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Application of Gravity Model: Measurement of International Competitiveness of Trade in Services

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Abstract
In the first part, the existing different indexes of testing international competitiveness are compared. After analyzing the result, the conclusion is made that existing these indexes are not suitable to a comprehensive evaluation of international competitiveness of trade in services. A new method- "gravity model", is applied to calculate international competitiveness of trade in services. Based on two group historical data which are major trading powers and various industries of trade in services of China, the new indexes are calculated and analyzed. At the last, countermeasures and advices are given according to Chinese current status of international competitiveness of trade in services.

Key words: Gravity model; International Competitiveness; Measurement

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1. THE ANALYSIS OF THE EXISTING TRADE COMPETITIVE INDEX

Reviewing the studies of trade competition, two indexes are usually applied. One is Revealed Comparative Advantage Indices (RCA), and the other is Trade Special Coefficient (TSC).

1.1 RCA

The original Revealed Comparative Advantage Indices is put forward by Balassa in 1965. The concept of revealed comparative advantage is grounded inconventional trade theory. It can be written as,

$$RCA_{ij} = \frac{X_{ij}}{X_i} \Big/ \frac{X_{wj}}{X_w} \quad (1)$$

where x represents exports, i is a country, j is a kind of merchandise export, t is all kinds of merchandise export, and w is all of the countries, RCA_{ij} is based on observed trade patterns; it measures a country's merchandise export relative to its total exports and to the corresponding export performance of total countries.

RCA presents a kind of industry comparative advantage of a country exports comparing with world average exports performance. After excluding the impact of the total exports tolerance from a country and world total exports tolerance, RCA could show a better representative. Different values of RCA indices have different meaning in the study of trade in services.

Table 1
RCA Index Evaluation

RCA Index value	Level of Trade in services Competitiveness
2.5<RCA	Strongest
1.25<RCA<2.5	Stronger
0.8<RCA<1.25	Normal
RCA<0.8	Weak

1.2 TSC

The other trade competition index is TSC, which is a major analysis tool applied on industry structure international competition. It could present comparative advantage of calculated objects.

$$TSC = \frac{E_{ij} - I_{ij}}{E_{ij} + I_{ij}} \quad (2)$$

Where i is a country, j is a commodity, E represents exports, I represents imports, TSC index could only be set within range of values, which are between -1 and 1.If TSC>0, then the country i belongs net export country of commodity j, and has strong competition on exporting commodity j. If TSC<0, then the country i belongs net import country of commodity j, and has weak competition on exporting commodity j. has If TSC=0, then division of export and import are balance. It presents country i not only export commodity j but also import commodity j. If TSC=-1, then country i only import commodity j. If TSC=1, then country I only export and does not import commodity j.

1.3 Detailed Introduction About RCA&TSC

Revealed Comparative Advantage Index is used to analyze the comparative advantage of one industry export based on comparing a country trade structure and world trade structure. Time Series could be applied to show the country trade structure and the world trade structure difference at the different time points. It could provide dynamic analysis output and comparative outputs of trade competitiveness. This technology is sensible measure. However, Cross Section Series method could present consistent world trade structure level at the same time point. Therefore, RCA could only represent different trade structure among different countries. This comparative analysis could not express comparative advantage principle. At the same time, the comparative analysis could not present dynamic comparison. It is not suitable to be a major analysis index of expressing trade competition.

Trade Special Coefficient is used to analyze relationship between total trade and net trade of special industry based on the level of import and export trade. It could represent not only dynamic time series character but also static cross section series character based on series study. Moreover, TSC could present the ability of a country trade development. If a country wants to occupy an important place in world trade in services, its total trade own high share in total world trade. If the occupancy ratio is low, the country has little trade in services benefit and weak impact. This country has potential trade growth development space. It could not push or control the whole international trade in services market changing. Therefore, it is not suitable to only use TSC to measure trade competitiveness.

In conclusion, a proper index could measure trade in services competition from two aspects, which are total volume and growing level. Hence, gravity model is applied to measure trade in services international competition as a new index.

2. GRAVITY MODEL APPLICATIONS ON TRADE IN SERVICES COMPETITION

The methods of Gravity model originated English physicist Newton theory "Universal Gravitation". Tinbergen and Poyhonen were the earliest two experts who applied gravity model to the international trade study area. Since the 1960s, gravity model was widely used to measure the trade potential, and to judge the effect of trade Ltd. Moreover, it was also used to analyze trade pattern, estimate the marginal cost of trade barrier, and explain the economic phenomena in reality.

