of a country's foreign trade, demand for manufactured goods increases, so the manufacturing industry has demand for expansion. In order to attract foreign investment and technology, governments tend to give preferential funds, taxes, lands and others to FDI which flowed into manufacturing. Eventually FDI "squeezes out" domestic capital with strong financial support or even replaces China's distorted financial system. Hausmann and Fernandez-Arias held that: if the host financial

market is imperfect or lack of efficiency, the foreign investors are more inclined to take the form of FDI to enter the market, and then the inflow of FDI essentially plays a substitution role to the imperfect host financial markets[4].

Model specification

Not only financial development and FDI respectively impact on the optimization of industrial structure, their interaction also affects the development of industrial structure. In addition, the economic development level in the region, the degree of government intervention, its trade openness, education, infrastructure and other factors will affect the level of China's industrial structure from different aspects. Based on this, let $IS23_{it}$ be the industrial structure of province i during period t; fin_{it} and fdi_{it} represent the financial development level and FDI respectively; $rgdp_{it}$ is the level of economic development; $goven_{it}$ is the degree of government intervention; $open_{it}$ represents trade openness; edu_{it} represents education, and $\inf_{it}$ is infrastructure; then their relationship can be formulated in the following form:

$$IS23_{it} = F(fin_{it}, fdi_{it}, rgdp_{it}, goven_{it}, open_{it}, edu_{it}, \inf_{it})$$
$$= (fin_{it})^{\theta_1}(fdi_{it})^{\theta_2}(rgdp_{it})^{\gamma_1}(goven_{it})^{\gamma_2}(open_{it})^{\gamma_3}(edu_{it})^{\gamma_4}(\inf_{it})^{\gamma_5} e^{\mu_i+\varepsilon_{it}}$$

After taking logarithm of both sides of the above function, we can get:

$$\ln IS23_{it} = \theta_1 \ln fin_{it} + \theta_2 \ln fdi_{it} + \gamma_1 \ln rgdp_{it} + \gamma_2 \ln goven_{it}$$
$$+\gamma_3 \ln open_{it} + \gamma_4 \ln edu_{it} + \gamma_5 \ln \inf_{it} + \mu_i + \varepsilon_{it} \quad \textbf{(1)}$$

However, formula (1) does not take into account the "threshold effect" of financial development, FDI and their interaction. Hansen raised the panel threshold regression (PTR) model, which can be used to observe threshold effect, but it cannot examine a continuous and gradually changing process. González, Terasvirta and Van Dijk further proposed the PSTR model, which is the general form of the PTR model[5]. The PSTR model introduces a continuous conversion function to replace the discrete indicative function in model PTR, so it allows the coefficients in the model to change continuously with the change of conversion variables, and the regime conversion will be a continuous and smooth process. By adding terms of the interaction between financial development and FDI and threshold effects to formula (1), the two-regime PSTR model is as follows:

$$\ln IS23_{it} = \mu_i + \beta_{01} \ln fin_{it} * \ln fdi_{it} + \beta_{02} \ln fin_{it} + \beta_{03} \ln fdi_{it} + \beta_{04} \ln rgdp_{it}$$
$$+\beta_{05} \ln goven_{it} + \beta_{06} \ln open_{it} + \beta_{07} \ln edu_{it} + \beta_{08} \ln \inf_{it} + (\beta_{11} \ln fin_{it} * \ln fdi_{it}$$
$$+\beta_{12} \ln fin_{it} + \beta_{13} \ln fdi_{it} + \beta_{14} \ln rgdp_{it} + \beta_{15} \ln goven_{it} + \beta_{16} \ln open_{it}$$
$$+\beta_{17} \ln edu_{it} + \beta_{18} \ln \inf_{it}) g(q_{it}; \gamma, c) + \varepsilon_{it}$$
$$i = 1, 2, \cdots, N; t = 1, 2, \cdots, T \quad \textbf{(2)}$$

where observable variable q_{it} is the conversion variable. In the empirical research, we select financial development as the conversion variable. Transfer function $g(q_{it}; \gamma, c)$ is a continuous bounded function about transform variable q_{it}; the slope coefficient γ determines the conversion speed; c is the location parameter when conversion occurs, and error term ε_{it} is independent and identically distributed with 0 mean and σ^2 variance.

