Trade Potential and Infrastructure: An Application of Gravity Model on OBOR Economies

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Abstract: One belt and road (OBOR) is a revolutionary project that involves 65 countries in trade, investment, economic integration and development. This study examines OBOR trade flow in terms of trade potential and infrastructural effects at bilateral and country level. We used bilateral and country level data sets to construct soft infrastructure trade facilitation indicators by employing Factor Analysis (FA) with eight primary variables. We used Gravity Model (GM) to correct multilateral resistance terms. Our results show that communication and financial infrastructure have large impact on China's trade with its OBOR trade partner countries. The trade partners of China must improve infrastructure to enhance their trade potential. Improvement in financial infrastructure is extremely significant for OBOR countries. Some trade barriers discourage trade potential through cost channel however, economic size (GDP) impact significantly on the trade.

1. Introduction

One belt and road (OBOR) initiative is one of the hallmark projects initiated by Chinese government in the 21st century. The project was officially named in 2016 and its entire focus is on connectivity among different countries in terms of trade, investment, regional cooperation, cultural exchange and economic integration. This project is a step towards practical involvement of China in international trade. The trade policy of China gets open to the world and regional cooperation in science, technology, engineering and other domains has been enhanced that reflects new patterns on socio-economic picture of the world. The most recent trade cooperation under OBOR sets a benchmark that not only crosses East Asia (EA) boundaries but also spans to European regions. Recent policies after selection of new president in 2012 reflect a new trend of cooperation across the globe for which OBOR has acquired significant importance in the world [1,2].

We study the influence of communication and financial infrastructure on China's trade with its OBOR trade partner countries. We used a sample on China's bilateral trade with OBOR countries from 2000 to 2016 and constructed communication and financial infrastructure indicators through primary or sub-variables, by employing econometric technique Factor Analysis (FA). Further, we employed GM that incorporates the influence of trade barriers and infrastructural indicators on China's trade to estimate multilateral resistance terms (MRT). The robustness, zero trade issues and endogeneity were examined through econometric techniques such as Poisson Pseudo-Maximum Likelihood (PPML) and Two-Stage Least Squares (2SLS). Our findings suggest that all coefficients have expected signs and significantly contribute in China's trade with other OBOR countries.

2. Literature review

Several traditional trade theories have been introduced by authors that analyze different factors which affect the trade. Limao and Venables [3] used different data sets to investigate the dependence of transport costs on geography and infrastructure as infrastructure is an important determinant of transport costs especially for landlocked countries. Bouet and coauthors [4] discussed the challenges associated with infrastructure influence measurements on trade due to its interactive nature. It is therefore essential to study infrastructure influence by taking into account infrastructural interactions and types. The enhancement of infrastructural impact on export performance reduces per capita income however in rich countries, information and communication technology is progressive and effective [5]. Donaubauer and co-authors [6] studied the impact of infrastructure on bilateral trade by considering 150 developed and emerging economies as sample and showed that improvement in infrastructure endowments and quality reduces trade cost significantly and further enhances trade flow. Such an improvement in infrastructure also ensures multilateral trade cost reduction and high export flow in comparison to domestic trade flow. Some other authors also discussed improvement in infrastructure and its impact on trading environment, welfare and connectivity [7-9]. In assessing the impact of infrastructure on trade, an important question of asymmetry in bilateral trade arises that has also been studied by many authors [10,11]. Besides, Ali and coauthors discussed the transport culture related to economic trade between China and Pakistan [12]. Latif and coauthors highlighted trade development in Asia [13]. Khamphengvong and coauthors reported inflow determinants of foreign direct investment [14]. So far, there is no study on trade potential and infrastructure of OBOR economies using Gravity Model therefore, we discuss this topic in our work.

The paper is organized as follows. In Section 3, constructing trade facilitation indicators is given. In Section 4, methodology is presented. In Section 5, gravity model for international trade is briefly discussed. In Section 6, results are presented with discussion. In Section 7, we provide implications of the study and the last section concludes our work.

3. Constructing trade facilitation indicators

This section describes constructing trade facilitation indicators to incorporate the influence of soft infrastructure on trade. We applied principle component analysis (PCA) and factor analysis (FA) to test the correlation and variation in the data. The PCA technique reduces multidimensionality of the data by estimating variance in new coordinate system. In new coordinate system, first component contains greatest variance and second component contains remaining variance and so on. FA is rather advanced and refined technique with similar interpretation of principle component regarding the data. The correlation among a set of variables (observations) can be estimated through a linear combination of unobserved random factors. For a single factor F, we have

$$X_1 = \lambda_1 F + \varepsilon_1, \quad (1)$$
$$X_2 = \lambda_2 F + \varepsilon_2, \quad (2)$$

and

$$X_m = \lambda_m + \varepsilon_m. \quad (3)$$

λ_k represents loading factors and X_k stands for observed factors. The weights and correlation between each variable and common factor are calculated from loading factors. A high value of loading factor represents more relevance to primary variable and is significant in defining the dimensionality of the data.