Newton's gravity model,

$$Y = \frac{AX_iX_j}{D_{ij}} \tag{3}$$

Gravity model definition: The force of attraction between two objects is decided by the distance between two objects. Tinbergen and Poyhonen applied the model to international trade volume. They put forward the formula. Please see the following formula 4

$$T_{ij} = \frac{AY_iY_j}{D_{ij}} \tag{4}$$

Where A is constant, i, j are individually a country, T_{ij} is bilateral trade between i country and j country, Y is economic size, GDP is used to be Y value, D_{ij} is distance between i country and j country. The formula is converted to liner from logarithm on empirical test.

Based on the previous part's thought, trade in services competition could not only present the trade level, but also present the growth development. The average trade data from every country is assumed to regard as a standard. In other words, the every country's trade growth development of the world is consistent. The gravity model is built based on the major factor impacting the total trade in services, and its formula is the following,

$$T_{ij} = \frac{\mathrm{A}GDP_iGDP_k}{TL_{ij}} \tag{5}$$

Where i is a country, j is a industry, T is the total trade exports, A is constant, GDP_i is country i Gross Domestic Product, GDP_{Ki} is the total Gross Domestic Products from every country in the world except country i., TL is the trade barrier level.

Population, Income and trade in services import are considered as factors. The formula is updated based on the above gravity model after adding population and trade in services import factors.

$$T_{ij} = \frac{\mathrm{A}GDP_iGDP_kP_iP_kI_{ij}}{TL_{ij}} \tag{6}$$

Where, i is a country, P is the total population, P_i is the total population of country i, P_k is the total population of the world except country i, I is the total imports.

Converting formula 6 with liner transformation, taking the logarithm of formula and then the corrected model of the total trade in services is the following,

$$LnT_{ij} = \beta_0 + \beta_1 LnGDP_iGDP_k + \beta_2 LnP_iP_k + \beta_3 LnI_{ij} + \beta_4(-LnTL_{ij}) + \varepsilon \tag{7}$$

Based on formula 7, regression equation is the following,

$$LnT_{ij}' = \beta_0 + \beta_1 LnGDP_i GDP_k + \beta_2 LnP_i P_k + \beta_3 LnI_{ij} + \beta_4 (-LnTL_{ij}) \quad (8)$$

Forecast value $\hat{T}_{ij}$ is calculated by filling with country i data based on assuming the same growth development of every country. Comparing observed trade in services value T_{ij} with forecast value $\hat{T}_{ij}$, The Corrected Trade in services competition based on Gravity Model (CTG) could be calculated. The formula of CTG is the following,

$$CTG_{ij} = \frac{T_{ij}}{\hat{T}_{ij}} \quad (9)$$

If CTG>1, then the competition ability of trade export is stronger than the pull of trade import. Moreover, it presents the country i has strong trade in services competition. On the contrary, if CTG<1, it presents the country i has weak trade in services competition.

In the formula 7, it has a premise and assumption that is every country has the same growth development. The average value of every country in the world is considered as standard value.

Where T_{ij} is the average value of trade in services export in the world, I_{ij} is the average value of trade in services import in the world, GDP_i is the average value of GDP in the world, P_i is the average value of the total population in the world.

Every value is filled in the formula 8 to get forecast value. The average standard presents the same background of every country. It also represents T_{ij} should equal to $\hat{T}_{ij}$ based on no difference among every country's competition. If T_{ij} is not consistent with $\hat{T}_{ij}$, then the estimation error caused it during regressing. After comparing the average standard and average forecast standard value, CTG_A is calculated to regard as the corrected CTG., and to present the real competition index.

During the previous process, the trade in services export forecast factor is built on the average standard. Therefore, it could present the total trade in services is different with the impact of trade competition. The competition index is got because of the difference between the actual growth development and the average growth development when calculating CTG. Hence, CTG judges a country's trade in services competition from two aspects, the total trade in services and the growth development.

In the empirical test part in this paper, the average trade in services value of major counties is regarded as the standard. If the range of the study objects changes, the standard could be redefined again. For instance, studying countries fromG20 trade in services international competition or studying countries from Asia Pacific trade in services international competition, the average value among the study area could be regarded as the standard. The study result is more pertinent.

3. EMPIRICAL TESTS

3.1 Index Selection

Based on the previous analysis, CTG has been defined in formula 7. Setting values individually for trade in services export (T_{ij}), trade in services import (I_{ij}), world GDP (GDP_i), world population (P_i), formula 8 could be gotten.

