Article

Modeling the effects of the sustainable accession of the republic of Belarus to the shanghai cooperation organization

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Abstract: The article investigates trade flows between the Shanghai Cooperation Organization (SCO) member-states and Belarus before the upcoming Belarus' joining the organization. The export flows of the countries are modeled using a power function based on the time data. The results of the qualitative and quantitative analysis of foreign trade between the organization and the Republic of Belarus are presented, as well as the quantitative forecast of the prospects open to Belarus in connection with its joining the organization based on three original scenarios using econometric models. The results of the study show that Belarus has certain promising sectors of foreign economic activity, which can contribute to an increase in income from trade. It was found that the integration of the country will have a positive effect on increasing the volume of trade turnover with the participating countries, while in order to maintain sustainable economic growth of the country, domestic development of production should remain a priority, as evidenced by the obtained parameter estimates for the factors. An assessment of potential economic effects can be used to make a decision on whether a country should join an international organization. In particular, based on the assessments in our study in trade with Russia the expected increase in Belarus exports upon joining the Shanghai Cooperation Organization will constitute an increase of nearly 5%, exports to Kazakhstan are expected to increase by almost 75%, and to India and China by almost 90%. In the context of reshaping of international associations and organizations, the problems and issues raised in the study become even more relevant.

Keywords: export; import; Shanghai Cooperation organization; Belarus; commodity flows; development prospects; co-integration

1. Introduction

In modern conditions, when international economic relations and objectives of states are rapidly changing, the role of international organizations, aiming mainly at international integration, is changing. The benefits (economic and political) a state attains by joining an association become a priority. The process of acceptance to international organizations has accelerated significantly as the states strive to protect their interests.

At the same time, the integration process can be viewed from different sides and from the standpoints of various spheres. The primary contact points are politics, culture, and social sphere, while economy comes second in this respect (Adeniran et al., 2023; Grega and Nečas, 2022; Maksimtsev et al., 2022; Tobisova et al., 2023; Vasiľková, 2023).

Economic integration, in its turn, implies the merge of economies in national market and the formation of a common market space with a common currency (Shishkov, 2001). Hence, the utmost stage of an international organization

development can be considered as establishing an institutional and operational center, which is the focal point attracting the states to form a single economic area.

In this context, the territories of Eastern Europe and Central Asia face an increasing trend towards shifting the focus to the East. Such changes in the foreign policy emerged long before the current world events. Primarily, they were caused by the growing importance of China in the world economy. As Drobot states in (Drobot, 2022), after the crisis of 2020 caused by COVID-19 pandemic, thanks to a successful combination of strict governmental measures mitigating the economic losses caused by the lock-down and the large functioning private sector, China was able to recover from the crisis efficiently and laid its claims to world leadership.

As China became an economic pole long before the mentioned pandemic, and so did the current trends in its economic development, one cannot deny that the economic integration of its neighboring countries to form an international association is more than relevant (Kalistratova, 2021).

The sanctions imposed after the start of the Special Military Operation (SMO) also affected Belarus shutting down the prospects of its trade with European countries. This prompted the decision determining the vectors of its foreign trade development.

On 15 July 2022 in particular, Belarus applied to join the Shanghai Cooperation Organization (SCO) as a member state. It is assumed, that as it is granted the status, the relations between Belarus and other SCO member will intensify and grow in scale, which will positively impact the development of the international commodity flows. SCO is a regional international association, uniting Russia, India, China, Kazakhstan, Pakistan, Tajikistan, and Uzbekistan.

The scientific novelty of the research into the prospects associated with Belarus' entering the SCO lies in the original assessment of the economic consequences of such, the identification of the advantages and disadvantages of such membership, and the evaluation of the potential of Belarus' interaction with other countries of Asia and Pacific. The aforementioned prospects have been analyzed both quantitatively and qualitatively using adjusted original co-integration ratios for the SCO member states.

The present study aims at assessing the prospects and establishing the effects of Belarus joining the SCO in 2024. The following tasks were set out to achieve this aim:
1) To analyze the economic situation of the SCO member states and Belarus according to the structure of foreign trade for 2023;
2) To establish the nature of the dependence of international commodity flows between Belarus and the SCO member states for 2024;
3) To estimate Belarus exports to the SCO member states short of the effect caused by joining the organization in 2024;
4) To estimate Belarus exports to the SCO member states, with account to the effects of joining the SCO in 2024;
5) To compare the results and establish the effects of joining the SCO.

The object of the study is the process of Belarus joining the SCO: the economic aspects of such are investigated along with the evaluation of possibilities and prospects of cooperation between Belarus and other members of the organization. The subject of the study is the export flows between the SCO member states and the Republic of Belarus. The research employs such methods as generalization, comparison, systematization, analysis, synthesis, induction, and deduction.

It is assumed that the potential economic effects of joining the Shanghai Cooperation Organization will have a positive impact on the volume of trade flows between Belarus and the SCO countries.

The application of cointegrated series systems to assess the effects of a country's entry into an international association is a novel mechanism. In the future, the main premises of this method of assessing international trade can be used to test a set of measures or actions of public policy both in the domestic market and in foreign markets.

2. Literature review

The work (Sargento, 2007) analyzed the use of a gravity model to describe the behavior of trade flows and the predictive properties of the model. Due to the use of a relatively small data sample, the model showed imprecise results. However, to clarify the characteristic properties, additional variables were added to the model, which provided an informative description of trade flows. But the problem of considering a narrow range of data, in our opinion, is quite significant. International relations are based on the long-term experience of counterparties with each other, so it would be expedient to consider the long-term equilibrium of commodity flows in quest for key characteristics.

To assess the effectiveness of foreign direct investment (Gao et al., 2024), the cited authors also used the basic configuration of the gravity model with the addition of proprietary indicators. Using in this context the degree of dependence of a country on international commodity flows has shown its effectiveness and therefore can be used in the future with some adjustments: the export flow represents the productive capacity of the economy, without limiting it. To assess the degree of dependence, the ratio of imports to gross domestic product (GDP) can be utilized.

To assess the effects of international integration (Pasara and Dunga, 2023), the cited authors used dummy variables. The analysis of only spatial or only temporal effects is one-sided, so it is necessary to move on to the search for a methodology that would generally take into account both aspects: spatial and temporal.

