FORECASTING THE MUTUAL TRADE VOLUME BETWEEN THE REPUBLIC OF BELARUS AND CHINA BASED ON CORRELATION AND REGRESSION ANALYSIS

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Introduction

World trade is a complex system that is constantly changing. The most significant changes have been observed in recent decades. China has become one of the largest countries in the world economy, showing strong economic growth. At the present stage, China is the largest participant in international trade, its share is approximately 12 %. In this regard, China began to play an important role on the world stage.

Relations between the Republic of Belarus and China are long-standing. The beginning of diplomatic relations is considered to be the acquisition of independence by the Republic of Belarus in 1992. In recent years, the Republic of Belarus and China have been actively developing mutual cooperation. This is manifested in the creation of joint ventures, investment by Chinese investors in the development of Belarusian enterprises.

Belarus and China enjoy close cooperation and positive development in their economic and trade relations because the main principles of their domestic and foreign policies are similar. The president of Belarus supported the development of bilateral relations and signed the "on the development of bilateral relations between the Republic of Belarus and the people's Republic of China" and the "Treaty of friendship and cooperation".

The development of relations with China is a strategic direction of the Belarus' foreign policy. Systematic meetings of the both countries leaders contribute to the further formation and strengthening of integration processes between States.

The political links between Belarus and China is directly reflected in the development of economic relations, especially because in the course of mutual visits, more and more documents have been signed to promote the economic and trade development of the two countries. Another important factor to promote economic and trade between the two countries is to reduce the trade barriers and the financial barriers.

Another important factor in the effectiveness of mutual trade is the global market situation. Belarus is not the China's main trading partner, but China is one of Belarus' largest commodity suppliers. So, the fluctuation of global resource price, exchange rate, distance between countries and other factors has a great impact on the export of Belarus to China, but has little impact on China.

A special function of developing foreign economic relations is to attract China's direct investment in Belarus and expand international trade between the two countries. At present, China's exports to Belarus are small. China exports the most goods to the United States, Hong Kong and Japan. China imports the most products from the Japan, Korea, USA. China does not think Belarus is its main trading partner. From the Belarus's perspective, the situa-

tion seems different. Belarus exports the most goods to Russia, Ukraine and the European Union and Belarus imports the most products from the Russian Federation, China, and Germany. In recent years, China has ranked second among the major partners in the Belarus' import. Belarus intends to establish closer relations with China, including expanding foreign trade. This will let Belarus to attract more monetary resources, improve the competitiveness of its national economy and increase its GDP. In order to predict the prospects of the economic development of the two countries, it is necessary to analyze the development of mutual trade between the two countries in recent years, and find out the most important economic factors affecting the international trade between the two countries.

A major aim of the work: to study trends in trade relations between Belarus and China on the basis of correlation-regression models and the development of forecast indicators of mutual trade.

This aim determined the objectives of the work:

1. Factors that can theoretically influence the trade turnover between Belarus and China have been studied.

2. The most significant factors affecting the volume of trade between the two countries has highlighted.

3. A correlation analysis of factors has carried out.

4. A regression model has constructed that reflects the dependence of the volume of mutual trade on the main factors.

5. The quality of the regression equation has estimated.

6. The forecast of the development of trade volume between the two countries has made.

Materials and methods

The authors' research was based on the statistical data published on the official website of the National statistical Committee of the Republic of Belarus, using "2017 China Statistical Yearbook" and "2017 China Statistical Yearbook". The research based on the statistical data from 2010 to 2018. The time interval that was used for the analysis is limited by the statistical information that is available for the study. We used multiple regression analysis to study the bilateral international trade between Belarus and China.

Main part

In order to analyze the international trade between Belarus and China, we have listed the main factors that may affect the international trade between the two countries. From our perspective, these factors maybe include in theory the following aspects:

1. China's annual gross domestic product.

2. China's export to major countries.

3. China's import from major countries.

4. Belarus' annual Gross domestic product.

5. Belarus' export to major countries.

6. Belarus' import from major countries.

7. Number of Belarus' organizations with Chinese investments.

8. Total accumulated investment in the real sector.

9. Belarus' average prices indices of goods' export;

10. Belarus' average prices indices of goods' import.

The statistics of international trade between Belarus and China from 2010 to 2018 are shown in Table 1.

