TALENT HUB FOR SUPPLY CHAIN
Zaragoza Logistics Center

INTERMODAL TIR

Scientific study on transport facilitation in the BSEC region

Final Report

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ZLC: Zaragoza Logistics Center (ZLC) is a research institute established by the Government of Aragon in Spain in partnership with the Massachusetts Institute of Technology and the University of Zaragoza. Founded in 2003, the ZLC campus is located in the heart of PLAZA, the largest logistics park in the southwest of Europe that serves as a working laboratory to transfer new knowledge and working practices. ZLC mission is to create an international center of excellence for research and education in logistics and SCM that actively engages with industry and the public sector to develop and disseminate knowledge.

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1 Executive summary

The Black Sea area is an important region at the heart of three major continents, placing it on strategic transport and trade routes and energy corridors in Eurasia. Members of the BSEC today cover an area of approximately 20 million square kilometers with a population of 340 million people, representing a large economic potential. According to the data from 2012 (Noyan and Guney, 2012), the region represents 7.6% of the overall world economy and its total GDP amounts to around 3.4 trillion USD.

Initiatives aiming to increase the trade flows in the region are closely linked to the efforts in improving the transportation infrastructure and reducing total transport times. In this respect, the objective of this study is to analyze and quantify the role of the TIR System in facilitating border crossing and export/import activities, and therefore reducing total transport times. A selected sample of countries from the BSEC region (Serbia, Bulgaria, Turkey, Georgia and Azerbaijan) has been chosen for a particular route, as illustrated in **¡ERROR! NO SE ENCUENTRA EL ORIGEN DE LA REFERENCIA.**FIGURE 1-1. This selection is based on the following: (1) this route is considered typical by some stakeholders contacted, (2) there exist four border crossings, which are ideal to show the impact of a typical long-distance intermodal transport, and (3) the route includes one of the major countries in the BSEC region, namely Turkey. A simulation study is performed to quantify the benefits of the TIR system on this particular route.

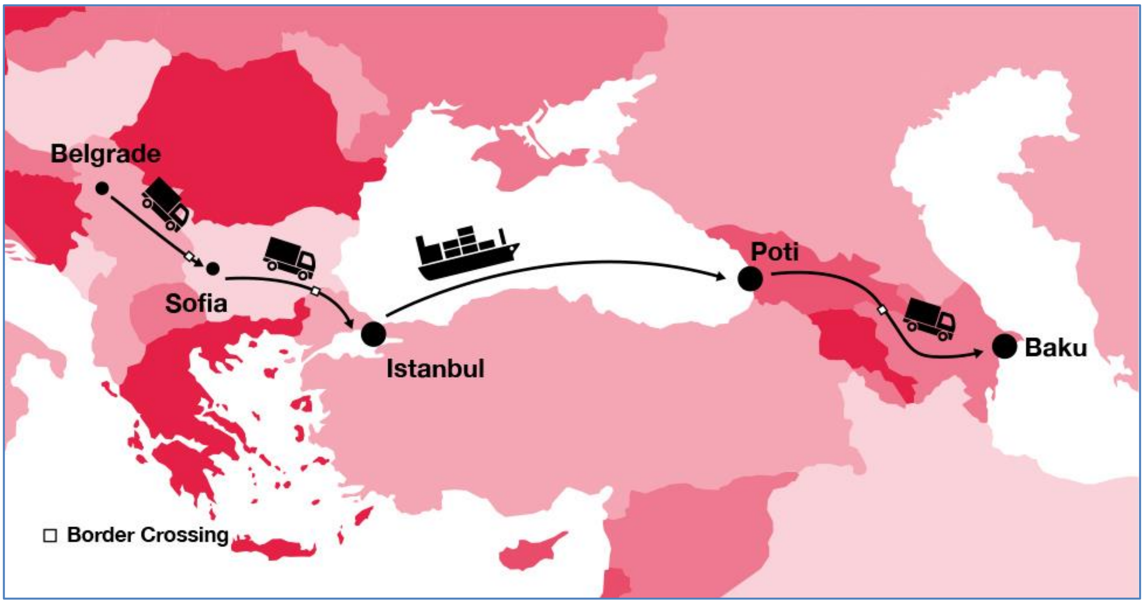

Figure 1-1 Serbia- Azerbaijan - Intermodal transport flow

To our best knowledge, this is the first study investigating the role of TIR system in intermodal transport in the BSEC region. The main complexity in intermodal transport, compared to road transport only for instance, stems from the fact that the switch from one mode to another may not be as smooth if the trip is not well planned. In case there is not enough “slack time” introduced to mitigate operational risks at intermodal terminals and/or border crossings, movements and modal shifts along the way are not synchronized. The TIR system specifically addresses the problems associated with the lengthy and uncertain border crossing activities and aims to minimize the actual duration as well as the variation in such activities. With this model, we present a tool to estimate the reduction in the total transport time and related transport/inventory/other costs incurred in intermodal transport as a result of TIR usage. In doing so, the total time it takes to ship (intermodal) goods from origin to destination with and without TIR carnets are compared. The difference yields estimates as to what the value of the TIR usage is, and subsequently helping to quantify the resulting cost reductions. In addition, we also consider the “transport time independent” costs of financial guarantees with and without TIR usage.