In addition, a series of works by respected authors devoted to the use of cointegration to assess international financial markets is of great interest (Lien and Hung, 2023; Malmierca-Ordoqui et al., 2024; Niu et al., 2023; Xu, 2018; Xu, 2020), since the authors apply both classical methodology and cointegration testing for panel and temporal data.

3. Materials and methods

The study is built on the data on the export flows and population obtained from open sources of customs services, federal statistical bureaus, information and analytical agencies of the SCO member states for the period of 2000–2023 (Word Bank, WTO, IMF, UNEP, State Bank of Pakistan, Ministry of Economic Development and Trade of the Republic of Tajikistan, Statistics Agency Under the President of the Republic of Uzbekistan, trendeconomy.ru, EAEU, Government of India, Federal State Statistics Service of the Russian Federation, Statistical Center of Iran, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, Pakistan Bureau of

Statistics, The Central Bank of the Russian Federation, statista.com, National Statistical Committee of the Republic of Belarus, Government of Pakistan, Government of India, Customs of the People's Republic of China, National Statistical Committee of the Kyrgyz Republic, National Bank of Tajikistan, Santander.com). The GDP data originate from the World Bank website (Word Bank).

The article models the export flows of the countries using a power function based on the time data. The models' quality is evaluated according to the following criteria:
1) Normal error distribution test;
2) Durbin-Watson statistics and residue correlation coefficient;
3) Approximation error (MAPE);
4) Series stationarity tests: Dickey-Fuller (ADF) test and Kwiatkowski, Phillips, Schmidt, Shin (KPSS) test.

The model of international trade (1962) by Jan Tinbergen has become extensively used in research in the following form (Tinbergen, 1962):

$$F_{ij} = G \times Y_i^{\delta 1} \times Y_j^{\delta 2} \times D_{ij}^{\delta 3}$$

where, F_{ij} is the export from state *I* to state *j*;

$Y_i^{\delta 1}$—GDP of state *I*;

$Y_j^{\delta 2}$—GDP of state *j*;

$D_{ij}^{\delta 3}$—distance between the states *i* and *j*;

G—the gravitational constant.

In this configuration, spatial data on the distance between the countries considered and the volume of their GDP are to be used to estimate the "gravitational" force, which is determined by the value of the constant G and is used to characterize the intensity of commodity flows between the counterparties (Maksimtsev et al., 2022).

However, this type of data does not allow estimating forecast export values without panel data, so the model was transformed by the authors: the distance between the countries was excluded as a factor in order to allow temporary data consideration.

In our opinion, it is not entirely correct to evaluate exports only as a function of the GDP of the counterparty countries. GDP is an absolute indicator that does not allow comparing the economies of different countries. The values of this indicator characterize the overall scale of the economy, but do not estimate its capacity. Evaluating potential markets are to be evaluated as part of the research and the development models. The indicators calculated per capita are most often used to integrate such characteristics.

Therefore, the authors modified the model:

The GDP of country *i* (the exporting country) has been replaced by GDP per capita calculated based on the purchasing power parity. GDP calculated as such, firstly, provides the comparability of data, and secondly, allows obtaining comprehensive conclusions about the characteristics of the country's economy, containing a relative estimate of the scale of the economy per capita. The GDP of country *j* (the importing country) was replaced by the share of imports of the exporting country in the total GDP. This indicator stands for the degree of the countries' economic independence (Gao et al., 2024). A large share of imports in the total GDP

may indicate weak economic development and low export potential. Thus, taking into account the author's modifications, the model takes the Equation (1) (the example of Belarus exports to other countries):

$$EXP_{bel-j} = const \times VVP_{bel}^{\alpha} \times IMP_{bel}^{\beta} \times \varepsilon_t \tag{1}$$

where,

EXP_{bel-j}—Belarus (BEL) exports to country j;

VVP_{bel}^{α}—Belarus (BEL) GDP per capita by PPP,

IMP_{bel}^{β}—the share of imports in the total GDP of Belarus.

ε_t—random model residuals.

In addition to the model described above, the export flows were modeled using the co-integration ratio, which will be described in more detail in the description of the research outcomes.

All calculations were carried out using the Gretl software.

4. Results and discussion

4.1. Study of international trade flows of the SCO

The structure of international commodity flows can be characterized in two ways:

1) Assessment of the shares of the international flows in the total value of a country's exports or imports. Then, the resulting shares will describe how closely the economies interact within the SCO, that is, characterize the role of the organization in coordinating the cooperation of the countries.

2) The assessment of the share of imports and exports volumes of a country to the member-states only. Then obtained values will characterize the economic integration system functioning in the association. These values will allow analyzing the degree of commodity flows concentration, characterizing the members by the degree of their participation in international trade.

Since the purpose of the study was to assess the effects of Belarus joining the SCO, its first stage required identifying the existing, successfully functioning system of commodity flows between the countries that would provide the new member with the necessary resources and a market for its products. Therefore, the structure of export flows was calculated only for the SCO members. To do this, the data on the member states' and Belarus' 2023 exports in USD were downloaded from the portals of the official statistical bureaus and customs services (Word Bank, WTO, IMF, UNEP, State Bank of Pakistan, Ministry of Economic Development and Trade of the Republic of Tajikistan, Statistics Agency Under the President of the Republic of Uzbekistan, trendeconomy.ru, EAEU, Government of India, Federal State Statistics Service of the Russian Federation, Statistical Center of Iran, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, Pakistan Bureau of Statistics, The Central Bank of the Russian Federation, statista.com, National Statistical Committee of the Republic of Belarus, Government of Pakistan, Government of India, Customs of the People's Republic of China, National Statistical Committee of the Kyrgyz Republic, National Bank of Tajikistan, Santander.com). Then, the shares of the selected export destinations in the total volume of the export flows within the SCO member states and

Belarus were estimated (**Table 1**).

Table 1. Structure of export flows within the SCO, 2023, percentages.