The conversion function is like this:

$$g(q_{it}; \gamma, c) = \left[1 + \exp\left(-\gamma \prod_{j=1}^{m} (q_{it} - c_j)\right)\right]^{-1}, \gamma > 0, c_1 \le c_2 \le \cdots \le c_m \quad \textbf{(3)}$$

When $m = 1$, the conversion function $g(q_{it}; \gamma, c) = 0$, corresponding formula (2) is referred as low regime; when $g(q_{it}; \gamma, c) = 1$, formula (2) is high regime. Values of $g(q_{it}; \gamma, c)$ are in smooth transition between 0 and 1, so that the model smoothly converts between the above two different regimes. In the PSTR model, the elastic coefficient of $\ln IS23_{it}$ with respect to $\ln fin_{it}$ is the weighted average of β_{02} and β_{12}. Namely:

$$e_{it} = \frac{\partial \ln IS23_{it}}{\partial \ln fin_{it}} = \beta_{02} + \beta_{12} g(q_{it}; \gamma, c) \quad \textbf{(4)}$$

where the sign symbol of β_{12} characterizes the relationship between parameter e_{it} and the converted variable q_{it}.

MODEL ESTIMATION AND TESTING

Data, variables and pretreatment

In this paper, the time span of the data is from 1993 to 2011. Due to serious data missing in Tibet and the fact that Chongqing has corresponding statistical data only after it became a municipality in 1997, neither is included in the sample range, so the samples are 29 provincial-level units.

Variable $IS23_{it}$ represents industrial structure optimization of province i during period t, which is measured with the GDP proportion of the total added value of secondary and tertiary industries, namely the non-farm output proportion. fin_{it} is the financial development level of province i during period t, measured with the ratio of loans of financial institutions to GDP in every province or municipality; fdi_{it} represents the FDI absorbed by province i during period t, measured with the ratio of FDI's actual using amount to GDP; $rgdp_{it}$ is GDP per capita of province i during period t; $goven_{it}$ stands for the degree of government intervention of province i during period t, measured with government spending share of GDP; $open_{it}$ is the degree of trade openness of province i during period t, measured with the ratio of import and export trade value in RMB to GDP; edu_{it} represents the educational level of province i during period t, using the average years of education received by people over six to measure; assume the average years of education for residents are 0 year for the illiterate and semiliterate, six years for the elementary schooling, 9 years for junior high, 12 years for senior high, and 16 years for the college-educated, then $edu_{it} = 6 \times prim_{it} + 9 \times mid_{it} + 12 \times hig_{it} + 16 \times uni_{it}$; $\inf_{it}$ stands for infrastructure of province i during period t, measured with the total freight; Data are from the "New China 60 Years Statistics Compilation," the provincial statistical yearbooks, and China's statistical yearbooks of different periods.

Pre-treatment is needed before estimating with the data. Except for taking logarithm of per capita GDP, per capita education, and total freight, other variables are multiplied by 100 and then taken logarithm, so as to ease data's heteroscedasticity, reduce the non-stationary properties, and handle multicollinearity which may exist among variables. For variables involve interaction terms and squared terms, they are under center standardized treatment, which can not only help avoid multicollinearity but also give a more meaningful interpretation to the results.

Parameter estimation

According to the aforementioned theoretical explanations, combined with the experiment results, we found that financial development, FDI and their interaction have threshold effects; that is to say, in the context of financial development, financial development, FDI and their interaction have different impacts on the industrial structure. In order to test their impacts on the industrial structure in different threshold levels, we choose financial development as the conversion variable and screen the explanatory variables according to AIC, and then we select the fixed-effect model as shown in formula (2). In this paper, the fixed-effect model is estimated with stata11.0, and the PSTR model is processed with the mat lab program proposed by Colletaz G and Hurlin C.

First, we test whether there is a nonlinear relationship among variables in formula (2), that is to identify the threshold effects in order to examine whether the regime conversion is significantly effective or not; if the null hypothesis is rejected in the "linear test", then a "residual non-linear" test is conducted to determine the number of conversion functions which characterize all the non-linear relationship of the industrial structure with financial development, FDI, and their interaction. We adopt the test statistics LM and LM_F respectively for the "linear test" (the null hypothesis is $H_0 : r = 0$; the alternative hypothesis is $H_1 : r = 1$); we conduct a "residual non-linear test" to the null hypothesis $H_0 : r = a$ and the corresponding alternative hypothesis $H_1 : r = a + 1$. Because the test statistic F bears better small sample properties than the statistic of asymptotic χ^2 distribution, so we only present the results of the test statistic F, namely the result of the test statistic LM_F. The test results are shown in TABLE 1.

