## Illicit Trade of Raw Materials in Logistics Sanctions Circumvention: Causes and Consequences

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**Abstract:** This research explores the illicit trade of raw materials as a response to logistics sanctions, focusing on the interplay between sanctioned and non-sanctioned countries through regional trade agreements. The study's findings reveal that the high economic value of critical raw materials and disruptions to legitimate supply chains have catalyzed the emergence of illicit trade networks. Methodologically, moderation, reliability, and correlation analyses were employed, demonstrating that logistics sanctions positively influence unauthorized interactions with countries (NCI = 0.43, p < 0.05) and significantly impact supply shortages (SS = 0.64, p < 0.05), customs regime (CR = 0.42, p < 0.05), transaction values (TV = 0.25, p < 0.05), and the establishment of alternative routes (AR = 0.39, p < 0.05). Notably, regional trade agreements did not mitigate these relationships. This research underscores the need to understand how regional trade dynamics facilitate sanction evasion, thereby influencing the frameworks of illicit trade and logistical operations.

Keywords: Illicit Trade, Sanctions Circumvention, Logistics, Illegal Schemes, Raw Materials

### JEL Classification codes: 017, F23, L91

### INTRODUCTION

The imposition of logistical sanctions on Russia in response to its actions in Ukraine has catalyzed a significant transformation in the global trade landscape, particularly concerning the illicit trade of raw materials. This research delves into the intricate relationship between sanctions and the burgeoning underground markets that have emerged in Central and Eastern Europe. The illicit trade of essential raw materials, driven by complex supply chains and regional dependencies, has become a prominent consequence of these sanctions. According to Anzoom et al. (2021), "sanctions often create unintended consequences that foster adaptive behaviors in economies, leading to the proliferation of illicit networks." As nations pursue alternative avenues for acquiring raw materials, the dynamics of global trade have been irrevocably altered, with Europe witnessing an increase in clandestine activities.

The conflict in Ukraine has not only served as a catalyst for sanctions but has also exposed the intricate network of trade agreements established by sanctioned nations with non-sanctioned counterparts. Research by Stepien & Weber (2019) emphasizes the necessity of examining these networks, asserting that "the adaptive strategies employed by sanctioned states can significantly undermine the intention of regulatory frameworks." Furthermore, the ramifications of logistical sanctions extend beyond mere economic implications, influencing geopolitical relations and regional stability. The International Trade Centre (2023) posits that

"the consequences of sanctions-induced changes in trade relations can destabilize regional economies, creating a power vacuum that illicit networks exploit." This destabilization disrupts the economic landscape and creates security threats, exacerbating tensions between neighboring countries.

The core of this investigation lies in comprehending the operation of these illicit trade channels, elucidating the interaction between legal and illegal logistical frameworks in the distribution of critical raw materials. As highlighted by the OECD (2023), "the adaptation of trade routes, coupled with the emergence of alternative sources of supply, underscores the inherent challenges in enforcing sanctions effectively." Assessing the effectiveness of sanctions over time presents significant challenges. In particular, Van Bergeijk & Van Marrewijk (1995) formulated the fundamental notion that sanctions require an adjustment period during which targeted states and actors must adapt to the imposed constraints. Furthermore, Vines (2012) highlights historical and contextual differences in the implementation of sanctions by international bodies such as the The United Nations and the European Union. However, Caetano et al. (2023) emphasize that the determinants of sanctions effectiveness are complex and often intertwined with various economic and political factors. Thus, difficulties in assessing the effectiveness of sanctions over time arise due to the existence of adaptation periods for targeted actors and contextual variability that shapes the effectiveness of such measures and inadvertently contributes to the development of illicit trade.

The analytical performance of the reconsideration of legal and illegal practices for evading and circumventing logistical sanctions is illustrated in Fig. 1. The subsequent sections will further elucidate the origins of these illicit networks, examining the various legal and illegal channels employed and their broader implications for the geopolitical landscape of Central and Eastern Europe.



# Fig. 1: Analytical performance of legal and illegal schemes for evading and circumventing logistical sanctions

### Source: own elaboration

The study aims to evaluate the impact of logistical sanctions on the formation of regional trade agreements between sanctioned and non-sanctioned countries by moderating changes such as: shortages of critical raw materials (dependencies and unmet needs), customs regimes

(routes for sanctions circumvention), transaction costs (increased supply chain expenses), alternative routes (additional logistics points), and interactions with non-sanctioned countries (to distort the actual raw material base). The significance of this research lies in investigating how the establishment of regional trade agreements mitigates the constraints imposed by logistical sanctions and facilitates adaptation over time through variable parameters. Additionally, it examines how the interaction between non-sanctioned countries and regional trade agreements mutually influences the outcomes of sanctions circumvention through the emergence of illicit trade practices based on legal logistics channels.

