PANEL DATA ANALYSES ON FDI AND CHINA'S EXPORTS: 1995 - 2002*

Rui Chen[1*] & Jian Wang[2]

*[*1] Institute of Policy and Management, Chinese Academy of Sciences, Beijing 100080, China*
*Email:*tylcr@yahoo.com.cn
[2] Institute of Policy and Management, Chinese Academy of Sciences, Beijing 100080, China
Email:wj@casipm.ac.cn

ABSTRACT

Based on data for the years 1995 to 2002, this paper has established a panel data model that reflects the relationship between China's foreign direct investment and China's exports, and regarding this, empirical analysis is made. The selected countries and regions include: Hong Kong of China, China's Taiwan, Japan, South Korea, the European Union, and the United States. We have found that the relationship between the accumulated FDI (FDE stock) of different countries and regions in China and Chinese exports to the target countries is quite strong.

Keywords: GDP, Economic growth, Foreign direct investment, Export trade, Panel data

1 INTRODUCTION

Since the 1990s, in 1994 in particular, the combination of exchange rates and FDI (Foreign Direct Investment) has played a significant role in China's economic development. In recent years, research by economists on the relationship between FDI and China's foreign trade has been considerable. Researchers hold that FDI has improved the domestic investment environment and corporate governance standards, which have accordingly accelerated China's economic growth. Almost all studies have focused on the contribution made by current FDI inflows to the current economic growth (Liu, 2004) or the contribution made by the FDI lagged for one year to exports (EX) (Li et al., 2003). However, these studies have basically ignored the relationship between the growth situation of a country's stock of capital in China (accumulation of FDI inflows) and China's export trade, for which results are incomplete and inconclusive.

The objectives of this paper are as follows: first, using a number of countries (or regions) as research targets, to build a Panel Data Model on the basis of the consideration of national strength. Second, using our constructed model based on a number of countries' GDP and FDP stock in China, to make an empirical analysis of the

* *Funded projects: National Natural Science Fund Project " Based on the Ecological Rebuilding of Basin Scale Control Model of Water Resources " (No. project approved:40601038)*

changing demand of China's exports.

2 MODEL

In effect, utilizing Panel Data to analyze and research the macroeconomy is a relatively recent matter, which is wonderfully manifested in the most successful example of the utilization of Panel Data for research on the international economy and foreign investment.

The problems we are most likely to encounter in using Panel Data are heteroscedasticity of cross sections and autocorrelation of the sequence. Because both of these two phenomena have broken through the classical regression model assumptions, to use the least-squares procedure (OLS) at this time is inappropriate. In order to eliminate the influence of such phenomena, this paper tries to adopt the Seemingly Unrelated Regression (SUR) to make calculations when such a situation is encountered.

The general form of the single equation Panel Data is given as Equation 1.

$$y_{it} = \alpha_i + x_{it}\beta_i + u_{it} \tag{1}$$

Here, x is the vector of 1XK, β the vector of KX1, and K the number of explanatory variables. According to the normalized expressions, x and β should be written as matrix X_{it} and B. This paper has adopted the above written forms. The equalizing value of error item u_{it} is zero, and the variance is σ_u^2.
Models in common use are shown in Equations 2 – 4.

$$\alpha_i = \alpha_j, \quad \beta_i = \beta_j, \quad \forall i \neq j, i = i, \cdots, n, t = 1, \cdots T ; \tag{2}$$

$$\alpha_i \neq \alpha_j, \quad \beta_i = \beta_j, \quad \forall i \neq j, i = i, \cdots, n, t = 1, \cdots T ; \tag{3}$$

$$\alpha_i \neq \alpha_j, \quad \beta_i \neq \beta_j, \quad \forall i \neq j, i = i, \cdots, n, t = 1, \cdots T \tag{4}$$

Equation 2 states no individual difference in cross sections and variances in structure are assumed (namely all the trading partners are considered totally the same), and the estimation made by the least-squares procedure (OLS) has given the consistent and effective estimation of α and β. At this time, it equals putting together cross sections data during various periods as sample data.

Equation 3 is the changing intercept model. The individual influence in cross sections is different, which manifests itself in the variable impact which reflects the ignored individual difference. Such influence can be divided into two situations: fixed effects and random effects. This paper mainly makes quantitative studies on such two effects.