TABLE 1 : The test statistic LM_F of the residual non-linear test

number of location parameter	m=1	m=2
$H_0 : r = 0 \; vs \; H_1 : r = 1$	**8.43 (0.000)**	**4.94 (0.000)**
$H_0 : r = 1 \; vs \; H_1 : r = 2$	1.00 (0.433)	3.27 (0.000)
$H_0 : r = 2 \; vs \; H_1 : r = 3$	—	1.43 (0.123)

Note: The values in parentheses are the P value.

The test results in TABLE 1 indicate that the test statistic LM_F significantly rejects the null hypothesis about a linear relationship, which fully manifests that the relationship of the industrial structure with financial development, FDI, and their interaction change in a nonlinear form with the increasing level of financial development.

On the basis of the above "linear test", in order to correctly describe the nonlinear relations of the industrial structure with financial development, FDI, and their interaction, we conduct a "residual non-linear test" to examine the optimal number of the nonlinear conversion function (regime conversion interval) in model PSTR. TABLE 2 shows that according to AIC and BIC, the optimal number of non-linear conversion function should be one, and there is one location parameter (although AIC and BIC came to different conclusion, yet when m=2, the number of parameters increased significantly, and reduced AIC statistics are less than increased BIC statistics, so we choose the PSTR model when m=1).

TABLE 2 : determination of the number of location parameters

number of location parameters	m=1	m=2
number of optimal conversion functions	1	2
sum of residual squares	0.45	0.42
number of parameters	18	30
AIC	-6.99	-7.01
Schwarz Criterion	-6.85	-6.77

Note: The parameter number is determined by $K(r^*+1)+r^*(m+1)$, where K represents the number of explanatory variables

Second, we estimate parameters with the PSTR model selected according to the "linear test" and the "residual nonlinear test". In order to obtain consistent and progressive unbiased parameter estimates, the parameter estimation of the model is divided into two steps: step one is to eliminate the individual effects, that is to deflate the individual mean; step two is to use the nonlinear least squares estimation method (NLS) to estimate parameters, where the "optimal" initial estimate is obtained by grid search method; meanwhile, the covariance matrix which allows heteroscedasticity is used to adjust the standard errors, and t statistic is calculated on the basis of corrected standard errors. The results of parameter estimation are shown in TABLE 3.

TABLE 3 : The parameter estimation results of PSTR model

parameter	estimates (t value)	parameter	estimates (t value)
β_{01}	-0.1950(-1.9321)	β_{11}	-0.8964 (-2.1361)
β_{02}	0.0851 (4.3142)	β_{12}	0.4179 (4.8881)
β_{03}	-1.3332 (-2.0159)	β_{13}	8.2463 (2.0176)
β_{04}	0.0906(5.2649)	β_{14}	-0.2787(-2.9345)
β_{05}	0.0299(1.1704)	β_{15}	-0.0548(-0.3147)
β_{06}	-0.0078(-0.3455)	β_{16}	-0.1189(-0.9846)
β_{07}	0.0096(0.9025)	β_{17}	-0.0072(-0.1184)
β_{08}	0.0320(2.1744)	β_{18}	-0.0722(-1.0016)
smoothing parameter	0.3099	Location parameter	5.3095

Interpretation of the results

TABLE 3 shows that the results estimated with the PSTR model are very different from those estimated with the fixed-effect model. It can be found from the coefficients of the variables that, compared with the fixed-effect linear model, the impacts of financial development, FDI and their interaction on the industrial structure are still significant in the PSTR model, and the degree and direction of influence has also undergone a significant change. From the economic perspective, the PSTR model takes into account the impact of each factor on the industrial structure against the background of financial development, and it also characterizes the gradient features of the nonlinear influence path. Thus, PSTR model can better explain the development of the industrial structure.