## **1** LITERATURE REVIEW

This historiographical review synthesizes key contributions to the literature on economic sanctions, highlighting the complexities and nuances inherent in their application, with a further projection in 1.1-1.7 onto logistical sanctions. Thus, Lam (1990) provides a foundational assessment of economic sanctions, critically evaluating their ability to achieve foreign policy objectives. Morgan & Schwebach (1995) extend this analysis by investigating the domestic political considerations that shape the imposition and effectiveness of economic sanctions. According to their findings, the alignment between domestic political interests and foreign policy goals significantly influences the efficacy of sanctions as a foreign policy instrument. In a legal and policy-oriented context, Segall (1999) examines the constraints that international law and political considerations impose on the implementation of economic sanctions. This research highlights the challenges that states face when balancing the enforcement of sanctions with compliance with legal frameworks, thereby complicating the discourse surrounding their legitimacy and overall effectiveness. Morgan (2000) presents a critical reflection on the paradox of sanctions and posits that the intended outcomes of economic statecraft often diverge from actual results, leading to a complex interplay between sanctions and international relations. This paradox raises questions about the assumptions underlying sanction strategies and their actual impacts on target states. Hafbauer & Schott (2007) undertake a comprehensive reevaluation of economic sanctions, considering historical cases and contemporary examples to discern patterns of success and failure. Their work contributes to an understanding of the strategic calculation involved in the use of sanctions, proposing that contextual factors, such as the economic resilience of the targeted state and international support for sanctions, significantly influence their effectiveness. Schmitt (2012) advocates for a strategic approach to sanctions research, suggesting the formulation of a research agenda that incorporates diverse methodologies and cross-disciplinary perspectives. Finally, Rogoff (2015) raises pertinent questions about the overarching effectiveness of economic sanctions, critically discussing whether they achieve their intended results. In summary, the evolution of sanctions theory demonstrates a shift from linear, simplistic models to a more nuanced understanding that incorporates multiple dimensions of state behavior and international relations.

## 1.1 Logistic sanction

Sanctions are instrumental in maintaining international peace and security, particularly in Europe, where they are employed to modify the conduct of individuals and regimes implicated in conflicts. Logistic (Transport) sanctions exert economic pressure on targeted nations to fulfill diplomatic goals, limit access to critical materials and markets, and ensure compliance with international laws. These measures also serve to mitigate risks by diversifying suppliers and markets (Sun et al, 2022).

The term "Logistic (Transport) Sanction" encompasses regulatory measures that restrict or prohibit the movement of goods, services, or individuals across various transportation channels. EU sanctions aimed at critical raw materials seek to curtail the supply of essential resources crucial for diverse industries, including electronics, aerospace, and defense. These sanctions are designed to exert pressure on Russia by limiting its access to the European market, thereby affecting its economic stability (Kumagai et al., 2022). Notably, the EU has implemented import bans on raw materials for steel production, processed aluminium products, and various metal goods (Davarzani et al., 2015). The logistics sector is vital in executing and assessing the impact of EU sanctions on critical raw materials and managing the transportation, storage, and distribution of these resources. Sanctions may necessitate adjustments in logistics operations, such as identifying alternative supply routes, incurring increased transaction costs, and engaging with countries not subject to sanctions.

Regional trade agreements play a significant role in circumventing EU sanctions against Russia. These agreements can facilitate alternative routes and sources for critical raw materials, allowing sanctioned countries to maintain their trade activities. For instance, Russia has advocated for intra-regional trade within the Eurasian Economic Union (EAEU) to sustain trade with the European Union and other nations that have imposed sanctions. This strategy aims to utilize these countries as intermediaries to bypass sanctions and continue trade operations (Giumelli et al., 2021). The legal circumvention of sanctions can lead to the emergence of illicit trade phenomena. When countries identify methods to legally navigate around sanctions, it can create opportunities for illicit trade activities. The rise of multi-regionalism, driven by imposed or potential economic sanctions, may undermine the unilateral system of international trade regulations under the World Trade Organization. Additionally, sanctioned economies are increasingly leveraging innovation to navigate sanctions, which can inadvertently foster illicit trade activities (Investigate Europe, 2023).