		Export destination									
		China	**Iran**	**Pakistan**	**Kazakhstan**	**Kyrgyzstan**	**Uzbekistan**	**Belarus**	**Russia**	**Tadjikistan**	**India**
Exporter, %	China	x	3.6	8.7	6.2	5.8	0.2	1.2	28.7	0.8	44.7
	Iran	72.4	x	3.0	0.2	1.3	3.7	0.9	8.6	1.4	8.3
	Pakistan	33.7	12.6	x	4.4	7.6	2.3	2.9	14.4	0.8	21.2
	Kazakhstan	44.4	1.1	0.1	x	2.5	12.5	0.5	29.6	3.0	6.4
	Kyrgyzstan	3.5	0.8	0.1	24.9	x	13.4	2.0	54.6	0.2	0.6
	Uzbekistan	31.8	2.2	1.1	13.6	11.3	x	1.3	31.8	6.3	0.6
	Belarus	6.2	0.2	0.3	3.2	0.1	1.4	x	85.3	0.7	2.5
	Russia	53.5	<0.01	<0.01	8.1	1.1	5.0	12.0	x	0.7	19.5
	Tadjikistan	29.4	9.1	1.0	38.6	0.1	14.2	0.6	7.0	x	0.01
	India	70.3	8.1	3.0	2.1	0.2	1.3	0.2	14.5	0.2	x
	Share in the total exports	34.5	3.8	1.7	10.1	3.0	5.4	2.2	27.5	1.4	10.4

(Compiled by the authors based on Word Bank, WTO, IMF, UNEP, State Bank of Pakistan, Ministry of Economic Development and Trade of the Republic of Tajikistan, Statistics Agency Under the President of the Republic of Uzbekistan, trendeconomy.ru, EAEU, Government of India, Federal State Statistics Service of the Russian Federation, Statistical Center of Iran, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, Pakistan Bureau of Statistics, The Central Bank of the Russian Federation, statista.com, National Statistical Committee of the Republic of Belarus, Government of Pakistan, Government of India, Customs of the People's Republic of China, National Statistical Committee of the Kyrgyz Republic, National Bank of Tajikistan, Santander.com).

Table 2. Structure of import flows within the SCO, 2023, percentages.

		Source of imports									
		China	**Iran**	**Pakistan**	**Kazakhstan**	**Kyrgyzstan**	**Uzbekistan**	**Belarus**	**Russia**	**Tadjikistan**	**India**
Importer, %	China	x	4.0	2.1	9.2	0.1	1.4	1.1	71.0	0.2	10.9
	Iran	12.3	x	17.6	5.1	1.7	17.5	2.0	10.8	9.5	23.5
	Pakistan	13.4	26.0	x	8.9	5.5	8.3	7.1	14.7	9.7	6.2
	Kazakhstan	34.1	0.7	0.1	x	1.2	4.0	2.7	53.9	1.6	1.8
	Kyrgyzstan	53.0	0.5	0.1	9.8	x	4.7	0.9	29.5	0.1	1.4
	Uzbekistan	39.2	2.3	0.9	17.6	1.0	x	1.7	33.3	0.6	3.6
	Belarus	16.0	0.1	0.1	0.5	0.1	0.3	x	81.3	0.1	1.6
	Russia	63.8	<0.1	<0.1	7.4	0.8	3.4	22.2	x	0.1	2.4
	Tadjikistan	20.4	3.0	0.5	23.2	0.3	9.1	2.0	38.4	x	3.0
	India	67.9	0.5	<0.1	0.2	0.3	<0.1	0.1	31.1	<0.1	x
	Share in the total imports	32.0	3.7	2.1	8.2	1.1	4.9	4.0	36.4	2.2	5.4

(Compiled by the authors based on Word Bank, WTO, IMF, UNEP, State Bank of Pakistan, Ministry of Economic Development and Trade of the Republic of Tajikistan, Statistics Agency Under the President of the Republic of Uzbekistan, trendeconomy.ru, EAEU, Government of India, Federal State Statistics Service of the Russian Federation, Statistical Center of Iran, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, Pakistan Bureau of Statistics, The Central Bank of the Russian Federation, statista.com, National Statistical Committee of the Republic of Belarus, Government of Pakistan, Government of India, Customs of the People's Republic of China, National Statistical Committee of the Kyrgyz Republic, National Bank of Tajikistan, Santander.com).

The table evidentiates that the structure of the inter-state exports flows is highly concentrated: 82.5% of the total exports goes to 4 countries, i.e. China, Kazakhstan, Russia, and India. This is primarily due to the scale of their economies in comparison to the partners. The presented structure shows the main export destinations, and indicates which countries are the main consumers of goods within the SCO.

In order to assess the main sources of commodity flows, the outline of import flows of the Shanghai Organization member countries was compiled (**Table 2**).

The situation similar to **Table 1** is presented in **Table 2**. Here, the share of commodity flows from China, India, Russia and Kazakhstan in the total volume of the SCO member-states import flows is 82.05%.

The obtained results suggest that despite the sanctions imposed in 2023 against Russia and Belarus, the increased intensity of commodity flows did not diversify them. There is a problem that some of the SCO member-states (Pakistan, Iran, Tajikistan and Uzbekistan) are not involved in the international commodity flows. The efficient systems function only in Russia, Kazakhstan, India, and China. Belarus is also characterized by low shares in the structure of international commodity flows with most of the SCO member-states (Russia is an exception due to the unconditional close cooperation between the countries). However, this is quite typical for a country that has not yet received the status of a permanent member of an international organization.

Relatively low volumes of international flows, which are characterized by corresponding low shares, may indicate the concentration of commodity flows in a particular industry or several industries. The calculation results obtained from such data may be unreliable due to the high instability of international relations, when a crisis in one industry can significantly affect the overall volume of trade turnover. Diversification, which is typical for large economies, provides greater stability in international trade turnover.

Thus, the SCO, being a potential tool for the execution of international agreements that could influence the customs conditions between Belarus and the member countries of the organization to facilitate mutually beneficial international trade, is currently of the greatest interest in the light of cooperation with China, Kazakhstan, India, and Russia.

4.2. Assessment of the forecast Belarus exports to Kazakhstan, China, India, and Russia short of the effects of joining the SCO

The modeling of the forecast values of Belarus exports considered only the countries with highly intensive commodity flows with the majority of SCO member-states, namely: Russia (RUS), China (CHI), Kazakhstan (KZ), India (IN), because a large-volume export flow dynamics is insignificantly impacted by the short-term factors. This ensures greater reliability of the forecast values. **Table 3** presents the results of modeling carried out using the Gretl software using the appropriate econometric methods (IMF, Government of India, Federal State Statistics Service of the Russian Federation, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, National Statistical Committee of the Republic of Belarus, Customs of the People's Republic of China).