The simulation results indicate significant reductions in total transport time and economic benefits for a container using TIR in comparison to the situation without a TIR carnet. Combined with the results from the financial guarantees model, we observe that TIR is an attractive option for transport operators in most situations. The model presented in this report also serves as a tool to further quantify similar benefits on different routes within the region and understand the role of TIR as a facilitator in the intermodal transport operations in the BSEC region. The insights obtained from this study can be used to communicate the effectiveness of the TIR system in facilitating intermodal transport to transport operators, clients (shippers/buyers) of transport service, and policy makers.

2 Introduction

2.1 Motivation

The TIR System (Transports Internationaux Routiers) is an international Customs transit system to facilitate trade and transport whilst implementing an international harmonized system of Customs control that effectively protects the revenue of each country through which goods are carried.

In practice, it allows goods to transit from a country of origin to a country of destination in sealed load compartments with Customs control recognition along the supply chain. In addition, in combination with the TIR, operators have the opportunity to use one international financial guarantee to cover all customs duties and taxes that are due in each country of transit.

The TIR System's capacity to flexibly adapt to an ever changing economic and geopolitical environment has made it one of the most successful UN trade and transport facilitation instruments. Currently, the TIR Convention has 70 Contracting Parties on four continents and is operational in 58 countries. All countries in the BSEC Region have adhered to the TIR Convention and TIR is operational in all.

The future development of trade and goods movement in the region depends on transport facilitation and the backbone of this is the TIR System. With the development of international trade volumes it will be key to facilitate transport and the TIR System, including its intermodal aspects, is expected to play an ever more pivotal role in promoting further securing and facilitating trade and international transport.

The popularity of the TIR System is mainly due to its special features which offer:

- Security in the supply chain: only approved haulers and vehicles – sealed by Customs – have access to the TIR procedure;
- Free of charge IT support which allows cargo pre-declaration to Customs and provides risk management tools;
- The possibility to implement dedicated "Green Lanes" for all TIR trucks as these fulfil all security requirements;
- The possibility of expediting international trade: goods move across international borders with minimum interference thanks to streamlined border crossing procedures;
- Customs formalities which are carried out at origin and destination rather than at the border;
- Reduced delays and costs for the international transit of goods; and
- Guaranteed payment of Customs duties and taxes thanks to a credible international guarantee chain.
- Possibility transporting unaccompanied loading units transport.

- More than one carrier can be involved in the transport operation (so called sub-contracting operations in TIR, in which the TIR Carnet holder can sub-contract part or the entire transport operation to another transport operator provided this is allowed under national legislation).

2.2 Expected outcome of the study and scope

This study has been carried out to support the development of intermodal transport of goods in the BSEC Region.

In this respect, the objective of this study is to analyze and quantify the economic benefits of the TIR System. A selected sample of countries from the BSEC region has been chosen for a particular route that will be simulated: Serbia, Bulgaria, Turkey, Georgia and Azerbaijan. The simulation shows the economic benefits for a container using TIR in comparison to the situation without a TIR carnet.

With this, and the special TIR features in mind, the study aims to:

- Show how TIR can facilitate intermodal transport in the region and therefore contribute to the growth of the sector;
- Recommend actions to be undertaken by regional, notably BSEC, and national stakeholders to capitalize on the benefits provided by TIR; and
- Include, for a representative sample of BSEC countries, recommendations and implementation steps to allow efficient intermodal transport.

3 BSEC region and TIR adoption

3.1 An overview of the Black Sea Economic Cooperation

The Black Sea Economic Cooperation (BSEC) emerged in 1992 and was officially established in 1999 as a multilateral political and economic initiative aimed at fostering interaction among twelve Member States:

- Republic of Albania
- Republic of Armenia
- Republic of Azerbaijan
- Republic of Bulgaria
- Georgia
- Hellenic Republic
- Republic of Moldova
- Romania
- Russian Federation
- Republic of Serbia
- Republic of Turkey
- Ukraine

Figure 3-1 BSEC Countries.

BSEC covers a geography encompassing the territories of the Black Sea littoral States, the Balkans and the Caucasus with an area of nearly 20 million square kilometers. The BSEC region is located on two continents and represents a region of 330 million people, reaching an intra-BSEC trade volume of USD 300 billion annually. It is becoming Europe's major transport and energy transfer corridor.