Logistic sanctions are shaped by various factors influencing the behavior of sanctioned entities, including shortages in raw material supply, increased transaction costs for supply operations, restrictions on customs regimes, the search for alternative routes, and the necessity for engagement with countries not included in the sanctions lists (Sun et al, 2022). A critical moderating factor in this context is the establishment of regional trade agreements to address the challenges posed by imposed sanctions (Santeramo & Lamonaca, 2022). The evasion of sanctions, including logistical ones, through trade agreements between sanctioned and non-sanctioned states represents a transitional structure from illegal to legal trade and exemplifies the adaptation process to sanctions (Giumelli et al., 2021).

## 1.2 Supply shortage

The European Unionhas imposed extensive sanctions on specific states to address geopolitical tensions and human rights violations. However, these sanctions can inadvertently lead to supply shortages of critical raw materials, which are vital for various industries, including technology, construction, and energy (Salimian et al., 2024). The scarcity of resources in sanctioned countries often fosters an environment conducive to illicit trade practices. The effects of sanctions are multifaceted; while they aim to restrict economic activities in targeted nations, they also create market imbalances that illicit networks exploit (Vuola, 2015). A significant consequence of these supply shortages is the elevation of prices for raw materials, which can further destabilize markets in the EU and beyond (Cebotari, 2021). Consequently, businesses that rely on these materials can experience operational disruptions, forcing them to seek alternative suppliers. Such a search often leads to engagement with unregulated sources, which may include illegal markets that often bypass existing sanctions. This phenomenon has been documented in various sectors, from the mining of strategic minerals

to the procurement of rare earth elements, where shadow networks flourish due to increased demand and decreased availability from sanctioned sources (Larch et al., 2022).

Moreover, the rise of technological advancements complicates the monitoring and enforcement of sanctions. The digital age has provided criminals with easier access to the tools necessary for covert operations, allowing illicit trade channels to thrive under the radar of regulatory bodies (Basu, 2014). The EU's reliance on raw materials necessitates prudent policy considerations that address both the challenges of supply shortages and the repercussions of engaging in illicit trade. In conclusion, the imposition of sanctions by the EU, while aiming to curtail aggressive and unethical actions, inadvertently fosters a response mechanism that encourages the development of illicit trade networks. The resultant search for alternative sources of raw materials serves as a stark reminder that sanctions, without complementary strategies for resource management and enforcement, may lead to unintended consequences. Thus, the hypothesis emerges that the pressing shortage of supplies leads to a search for ways to circumvent sanctions, potentially aggravating the very issues the sanctions were meant to resolve. The above arguments conclude the following hypothesis:

• H1: Supply shortages have a positive impact on logistical sanctions but lead to the search for workarounds.

## 1.3 Customs regime

The circumvention of European Union sanctions through different customs regimes has become a focus of concern for both policymakers and researchers. The complexity of customs procedures can inadvertently facilitate illicit trade, particularly in raw materials, by allowing operators to exploit loopholes in the existing regulatory framework. It has been noted that the diversity of customs regimes allows operators to engage in fraudulent misrepresentation of goods, often resulting in the rerouting of sanctioned materials (Forganni, 2019). This is particularly problematic given that raw materials are often the focus of strategic economic interests, requiring strong regulatory measures (Adam & Ahamat, 2023). In addition, there has been a shift towards informal trading networks where parties can evade control by operating through less regulated jurisdictions, thereby undermining EU efforts to maintain effective sanctions (Kupatadze & Marat, 2023). Studies have shown that integrating advanced technological measures into customs regimes can mitigate these problems by increasing transparency and traceability, thus helping to detect sanctions evasion (Gkoni et al., 2024). However, opportunities for circumvention remain widespread as long as there are differences in customs practices across member states (Bali et al., 2024). Given these findings, it is hypothesized that the introduction of a harmonized customs regime in the EU has a positive impact on reducing the circumvention of logistical sanctions. By standardizing customs procedures, increasing cooperation between member states, and strengthening enforcement measures, the EU can significantly disrupt the channels through which illicit trade thrives.

• H2: The Customs Regime has a positive effect on Logistic Sanction.