Table 1

Data for the research

Indicators	Symbols	The values of the indicators by years								
		2010	2011	2012	2013	2014	2015	2016	2017	2018
Dependent variable Trade between China and the Republic of Belarus, mln USD	y	2159.9	2830.5	2806.1	3290.1	3013.5	3182.2	2602.2	3106.8	3640.6
Independent variables:										
China's annual gross domestic product, bln USD	x_1	5.8	6.78	8.01	9.19	10.23	10.85	11.32	11.96	13.18
China's export to major countries, mln USD	x_2	88590	96526	91343	93204	99051	93265	91472	98956	104365
China's import from major countries, mln USD	x_3	95933	99102	89348	88263	87309	81511	83869	89074	98382
Belarus' annual Gross domestic product, mln USD	x_4	57241.8	66460.1	65693.0	75562.0	78875.6	56671.8	47749.1	54740.7	59691.8
Belarus' export to major countries, mln USD	x_5	15359.3	24796.9	29417.4	21192.1	36080.5	15853.8	14873.4	18644.5	20116.8
Belarus' import from major countries, mln USD	x_6	22345.2	29684.3	32656.5	28769.8	40502.4	20929.9	18768.9	24071.5	27628.2
Number of Belarus' organizations with Chinese investments	x_7	27	27	49	51	57	67	72	90	126
Total accumulated investment in the real sector, mln USD	x_8	0	38.3	103.8	203.7	283.2	378.0	503.3	579.6	634.9
Belarus' average prices indices of goods' export	x_9	115.4	123.2	100.2	97.8	93.4	72	88	114.6	110.1
Belarus' average prices indices of goods' import	x_{10}	113.1	113.2	92.7	99.9	94.5	84.4	93.6	109.4	106.9

Before forming the factor table, we should follow the basic requirements of regression analysis:

– independence of observations from each other;

– the initial data should be homogeneous, without anomalous observations;

– when building relationship and regression models, the number of observations should be at least three to four times the number of factors;

– factors "x" should not be among themselves in functional dependence, because it leads to the incorrect regression models construction.

Correlation and regression analysis are related. Correlation analysis can determine whether there is a link between the factors "x" and "y". This is a mandatory stage of the study, because correlation refers to the statistical relationship between factors and results, in which the change of independent variable "x" leads to the change of random variable "y". Regression analysis can determine the correlation between one factor and several other factors, and determine the relationship model between them.

So, in the first stage, we made a correlation analysis to identify the factors that most important affect the dependent variable change (sign of the result) – the international trade volume between Belarus and China. Using Excel (the "Correlation" tool), we got the following paired correlation coefficients matrix (Table 2).

Table 2

Matrix of paired correlation coefficients

Symbols	y	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
y	1										
x_1	0.7152	1									
x_2	0.7692	0.6556	1								
x_3	−0.0313	−0.3422	0.3307	1							
x_4	0.2713	−0.2643	0.1912	0.1189	1						
x_5	0.1519	−0.1400	0.2955	0.0801	0.8018	1					
x_6	0.2366	−0.1347	0.3710	0.1891	0.8797	0.9761	1				
x_7	0.7138	0.9334	0.7175	−0.0523	−0.3168	−0.1899	−0.1486	1			
x_8	0.6034	0.9763	0.6159	−0.2724	−0.4308	−0.2854	−0.2830	0.9369	1		
x_9	−0.1712	−0.3631	0.2433	0.8838	0.0567	0.0714	0.1485	−0.1291	−0.2525	1	
x_{10}	−0.1853	−0.3133	0.2238	0.8547	−0.0465	−0.1417	−0.0347	−0.0942	−0.1783	0.9532	1

We analyzed the matrix of paired correlation coefficients. In the first phase of the analysis, we excluded the independent variable x_3 because it is collinear with the independent variables x_9 and x_{10} (its correlation coefficients is 0.8838 and 0.8547, respectively), while its influence on the independent variable y is very small, because its correlation coefficient with y is −0.0313. In addition, in the course of performing intermediate calculations, we determine private and multiple correlation and determination coefficients. And then carry out further correlation analysis. According to the requirement 3, the number of factors in the multiple regression model cannot exceed 3, because the number of observations is 9. As a result, we found that the regression equation should contain the independent variables x_1, x_2, x_4. See the Table 3 for the analysis results.

