A Gravity Model on Trade between Mongolia and China

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1. Introduction

Trade is an integral part of the overall development efforts and national growth of an economy. The gravity model for trade is analogous to Newton's law of universal gravitation. The analogy is as follows: "trade flow between two countries is proportional to the product of each county's economic mass, generally measured by GDP, each to the power of quantities to be determined, divided by the distance between the countries' respective economic centers of gravity, generally their capitals, and raised to the power of another quantity to be determined".

Based on the trade theory, this gravity model has been chosen to quantify Mongolia's trade with China and other six major trading partners.

Using the data set /2000-2011 panel data/, we have estimated three gravity models of Mongolia's trade:

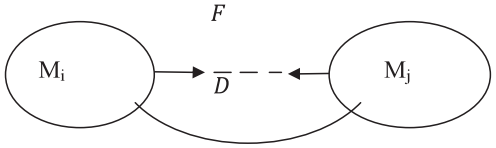
(a) The gravity model of Mongolia's total trade;
(b) The gravity model of Mongolia's exports;
(c) The gravity model of Mongolia's imports;

Since the dependent variable in the gravity model is bilateral trade between the pairs of countries, product of GDP and product of per capita GDP have been used as independent variables. We have added some additional independent variables in our model. Dummy variables were also included in the gravity equations in order to investigate qualitative variables, such as border.

2. Theoretical Justification of the Model

Gravity model is commonly used in empirical researches by trade economists. The gravity model based on the Newton's gravity theory is an econometric trade model. The model applies Newton's universal law of gravitation in physics, which states that gravitational attraction between two objects is proportional of their masses and inversely relate to square of their distance. The gravity model is expressed as follows:

$$F_{ij}=G\frac{M_iM_j}{D_{ij}^2} \qquad (1)$$



Where:
F_{ij} - Gravitational attraction
G - Constant of Gravitation
M_i, M_j -the mass of two objects
D_{ij} - distance

The estimated Gravity model has following form:

$F= GM_iM_jD^{-1}U$ (2)

F- Total trade between two countries
G- Constant term
M_i- Country i economic mass
M_j- Country j economic mass
D- Distance between i and j objects
U- Error term. (Equal to 0 or 1)

We can linearize the model by taking the natural logarithm of all variables.

$\ln F= \beta_0+\beta_1\ln M_i+\beta_2\ln M_j+\beta_3\ln D+ \ln U$ (3)

The classical gravity models generally use cross-section data to estimate trade effects and trade relationships for a particular time period, for example one year. In reality, however, cross-section data observed over several time periods (panel data methodology) result in more useful information than cross-section data alone.

The advantages of this method are: first, panels can capture the relevant relationships among variables over time; second, panels can monitor unobservable trading-partner-pairs' individual effects. If individual effects are correlated with the regressors, OLS estimates omitting individual effects will be biased. Therefore, we have used panel data methodology for our empirical gravity model of trade.

3. Analyses of the Mongolia's Trade using Panel Data and the Gravity Model

Since the dependent variable in the gravity model is bilateral trade (sum of exports and imports) between the pairs of countries, the product of GDP and the product of per capita GDP have been used as independent variables. We have added some additional independent variables in our model. Thus the gravity model of Mongolia's total trade in this study is:

$\ln(\text{Trade})=\beta_0+\beta_1\ln(GDP_{it})+\beta_2(GDP_{jt})+\beta_3(POP_{jt})+\beta_4(ER_{it})+\beta_5(ER_{jt})+\beta_6(Inf_{jt})+\beta_7\text{border } U$ (4)

GDP_{it}- Country i GDP in year t
GDP_{jt}- Country j GDP in year t
POP_{jt}- Population of country j in year t
ER_{it}- real exchange rate between country i and country j in year t
Inf_{jt} - Inflation rate of country j in year t
$Dist_{ij}$- Distance in kilometers between country i and country j
Border-Land border between country I and j (dummy variable)
U- Error term (equal to 0 or 1)
The Gravity model of Mongolia's imports as follow

$$\ln(M_{ij})=\alpha_0+\alpha_1 \ln GDP_i+\alpha_2 \ln GDP_j+\alpha_3 \ln POP_j+\alpha_4 \ln ER_j+\alpha_5 \ln PCGDP_j+\alpha_6 \ln(\inf_j)+\alpha_7 \ln Dist+\frac{\alpha_8 EX}{GDP}+\alpha_9 border+U \quad (5)$$

Where, M - total import in year t
EX/GDP - export to import ratio
With regard to the gravity model of Mongolia's export, we consider the following model

$$\ln(X_{ij})=\alpha_0+\alpha_1 \ln GDP_j+\alpha_2 \ln GDP_i+\alpha_3 \ln POP_j+\alpha_4 \ln ER_j+\alpha_5 \ln PCGDP_j+\alpha_6 \ln(inf_j)+\alpha_7 \ln Dist+\frac{\alpha_8 IM}{GDP}+\alpha_9 border+U \quad (6)$$