## 1.4 Transaction value

The imposition of European Union sanctions has significantly increased transaction costs associated with evading these restrictions, largely due to heightened transportation and additional logistics costs. As sanctions disrupt traditional trade routes and induce compliance costs, businesses are compelled to explore alternative, often risk-laden, channels. The need to navigate these complex logistics can lead to inefficiencies and increased operational expenses, further inflating transaction costs (Mykyta, 2025). Additionally, the development of

illicit trade in raw materials has emerged as a primary consequence of these elevated transaction costs. As legitimate avenues for acquiring goods become restricted, black markets proliferate, often resulting in price surges and the deterioration of standardized supply chains (Bevan et al., 1989). Research indicates that criminal networks thrive under sanction regimes, capitalizing on the opportunity to meet illicit demands for resources while simultaneously exacerbating the risks associated with supply chain disruptions (Seepma, 2021). These escalating costs not only reflect the challenges inherent in circumventing EU sanctions but also serve to reinforce the economic isolation intended by such measures. Transaction costs, therefore, can be construed as an unintentional yet effective feedback mechanism for the broader goals of sanctions policy (Drezner, 1999). While the repercussions of increased transaction costs due to sanctions are multifaceted, they ultimately contribute to enforcing compliance and reducing the efficacy of illicit trading practices. Thus, the hypothesis emerges that increasing transaction costs may be interpreted as a positive effect of logistics sanctions, deterring illicit trade while promoting adherence to international norms and regulations.

• H3: Transaction Value has a positive effect on Logistic Sanction.

## **1.5** Alternative route

The imposition of EU sanctions has significantly changed the dynamics of commodity trade in the region and beyond. In particular, entities subject to these sanctions are increasingly seeking alternative routes through non-EU countries to facilitate their continued access to key resources. This shift is driven by the need to maintain supply chains while adhering to the regulatory frameworks dictated by the sanctions (Afesorgbor, 2019). As a result, trading networks often engage in complex logistical mechanisms that exploit vulnerabilities in international trade rules, allowing sanctioned entities to gain indirect access to commodities (Stepien et al., 2024). In addition, illicit commodity trade has expanded as a direct consequence of the sanctions. The emerging black market is characterized by a lack of regulation, as transactions often take place in jurisdictions that do not adhere to strict compliance measures (Basu, 2013). The emergence of middlemen makes tracking more difficult, thereby exacerbating the challenges regulators face in effectively enforcing sanctions (Bove et al., 2023). These developments highlight a paradox; while sanctions are intended to deter certain activities, they inadvertently encourage the very behavior they seek to suppress, leading to the proliferation of illicit trade networks operating outside of formal markets. In addition, the increased transaction costs associated with navigating these alternative routes have been a notable consequence of logistical sanctions. As businesses engage in more complex supply chains and face compliance hurdles, costs inevitably increase (Larch et al., 2022). Thus, while sanctions are intended to impose economic pressure on targeted entities, the associated increase in transaction costs may serve as a buffer against unregulated trade, potentially mitigating the adverse effects of illicit practices. In summary, the intricate dance of circumventing EU sanctions through alternative routes has had a multifaceted impact on commodity trade. This situation suggests that increased transaction costs, rather than simply burdens, may constitute a constructive friction that deters illicit trade. The above debate concludes the following hypothesis:

• H4: Alternative Route has a positive effect on Logistic Sanction.

## **1.6 Non-sanctioned country interaction**

The interaction between non-sanctioned countries plays a crucial role in the effectiveness of logistics sanctions. When non-sanctioned countries collaborate, they create a robust network that minimizes the chances of sanctioned countries finding loopholes to circumvent restrictions.

Key academic research on international sanctions draws heavily on the seminal contributions of Kaempfer and Loewenberg (1988, 1999), which explain the resilience of large economies in the face of sanctions by emphasizing how their size contributes to their inherent selfsufficiency. A detailed discussion of the size of a target economy provides a more nuanced understanding of its ability to withstand economic constraints. Furthermore, the presence of "black knights"—third-party allies—can play a key role in mitigating the adverse effects of such sanctions. Finally, cooperation among non-sanctioned countries has been shown to have a positive impact on the logistical effects of sanctions, suggesting that cooperative strategies can enhance economic resilience. This hypothesis is supported by various studies and reports, which highlight the positive impact of such interactions on the enforcement of sanctions. A study by Li et al. (2024) found that firms in sanctioningcountries reduced exports of sanctioned products to Russia when their headquarters were in countries. However, domestic firms in neutral countries significantly increased exports of sanctioned products, undermining sanctions (Li et al., 2024). This indicates that while non-sanctioned countries can help enforce sanctions, their domestic firms may still find ways to bypass restrictions. Another report by the International Trade Centre (2023) emphasizes the importance of multinational enterprises (MNEs) in non-sanctioned countries complying with 'long-arm' sanctions. These sanctions restrict the export of products using technology or inputs from sanctioning countries, thereby ensuring that non-sanctioned countries do not become conduits for sanctioned goods (International Trade Centre, 2023). This compliance is essential for maintaining the integrity of the sanctions regime. Furthermore, a report by the United Nations Conference on Trade and Development (UNCTAD, 2023) highlights that non-sanctioned countries increased their exports of non-sanctioned products to Russia by 40%, while non-sanctioning countries reduced their exports by 80%. This shift in trade patterns underscores the role of non-sanctioned countries in supporting the sanctions framework. This highlights the need for coordinated efforts among non-sanctioned countries to ensure that sanctions are not undermined. In conclusion, the interaction between non-sanctioned countries has a positive effect on logistics sanctions. By collaborating and complying with international regulations, these countries can prevent sanctioned countries from exploiting loopholes. This cooperation is vital for the success of sanctions and the prevention of illicit trade in raw materials.