4. Methodology

We employed several econometric techniques to incorporate trade potential and influence of infrastructure on China's trade flows with its trade partner OBOR countries. The sample model is as follows.

$$trade_{ijt} = \square\beta_0 + \beta_1 comminf_{it} + \beta_2 fininf_{it} + \delta_1 gdp_{ijt} + \delta_2 Pop_{it} + \delta_3 Pop_{jt} + \delta_4 tariff_{it} + \delta_5 tariff_{jt} + \delta_6 lndistance_{ijt} + \delta_7 AS_{it} + \delta_8 CB_{it} + \varepsilon_{ij}. \quad (4)$$

Where, □ = intercept, β_1, β_2 = slopes, $\delta_1, \delta_2, \ldots \delta_8$ = delta, $trade_{ijt}$ represents exports and imports from country i to country j in year t, $comminf_{it}$ stands for communication infrastructure of country i in year t, $fininf_{it}$ is financial infrastructure of country i in year t, gdp_{ijt} stands for gross domestic product of country i and j in year t, Pop_{it} stands for population of country i (exporter) in year t, Pop_{jt} is population of country j (importer) in year t, $tariff_{it}$ is tariff of country i (exporter) in time t, $tariff_{jt}$ is tariff of country j (importer) in year t, $lndistance_{ijt}$ is log of distance (in kilometers) from origin country i to destination country j in year t, AS_{it} is access to Indian or Pacific Sea of country i (exporter) as dummy variable and CB_{it} is common border of country i with country j.

We focused on the influence of soft infrastructure (communication and financial) for trade activities between bilateral or multilateral partner countries. For that, communication infrastructure was constructed by using four primary variables [1]. Similarly, financial infrastructure was constructed by four primary variables[2] as well as GM in order to correct the multilateral resistance among the nations. The traditional gravity variables[3] discourage trade activities among trade partners, for example, long distance increases trade cost through infrastructure network however, augmented gravity model suggests that the value of trade policy variable[4] must reduce during trade with partners especially China to enhance trade volume with OBOR countries [15].

5. Gravity model for international trade

Different authors have applied gravity model to study the effect of several factors on exports volume and trade flow. This model is a useful instrument to analyze international trade flow based on economic sizes and distance between two units such as imports and exports flow from country i to j. The model for trade between two countries i and j takes the form

$$F_{ij} = G\,\frac{M_i^{\alpha} * M_j^{\beta}}{D_{ij}^{\theta}}, \qquad (5)$$

where G is a constant and F represents the trade flow from origin i to destination j. D is the distance between two countries i and j. M stands for economic dimensions of two countries or in other words, it represents the economic size of country i and j. For further econometric estimations, we used natural log of gravity equation to obtain a linear relationship between log trade flows, log economy size and log distance in the form

$$lnF_{ij} = \alpha lnM_i + \beta lnM_j - \theta lnD_{ij} + \ldots \qquad (6)$$

We applied gravity model in our calculations and the details about the model can be found in earlier published literature [16-26].

6. Results and discussion

6.1 Augmented gravity and multilateral resistance terms

The estimates of augmented gravity model and MRT correction terms are tabulated in Table 1. The presented data in the columns shows that gravity model includes random effect and fixed effect. Most of these coefficients have expected relation except communication infrastructure as each country has different characteristics. The traditional gravity variable distance has expected sign and relation with exports however, it is statistically significant at 10% level. The trade policy variable tariff is found negative however, it is statistically insignificant. The factor with high impact is common border with value 897%.

[1] For instance, cellular mobile phone, broadband telephone, secure internet server and fixed broadband.
[2] For instance, deposit account, ATM networks, merchants and point of scale.
[3] Distance and gross domestic product measured in kilometer from capital to capital and US dollars (million) respectively.
[4] Average tariff on all products for each country.

Table 1 Augmented gravity model and multilateral resistance terms

Estimation	GM	MRT	GM-RE	GM-FE
	(1)	(2)	(3)	(4)
Variables	lnexports	lnexports	lnexports	lnexports
Comminf	0.363	0.363	1.574***	1.574***
	(0.404)	(0.404)	(0.173)	(0.171)
Fininf	-0.208	-0.208	0.131	0.131
	(0.306)	(0.306)	(0.193)	(0.191)
Lngdpimporter	0.316	0.316	30.84***	
	(0.274)	(0.274)	(10.88)	
Lnpopimporter	0.130	0.130	23.32	
	(2.971)	(2.971)	(16.23)	
lndistance	-2.687***	-2.687***	-2.047***	-2.047***
	(0.220)	(0.220)	(0.276)	(0.272)
Common border	8.976***	5.720***	10.45***	10.45***
	(0.847)	(1.023)	(0.537)	(0.531)
lnmtariff	-0.377	-0.377	-560.1***	
	(0.476)	(0.476)	(130.3)	
Constant	15.83	19.09	-146.7	22.79***
	(38.54)	(38.72)	(289.4)	(2.286)
Observations	1054	1054	1054	1054
R-squared	0.807	0.807		0.791
Number of years			17	17

Note: Robust standard errors in parentheses, level of significance ***, **, * 10%, 5% & 1% respectively.