One of the main points of the Economic Agenda of the BSEC region is the deployment of an efficient transport network among the Member States. For this goal, several actions have to be performed:

- Promoting sustainable transport systems meeting economic, social and environmental needs of the people in the BSEC region. It is highlighted the need for a cooperation in transport, focusing on how to use effectively the intra-regional capacity and the potential of the region. Most important achievements have been done in the road and maritime infrastructure and the facilitation of road transport of goods. The three important BSEC projects in these fields constitute also the BSEC's contribution to the extension of Trans-European Networks and the development of Euro-Asian transport links.

- The Black Sea Ring Highway project envisages a four lane ring highway system, approximately 7500 km long, to connect the BSEC Member States with each other. Turkey has constructed its part of the Ring Highway from the border of Georgia to Istanbul, while Greece has put into operation the Egnatia Odos Highway, which connects the Ioannina Sea to the Turkish frontier.

- The project on the development of the Motorways of the Sea in the BSEC Region is about strengthening the maritime links among the ports of the BSEC Member States. Some of the actions that this project aims are: Creating the necessary infrastructure for better connecting the Black Sea ports and, also, the Black Sea with the Mediterranean and the Caspian Seas, including upgrading of port facilities, identification of projects of common interest, securing free and fair competition in international shipping, facilitation of access to all modes of transport and enhancement of maritime security and safety in the BSEC Region.

- Elaboration of a Regional Integrated Maritime Policy in the field of maritime transport, ports, ship-building and ship-repairing in the BSEC Region.

- Facilitation of Road Transport of Goods at the BSEC Region. The purpose is to enhance co-operation among the Governments of the BSEC Member States towards the harmonization of certain key-elements concerning international road transport of goods in the region, in line with internationally accepted agreements.

The Black Sea area is an important region at the heart of three major continents. That's the reason why it is on strategic transport and trade routes and energy corridors in Eurasia. For this reason, the BSEC region also cooperates with other international organizations, in particular, UNECE, IRU, BSEC-URTA (Union of Road Transport Association in the BSEC Region), BASPA (Black and Azov Seas Ports Association), BINSA (Black Sea International Ship owners Association) and BRASS (Black Sea Region Association of Shipbuilders and Ship repairers).

3.2 Trade flows and transport industry in BSEC region and the world

The BSEC officially became a “regional economic organization” with an international legal identity in May 1st, 1999. The organization has preferred a project-based approach, mostly in the area of economic cooperation. BSEC Economic Agenda for the Future document, adopted by the Council of Ministers meeting in Moscow in March 2001, listed several sectors for future cooperation and emphasized the priority of joint projects, which would bring in tangible benefits and stimulate internal reforms and integration of national economies in the region. It also highlighted, for immediate attention, the adoption of macroeconomic reforms, establishment of strong and resilient financial systems, adaptation of existing economic institutions towards the market economy, encouraging support for national stabilization and development programs, deregulating of product and service markets, and improving capital markets, promoting the use of new technologies, and encouraging the exchange of economic experts among the member states.

Black sea countries are increasingly connected through trade, financial transactions, foreign direct investments, and other economic relationships. Also Black sea countries are integrated in world economy by building a network of bilateral agreements on free trade, and other which provide the opportunity to exploit their comparative advantage.

3.2.1 Trade and economic development

Regional trade flows continually increase as a result of a number of policy and market driven processes. There are large numbers of regional and bilateral trade agreements made in the last decade. Also there are substantial investments and trade in energy sector, services and manufacturing.

However, there is a space for further trade integration and thus regional efforts to trade and investment facilitation would bring the added value and underpin the efforts of the countries to improve their economic competitiveness.

Figure 3-2 presents the trade flows within the BSEC region. As it can be seen, Turkey, Russian Federation, Ukraine, Romania and Bulgaria present the maximum values for both import and export. For imports, Russian Federation ranked number 1 in 2015, while Turkey did the same for exports in 2015.