Table 3. Model of the Belarus' exports in 2000–2023.

Country	Model	R^2	rho	DW	Normal distribution of residues, *p*-value	MAPE, %
Kazakhstan	$EXP_{bel-kz} = 3699 \times VVP_{bel}^{2.21} \times IMP_{bel}^{0.78} \times \varepsilon_t$ (8.65), (3.06), (8.70)	0.98	0.11	1.67	0.15	0.76
China	$EXP_{bel-chi} = 191\,41.23 \times VVP_{bel}^{1.25} \times IMP_{bel}^{0.13} \times \varepsilon_t$ (7.59), (5.83), (5.05)	0.78	0.01	1.91	0.16	1.84
Russia	$EXP_{bel-rus} = 231\,169\,005 \times VVP_{bel}^{1.65} \times IMP_{bel}^{-2.29} \times \varepsilon_t$ (8.47), (6.55), (−2.76)	0.95	0.01	1.66	0.28	0.51
India	$EXP_{bel-in} = 1486.26 \times VVP_{bel}^{1.86} \times IMP_{bel}^{0.025} \times \varepsilon_t$ (5.04), (3.96), (6.50)	0.77	0.17	1.62	0.55	2.50

(Calculated by the authors based on IMF, Government of India, Federal State Statistics Service of the Russian Federation, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, National Statistical Committee of the Republic of Belarus, Customs of the People's Republic of China).

The actual values of the student's t-criteria are indicated in parentheses under the model (*t*-table = 2.079).

Table 3 shows the specifications of the generated models, as well as the results of their quality test against statistical criteria. The obtained models are characterized by high statistical accuracy and quality, which makes it possible to estimate the values of the coefficients in terms of their economic impact on the volume of export flows.

The following are the derived root mean square error (RMSE) values (Jamieson et al., 1991) for the applied models:

1) For Kazakhstan −12,388.66 in US dollar equivalent;
2) For China −11,206.90 in US dollar equivalent;
3) For Russia −152,372.71 in US dollar equivalent;
4) For India −7,148.33 in US dollar equivalent.

Considering the volume of trade flows between countries under the investigation, such RSME and MAPE values prove the high accuracy of the applied models.

The resulting elasticity with the GDP per capita according to the purchasing power parity (PPP) of Belarus in all models exceeds 1, which indicates a multiplicative effect of economic development, that is, an increase in this indicator leads to an even greater increase in exports. At the same time, an increase in the share of imports in the total GDP on a smaller scale increases the volume of Belarus exports or reduces it—the coefficient for this indicator in all models turned out to be less than 1.

A forecast for 2024 has been made for Belarus export flows to Russia, China, Kazakhstan, and India (**Table 4**) according to the constructed models (**Table 3**). The obtained values reflect the existing dynamics of Belarus exports short of the effects of joining the SCO (Word Bank, Government of India, Federal State Statistics Service of the Russian Federation, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, The Central Bank of the Russian Federation, National Statistical Committee of the Republic of Belarus, Government of India, Customs of the People's Republic of China).

**Table 4.** Assessment of Belarus' exports in 2024.

Export destination	Lower limit of the interval forecast for 2024, thousand dollars.	Point forecast for 2024, thousand dollars.	Upper limit of the interval forecast for 2024, thousand dollars.
BEL-KZ	609,853.47	846,386.17	1,079,599.0
BEL-CHI	267,539.1	661,802.2	1,023,177.9
BEL-RUS	17,526,559.95	22,658,418.08	29,292,908.09
BEL-IN	146,047.33	377,033.38	973,343.18

(Word Bank, Government of India, Federal State Statistics Service of the Russian Federation, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, The Central Bank of the Russian Federation, National Statistical Committee of the Republic of Belarus, Government of India, Customs of the People's Republic of China).

The presented assessment of Belarus export flows is a basic scenario, in which Belarus does not join the Shanghai Cooperation Organization and receives no additional advantages in signing international agreements.

4.3. Assessment of the forecast Belarus exports to Kazakhstan, China, India, and Russia including the effects of joining the SCO

Assessing the change in the exports after Belarus joins the SCO requires using the existing experience of interaction between the countries with intensive commodity exchange. For this the authors analyzed the exports dynamics for the states (Kazakhstan, India, China, Russia) which have intensive trade turnover, and Belarus (**Figure 1**) (Government of India, Federal State Statistics Service of the Russian Federation, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, The Central Bank of the Russian Federation, National Statistical Committee of the Republic of Belarus, Government of India, Customs of the People's Republic of China).
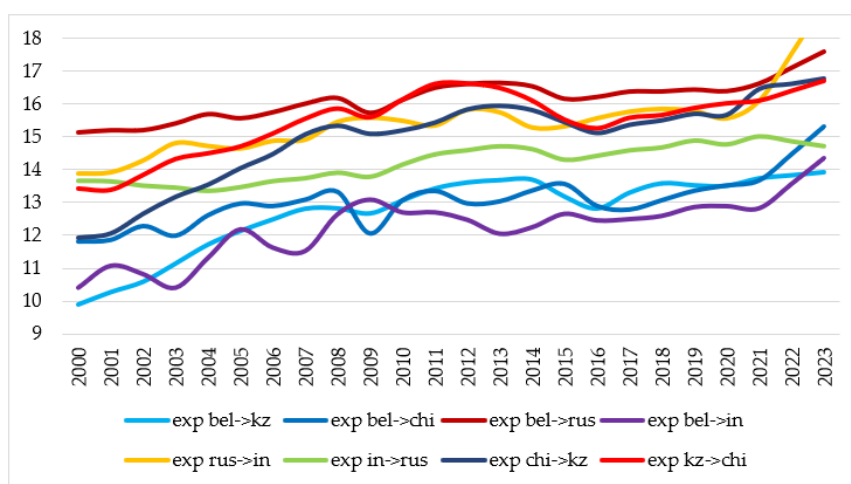
Figure 1. Dynamics of logarithmic export volumes of the SCO countries and Belarus.

(Generated by the authors based on Government of India, Federal State Statistics Service of the Russian Federation, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, The Central Bank of the Russian Federation, National Statistical Committee of the Republic of Belarus, Government of India, Customs of the People's Republic of China).