Equation 4 is a variable coefficient model. Apart from the existent individual influences, there are changing economic structures in cross sections, and consequently structural parameters in the different cross sections units are different. The commonly used models include the Fixed Effects Model and the Random Effects Model.

2.1 Fixed Effects Model

Through F check and changing intercept model, its format can be showed as Equation 5.

$$y_{it} = \alpha_i + x_{it}\beta + u_{it} \quad i = 1, \cdots, n, \qquad t = 1, \cdots, T \tag{5}$$

Here, x_{it} is the vector of 1XK, β the vector of KX1, α_i the individual influence and the ignored influence reflecting individual differences; u_{it} are the random error item and the ignored factor influence changing with cross sections and time. Similarly, its equalizing value is zero and its variance is constant. u_{it} and x_{it} are irrelevant.

Random Effects Model

When the cross section units are the whole units of the population, the fixed effects model is a reasonable model. If the cross section units are randomly selected from a large population, such models are merely applied to the selected cross section data units but not to the other units outside the sample. Under such situations, to regard the individual differences in the population as being subject to random distribution will be more appropriate, hence its form can be written as Equation 6.

$$y_{it} = \mu + \alpha_i + x_{it}\beta + u_{it} \quad i = i,\cdots,n, \quad t = 1,\cdots T \tag{6}$$

When international trade is analyzed, it is only to select China's major export trading partners. Therefore, sample units are relatively smaller, and random effects changing cross sections are more effective at this time. In order to make further judgment between these two methods, the Hausman Check can be adopted.

3 DATA ANALYSIS

Data in this paper has its root in the *Statistical Yearbook of the World Economy* for the years 1995 to 2002, the *Statistical Yearbook of China's Economy* of the State Statistical Bureau for the years 1995 to 2002, the *International Statistical Yearbook*, the *Statistical Yearbook of China's Foreign Trade,* and eight-year data in the *World Bank Data Base*.

For the convenience of calculation, models are built under the following premises: using dollars as unified measurement units and taking the natural logarithms of the original data when calculating. The selected countries and regions include Hong Kong of China, China's Taiwan, Japan, South Korea, the EU, and the United States.

As an explanatory variable, export (EX) denotes the volume of exports from China to the target country. The data come from the *Project of the Total Sum of China's Customs Exports to Every Country (Region)* in the *Statistical Yearbook of China's Economy*; GDP refers to the gross domestic product of every country or region, whose data come from the *International Statistical Yearbook*, the *Statistical Yearbook of China's Foreign Trade,* and the *World Bank Data Base*. F1 refers to the FDI stock of every country in China. Export being an explanatory variable, its data have root in the *Project of the Actual Use of Foreign Investment and Other Amount of Investment (according to different countries and regions)* and in the *Statistical Yearbook of China's Economy*. Respectively, its variables are GDP, one hundred billion dollars; F1, ten thousand dollars; EX, ten thousand dollars.

The adopted initial model is given as Equation 7.

$$\ln EX_{it} = \widehat{\beta}_0 + \widehat{\beta}_1 \ln F1_{it} + \widehat{\beta}_2 \ln GDP_{it} + e_{it}$$

$$i = 1 \sim 6 \text{ countries and regions}, \quad t = 1 \sim 8 \text{ years.} \tag{7}$$

4 ANALYSIS OF EMPIRICAL RESULTS

First of all, utilizing the current FDI to do a regression analysis on EX and adopting E-VEWS 3.1 Statistical software, we can make estimates using the models. The following results can be gained through calculation as shown in Table 1.

Table 1. Current FDI and GDP to China's EX

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	1.284528	0.298974	4.296451	0.0001
FDI	0.790787	0.153805	5.141479	0.0000
Fixed Effects				
HK	-5.639879			
TAIWAN	-7.297382			
JAPAN	-8.798276			
KOREA	-6.607252			
EU	-9.584677			
US	-9.621947			
R-squared	0.958586	Mean dependent var		14.54169
Adjusted R-squared	0.951338	S.D. dependent var		0.946504
S.E. of regression	0.208794	Sum squared resid		1.743791
Log likelihood	11.45429	F-statistic		925.8465
Durbin-Watson stat	0.946855	Prob(F-statistic)		0.000000