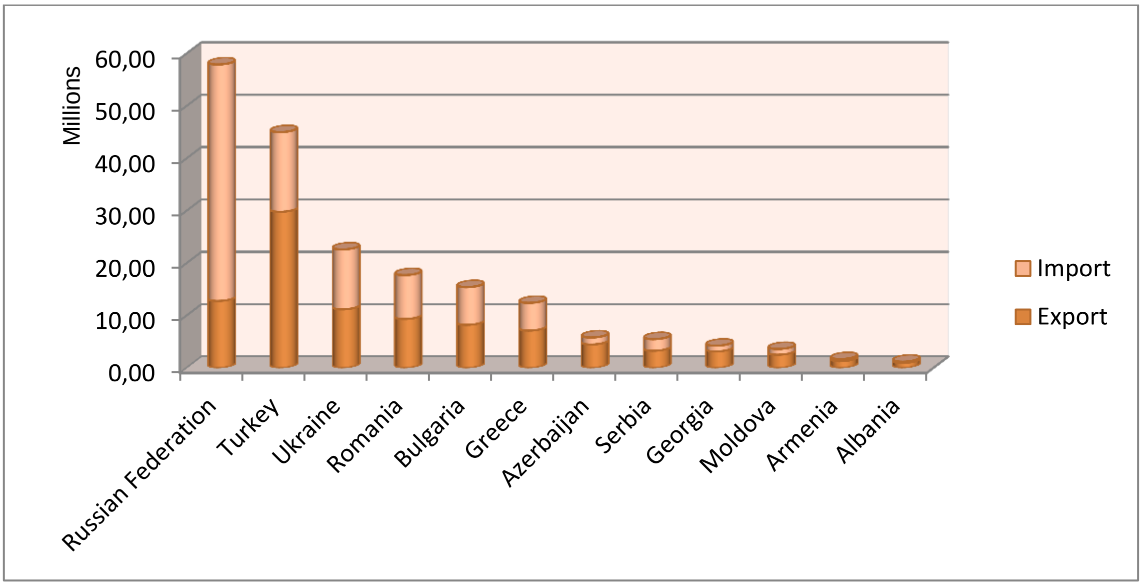

Figure 3-2 Export and import within the BSEC region for 2015. (€)

The same behaviour happens when considering trades between BSEC region and the rest of the world as shown in Figure 3-3. Highest imports are in Russian Federation while the highest levels of exports happened in Turkey during 2015.

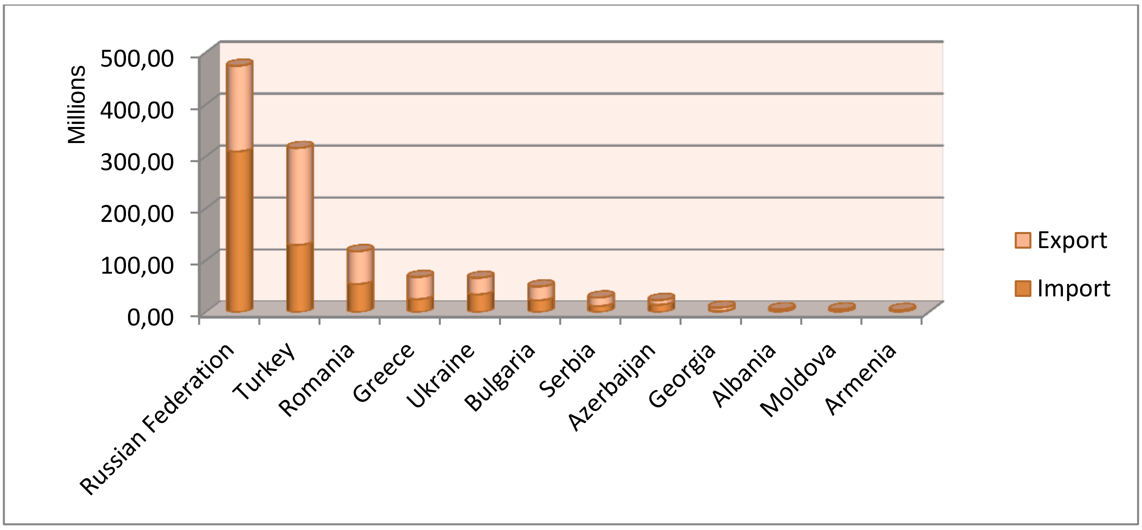

Figure 3-3 Export and import between BSEC region and the world for 2015. (€)

The priorities for regional and intermodal development in the BSEC region have been integrated into the projects and initiatives since 1993 within the framework of the Asia-Caucasus-Europe transit corridor "TRACECA", supplemented by the Black Sea Pan-European Transport Area (PETrA), to guarantee the development of transport, efficient traffic management, safety and environmental protection of all the countries in the region.

Considering the economic development among the countries in the BSEC region there is a wide variation. The logistic performance index (LPI) of the World Bank provides the most comprehensive international comparison tool to measure the trade and transport facilitation friendliness of countries. LPI has two main parts: the International LPI, where up to 166 countries are benchmarked against each other, and the Domestic LPI, which provides an insight on a set of logistics conditions within each country. The International LPI looks at six dimensions that capture the most important aspects of countries trade logistics performance, where each dimension is rated on a 5-point scale (Arvis et al., 2014):

- Customs: efficiency of the customs clearance process;
- Infrastructure: quality of trade and transport-related infrastructure;
- International Shipments: ease of arranging competitively priced shipments;
- Logistics competence: competence and quality of logistics services;
- Tracking and Tracing: ability to track and trace consignments;
- Timeliness: frequency with which shipments reach the consignee within the scheduled or expected time.