TL_{ij} is trade in services barrier. It is a bit hard to quantize trade in services barrier. Moreover, the originative and breakthrough outputs of independent service barrier index system are few. Therefore, the method of choosing the key words index those are "trade in services barrier" and "Service trade liberalization" to randomly extract more than 100 relative literatures is used. After that, removing the literatures with non quantized index of trade in services barrier or service trade liberalization, the common single index used to present trade in services barrier is trade import dependence in the rest 63 literatures. Import Dependency of Trade indicates the dependent degree on trade import of a country. Therefore, import dependency of trade would be regarded as trade in services barrier standard. On the one hand, this index is used based on scholar's study analysis outputs. On another hand, during time spent studying trade in services barrier is short. Subordinating to easily obtaining principle, trade in services barrier is suitable regarded as index to measure.

3.2 Building Relative Model and Applying Regression Analysis

The total trade in services, the economic output, population and trade in services barrier data are collected. Moreover, to obtain the pertinent analysis of CTG, the major trade in services countries is to be main studying objects. The following are steps.

Step 1 Confirming studying objects

The first 30 countries on the list of 2008 trade in services import and export are individually to choose. Confirm the countries who not only list in the first 30 countries in 2008 trade in services import but also list in the first 30 countries in 2008 trade in services exports.

Step 2 Collecting data

After confirming major studying objects, relative data of studying countries are collected those include trade in services forecast export.

Step 3 Calculating CTG

The last step is to obtain CTG of every country after comparing the actual value and forecast value. For removing calculating error caused by non-competition factor, the forecast results need to be corrected. To insert the average study level in formula 8 and 9 and get corrected factor of CTG. After that, correcting respective country's CTG.

During regression process of multi arguments, we often met self-regression, heteroscedasticity and multi -

collinearity. Hence, the method of stepwise regression is used. The basic idea of stepwise regression is "Inclusion or Exclusion". The detailed approach is to select variables one by one based on sum of the square of argument regression. Involve argument one by one in the regression model and test them for statistical significance, delete any that are not significant. Methods are a combination of the above, testing at each stage for variables to be included or excluded. At last, the optimize model is gotten.

The multiple liner regression is finished with software SPSS. The result is the following,

Table 1
Variables Entered/ Removed (a)

Model	Variables Entered	Variables Removed	Method
1	Trade in services import	.	Stepwise (Criteria: Probability-of-F-to-enter <= .100, Probability-of-F-to-remove >= .200).
2	Trade in services barrier	.	Stepwise (Criteria: Probability-of-F-to-enter <= .100, Probability-of-F-to-remove >= .200).
3	GDP .		Stepwise (Criteria: Probability-of-F-to-enter <= .100, Probability-of-F-to-remove >= .200).
4	.	•Trade in services import	Stepwise (Criteria: Probability-of-F-to-enter <= .100, Probability-of-F-to-remove >= .200).

a. Dependent Variable: Trade in Services Export

Table 1 is the process of involving and removing variables. The stepwise has three steps from the above table. The model involves three arguments, which are trade in services import, GDP and trade in services barrier. At the same time, after involving GDP variable in the model, trade in services import variable was removed. The population is not accepted in the model. Therefore, the main elements influencing to trade in services import are GDP and trade in services barrier dependency.

Table 2
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.915(a)	.837	.830	.27631
2	.933(b)	.870	.859	.25147
3	.958(c)	.918	.903	.03929
4	.977(d)	.955	.946	.03847

a. Predictors: (Constant), trade in services import
b. Predictors: (Constant), trade in services import, trade in services barrier
c. Predictors: (Constant), trade in services import, trade in services barrier, GDP
d. Predictors: (Constant), trade in services barrier, GDP

Table 2 is the descriptive of statistic. Model 4 adjusted R square is 0.946. The regression converge is good. This means that trade in services barrier and GDP have a liner relationship with the logarithm of trade in services export.