Based on the analysis of the export flows dynamics (**Figure 1**): In logarithmic

representation, the series are more visual. The general local extremes, excluding the trend component, become visible. Then the assumption arises, that international commodity flows between countries connected by close international interaction, can influence each other and lead to long-term equilibrium. One can suggest that the studied indicators are in a long-run equilibrium. This hypothesis can be verified based on the Engle-Granger test (Engle and Granger, 1987), according to which the residuals should be stationary.

A cointegration ratio is constructed for two variables that have a long-term dependence, with the stochastic nature of short-term changes.

When analyzing international commodity flows, the use of such econometric analysis methodology is recognized by the Center for Integration Studies of the Eurasian Development Bank (Vinokurov et al., 2019): "However, the relationship between variables having a common trend can be quite real if these variables are cointegrated." This method of analyzing international interaction has also become widespread in science, i.e., Huseynova (2023) analyzes the co-integration ratios of the current account of the balance of payments and the GDP of Azerbaijan. Orudzev and Huseynova (2020) examined the reciprocal influence of the GDP of Azerbaijan, Russia, Belarus and Kazakhstan.

The context of this study also requires mentioning the research of Zibanani (2022), which analyzed international trade with cointegration ratios. The author found that the openness of international trade has a positive effect on the GDP growth.

Thus, the use of cointegration models allows predicting the values of one variable, while maintaining the general dynamics of the other (Bochenina, 2020). In this study, cointegration models are used by the authors as a tool that allows projecting the impact of agreements existing between two member countries of an international organization on a third state that has not been accepted as a member of the union.

Only the dynamics of the export flows that meet the cointegration criteria can be projected on other countries.

Table 5. Stationary check of the series' first differences.

Series name	*p*-value of the ADF test	*p*-value of the PP test	*p*-value of the KPSS test
$d\_EXP_{bel-rus}$	0.002	0.013	0.171
d_EXP_{in-rus}	0.003	0.025	0.111
d_EXP_{bel-kz}	0.018	3.205e-05	0.273
d_EXP_{chi-kz}	0.003	0.004	0.130
$d\_EXP_{bel-chi}$	8.103e-06	1.106e-08	0.207
d_EXP_{kz-chi}	0.002	0.017	0.136
d_EXP_{bel-in}	0.001	0.031	0.161
d_EXP_{rus-in}	5.519e-05	0.0211	0.243

(Compiled by the authors on Government of India, Federal State Statistics Service of the Russian Federation, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, The Central Bank of the Russian Federation, National Statistical Committee of the Republic of Belarus, Government of India, Customs of the People's Republic of China).

The primary cointegration condition is that the series must have the same order of integration (Bochenina, 2021). Therefore, the export series were tested by the

extended Dickey-Fuller test (ADF test) (Dickey and Fuller 1981), Phillips-Perron test (PP test) (which showed that the series themselves are non-stationary, but their first differences are stationary (**Table 5**). Hence, within the framework of the problem solved in the article, it is possible to build models that determine the export volumes of one country using the nature of the export dynamics of another.

The P-values of the ADF and PP test for all variables in **Table 5** are less than 0.05. Consequently, the null hypothesis of the extended Dickey-Fuller test holds and the series represent an integrated first-order process. Then it is possible to build a co-integration ratio of the dynamics of exports from Belarus to the *j*-th SCO country and exports from the *i*-th SCO country to the *j*-th SCO country of the Equation (2).

$$EXP_{bel-j} = const \times EXP_{i-j}^{\gamma} \times \varepsilon_t \tag{2}$$

where,

EXP_{bel-j}- Exports of Belarus to the *j*-th SCO country;

EXP_{i-j}^{γ}-Exports of the *i*-th SCO country to the *j*-th SCO country;

ε_t- random residues.

Model (1) can and will be used in the future to estimate the forecast value of exports between the two main SCO exporting countries, and model (2) allows estimating Belarus exports while maintaining the general process described in the first model.

The second condition of cointegration is that the residuals of the obtained ratio must be stationary, therefore, according to (Bochenina, 2021), the stationarity was checked with two tests: the ADF test and the Kwiatkowski-Phillips–Schmidt–Shin test (Kwiatkowski, Phillips, Schmidt, Shin – KPSS), the null hypothesis of which is that the series are stationary. It is confirmed when the p-value is >0.05. Based on the checks, it was found that the model (2) is possible to be generated for:

- exports of Belarus to Kazakhstan and China to Kazakhstan;
- exports of Belarus to India and Russia to India;
- exports of Belarus to Russia and India to Russia;
- exports of Belarus to China and Kazakhstan to China.

Thus, the described methodology will use models (1) and (2) to construct export flow ratios of the above-mentioned countries in order to ensure the statistical quality of the models and their representativeness.

This methodology is aimed at identifying the impact of the international agreements that a country ratifies when joining the organization. It is assumed that the membership in an organization has a primary positive impact on the economic interaction of the states, as a result of which customs duties and other economic trade flow barriers are reduced.

The effects, expected to stem from the entry of a state into an international organization, are influenced by the political regime, the degree of openness of the economy, the geographical location of the country and other characteristics of the state (Maksimtsev et al., 2022). The impact of these factors is different for each country, so the acceptance process will be unique for each country.

The different empirical experience of a country's joining the Shanghai Cooperation Organization was evaluated with the generated systems of equations,

each of which describes the effects of Belarus' accession to the SCO based on the experience of another SCO member state.

The effects of Belarus joining the organization were first modeled based on the experience of India. The resulting models of India's exports to Russia and exports from Belarus to Russia have the following form:

$$\begin{cases} EXP_{in-rus} = 337729{,}3 \times VVP_{in}^{1,37} \times IMP_{in}^{0,24} \times \varepsilon_t, \\ EXP_{bel-rus} = 121{,}51 \times EXP_{in-rus}^{0,8} \times \varepsilon_t \end{cases},$$

where EXP_{in-rus}—exports from India to Russia;

VVP_{in}—India GDP per capita by PPP;

IMP_{in}—the share of imports in the total GDP of India.

$EXP_{bel-rus}$—exports from Belarus to Russia;

ε_t—random residues.

The results of the statistical quality checks of the model are shown in **Table 6**.

Table 6. Model of Belarus exports to Russia, 2000–2023.