The scorecard (Figure 3-4) demonstrates comparative performance (the dimensions show on a scale from 1 to 5 relevant to the possible comparison groups) of countries belonging to BSEC region.

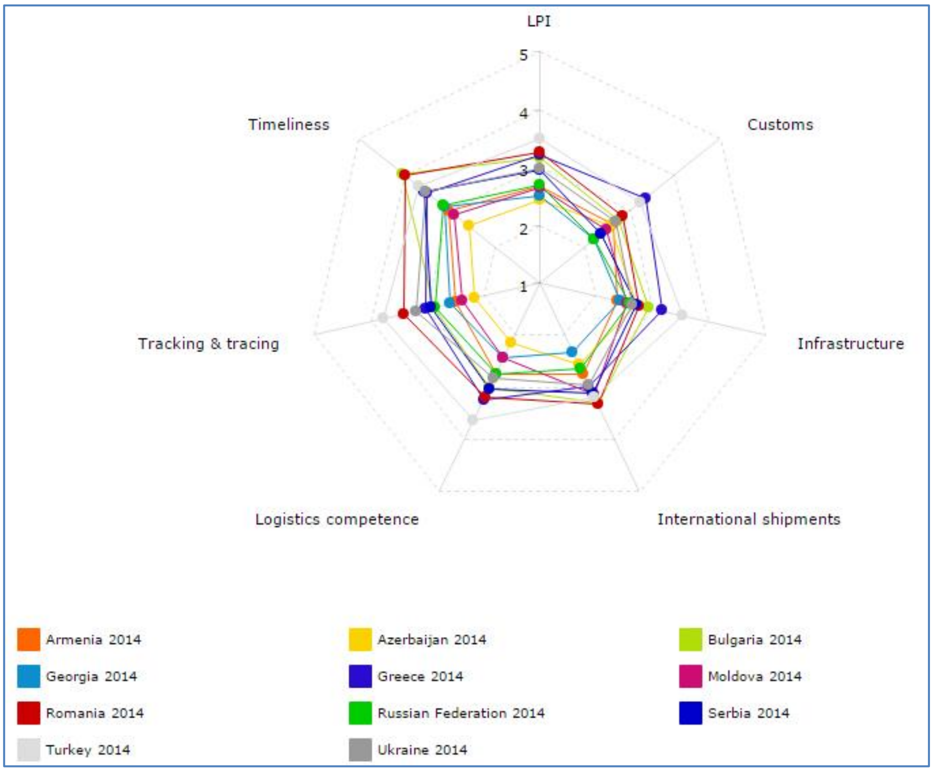

Figure 3-4 International LPI – BSEC region

As it can be seen in Figure 3-4 and contrasted in Table 3-1, Turkey is ranked the first on LPI score, having the first position of the BSEC countries in the dimensions related to Infrastructure, Logistics competence and Tracking & Tracing. Romania, as the second ranked, has the first position in the dimension related to International shipments and Greece and Bulgaria –ranked as the third and fourth- have the first position in Customs and Timeliness respectively. International LPI identifies the challenges and opportunities the BSEC countries face in their performance on trade logistics; the scores identified has given insights to elaborate the route for the model simulation, according to the correspondence between the highest scores and the most relevant countries in trade flows.

Table 3-1 LPI score and related criteria for BSEC region

Country[1]	LPI Rank	LPI Score	Customs	Infrastructure	International shipments	Logistic competence	Tracking & Tracing	Timeliness
Turkey	30	3.50	3.23	3.53	3.18	3.64	3.77	3.68
Romania	40	3.26	2.83	2.77	3.32	3.20	3.39	4.00
Greece	44	3.20	3.36	3.17	2.97	3.23	3.03	3.50
Bulgaria	47	3.16	2.75	2.94	3.31	3.00	2.88	4.04
Ukraine	61	2.98	2.69	2.65	2.95	2.84	3.20	3.51
Serbia	63	2.96	2.37	2.73	3.12	3.02	2.94	3.55
Russian Federation	90	2.69	2.20	2.59	2.64	2.74	2.85	3.14
Armenia	92	2.67	2.62	2.38	2.75	2.75	2.50	3.00
Moldova	94	2.65	2.46	2.55	3.14	2.44	2.35	2.89
Georgia	116	2.51	2.21	2.42	2.32	2.44	2.59	3.09
Azerbaijan	125	2.45	2.57	2.71	2.57	2.14	2.14	2.57

The Domestic LPI provides information on particular aspects within respondent's countries of work, including imports/exports, lead times, supply chain costs, customs clearances and the percentage of shipments subjected to physical inspection. The overall index is calculated by analyzing the six dimensions listed. Many studies have identified issues related to customs clearance and delay at the border as a major constraint in the transport process along a corridor. World Bank (2005) found that as an average more than 50% of transit time is lost at waiting at borders. Domestic LPI has given some insights of the order of magnitude to the work developed in the next chapter, regarding lead times and cost among others.