Where, X- total export in year t
$PCGDP_j$ -Per capita GDP of the country j in year t
IM/GDP- import to GDP ratio
The estimation results are provided below.

$$\ln(\text{Total trade})=\underset{(-6.21)}{-15.4}+\underset{(1.79)}{0.37}\ln(GDP_{it})+\underset{(6.59)}{2.07}\text{Ln}(GDP_{jt})+\underset{(2.08)}{0.43}\text{Ln}(POP_{jt})+\underset{(2.87)}{0.11}\text{Ln}(ER_{jt})+\underset{(2.99)}{0.07}(\text{Inf}_{it})\underset{(-1.02)}{-0.28}\text{Ln}(\text{Dist})+\underset{(2.85)}{1.01}(\text{border})+U \quad (7)$$

The regression results were statistically significant (Table 1, Equation 7). We have estimated the generalized gravity models of total trade. Our results show that Mongolia's trade (sum of exports and imports) is positively determined by the size of the economies, real exchange rate between two countries, inflation rate of country j, distance and border (Equation 8).

Table1 The Estimation Results: The Dependent variable: Total TRADE

Independent variables	2000-2011 (Random effects)
GDP_i	0.37 1.79
GDP_j	2.07 6.59
POP_j	0.43 2.08
ER_j	0.11 2.7
Inf_j	0.07 2.99
$Dist_{ij}$	-0.28 -1.02
Border	1.01 2.85
Observations	96
R^2	0.90

$$\ln(X_{ij})= -17.5 -2.6 \ln GDP_j+1.82 \ln GDP_i+24.17 \ln POP_j+0.17 \ln ER_j+22.46 \ln PCGDP_j -0.19 \ln Dist - \frac{0.866IM}{GDP} +0.26\, border+0.13 \inf+U \quad (8)$$

Mongolia's' export is positively determined by the size of the economies, population, real exchange rate between two countries, inflation rate of country j, import to GDP ratio and border (Equation 8).

$$\ln(M_{ij})= -42.48+0.4lnY_j+2.35lnY_j+0.1lnPOP_j-0.09ER +0.07inf+0.011lnPCGDP_j-1.14lnDist - \frac{1.009EX}{GDP} +2.46\, border+U \quad (9)$$

Mongolia's import is positively determined by the size of the economies, population, per capita GDP, and border (Equation 9).

Further, we used the concept of speed of convergence to calculate the potential trade.

Speed of convergence = (Average growth rate of potential trade/average growth rate of actual trade)*100-100 (10)

It was estimated that Mongolia's trade with China and other main 7 trading parthers are still under their potential levels (Table 2).

4. Conclusion

Foreign trade in Mongolia is growing rapidly. Total foreign trade turnover became $27.3 billion in during the last four years (2008-2011). In particular, total turnover of 11.4 billion dollars in 2011 was 2.7 percent higher than those during the period 2004-2007 that equaled to $11.1 billion.

Total trade amount in 2008-2011 increased 2.5-fold compared to the total amount in 2004-2007. The vast

Table 2 Potential Trades between Mongolia and China and Other Main 7 Trading Parthers based on Speed of Convergence, 2011, $ Million

Country	Trade turnover (Potential)	Trade turnover (Actual)	Difference (Actual - Potential)	Percentage (Actual / Potential)
China	7,620.28	6,462.0	-1,158	84.8%
Russia	1,892.77	1,624.801	-267.97	85.8%
USA	633.91	583.2	-50.71	92%
Japan	550.2	501.2	-49.56	91%
Republic of Korea	423.27	393.654	-29.62	93.1%
Germany	707.1	675.689	-31.5	96%
Great Britain	188.266	169.446	-18.8	90%
Italy	115.2	109.797	-5.504	95.3%
Total	12,131	10,519.79	-1,611.66	86.7%

majority of foreign trade turnover is mostly related to and depends on the neighboring two countries, namely, China and Russia. Foreign trade turnover of Mongolia and China reached $14.3 billion in the past four years (2008-2011). In particular, total turnover of $6.4 billion in 2011 was 31 percent higher than the total amount of $4.9 billion in 2004-2007. The People's Republic of China is the largest trading partner of Mongolia and trade turnover between two countries in 2008-2011 has increased nearly 3-fold compared those in 2004-2007.

According to the research results based on the gravity model, we could say that it is possible to increase the trade turnover of Mongolia by approximately13.3 percent. In particular, the results show the possibility to increase the amount of foreign trade with China, Russia, South Korea, Japan and other countries by 4 percent to 14 percent.

The estimated results show that Mongolia's trade with its seven major trading partners has entered into recession for years. It is not because bilateral trade has reached its peak; it is however, mainly due to the unattractive business environment and tendencies to trade intensively with new markets.

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