• H5: Interaction between Non-sanctioned Country Interaction has a positive effect on Logistic Sanction.

## **1.7 Regional trade agreement**

One common pattern of sanctions circumvention involves the use of intermediary countries that are part of a regional trade agreement (RTA) with both the sanctioning and sanctioned countries. These intermediary countries can act as conduits for goods and raw materials, allowing sanctioned countries to access restricted items indirectly. For example, a study by Silingardi (2024) found that Russian firms were able to import high-tech components through Belarus, a member of the Eurasian Economic Union (EEU), despite EU sanctions. This highlights the role of RTAs in facilitating the flow of goods between sanctioned and non-sanctioned countries.

Another scheme involves the re-exportation of goods. Non-sanctioned countries within an RTA can import goods from sanctioning countries and then re-export them to the sanctioned country, effectively bypassing the sanctions. A report by the International Trade Centre (2024) documented instances where goods exported from the EU to Kazakhstan were subsequently re-exported to Russia, circumventing EU sanctions (International Trade Centre, 2024). This practice underscores the challenges in enforcing sanctions within the framework of RTAs. Furthermore, RTAs can provide legal cover for sanctioned countries to engage in trade by exploiting loopholes in the agreements. Research conducted by Flach et al. (2024) indicates

that Russian enterprises leveraged preferential trade conditions under the Eurasian Economic Union to import goods that were otherwise prohibited by European Union sanctions. This illustrates the potential for RTAs to be exploited as a means of circumventing sanctions.

The above cases and arguments are summarized in Fig. 2 as a schematic model of the involvement of non-sanctioned countries in the practice of circumventing sanctions through RTAs.

## Fig. 2: Schematic model of logistics sanctions circumvention involving non-sanctioned countries based on RTA



Note: RM – raw material; MF – money flow

Source: own elaboration

The involvement of MNEs in RTAs also plays a crucial role in sanctions circumvention. MNEs with operations in both sanctioning and non-sanctioned countries can leverage their global supply chains to move goods across borders, bypassing sanctions. A report by the United Nations Conference on Trade and Development (UNCTAD, 2023) highlighted cases where MNEs re-routed their supply chains through non-sanctioned countries to continue trading with Russia (UNCTAD, 2023). This indicates the complexity of enforcing sanctions in a globalized economy.

In conclusion, regional trade agreements can inadvertently facilitate the circumvention of sanctions through various patterns and schemes involving third countries. The use of intermediary countries, re-exportation of goods, exploitation of legal loopholes, and involvement of multinational enterprises are some of the key mechanisms through which sanctioned countries can bypass restrictions. Addressing these challenges requires coordinated efforts and enhanced enforcement mechanisms within the framework of RTAs.

The above arguments conclude the following theoretical framework for research methodology in Fig. 3.





Note: thin line - independent variable; bold line - dependent variable; dashed line - moderating variable

Source: own elaboration

## 2 METHODOLOGY

## 2.1 Research methods

The study used a symbiosis of statistical methods to test the relationships between variables and their correlation. In particular, the following:

- Reliability analysis (Cronbach's alpha) establishing the reliability of a group of survey items (Cronbach's alpha coefficient) and internal consistency on a unified scale, where higher numbers mean items with greater agreement (Tavakol & Dennick, 2011).
- Pearson's coefficient determining the linear relationship and correlation between two variables, evaluating statistical hypotheses (Benesty et al., 2009).
- ANOVA tests checking the survey results for significance in order to select the correct hypothesis based on the test of group mean equality. This minimizes the prevalence of errors or false positive results (Blanca et al., 2023).

All data collected for this study were analyzed using IBM SPSS Statistics software.

## 2.2 Research limitations

The subjective opinions of respondents, along with assumptions derived from potentially limited sources influenced by political ideologies, were excluded from the analysis to maintain the integrity of statistical significance indicators in the context of Russia's military aggression against Ukraine. This study primarily focuses on Ukraine and the European Union, where the

extent of supply shortages has been assessed as a direct consequence of the logistical sanctions imposed on Russia affecting supply chains.