Model	R^2	rho	DW	Normal distribution of residues, *p*-value	*p*-value	
					ADF	KPSS
$EXP_{in-rus} = 337\,729.3 \times VVP_{in}^{1.37} \times IMP_{in}^{0.24} \times \varepsilon_t$ (20.6), (4.9), (2.21)	0.94	0.06	1.78	0.44	0.008	>0.10
$EXP_{bel-rus} = 121.51 \times EXP_{in-rus}^{0.8} \times \varepsilon_t$ (2.8), (5.6)	0.88	0.01	1.51	0.74	0.001	>0.10

(Compiled by the authors based on WTO, State Bank of Pakistan, World Bank, Government of India, The Central Bank of the Russian Federation, National Statistical Committee of the Republic of Belarus).

The actual values of the student's *t*-test are indicated in parentheses under the model (*t*-table = 2.079).

For the export model from India to Russia the RMSE value constituted 16,445.61 in US dollar equivalent. For the export model from Belarus to Russia the RMSE value constituted respectively 18,661.24 in US dollar equivalent. The MAPE values for the first model turned out to be 2.4%, and for the second −1.8%, i.e. the model errors are insignificant. Based on the values of the ADF and KPSS test, the residuals are white noise, therefore, the model fully satisfies the conditions of cointegration and is reliable, based on the results of residuals autocorrelation and normality tests. Since ADF and PP have the same null hypothesis about the non-stationarity of the series, the PP test was not calculated for each model, but was used only for the primary assessment (**Table 5**) of the series under study. Subsequently, KPSS and ADF tests were calculated for the models, since they have null hypothesis that are opposite in value. If we talk about the application of the PP test from the premise of the presence of significant structural shifts in the analyzed series, then we should add a comment that geopolitical events, although they caused some shocks, but as can be seen from **Figure 1** in the short term did not have a significant impact on the volume of commodity flows. In this configuration, confirmation by the ADF and KPSS tests is robust, and the use of the PP test does not increase the reliability of the results.

Two approaches can be used to forecast Belarus' exports to an SCO country. The first is based on using a model (1) and obtaining a point and interval forecast (**Table**

4). In the case of Belarus, this forecast does not account for the impact of the international agreements executed by the SCO member-states (baseline scenario).

The second approach takes these effects from international agreements into account and was carried out in two stages:

1) First, the values of GDP per capita and the share of imports in the GDP of the *i*-th SCO member country in 2000–2023 were used to estimate the volume of exports of this country to the *j*-th SCO country in 2024.

2) Then each of the 2024 export values (point forecast and interval boundaries) from the *i*-th to the *j*-th SCO country was used to estimate the volume of Belarus exports to this country in 2024. As a result, four scenarios of Belarus export volumes were presented:

    - "baseline"—obtained by the model (1), which characterizes the export volumes of Belarus if it does not receive the status of a permanent SCO member. And, presumably, Belarus did not have the opportunity to create profitable international agreements that would contribute to an increase in its trade with the SCO member states;

    - "negative" is the lower limit of the forecast according to model (2). It takes into account the circumstances under which Belarus received the status of a permanent SCO member and concluded mutually beneficial agreements that contributed to positive changes in the international trade conditions, but they did not have any real effect;

    - "normal" is a point forecast based on model (2), in which Belarus has concluded international agreements aimed at increasing trade turnover between countries and has received the most expected statistical effects;

    - "optimistic" is the upper limit of the forecast according to model (2). It represents the most profitable option for the development of international relations between Belarus and the SCO member-states (India, China, Kazakhstan and Russia) with the greatest benefits.

To estimate the forecast values of exports in 2023, the GDP estimates of the Eurasian Development Bank (eabr.org) and the values of exports in 2023.

The results of modeling Belarus exports to Russia in 2024, provided it joins the SCO following the example of India, and the basic exports scenario are presented in **Table 7**.

Table 7. Forecast values of Belarus exports to Russia for 2024.

Scenario of exports to Russia	Point forecast, thousand dollars.	95% Confidence interval, thousand dollars	
Negative	17,288,014.2	11,960,797.7	24,987,943.3
Without joining the SCO (basic)	21,605,360.2	17,526,559.9	29,292,908.1
Normal	22,658,418.1	14,947,774.7	31,288,197.1
Optimistic	27,000,879.6	18,680,691.4	39,026,833.3

(Compiled by the authors based on WTO, State Bank of Pakistan, World Bank, Government of India, The Central Bank of the Russian Federation, National Statistical Committee of the Republic of Belarus, National Bank of Tajikistan).

The analysis of scenarios of Belarus-to-Russia exports dynamics has shown that the forecast values not taking into account the effects of joining the SCO are within

the normal scenario, which accounts for these effects. At the same time, the point value of the forecast, according to the normal and optimistic scenario, exceeds the baseline value of the export estimate in 2024, which indicates the existing potential for growth.

Similarly, the co-integration ratios of the dynamics of Belarus exports to Kazakhstan and China's exports to Kazakhstan were compiled, the export volumes of Belarus were modeled with the account to its joining the SCO based on China's experience in 2024:

$$\begin{cases} EXP_{chi-kz} = 4842782 \times VVP_{chi}^{1.69} \times IMP_{chi}^{1.68} \times \varepsilon_t \\ EXP_{bel-kz} = 22.42 \times EXP_{chi-kz}^{0.64} \times \varepsilon_t \end{cases}$$

where,

EXP_{chi-kz}—exports from China to Kazakhstan;

VVP_{chi}—China GDP per capita by PPP;

IMP_{chi}—the share of imports in the total GDP of China.

EXP_{bel-kz}—exports from Belarus to Kazakhstan;

ε_t—random residues.

Table 8 presents the verification of the model against the statistical criteria.

Table 8. Model of Belarus exports to Kazakhstan for 2000–2023.

Model	R^2	rho	DW	Normal distribution of residues, *p*-value	*p*-value	
					ADF	KPSS
$EXP_{chi-kz} = 4842782 \times VVP_{chi}^{1.69} \times IMP_{chi}^{1.68} \times \varepsilon_t$ (20.1) (11.2) (2.9)	0.98	0.01	1.67	0.67	0.007	>.10
$EXP_{bel-kz} = 22.42 \times EXP_{chi-kz}^{0.64} \times \varepsilon_t$ (−0.3), (4.2)	0.97	−0.02	1.9	0.45	0.003	>.10

(Compiled by the authors based on WTO, IMF, World Bank, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, National Statistical Committee of the Republic of Belarus, Customs of the People's Republic of China).