Table 3
ANOVA (d)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.782	1	9.782	128.120	.000(a)
	Residual	1.909	25	.076		
	Total	11.691	26			
2	Regression	10.173	2	5.086	80.435	.000(b)
	Residual	1.518	24	.063		
	Total	11.691	26			
3	Regression	11.655	3	3.885	2517.322	.000(c)
	Residual	.035	23	.002		
	Total	11.691	26			
4	Regression	11.655	2	5.828	3937.984	.000(d)
	Residual	.036	24	.001		
	Total	11.691	26			

a. Predictors: (Constant), trade in services import
b. Predictors: (Constant), trade in services import, trade in services barrier
c. Predictors: (Constant), trade in services import, trade in services barrier, GDP
d. Predictors: (Constant), trade in services barrier, GD
e. Dependent Variable: trade in services export

Table 4
Coefficients (a)

Model		Unstandardized Coefficients		t	Sig.
		B	Std. Error		
1	(Constant)	.781	.520	1.502	.146
	trade in services import	.893	.079	11.319	.000
2	(Constant)	.929	.477	1.946	.063
	trade in services import	.976	.079	12.340	.000
	trade in services barrier	.148	.060	2.487	.020
3	(Constant)	7.525	.226	33.366	.000
	trade in services import	-.004	.034	-.112	.911
	trade in services barrier	1.036	.030	34.396	.000
	GDP	1.058	.034	30.990	.000
4	(Constant)	.409	.524	.781	.442
	trade in services barrier	-4.202	.078	12.070	.000
	GDP	.939	2.075	-2.025	.054

The Dependent Variable: trade in services import

Table 3 and table 4 present models 4 could not only be tested by liner regression, but also be tested by regression factor. It gave the conclusion that regression model makes sense. The model could express the correlation among trade in services import, GDP and trade in services barrier. The regression equation from the table is the following,

$$LnT_{ij}' = 0.409 + 0.939 LnGDP_i GDP_k - 4.202 LnTL_{ij} \quad (9)$$

Formula 9 expresses the positive correlation between GDP and trade in services export. And at the same time, it expresses the negative correlation between trade in services barrier and trade in services export. It is consist with the previous theoretical analysis.

3.3 Calculating International Competition Index CTG for Special Countries

Formula 9 could get the CTG. Please see the overleaf table 5.

Table 5 provides the 27 countries on the list of first 30 countries on trade in services import & export.

There are 8 countries that adjusted factor CTG is more than1. The first and second countries are respectively Hong Kong and USA, whose competitions are the strongest. It is because Hong Kong has totally trade liberalization. Hence, the trade barrier is low. The economic of USA is developed. The import and export occupies the significant proportion in the world.

There are 16 countries that adjusted factor CTG is less than 1. Adjusted factor CTG judge the trade in services competition not only from growth development aspect but also from the total value of competition. For instance, Netherlands' and Belgium's TSC are more than 0. It expresses Netherlands and Belgium have competition ability from single trade growth development aspect. However, the economic outputs from the two countries are less. The comprehensive estimation result presents the two countries could not occupy the significant place in the international trade communication.

Chinese adjusted factor CTG is more than 1. China is the ninth in the previous list. In the following calculation process, data are mainly collected from 2008. The data could present China occupies the significant place in the international competition. However, one thing should be paid attention after the trade in services industry dividing in detail. China only has strong competition on tradition trade in services. In the modern trade in services, China is still weak on it. On the one hand, tradition trade in services belongs to labor intensive industry. The developed countries are the "reduced" object of strategic in structure adjustment during post industry period. On the other hand, the developing countries excluding China are short of powerful industrial economic supporting and built on the whole nation system like China. Hence, these development countries could not on the same level with China.

From the comparative advantage, China has competition advantage on tradition trade in services. On the one hand, the modern trade in services is production of post industry strategic adjustment. In those industries, the developed countries master the core technology and management. At the same time, the modern trade in services belongs to knowledge intensive industry or capital intensive industry. China does not have competition advantage on the two aspects. Although China owns developed service industries such as Shanghai and Beijing, the actual ability and restrained condition cause that there are a long way to realize the aim.

Table 5
***GTC* from Different Countries**

Country	Trade Service import	Trade Service export	CTG	Corrected CTG	TSC
USA	3033	4540	1.5	1.34	0.1494
England	1947	2630	1.35	1.21	0.1535
Germany	2413	1970	0.82	0.73	-0.1086
Japan	1520	1360	0.89	0.8	-0.0717
France	1223	1300	1.06	0.95	0.04
Spain	1013	1270	1.25	1.12	0.1339
China	1097	1220	1.11	1	-0.0279
Italy	1196	1090	0.91	0.82	-0.0354
Netherlands	992	910	0.92	0.82	0.0111
Ireland	1125	870	0.77	0.69	-0.0333
India	676	860	1.27	1.14	0.0488
Hong Kong	480	820	1.71	1.53	0.3443
Belgium	762	730	0.96	0.86	0.0504
Signapore	850	660	0.78	0.7	-0.0294
Korea	886	640	0.72	0.65	-0.1409
Sweden	563	630	1.12	1	0.1351
Denmark	676	610	0.9	0.81	0.0427
Canada	856	610	0.71	0.64	-0.1348
Swiss	395	610	1.54	1.38	0.2979
Luxemburg	497	600	1.21	1.08	0.2632
Austria	439	540	1.23	1.1	0.1868
Australia	425	400	0.94	0.84	0.0256
Norway	455	390	0.86	0.77	0.0263
Russian Federation	561	380	0.68	0.61	-0.2
Thailand	397	280	0.71	0.63	-0.1515
Poland	251	280	1.12	1	0.098
Malaysia	300	280	0.93	0.84	0.0182
average weighted value	878	981	1.12	-	-