Next tables provide the data for domestic LPI for countries of the BSEC region. Countries for which data are not available are excluded from the tables. Following abbreviations are used in tables: Al-Albania, Az – Azerbaijan, Ar – Armenia, Bg – Bulgaria, Ge – Georgia, Gr – Greece, Mo – Moldova, Ro – Romania, Rus – Russian Federation, Srb – Serbia, Tr – Turkey, Ukr – Ukraine. Due to the lack of information related to some countries or some fields in the tables, data is not there.

[1] Data for Albania are not available

Table 3-2 Domestic LPI – Export time and cost/Port or airport supply chain

	States							
	Al	Bg	Ge	Gr	Ro	Rus	Tr	Ukr
Distance (km)	75	257	429	300	474	750	101	87
Lead time (days)	11	2	6	1	2	2	2	2
Cost (US$)	750	944	572	1000	707	2000	806	866

Table 3-2 represents the export times and cost in a supply chain considering a port or an airport. As it can be observed, highest lead times happen in Albania (11 days), where the distance is relatively short in comparison with the other countries and thus, the proportional cost is higher. In contrast, considering a land supply chain for export (Table 3-3), the highest lead time takes place in Greece, for a distance of 297 km.

Table 3-3 Domestic LPI – Export time and cost / Land supply chain

	States						
	Bg	Ge	Gr	Ro	Rus	Tr	Ukr
Distance (km)	667	297	75	300	474	3500	474
Lead time (days)	3	8	1	4	5	5	3
Cost (US$)	1277	630	3000	1500	1225	5000	1061

Table 3-4 Domestic LPI – Import time and cost / Port or airport supply chain

	States				
	Bg	Ge	Gr	Rus	Tr
Distance (km)	189	1025	300	474	1620
Lead time (days)	2	12	2	2	3
Cost (US$)	1030	612	3000	750	3162

Considering imports on a supply chain with a port or airport (Table 3-4), the highest lead time takes place in Greece (12 days), for a distance of 1025 km and a cost of

612US$. In a land supply chain for imports the highest lead time corresponds to Greece as well, for a distance of 1025 km. Table 3-5 provides also information related to other dimensions, such as quality criteria, number of agencies-exports/imports, number of documents-exports/imports, clearance time with/without physical inspection, physical inspection or multiple inspection.

Table 3-5 Domestic LPI – Import time and cost / Land supply chain

	States										
	Al	Ar	Bg	Ge	Gr	Mo	Ro	Rus	Srb	Tr	Ukr
Distance (km)	75	-	550	1025	300	300	474	-	1250	562	150
Lead time (days)	7	-	3	15	7	7	6	-	4	4	6
Cost (US$)	1000	-	1287	707	4000	1500	1061	-	1500	1362	1732
Shipments meeting quality criteria (%)	40	-	86.9	87.4	92.5	92.5	64.8	87.5	57.4	76.7	71.6
Number of agencies - exports	1	2	2	2	-	11	4	2	2	3	7
Number of agencies - imports	1	2	2	2	-	11	3	2	2	2	7
Number of documents - exports	3	-	2	3	-	8	4	8	5	4	8
Number of documents - imports	2	-	2	3	-	8	4	8	3	3	7
Clearance time without physical inspection (days)	1	-	1	1	-	2	1	1	1	1	1
Clearance time with physical inspection (days)	1	-	1	1	-	7	1	2	1	2	2
Physical inspection (%)	50	-	6.5	5.15	-	35	10.5	61.2	6-25	7.9	21.0
Multiple inspection (%)	50	-	1.9	2.06	-	35	3.27	61.2	6-25	2.6	2.5

Collaboration among stakeholders and developing collaborative hub networks can help to reduce logistics cost and maintain logistics services by selecting appropriate modes that ensures economies of scale.

3.2.2 Intermodal transport and corridors

Directly related to intermodal transport, trends in the BSEC regions were also considered; according to some findings in a preliminary search, there are in line with:

- Promoting sustainable transport systems which meet the economic, social and environmental needs of the people of the Black Sea Region, in order to reduce regional disparities and to link the BSEC Region's transport infrastructure to European and Asian Networks;
- Development of road and maritime infrastructure, as well as facilitation of road transport of goods;
- On-going projects to link EU to Asia and vice versa through the BSEC region: The three important BSEC projects in these fields constitute also the BSEC's contribution to the extension of Trans-European Networks and the development of Euro-Asian transport links;
- The following infrastructure/transport modes are planned to be developed:
    - The Black Sea Ring Highway;
    - Motorways of the Sea in the BSEC Region: Special emphasis will be given to this area;
- Increase of the competitiveness and effectiveness of transport corridors crossing the territory of the BSEC Member States.