The actual values of the student's *t*-test are indicated in parentheses under the model (*t*-table = 2.079).

The values of the RMSE in US dollar equivalent for the first and second models constitute 12,691.71 and 9491.65 respectively. MAPE values for both models constitute 1%. That is, the models describe the series well.

Table 9 presents the scenarios of Belarus exports to Kazakhstan in 2024, provided it joins the SCO following the example of China, and the basic exports scenario.

Table 9. Forecast values of Belarus exports to Kazakhstan for 2024.

Scenario of exports to Kazakhstan	Point forecast, thousand dollars.	95% Confidence interval, thousand dollars	
Without joining the SCO (basic)	609,853.5	846,386.2	1,079,599.0
Negative	804,877.2	568,089.9	1,140,360.5
Normal	1,065,100.8	751,758.19	1,509,048.7
Optimistic	1,409,455.5	994,807	1,996,934.9

(Compiled by the authors based on WTO, IMF, World Bank, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, National Statistical Committee of the Republic of Belarus, Customs of the People's Republic of China).

As **Table 9** shows, the scenario of Belarus exports to Kazakhstan short of the effects of joining the SCO is within the intervals of the normal scenario of exports to Kazakhstan, which accounts for the accession to the SCO. However, the point estimate of this scenario is lower than normal, which indicates the existing potential for the growing export to Kazakhstan: the point estimate of the normal scenario is 66% higher than the baseline.

Table 10 presents the scenarios of Belarus exports to India in 2024.

Table 10. Forecast values of Belarus exports to India for 2024.

Scenario of exports to India	Point forecast, thousand dollars.	95% confidence interval, thousand dollars	
Without joining the SCO (basic)	146,047.3	377,033.4	973,343.2
Negative	465,742.4	185,890.7	1,166,900.9
Normal	653,628.9	260,881.4	1,637,643.7
Optimistic	917,311.1	366,124.2	2,298,290.2

(Compiled by the authors based on IMF, World Bank, The Central Bank of the Russian Federation, National Statistical Committee of the Republic of Belarus, Government of India, eabr.org).

Then, the co-integration ratio of the dynamics of Belarus exports to India and Russia exports to India was developed:

$$\begin{cases} EXP_{rus-in} = 135496.13 \times VVP_{rus}^{0.6} \times IMP_{rus}^{-2.08} \times \varepsilon_t \\ EXP_{bel-in} = 260.26 \times EXP_{rus-in}^{0.44} \times \varepsilon_t \end{cases}$$

where,

EXP_{rus-in}- exports from Russia to India

VVP_{rus}- Russia GDP per capita by PPP;

IMP_{rus}- the share of imports in the total GDP of Russia;

EXP_{bel-in}- exports from Belarus to India;

ε_t- random residues.

Table 11 presents the verification of the model against the statistical criteria.

Table 11. Model of Belarus' exports to India for 2000–2023.

Model	R^2	rho	DW	Normal distribution of residues, *p*-value	*p*-value	
					ADF	KPSS
$EXP_{rus-in} = 135496.13 \times VVP_{rus}^{0.6} \times IMP_{rus}^{-2.08} \times \varepsilon_t$ (−2.97), (9.99), (3.01)	0.92	−0.17	2.2	0.14	0.004	>0.10
$EXP_{bel-in} = 17759.04 \times EXP_{rus-in}^{0.21} \times \varepsilon_t$ (9.75), (2.52)	0.7	0.09	1.8	0.99	0.01	>0.10

(Compiled by the authors based on IMF, World Bank, The Central Bank of the Russian Federation, National Statistical Committee of the Republic of Belarus, Government of India).

The actual values of the student's *t*-test are indicated in parentheses under the model (*t*-table = 2.079).

In this case the RSME value for the first model constituted 16,410.88 in US dollar equivalent, and for the second −9816.94. The MAPE values for the first model constitute 1.7%, and 2.8% for the second model respectively.

Table 10 presents the scenario of Belarus exports to India in 2024, provided it joins the SCO following the example of Russia, and the basic exports scenario.

The obtained forecast values indicate that there are prospects for the development of export flows to India: according to our estimates, the growth after joining the organization following the negative scenario is more than $300 million. At the same time, the optimistic scenario features even greater growth and indicates the existing potential.

The co-integration ratio of the dynamics of Belarus exports to China and Kazakhstan exports to China:

$$\begin{cases} EXP_{kz-chi} = 315180 \times VVP_{kz}^{1.78} \times IMP_{kz}^{0.98} \times \varepsilon_t \\ EXP_{bel-chi} = 75.64 \times EXP_{kz-chi}^{0.56} \times \varepsilon_t \end{cases}$$

where EXP_{kz-chi}—exports from Kazakhstan to China;

VVP_{kz}—Kazakhstan GDP per capita by PPP;

$EXP_{bel-chi}$—exports from Belarus to China;

IMP_{kz}—the share of imports in the total GDP of Kazakhstan.

ε_t—random residues.

Table 12 presents the verification of the model against the statistical criteria.

Table 12. Model of Belarus exports to China for 2000–2023.

Model	R^2	rho	DW	Normal distribution of residues, *p*-value	*p*-value	
					ADF	KPSS
$EXP_{kz-chi} = 315\,180 \times VVP_{kz}^{1,78} \times IMP_{kz}^{0,98} \times \varepsilon_t$ (156.8), (6.12), (11.45)	0.97	0.22	1.6	0.76	0.02	>0.10
$EXP_{bel-chi} = 75,64 \times EXP_{kz-chi}^{0,56} \times \varepsilon_t$ (1.85), (5.81)	0.64	0.08	1.8	0.76	0.008	>0.10

(Compiled by the authors based on WTO, IMF, World Bank, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, National Statistical Committee of the Republic of Belarus, Customs of the People's Republic of China).

The actual values of the student's *t*-test are indicated in parentheses under the model (*t*-table = 2.079).

The RMSE value for the first model constituted 7914.83 in US dollar equivalent, and for the second −17,301.8 respectively. MAPE value for the first model constituted 1.1%, and for the second −2.2% respectively. It should be noted that the second model is characterized by low determination, which leads to conclusions about the search for additional, hidden factors in the long-term equilibrium of commodity flows between countries.