Data Source: World Bank Internet Address: www.world.org

From 1997 to 2007, the three major tradition trade in services industries is improving the growth development step and step, which are Transportation, Travel and Construction. Please see table 6. The three major modern trades in services industries are developing slowly, which are Finance, Insurance, Consult and Patent License. For instance, TSC of Insurance and Patent is nearly -1. It presents the two industries does not have export ability and trade is totally dependent on import.

Table 6
China Industry TSC

Model Year	Transport	Travel	Communication	Construction	Insurance	Finance	Computer& information service	Patent licence fees and Roylaty rates	Consult	Advisement& Media	Movie&Recording
1997	-0.54	0.2	-0.03	-0.34	-0.71	-0.85	-0.47	-0.82	-0.15	-0.01	-0.63
1998	-0.49	0.16	0.59	-0.31	-0.64	-0.72	-0.43	-0.74	-0.19	-0.11	-0.44
1999	-0.53	0.13	0.51	-0.22	-0.81	-0.2	0.08	-0.83	-0.3	0	-0.66
2000	-0.48	0.11	0.7	-0.25	-0.92	-0.11	0.15	-0.88	-0.29	0.05	-0.54
2001	-0.42	0.12	-0.09	-0.01	-0.85	0.13	0.14	-0.89	-0.26	0.04	-0.28
2002	-0.41	0.14	0.08	0.13	-0.88	-0.28	-0.28	-0.92	-0.34	-0.03	-0.52
2003	-0.4	0.07	0.2	0.04	-0.87	-0.21	0.03	-0.94	-0.29	0.03	-0.36
2004	-0.34	0.15	-0.04	0.05	-0.88	-0.19	0.13	-0.9	-0.2	0.1	-0.62
2005	-0.3	0.15	-0.11	0.23	-0.86	-0.05	0.06	-0.94	-0.07	0.2	-0.07
2006	-0.24	0.17	-0.02	0.15	-0.88	-0.72	0.26	-0.94	-0.03	0.2	0.06
2007	-0.16	0.11	0.04	0.3	-0.84	-0.42	0.33	-0.92	0.03	0.18	0.34

Table 7 presents China trade in services competition is in a weak position from growth development. However, the weak tendency is reducing. In the future, China economic development, international status improvement and international connection standardization will push China trade in services international competition more powerful from China position and growth development.

Table 7
China TSC

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
TSC	-0.0617	-0.0514	-0.084	-0.0865	-0.0852	-0.0784	-0.0837	-0.0714	-0.059	-0.0464	-0.0303	-0.0223

CONCLUSIONS AND RECOMMENDATION

The essay explores to apply gravity model to get trade in services export forecast value by multiply variable regression analysis based on influencing factor of trade in services export. After comparing forecast value and actual value, correcting average standard value, the adjusted index CTG is designed. The adjusted index CTG considers economic output and growth development to appreciate.

Based on existing data, empirical test of CTG is finished. During the analysis process, the paper appreciates China trade in services competition. The output provides China trade in services has some advantages. The advantages are focused on tradition trade in services, not focused on modern trade in services.

The importance of trade in services is obvious. If developing China trade in services could be the powerful tool to improve China economic growth, the first step is to improve trade in services international competition. On the one hand, the enterprises in trade in services industries should continue to increase communication with enterprises with advanced technology in the world. They could learn advantage technology and absorb management method and experience. Then they could improve themselves competition. Moreover, by combining and annexing, the asset is re-organized and optimized. On the other hand, the government plays the important role, which needs to supervise infrastructure and facility, guide brain gains and invest. At the same time, perfecting the above relative law system, the operation platform is provide. At last, the medium level, professional association, connecting government and enterprise, need to assist government preserving the order of market operation, enhancing self-discipline, and protecting self benefit.