The characteristics of country such as economic size and population also have positive impact however, these are also statistically insignificant. The economic size of importer countries and population impact is around 31% and 13% respectively.

The column 3 (Table 1) indicates that multilateral resistance terms (MRT) have same sign as GM column 2 however, the standard errors have slightly changed. There is no change in the characteristics of the country such as economic size and population variables as estimated by gravity model and multilateral resistance terms however, only one variable common border has different standard error in both GM and MRT scales.

The column 4 (Table 1) indicates the estimates of random effect gravity model. The results show that only one factor, communication infrastructure (China as destination) has high impact on exports with value 157%. The remaining factor such as financial infrastructure was not observed with expected signs and considered as statistically insignificant. It has low impact on exports with value 13% however, on the other hand, economic size of importer countries has large impact. The trade policy variables imposed by importer countries on China's exports have negative relation with high coefficients value 560% as estimated by gravity model with random effect. Thus, the results illustrate that communication infrastructure has positive impact on exports with statistical significance at 10% level.

6.2 Robustness check

To check robustness, we used Iterative Re-weighted Least Squares (IRLS), Quantile Regression (QR), Poisson Regression and Two-stage Least Squares (2SLS). The estimates are shown in Table 2. Column 2 shows that estimates of IRLS and trade infrastructural variables have different signs but statistically insignificant. Only communication infrastructure has expected impact on China's exports. Besides, economic size and population variables have positive impact with coefficients value 13% and 200%.

The gravity variable distance has positive relationship with exports however, it is statistically insignificant. The geographical variable common border has high impact on exports with value 751% whereas trade policy variable has negative impact with value 72%. Column 3 indicates QR results based on median and provide an alternative to ordinary least squares (OLS) that is based on mean in the data. All soft infrastructural variables except communication infrastructure have statistical significance at 10% level. Median based regression produced negative relation between importer country's economic size, population and exports. Traditional gravity, geographical and trade policy variables have expected signs with changes in their coefficients.

To resolve zero trade flow, we performed Poisson regression and found that all soft infrastructural indicators have negative sign but statistically significant at 10% level. The zero trade issues attribute to heterogeneity in the data as each country has different characteristics. The distance and common border have expected relations with exports level. To test endogeneity, we applied best strategy of an instrumental variable to identify factors that correlate to error terms and variables.

The total economic size of all destinations of China's exports has negative impact on exports with coefficient value 1% which is endogenous variable along with GDP (exporter and importer) as instrumented variable. Therefore, soft infrastructure indicators have unexpected signs and are statistically significant.

Table 2 Robustness check

Estimation	**IRLS**	**QR**	**PPML**	**2SLS**
	(1)	(2)	(3)	(4)
VARIABLES	lnexports	lnexports	exports	lnexports
Comminf	0.0188	1.547***	-0.0982***	1.928***
	(0.257)	(0.206)	(0.00249)	(0.172)
fininf	0.0405	-0.307	-0.392***	-0.626**
	(0.131)	(0.326)	(0.00276)	(0.279)
Lngdpimporter	0.132	-0.0381		
	(0.212)	(0.587)		
Lnpopimporter	2.007	-2.641		
	(2.176)	(6.365)		
Lndistance	2.774	-1.461***	-6.536***	
	(1.800)	(0.418)	(0.0444)	
Commom border	7.516***	5.843***	5.090***	
	(0.449)	(0.704)	(0.0196)	
lnmtariff	-0.727*	-0.115		
	(0.397)	(1.176)		
	(0.342)	(0.209)	(0.00401)	(0.175)
gdptotal				-0.01***
				(0)
Constant	-51.62	56.71		5.053***
	(33.15)	(81.78)		(0.223)
Observations	1054	1054	1054	1054
R-squared	0.887			0.242
Number of years			17	

Note: Robust standard errors in parentheses, significance level at ***, **, * 10%, 5% & 1% respectively.

7. Implications of the study

The financial infrastructure of China's partner countries will improve and communication infrastructure will develop. The mutual benefits of partner countries will increase with time and small enterprises will grow. As a result, individuals and small enterprises will flourish in Pakistan.

Specially, women will take advantage of the revolution to run small enterprises [27].

8. Conclusion

In conclusion, we analyzed China’s trade potential and influence of infrastructure on trade with OBOR economies using gravity model. Multilateral resistance terms show that trade barriers discourage trade activities between China and its trade partners therefore, trade policy that reduces average tariff on all products must be employed in favor of all trade partners. In addition, communication infrastructure positively influences China’s trade so, partner countries must improve their communication infrastructure. Financial infrastructure has robustness due to large population of China that effects the relationships between trade and all primary variables. Our findings suggest that all countries must improve their financial services to enhance trade volume.

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