(HK: Hong Kong of China; TAIWAN: China's Taiwan; JAPAN: Japan; KOREA: South Korea; EU: European Union; US: United States)

It can be showed that the elasticity of the current FDI to China's EX is 0.79. The coefficients in the equation are notable. At the same time, for 48 observations and 2 explanations: $d_L = 1.462$ and $d_U = 1.628$ (5% Critical Value), $d_L = 1.285$ and $d_U = 1.446$ (1% Critical Value). In accordance with the rule of sequence-correlation and judgment principles, at 1% Critical Value because $\mathrm{DW} \leq d_L$, it can be judged that it has auto-correlation. Thus, new variables need to be brought in. If we adopt the accumulated value of FDI (F1) and add its current value (FDI) and at the same time make simulations to each country's GDP data, the result will be more satisfying as shown inTable 2.

Table 2. Accumulated FDI, Current FDI, and GDP to China's EX

Variable	Coefficient	Std. Error	t-Statistic	Prob.
F1	0.382214	0.044366	8.615083	0.0000
GDP	0.833425	0.185260	4.498675	0.0001
FDI	0.287006	0.108522	2.644668	0.0117
Fixed Effects				
HK	-1.156303			
TAIWAN	-2.753167			
JAPAN	-2.970497			
KOREA	-1.853213			
EU	-3.431447			
US	-3.438089			

R-squared	0.985734	Mean dependent var	14.54169
Adjusted R-squared	0.982808	S.D. dependent var	0.946504
S.E. of regression	0.124104	Sum squared resid	0.600672
Log likelihood	37.03273	F-statistic	1347.410
Durbin-Watson stat	1.774215	Prob(F-statistic)	0.000000

At 1% Critical Value, we can consider that there is no auto-correlation. If a weighting effect is used, the results are given in Table 3.

Table 3. Accumulated FDI, Current FDI, and GDP to China's EX (fixed effects weighting effect)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
F1	0.376427	0.041636	9.040822	0.0000
GDP	0.849820	0.154877	5.487075	0.0000
FDI	0.294081	0.103103	2.852299	0.0069
Fixed Effects				
HK	-1.286841			
TAIWAN	-2.891166			
JAPAN	-3.154161			
KOREA	-1.999077			
EU	-3.625612			
US	-3.633609			

Weighted Statistics			
R-squared	0.999728	Mean dependent var	16.98405
Adjusted R-squared	0.999672	S.D. dependent var	6.852819
S.E. of regression	0.124068	Sum squared resid	0.600318
Log likelihood	41.18756	F-statistic	71675.62
Durbin-Watson stat	1.748011	Prob(F-statistic)	0.000000
Unweighted Statistics			
R-squared	0.985727	Mean dependent var	14.54169
Adjusted R-squared	0.982799	S.D. dependent var	0.946504
S.E. of regression	0.124136	Sum squared resid	0.600980
Durbin-Watson stat	1.782851		

The difference between different countries and regions can be indicated in quotient $\widehat{\beta}_0$. Results can be improved if we make use of the fixed effects method as in Table 4.

Table 4. Accumulated FDI, Current FDI and GDP to China's EX(SUR)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
F1	0.439051	0.028307	15.51020	0.0000
GDP	0.787320	0.065756	11.97335	0.0000
FDI	0.221914	0.035207	6.303051	0.0000
Fixed Effects				
HK	-0.786026			
TAIWAN	-2.368492			
JAPAN	-2.454271			

KOREA	-1.441130		
EU	-2.879570		
US	-2.884154		
Weighted Statistics			
Log likelihood	78.85691		
Unweighted Statistics			
R-squared	0.985125	Mean dependent var	14.54169
Adjusted R-squared	0.982074	S.D. dependent var	0.946504
S.E. of regression	0.126726	Sum squared resid	0.626315
Durbin-Watson stat	1.720132		

Different models can be obtained if we adopt random effects without weighting as shown in Table 5.