Table 3

Final matrix of paired correlation coefficients

Coefficients	y	x_1	x_2	x_4
y	1			
x_1	0.715215	1		
x_2	0.76918	0.655566	1	
x_4	0.271293	−0,26432	0.191234	1

You can consider requirement 3 more strictly, and then exclude one of the independent variable also. Through the calculation and analysis in Table 2, it can be concluded that the relationship between dependent variables and independent variables is very weak, so x_4 should be excluded. But excluding the independent variable x_4 will lead to the poor quality of the regression equation, because the results of regression analysis prove this – decrease R^2.

So, the factors that most in line with the relevant analysis requirements are:

– China's annual gross domestic product, bln USD;
– China's export to major countries, mln USD;
– Belarus' annual Gross domestic product, mln USD.

So, as a result of correlation analysis, we used a set of variables for regression analysis, and the data is shown in Table 4.

Table 4

Initial data for the regression equation construction

Years	y	x_1 China's annual gross domestic product, bln USD	x_2 China's export to major countries, mln USD	x_4 Belarus' annual Gross domestic product, mln USD
2010	2159.9	5.8	88590	57241.8
2011	2830.5	6.78	96526	66460.1
2012	2806.1	8.01	91343	65693
2013	3290.1	9.19	93204	75562
2014	3013.5	10.23	99051	78875.6
2015	3182.2	10.85	93265	56671.8
2016	2602.2	11.32	91472	47749.1
2017	3106.8	11.96	98956	54740.7
2018	3640.6	13.18	104365	59691.8

In the next stage of research, we do regression analysis, and determine the regression equation. The parameters of the regression equation were determined using Excel. We get the following conclusion (Figure 1).

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0,87920548							
R Square	0,77300228							
Adjusted R Sq	0,63680365							
Standard Erro	256,978652							
Observations	9							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	1124406,581	374802,2	5,675551	0,045760612			
Residual	5	330190,1386	66038,03					
Total	8	1454596,72						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-1432,9227	2076,445971	-0,690084	0,520857	-6770,596985	3904,752	-6770,59698	3904,751605
X Variable 1	109,859821	57,56504334	1,908447	0,114614	-38,1158341	257,8355	-38,1158341	257,8354755
X Variable 2	0,02423842	0,028157599	0,860813	0,428679	-0,048142996	0,09662	-0,048143	0,09661983
X Variable 3	0,01629408	0,010801329	1,508525	0,191792	-0,011471623	0,04406	-0,01147162	0,044059777

Figure 1. Regression analysis Results

The regression equation has the following form:

$$y = 109{,}86x_1 + 0{,}024x_2 + 0{,}016x_3 - 1432{,}92.$$

In the next stage of the study, we evaluated the quality of the regression equation.

1. Parameters estimation of regression equation:

1.1. a_0 parameter estimation.

The coefficient a_0, in the analysis results table is the "intersecept". Parameter a_0 shows when $x = 0$, it means $y = -1432.92$. Since in this case the sign-factor x cannot be zero, so this independent variable is no meaning. This parameter has no economic content.

1.2. a_1 parameter estimation.

The coefficient $a_1 = 109.86$ in the analysis results table shows that if China's annual GDP will grow by \$ 1 bln the total international trade between Belarus and China will increase by US \$ 109.86 mln.

1.3. a_2 parameter estimation.

The coefficient $a_2 = 0.0242$ in the analysis results table shows the international trade volume between Belarus and China will increase by \$ 0.0242 bln or \$ 24.2 mln when every \$ 1 mln increase of China's export to major countries.

1.4. a_3 parameter estimation.

The coefficient $a_3 = 0.0163$ in the analysis results table shows the volume of international trade between Belarus and China will increase by \$ 0.0163 mln when every \$ 1 mln increase in Belarus' annual GDP.

2. Estimation of regression coefficients significance:

Significance of the correlation coefficient for small sample sizes is estimated using the Student's t-test.

Tabular value of student's t-test for a given level of significance $\alpha = 0.05$ and the number of degrees of freedom:

$$df = n - k - 1,$$

where n – is the number of observations; k – is the number of independent variables in the model).

The number of degrees of freedom is $9 - 3 - 1 = 6$.

The tabular value of the student's t-test is 2.5706.