The timeframe of the research spans December 2024 to January 2025, utilizing data gathered through value judgments regarding the effectiveness of the logistical sanctions as reported in the survey. To validate the interpretations of the empirical evidence presented, hypothetical conclusions drawn from scientific research were contextualized in relation to the responses obtained from the study participants. The respondent sample is deemed representative of the relevant subject range, thereby ensuring the reliability of the generalizations made within the constraints of the specified temporal context, geographical focus, and the volume of comparable scientific literature available at the time of analysis.

## 2.3 Data and sources

The study involved 18 multinational logistics companies that operated during the war in Ukraine. These companies represent various sectors, including shipping lines, port terminal operators and authorities, intermodal terminal developers, operators of sea and river locks and canals, road hauliers, railway and rail terminal operators, and third-party logistics providers. Air freight logistics operators were excluded from the survey due to the closed airport infrastructure and their limited activity during the conflict. A total of 144 respondents were selected, and questionnaires were distributed online via Google Docs to gather their insights.

The questionnaire is divided into two sections. The first section contains closed-ended questions on all variables. The scale was used to assess the responses of all variables (See Fig. 1), which include the dependent variable (logistic sanction), independent variables (supply shortage, customs regime, transaction value, alternative route, non-sanctioned country interaction) and the moderating variable (regional trade agreement) on a Likert scale (Joshi et al, 2015) ranging from (1) strongly disagree, (2) disagree, (3) neutral, (4) agree and (5) strongly agree. Statements for all variables can be collected from various journal articles used in the literature review to formulate hypotheses, as well as from the questionnaire.

The second section is a professional overview, which contains questions on logistics field affiliation, work experience, titles and age. A nominal scale was used for this section of questions.

### **2.4 Professional overview of the respondents**

The sample for this study includes 144 representatives working in 18 international logistics companies. Section 2 of the questionnaire contains professional survey questions. The professional portrait of the respondents shows that out of 144 respondents in the field of shipping lines – 14%, port terminal operators and authorities – 11%, intermodal terminal developers – 12%, operators of sea and river locks and canals – 10%, road hauliers – 20 %, railway and rail terminal operators – 23%, third-party logistics providers – 10%. In addition, the titles of the respondents include 12% - lead/head, 73% - senior, and 15% - middle managers. By work experience, the respondents are distributed as follows: up to 10 years – 23%, from 10 to 15 years – 72% and over 15 years – 5%. The age profile of respondents includes people under 30 years old - 17%, from 30 to 40 years old - 55%, and over 40 years old - 28%. The above questionnaire data is illustrated in Fig. 4 (a-d).



Fig. 4: Professional overview of the respondents: (a) Field; (b) Title; (c) Experience; (d) Age

## **3 RESULTS AND DISCUSSION**

### 3.1 Reliability analysis

When the goal is frequently measured, reliability analyses the stability of the results. Using Cronbach's alpha approach, the reliability of data about latent variables and operational constructs was evaluated (Tavakol & Dennick, 2011). While the construct is a fictitious variable that is assessed in it, Cronbach's alpha is a measure of dependability related to the discrepancy accounted for by the true mark of the underlying theory. In social sciences, if Cronbach's alpha is greater than 0.60, it indicates reliable data, and if it is less than 0.60, it indicates that the data is not reliable. For this study, we use Cronbach's alpha coefficient to evaluate the reliability of measurement tools.

Tab. 1 indicates that all the variables of this study have Cronbach's alpha larger than 0.60, which indicates that the data is reliable.

Variable Names	Abbreviation	Cronbach's Alpha	No. of Items
Logistic Sanction	LS	0.93	3
Supply Shortage	SS	0.82	4
Customs Regime	CR	0.75	3
Transaction Value	ΤV	0.73	4

 Tab. 1: Reliability Analysis of the Logistic Sanction Scale

Variable Names	Abbreviation	Cronbach's Alpha	No. of Items
Alternative Route	AR	0.86	2
Non-sanctioned Country Interaction	NCI	0.60	3
Regional Trade Agreement	RTA	0.78	10

Source: own processing with SPSS software

## 3.2 Correlation analysis

A statistical method known as correlation illustrates how closely two variables are connected. We can interpret the correlation analysis for this study by Pearson's correlation coefficient (Benesty et al., 2009). The link between the two continuous variables is assessed using this statistical method. The bivariate correlation shows how a change in the independent variable causes a variation in the dependent variable. A correlation coefficient value close to  $\pm 1$  indicates a perfect correlation, signifying that an increase in one variable is consistently associated with an increase (positive correlation) or decrease (negative correlation) in the other. The variations within the variables can be seen in Tab. 1.