Table 5. Accumulated FDI, Current FDI, and GDP to China's EX(random effects without weighting)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.051709	1.684662	-0.030694	0.9757
F1	0.400384	0.044374	9.023034	0.0000
GDP	0.543796	0.110263	4.931793	0.0000
FDI	0.283133	0.106986	2.646455	0.0112
Random Effects				
HK	0.793061			
TAIWAN	-0.599503			
JAPAN	-0.025186			
KOREA	0.437359			
EU	-0.312584			
US	-0.293148			
GLS Transformed Regression				
R-squared	0.982975	Mean dependent var	14.54169	
Adjusted R-squared	0.981815	S.D. dependent var	0.946504	
S.E. of regression	0.127639	Sum squared resid	0.716837	
Durbin-Watson stat	1.400729			
Unweighted Statistics including Random Effects				
R-squared	0.984786	Mean dependent var	14.54169	
Adjusted R-squared	0.983749	S.D. dependent var	0.946504	
S.E. of regression	0.120661	Sum squared resid	0.640602	
Durbin-Watson stat	1.567423			

It can be found that in the random effects model the elasticity of China's accumulated FDI to the target country or region is 0.4. However, there is a relative auto-correlation in the above model.

The Asian economic crisis broke out in the years 1995 to 2002, and for the years 1997 to 1999, a dummy variable can be considered to make a relative statistical adjustment. The definition is shown in Equation 8.

$$D_i = \begin{cases} 1, & \text{year 1997 to 1999} \\ 0, & \text{other years} \end{cases} \quad (8)$$

Simulation results of these fixed effects are given in Tables 6 - 8.

Table 6. Accumulated FDI, GDP, and D to China's EX (weighting is not included)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
F1	0.458672	0.033756	13.58772	0.0000
GDP	0.534671	0.169092	3.162006	0.0030
D	-0.146235	0.034594	-4.227239	0.0001
Fixed Effects				
HK	4.019115			
TAIWAN	2.222515			
JAPAN	2.866102			
KOREA	3.150098			
EU	2.601129			
US	2.629796			
R-squared	0.988462		Mean dependent var	14.54169
Adjusted R-squared	0.986096		S.D. dependent var	0.946504
S.E. of regression	0.111609		Sum squared resid	0.485804
Log likelihood	42.12657		F-statistic	1670.614
Durbin-Watson stat	2.114960		Prob(F-statistic)	0.000000

Table 7. Accumulated FDI, GDP, and D to China's EX (weighting is included)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
F1	0.469855	0.026294	17.86941	0.0000
GDP	0.603656	0.147916	4.081084	0.0002
D	-0.137513	0.028515	-4.822424	0.0000
Fixed Effects				
HK	3.327936			
TAIWAN	1.511726			
JAPAN	1.964329			
KOREA	2.416614			
EU	1.660065			
US	1.681013			
Weighted Statistics				
R-squared	0.999741		Mean dependent var	17.15814
Adjusted R-squared	0.999688		S.D. dependent var	6.277820
S.E. of regression	0.110899		Sum squared resid	0.479648
Log likelihood	47.37413		F-statistic	75286.14

Durbin-Watson stat	2.030093	Prob(F-statistic)	0.000000
Unweighted Statistics			
R-squared	0.988350	Mean dependent var	14.54169
Adjusted R-squared	0.985960	S.D. dependent var	0.946504
S.E. of regression	0.112150	Sum squared resid	0.490526
Durbin-Watson stat	2.107087		

Table 8. Accumulated FDI, GDP, and D to China's EX (SUR)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
F1	0.473318	0.019437	24.35147	0.0000
GDP	0.560268	0.044082	12.70960	0.0000
D	-0.136228	0.017885	-7.616827	0.0000
Fixed Effects				
HK	3.592372			
TAIWAN	1.807701			
JAPAN	2.379326			
KOREA	2.735107			
EU	2.100806			
US	2.125580			
Weighted Statistics				
Log likelihood	78.74089			
Unweighted Statistics				
R-squared	0.988365		Mean dependent var	14.54169
Adjusted R-squared	0.985979		S.D. dependent var	0.946504
S.E. of regression	0.112077		Sum squared resid	0.489888
Durbin-Watson stat	2.083064			

The simulation results of random effect without weighting are given in Table 9**.**

Table 9. Accumulated FDI, GDP, and D to China's EX (random effect without weighting)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.611820	1.186735	3.043494	0.0039
F1	0.465940	0.032569	14.30636	0.0000
GDP	0.450749	0.117324	3.841913	0.0004
D	-0.151021	0.033409	-4.520317	0.0000
Random Effects				
HK	0.909324			
TAIWAN	-0.819447			
JAPAN	0.051382			
KOREA	0.148900			
EU	-0.163025			
US	-0.127134			
GLS Transformed Regression				