Existing studies have shown that both financial development and FDI can significantly promote the industrial structure development, however, the interaction between financial development and FDI also affects the development of the industrial structure; at different levels of financial development, impacts of financial development, FDI and their interaction on the industry structure are inconsistent. According to the estimation results in TABLE 3, the model reflects the double regime influence effects on the industrial structure generated by financial development, FDI, their interaction and other

factors. When the conversion variable is too low or too high, the model is converted to high regime; when the state variable is the financial development level, financial development, FDI and their interaction exert greater impact on the industrial structure in areas of high financial development. Against the background of financial development, the function of FDI changed from prevention in low regime to promotion in high regime, showing obvious nonlinear characteristics; the interaction between financial development and FDI manifested a substitution effect, which hindered the development of the industrial structure, while financial development showed significant promoting effect in both regimes. It indicates that, at the current stage, financial development and FDI manifest a substitution effect in regions regardless of high or low financial development. The reason may be the incomparable advantages of FDI compared with domestic capital. Besides, state-owned enterprises, benefit from China's credit bias, have a strong preference to FDI's technical capacity and management systems, so that the domestic credit capital with stronger financial support is "squeezed out" by FDI. The above results also indicate that raising the financial development level is beneficial for FDI to fully play its role in optimizing the industrial structure, and the influx of FDI at this time can promote the development of the industrial structure to a greater extent, but it needs to take into account the prevention function generated by the substitution effect of FDI and financial development; therefore, to better FDI's optimization effect on the industrial structure, the local financial development should match with FDI. At current stage, although financial development can play a role in promoting the industrial structure, it is mainly due to government's guide, and the substitution effect between financial development and FDI should be noticed in the process of promoting financial development.

In the area of high financial development, in addition to the significant impediment performance of economic development, government expenditure, education, level of opening up, infrastructure and other factors all have non-significant negative effects on the industrial structure; while in the region of low financial development, only the level of economic development and the infrastructure level play a significant promoting role to the industrial structure; the level of opening up has a non-significant negative effect, whereas government expenditure and education level have non-significant promoting effect. This outcome may be caused by interplay among variables; for instance, after removing the variable GDP per capita, the level of education shows a significant impediment effect in high regime and a significant promoting effect in low regime. For the phenomenon that most of the factors manifest prohibition effect in the high financial development areas, the possible reason is that the current Chinese financial market, due to its selective suppression feature, has impacts on the regional economic development, government expenditure, education and infrastructure, thereby affecting the performance of these factors in promoting the industrial structure.

CONCLUSIONS AND POLICY IMPLICATIONS

In this paper, we first established the panel smooth transition (PSTR) model, and then made use of the panel data from 1993 to 2011 of China's 29 provinces or autonomous regions as samples to study the impact of financial development, FDI and their interaction on the industrial structure, with the financial development level as the conversion variable. The results show that, in the context of financial development, the impact of FDI on the industrial structure is larger than that without considering the factor of financial development; along with the transformation of financial development to high regime, FDI also changed from hindering the development of the industrial structure to promoting the industrial structure development, manifesting obvious nonlinear characteristics; no matter at high or low regime, the interaction between financial development and FDI shows a substitution effect in influencing the industrial structure, so it is not conducive to the development of the industrial structure. In all regions, the level of economic development, government expenditure, trade openness, the level of educational development, and the infrastructure level have impacts on the industrial structure; however, in the region of high financial development, these factors show non-significant negative effect; this may be due to China's financial distortion or selective suppression, which affects the performance of these factors. Based on the above analysis, we think that to promote the industrial structure optimization, financial development and FDI should be treated as a whole. Thus it is necessary to accelerate the reform of state-owned commercial banks, improve the financial system, and optimize the financial structure and efficiency; the government should focus not only on the amount but also on the quality of financial development. What's more, it is necessary to guide FDI to flow effectively, and to maintain an appropriate proportion of foreign and domestic capital in different developing stages of finance and FDI; FDI should match the level of local financial development, so that both FDI and financial development play a promoting role to the industrial structure, so as to change their interaction from preventing to promoting the development of the industrial structure. In addition, the regional infrastructure and soft environment should be strengthened to create conditions for the development of the industrial structure; China's trade openness policy should be appropriately adjusted to change the unfavorable impact on the industrial structure development; the local government's fiscal policy should continue to play a role in further promoting the industrial structure optimization.

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