In Tab. 2, there is 1 in the diagonal, and this is a mirror effect, as below and above 1 value are the same. Only the values that are significant at the 0.01 level are regarded. This means that they are significant at the 0.01 level.

Variables	LS	RTA	SS	CR	τν	AR	NCI
LS	1						
RTA	0.16	1					
SS	0.64	0.12	1				
CR	0.42	0.13	0.36	1			
TV	0.25	0.11	0.25	0.48	1		
AR	0.39	0.18	0.29	0.53	0.29	1	
NCI	0.43	0.13	0.45	0.44	0.39	0.34	1

 Tab. 2 Pearson's correlation between variables

Note: Correlation is significant at the 0.01 level (2-tailed)

Source: own processing with SPSS software

The above Tab. 2 indicates that the variables are perfectly positively correlated with each other. These values are positive, which means that if one variable increases (dependent variable), another variable (independent variable) also increases. This also states that there is a strong association between the two variables. The strongest correlation exists between Logistic Sanction and Supply Shortage, Customs Regime, Transaction Value, Alternative Route, and Non-sanctioned Country Interaction, as all the value correlations are significant at the 0.01 level, as shown in the above Tab. 2.

## 3.3 Hypotheses testing

The likelihood of receiving outcomes from a statistical hypothesis test that are at least as extreme as the actual outcomes, assuming the null hypothesis is true, is known as the p-value

in statistics. A p-value is a statistical measurement that is additionally used to test a hypothesis against actual data. The estimated probability is used in the p-value method of hypothesis testing to decide whether there is sufficient proof to reject the null hypothesis. Normally, a p-value of 0.05 or less is regarded as statistically significant, and in that case, the null hypothesis should be disregarded. If the p-value is larger than 0.05, the null hypothesis is not precluded because the deviation from it is not statistically significant (Blanca et al., 2023).

Tab. 3 shows the p-values for all the variables. The p-values are perfectly significant for all the variables so, it indicates that the result is statistically significant, and hence null hypothesis is rejected whereas the alternate hypothesis is supported. Therefore, hypotheses H1, H2, H3, H4, and H5 are supported, and there is a significant relationship between the dependent variable (Logistic Sanction) and independent variables (Supply Shortage, Customs Regime, Transaction Value, Alternative Route and Non-sanctioned Country Interaction).

 Tab. 3 The findings of p-values for dependent and independent variables

Variables	P-Value	Result
Supply Shortage $\rightarrow$ Logistic Sanction	0.00	Supported
Customs Regime $\rightarrow$ Logistic Sanction	0.00	Supported
Transaction Value $\rightarrow$ Logistic Sanction	0.01	Supported
Alternative Route $\rightarrow$ Logistic Sanction	0.00	Supported
Non-sanctioned Country Interaction $\rightarrow$ Logistic Sanction	0.00	Supported

Note:  $\rightarrow$  P-value is less than 0.05, indicates that hypothesis (H1 – H5) are accepted (supported)

Source: own processing with SPSS software

## 3.4 Moderation analysis

The moderator variable is the third variable used to inspect the power of the association between the independent and dependent variables. In addition, the moderator explains the magnitude of change among the independent and dependent variables, quantified by the linear regression coefficient of the product term. The product term, also called the interaction term, states the experimental consequence of the moderator on the relationship between the independent and dependent variables. In moderation analysis, it is important that the moderator variable does not have a causal relationship with the independent variable (Tavakol & Dennick, 2011). Moderation analysis is run in SPSS to see if the moderating variable (Regional Trade Agreement) moderates the affiliation amongst the dependent variable (Logistic Sanction) and independent variables (Supply Shortage, Customs Regime, Transaction Value, Alternative Route, and Non-sanctioned Country Interaction). To begin with moderation analysis, we first calculate the standardized values of an independent variable and a moderating variable. In addition, we calculate the intercept of each independent variable with the moderating variable by multiplying the standardized value of an independent variable by the moderating variable calculated before. Lastly, we run the linear regression analysis to test the interface effect amongst dependent, independent, and moderating variables.

The outcomes of the linear regression analysis demonstrate a significant causal connection between the independent variables (Supply Shortage, Customs Regime, Transaction Value, Alternative Route, and Non-sanctioned Country Interaction) and the dependent variable Logistic Sanction (p-value = 0.000). Since the p-value is  $\leq$  0.05, the relationship between the independent variables and the dependent variables is significant. A one-way ANOVA test is used to see the causal influence of the dependent and independent variables.