Table 13. Forecast values of Belarus exports to China for 2024.

Scenario of exports to China	Point forecast, thousand dollars.	95% Confidence interval, thousand dollars	
Without joining the SCO (basic)	661,802.2	267,539.1	1,023,177.9
Negative	954,895.3	424,719.4	2,146,890.3
Normal	1,251,918.8	556,829.8	2,814,688.1
Optimistic	1,641,332.6	730,033.7	3,690,202.9

(Compiled by the authors based on WTO, IMF, World Bank, Agencies for Strategic Planning and Reforms of the Republic of Kazakhstan, National Statistical Committee of the Republic of Belarus, Customs of the People's Republic of China).

Table 13 presents the scenario of Belarus exports to China in 2024, provided it joins the SCO following the example of Kazakhstan, and the basic exports scenario.

Table 13 shows that the scenario of exports to China without joining the SCO according to the point forecast turned out to be lower than the negative one when Belarus joined the organization. At the same time, the interval estimates are similarly lower. The existing negative scenario featuring joining the SCO, exceeds the forecast without joining the SCO by 44.28%. This also indicates the existing potential for cooperation and the increasing volume of commodity flows.

5. Discussion

The study analyzed the economic situation of commodity flows between the SCO member countries. The current situation is characterized by a high concentration of export-import flows between Russia, Kazakhstan, China, and India. Iran, Pakistan, Tajikistan, Uzbekistan and Kyrgyzstan are almost not involved in the processes.

Therefore, it will be important for Belarus to execute beneficial trade agreements with China, Kazakhstan, Russia, and India in joining the Shanghai Organization, given that there is potential in 2024 in cooperation with them:

- In trade with Russia, the expected increase in Belarus exports if the latter joins the Shanghai Cooperation Organization in comparison with the scenario in which Belarus will not receive permanent member status is 4.8%. This is explained by the already existing close relations between these countries. Such growth will be due to the overall development of the partner economies.

- Exports to Kazakhstan are expected to increase by 74.6%, which is a natural growth, provided there is an active bilateral interest in partnerships and the conclusion of international economic agreements.

- The increase in exports to China is expected at the level of 89.1%. China is the primary candidate to become the world's largest economy by the end of 2024. It is its size that determines the prospects for the export flows increase. As, if imported goods are not provided with the necessary market scales, the exports will be impractical.

- Trading with India has a pattern similar to Belarus exports to China – the expected increase in exports exceeds $500 million.

Speaking about the statistical quality of the obtained models, it should be mentioned, that despite the fact that they all meet the corresponding requirements, the RMSE values are slightly overestimated, in a similar comparison with the results of other authors on various subjects of research (Pandit et al, 2024; Jin and Xu, 2024a; Jin and Xu, 2024b; Jin and Xu, 2024c). In general, it could be concluded that the quality of the model can guarantee the validity of the forecasts, taking into account the volatility of international trade volumes. The difference in the share of variance explained (the pattern of dependence of Belarus' export to China on Kazakhstan's exports to China) raise the question that there are differences in the degree of codependence of different commodity flows. The search for these factors is one of the directions for further research. In addition, the structure of countries' economies also has a significant impact on the nature of international trade flows. To form a holistic picture, it is necessary to turn to dynamic stochastic general equilibrium modeling

(DSGE models) and an assessment of the domestic policies of countries in the near future in order to form scenario forecasts of economic development (DSGE models) based on proposed government measures, and then, based on the findings obtained, to form more reasonable assessments of future values of international trade of countries. The described assumptions lay the foundation for future research. In our opinion, the approach proposed in this article can be used not only in the context of world trade, but also at the level of individual sectors and industries through the structure of intermediate consumption, which opens up great prospects for its further application.

5.1. Policy implementations

The obtained estimates, on the one hand, correspond to the general premises of the current world situation. The expected increase in trade turnover with China is due to its hegemony in the East Asian region, as evidenced by the data in **Tables 1** and **2**. The prospects associated with Kazakhstan and India are explained by the recent development of these countries and the increase in both their domestic market and export flows. Russia is a long-time partner and therefore the prospects in its market are determined by the natural development of countries. On the other hand, parameter estimates in models allow countries to be positioned relative to their target growth points: increasing GDP or increasing import supplies. This is best illustrated by the example of Kazakhstan. In the particular case, for this country the elasticity for GDP is 1.78, while for imports it is 0.98. That is, at the moment the domestic market is saturated with goods and the key to the country's sustainable development lies in increasing its own production potential. While the parameter estimates for China are correlated with each other, that is, China, having a large domestic market, can use it as a development driver along with increasing its own production.

At the same time, the fundamental factor in the increase in Belarus foreign trade turnover with the considered countries is the overall growth of its own economy. As calculations show, the increase in unilateral imports of goods increases its exports in a proportion less than 1:1, since the elasticity coefficients for the share of imports in total GDP in **Table 5** are less than 1 in all cases. This confirms the theoretical assumption about the nature of impact this indicator has on Belarus exports, i.e. the high share of imports in the GDP may indicate weak economic development and low export potential, which in the long term may turn the country into a raw material colony of its neighbors.

Thus, the prospects for Belarus joining the Shanghai Cooperation Organization are quite positive, given that its transit role in world trade has lost relevance as the sanctions were imposed in 2022. This confirms the hypothesis about the beneficial effect of Belarus integration into the SCO.

At this stage of development, the issues of mobilizing Belarus own economic potential to create effective trade flows with friendly countries are a priority. Here, joining the SCO can significantly speed up and facilitate this process: the alliance allows concluding beneficial agreements aimed at supporting domestic production.

5.2. Assumptions and limitations

This work did not consider the approach of competing directions (Fotheringham,

1983). In relation to the issue discussed in the work, this may be useful from the point of view of studying political and other barriers that affect the choice of export destination. Integration into an international organization should help remove such restrictions. But such a technique should be based on the results obtained in this investigation. Modeling a two-stage consumer choice of a macroregion is beyond the scope of the methodology used. However, the diffusion of international trade flows has a significant impact on their volumes between countries, especially with parallel imports and secondary sanctions. It is planned to investigate this issue utilizing DSGE models.

The very mechanism for assessing a country's entry into an international organization according to the scenario of a particular country presupposes some conditional similarity of countries in order to be able to project effects on the economy of another country.

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