R-squared	0.987388	Mean dependent var	14.54169
Adjusted R-squared	0.986528	S.D. dependent var	0.946504
S.E. of regression	0.109860	Sum squared resid	0.531043
Durbin-Watson stat	1.932558		
Unweighted Statistics including Random Effects			
R-squared	0.988383	Mean dependent var	14.54169
Adjusted R-squared	0.987591	S.D. dependent var	0.946504
S.E. of regression	0.105438	Sum squared resid	0.489160
Durbin-Watson stat	2.098028		

5 MODEL SELECTION

Among the above analysis, u_{it} and ε_{it} are all disturbance terms in the Fixed Effects Model and the Random Effects Model. In measuring analysis, Hausman's Test is often used to judge whether Fixed Effects or Random Effects are more effective. The check forms are as follows: H= $\chi^2[K]=[b-\beta]'\hat{\sum}^{-1}[b-\beta]$, in which $\hat{\sum}$ =Var[b]-Var[β]. Models can be chosen through the utilization of STATA 8.0 and the Hausman Test as given in Tables 10 and 11.

Table 10. Accumulated FDI, Current FDI, and GDP to China's EX

	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	. fixed		Difference.	S.E
fdi	.2870056	.2831336	.003872	.0181967
f1	.3822137	.4003841	-.0181704	. .028190
gdp	.8334239	.5437954	.2896285	.1488735

b = consistent under Ho and Ha; obtained from xtre
B = inconsistent under Ha, efficient under Ho; obtained from xtreg
Test: Ho: difference in coefficients not systematic
chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B) =6.01
Prob>chi2 =0.1112

Thus, model analysis results approach more closely the acceptance of the Random Effects Model.

Table 11. Accumulated FDI, GDP, and D to China's EX

	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	. fixed		Difference	S.E.
d	-.1462352	-.1519925	.0057573	.0067816
f1	.4586723	.468268	-.0095958	.006982
gdp	.53467	.4342711	.1003989	.1310028

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 4.76

Prob>chi2 =0.1900

Therefore, model analysis results approach more closely the acceptance of the Random Effect Model.

5 CONCLUSION

In the past, a good many studies held that FDI and exports are inextricably intertwined, which is mainly based on the relative analysis of the impact of FDI on the sum foreign trade. These studies adopted FDI as the explanatory variable and made a quantitative analysis by placing the total sum of exports as the explanatory variable to research their correlation. For instance, using data from the years 1983 to 2002, the multiplicator effect of FDI to exports trade can be calculated: $EX = -21.2747 + 0.2054FDI$ (Gao, 2003); using data from the years 1980 to 2000, placing the gross account of China's exports (EX) as the explanatory variable and the sum of foreign direct investment one year lagging behind as the explained variable, the regression is: $EX_t = 512.88 + 3.81FDI_{t-1}$. Analysis shows that China's exports are inextricably intertwined with foreign direct investment, and each additional dollar of foreign direct investment in one year will lead to the increase of 3.81 U.S. dollars in the next year (Li, Song, & Liu, 2003).

Different from the original study work, we are not directly utilizing the sum data to analyze the relationship between FDI and exports. We believe that such a relationship has hidden a number of problems. Through research on the Panel Data Model, we present new discoveries in this paper. If we make an analysis based on the relationship between the FDI of an individual country and its exports, the relationship between FDI and exports is not notable, and auto-correlation is serious. However, based on the Panel Data Model, it is found that the relationship between accumulated FDI (or FDE stock) of different countries and regions in China and exports from China to the target countries is quite notable, which not only can indicate the difference between countries and regions but also can effectively eliminate the issues related to sequence.

6 REFERENCES

Gao, C. & Zhang, C. (2003).Analysis of Trade Effect of Foreign Direct Investment. *Journal of China Geology University* (Social Science Edition), 12(6), 1-8.

Liu, S. (2004) Foreign Direct Investment and Majorizaion of China's Export Commodities. *Science of Finance* *and Economics*, pp 36-38.

Wang, R., Zeng, G., & Ren, Y. (2004) Inter-district Demonstration of Foreign Investment Performance and "Crowding-out Effect." *Contemporary Economy,* pp 100-106.