Moreover, moderation effect results can be seen in the coefficients after running a linear regression analysis. We can see the p-value of the interaction term of each independent variable with the moderating variable. Tab. 4 below shows the p-value of the interaction term (INT).

#### Tab. 4: Interaction Term (INT)

Variables	p-value
INT (Regional Trade Agreement & Supply Shortage)	0.08
INT (Regional Trade Agreement & Customs Regime)	0.12
INT (Regional Trade Agreement & Transaction Value)	0.17
INT (Regional Trade Agreement & Alternative Route)	0.86
INT (Regional Trade Agreement & Non-sanctioned Country Interaction)	0.30

Source: own processing with SPSS software

The analysis indicates that the interaction term exhibits p-values exceeding 0.05, as previously illustrated in the table. Given that the p-value surpasses the 0.05 threshold, it can be concluded that the moderator variable, Regional Trade Agreement, does not significantly influence the relationship between the independent variables — Supply Shortage, Customs Regime, Transaction Value, Alternative Route, and Non-sanctioned Country Interaction — and the dependent variable, Logistic Sanction. Therefore, hypotheses H6, H7, H8, H9, and H10 are considered rejected.

#### CONCLUSION

The EU's logistical sanctions against Russia have highlighted the vulnerability of global supply chains to geopolitical tensions and the importance of diversifying supply sources in countering the growth of illicit trade. The key findings from the study are as follows: (1) the emergence of illicit trade networks in response to the sanctions has been driven by the high economic value of critical raw materials and the disruption of legal supply chains; (2) illegal logistical channels and smuggling routes have become prevalent, exploiting the gaps in legal supply chains to transport and distribute critical raw materials; (3) regional trade agreements involving sanctioned and non-sanctioned countries have facilitated sanctions evasion, allowing sanctioned countries to maintain their economic activities despite restrictions.

To conclude, the study's primary goal was to ascertain if a Regional Trade Agreement plays a moderating role in Non-sanctioned Country Interaction and Logistic Sanction in logistics companies. Moderation, reliability, and correlation analysis were carried out to find the results of this study. The findings proposed that Logistic Sanction had an optimistic effect of 0.43 on Non-sanctioned Country Interaction (p=0.00, p<.05). Non-sanctioned Country Interaction is one of the crucial variables to achieving Logistic Sanction. The results also matched the previous studies according to Giumelli et al. (2021). International logistics companies that had greater skills in interacting with non-sanctioned countries and were actors in logistics sanctions. Another result of this study indicates that logistics sanctions also had a positive effect of 0.64 on supply shortage (p=0.00, p<0.05). For achieving logistics sanctions, this aspect is also very important. The results of this finding are consistent with the results of previous studies conducted (Larch et al., 2022; Basu, 2014).

The next finding of this study indicates that logistics sanctions had a positive effect on the customs regime by 0.42 (p=0.00, p<0.05). The results of this finding are also related to previous studies conducted by other scholars (Kupatadze & Marat, 2023; Gkoni et al., 2024;

Bali et al., 2024). The fourth finding of this study indicates that logistics sanctions had a positive effect of 0.25 on Transaction Value (p=0.01, p<0.05). The results of the study are consistent with the results of previous studies (Bevan et al., 1989; Seepma, 2021). The last result of this study indicates that logistics sanctions had a positive effect of 0.39 on alternative route (p=0.00, p<0.05). The results of this finding are consistent with the results of previous studies (Bove et al., 2023; Larch et al., 2022). In addition, one of the important aspects that affects logistics sanctions is the participation of sanctioned countries with non-sanctioned ones in regional trade agreements (Li et al., 2024), and the effect will be negative. Finally, to summarize the results of this study, it was demonstrated that the dependent variable (Logistics Sanction) has a stable positive relationship with the independent variables (Supply Shortage, Customs Regime, Transaction Cost, Alternative Route and Non-sanctioned Country Interaction). Furthermore, the moderating variable (Regional Trade Agreement) does not moderate the relationship between the dependent variable and the independent variables.

Further research will focus on the following areas: the role of digital technologies, such as blockchain and artificial intelligence, in enhancing supply chain visibility and traceability; the impact of sustainability and circular economy practices on reducing dependence on raw material imports and promoting resource efficiency; the effectiveness of international cooperation and partnerships in addressing common challenges related to supply chain disruptions and geopolitical tensions. By addressing these areas, future studies can contribute to a deeper understanding of the complexities of global supply chains and the strategies needed to ensure their stability and efficiency in the face of geopolitical challenges.

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