The coefficient of the regression equation is considered significant if:

1) the actual Student's t-statistic value for this coefficient is greater than the table value;

2) the P-value of the Student's t-statistics for this coefficient is less than the significance level ($\alpha = 0.05$);

3) the confidence interval for this coefficient, calculated with a probability of 95 %, does not contain zero within itself, that is, if the lower 95 % and upper 95 % of the confidence interval boundary have the same signs.

The actual values of the student's t-test are shown in the table "ANOVA", column "t Stat". They are for a_0: −0.69; for a_1: 1.908; for a_2: 0.86; for a_3: 1.509.

The p-value of the student's t-statistics for all coefficients is greater than the significance level (0,52; 0,115; 0,429; 0,192).

Confidence intervals for all coefficients contain zeros within themselves.

Consequently, the coefficients are negligible.

3. The regression equation significance evaluating

3.1. Evaluation of the significance of the regression equation using Fisher's F-test. The actual value of Fischer's F-test is shown in the table "ANOVA", column "F".

The tabular value of the F-criterion at the significance level $\alpha = 0.05$ and the number of degrees of freedom equal to $v_1 = 3$ (the number of independent variables) and $v_2 = 9 - 3 - 1 = 5$ is 5.41. Since the calculated value is greater than the table value $(5{,}676 > 5{,}41)$, the regression equation should be considered significant. It can be used for forecasting.

3.2. The coefficient of multiple correlation. This coefficient is universal because it reflects the tightness of the connection and the accuracy of the model. The closer its value is to one, the higher the quality of the model. The value of multiple correlation is shown in the table "Regression statistics" and is $R = 0.879$. The reliability of the equation is quite high.

4. Determination coefficient.

The actual value of the determination coefficient is shown in the table "Regression statistics" and is $R^2 = 0.773$. The reliability of the equation is quite high. The variation of the result (y) by 77.3 % is explained by the variation of the factors (x_i).

Using the obtained regression equation, we can predict the changes of bilateral international trade between Belarus and China. To do this, we first determine the trend of independent variables, and we establish a simple regression for each factor. In this case, the independent variable period is 1 to 9:

x_1: $y = 0.889x + 5.2572$.

x_2: $y = 170.56x^2 + 527.16x + 92431$.

x_4: $y = -660.69x^2 + 5271.3x + 57086$.

We then calculated the forecast values of the independent variables. After that, we substituted the forecast values of independent variables into the multiple regression equation and to calculate the forecast values of bilateral international trade between Belarus and China for the next two periods. The results are shown in table 5.

Table 5

Results of forecasting the bilateral international trade between Belarus and China

Years	Trade between China and the Republic of Belarus	China's gross domestic product per year, bln USD	China's export by principal countries, mln USD	Belarus' Gross domestic product, mln USD
2010	2159.9	5.8	88590	57241.8
2011	2830.5	6.78	96526	66460.1
2012	2806.1	8.01	91343	65693
2013	3290.1	9.19	93204	75562
2014	3013.5	10.23	99051	78875.6
2015	3182.2	10.85	93265	56671.8
2016	2602.2	11.32	91472	47749.1
2017	3106.8	11.96	98956	54740.7
2018	3640.6	13.18	104365	59691.8
Forecast 1	3359.8	14.15	104215	43730
Forecast 2	3398.8	15.04	107270	35126.8

Summary

Thus, it is possible to get a conclusion. The regression equation can be used to predict changes in bilateral international trade between the Republic of Belarus and China, but this forecast will not be correct enough. this reason is that the total business volume is very

strongly influenced by the factors that can not be measured quantitatively (for example, political).

Because these factors cannot be measured, they cannot be included in a traditional regression model. When different models are used, it is possible to obtain higher precision and reliability for regression equations.

So, the factors that most in line with the relevant analysis requirements are: China's annual gross domestic product, China's export to major countries, Belarus' annual Gross domestic product. The reliability of the equation is quite high.

Using the obtained regression equation, we can predict the changes of bilateral international trade between Belarus and China. The forecast of total trade between the Republic of Belarus and China shows that, Considering the general trend of the main independent variables, we expect the total trade to increase to $ 3359.8 mln and then to $ 3398.8 mln.

The results of the research can be used for scientific justification of priority directions of mutual relations between the Republic of Belarus and China development and strengthening; development and deepening of scientific research in this area; forecasting the trade turnover between the countries volume.

Literature

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