An important issue that is being discussed by the Transport Working Group is the Regional Integrated Maritime Policy in the field of maritime transport, ports, ship building and ship-repairing in the BSEC Region. The overall long-term objectives will be:

- Creating conditions for maximum increase in the sustainable exploitation of the Black Sea;
- Improving the quality of life and developing the maritime sector in the coastal areas;
- Developing a competitive, environmentally friendly and safe maritime transport.

Transport corridors have become crucial in the international trade. A transport corridor can be a specified route, ideally intermodal, that can expedite the movements of goods and people across international borders by connecting key points in different countries. Due to their remoteness from seaports, landlocked countries face additional challenges associated with high transportation cost and time. International cooperation is essential to provide transit access and the development of an efficient transportation system for those countries (Chowdhury & Erdenebileg, 2006). Figure 3-5 presents main transport links passing through Bulgaria and connecting all BSEC member states.

Figure 3-5 Pan European transport corridors related to BSEC region

Standard and quality of infrastructure, underdevelopment of logistics infrastructure and services, limited availability of multi-modal transport services and relatively high costs of international transport services for small cargo are often seen as barriers for the growth of intermodal transport. Transportation cost also includes vehicle operation cost, cost of fuel, driver, loading and unloading, handling of containers at ports and borders, and transshipment. In the case of railway it also includes locomotive operation cost, track access fee, and cost of return of empty containers.

The development of intermodal transport in the BSEC region is crucial due to the capacity of connection between the Euro-Asia network and the TEN-T corridors. In particular, the Orient-East-Med corridor and the Rhine-Danube corridor, are connected to the BSEC region and provides a high potential for the trade and economic relations to the BSEC region and consequently to Europe and Asia. Both corridors are shown in the following figures and described below:

- ❖ Orient-East-Med corridor (Figure 3-6): This long northwest-south eastern corridor will connect central Europe with the maritime interfaces of the North, Baltic, Black and Mediterranean seas, allowing to optimize the use of the ports concerned and the related Motorways of the Sea. This corridor will foster the development of those ports as major multimodal logistic platforms and will improve the multimodal connections of major economic centers in Central

Europe to the coastlines, using rivers such as the Elbe. The corridor will also provide the link to Cyprus.

- ❖ Rhine-Danube corridor (
- ❖ Figure *3-7*): This corridor will provide the main east–west link between continental European countries, connecting France and Germany, Austria, the Czech Republic, Slovakia, Hungary, Romania and Bulgaria all along the Main and Danube rivers to the Black Sea by improving (high speed) rail and inland waterway interconnections.

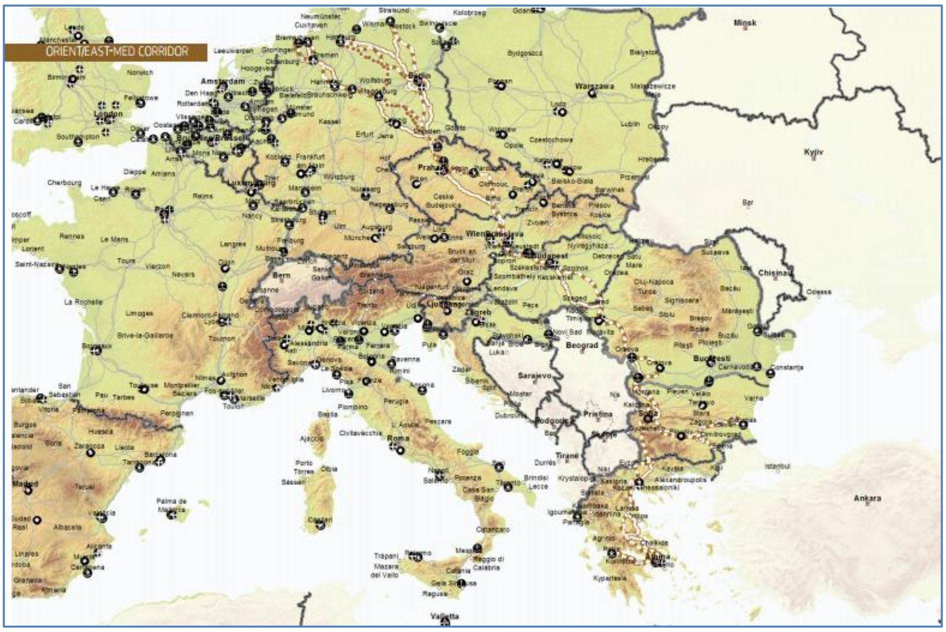

Figure 3-6 Orient-East-Med corridor

Figure 3-7 Rhine-Danube corridor

Due to the relevance of the connectivity between Europe and Asia, the simulation model developed in next chapter follows this scenario:

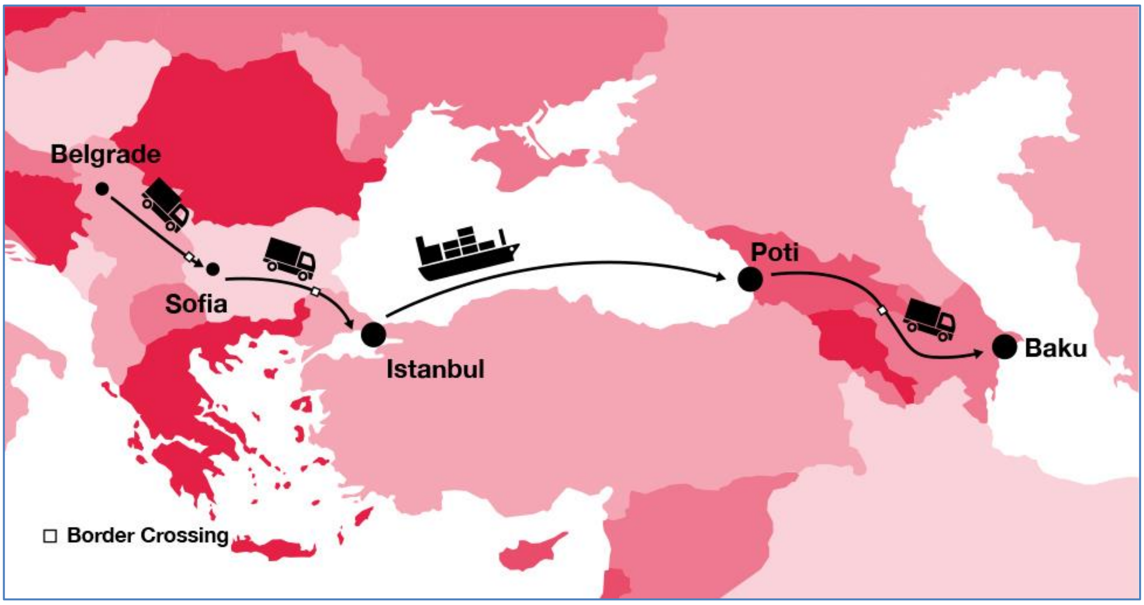

Figure 3-8 Serbia- Azerbaijan Intermodal transport flow

The reasons for the selection of this route are: 1) Some of the stakeholders contacted suggested that this was a typical route; 2) the aim was having as many border crossings as possible to check the model (four in this case); 3) we included Turkey as it is one of the major countries in the BSEC region.

3.2.3 Data from countries involved in the scenario

3.2.3.1 Turkey

Turkey is the world's 17th largest economy and 22nd largest exporter by value. Its economy grew with an average GDP rate of 4.9 between 2008 and 2013 and it's projected to maintain its position with a growth rate of 4.2% between 2014 and 2030 acording to OECD (2014).

Turkey is a very important center for international trade due to its geographical position on a traditional route between Asia and Europe. Turkey's export have become more globally competitive and are expected to grow more than 5% in the incoming years, while imports growth is projected to be more than 9.5% on the same period.

Customs clearance times in Turkey's customs has improved as a result of a decrease in the variability of clearance times due to the simplification and automation of customs procedures, increased productivity gains (improved IT capability) and investment in improved management and human resources capability. Clearance score (LPI) increased from 2.82 to 3.23 between 2010 and 2014.

Table 3-6 represents times of clearance (hours) and mean for red (need to be checked, physical verification and mandatory inspection of documentation), green (no verification) and yellow (mandatory inspection of documentation) channels:

Table 3-6 Times of clearance in Turkey's custom (hours)

			2009	2010	2011	2012	2013
Exports	Red channel	Mean	21.6	24.1	20.0	25.9	23.7
		CV	1.8	2.5	1.4	1.5	1.8
	Green channel	Mean	11.8	10.5	9.8	8.0	9.7
		CV	2.0	2.1	1.3	1.3	1.3
	Yellow channel	Mean	11.5	14.3	13.2	11.2	11.6
		CV	1.4	2.1	2.3	1.8	1.8
Imports	Red channel	Mean	33.6	41.7	49.5	45.0	66.0
		CV	1.4	1.6	1.4	1.3	1.3
	Green channel	Mean	18.7	10.5	18.3	16-2	17.5
		CV	2.2	2.1	1.6	1.5	1.5
	Yellow channel	Mean	30.7	36.8	31.7	28.5	34.6
		CV	1.8	1.1	1.8	1.5	1.6

Source: Turkish Ministry of Customs and Trade

3.2.3.2 Bulgaria

Average waiting times for custom clearance in Bulgaria (Kalotina Border Crossing Point with Serbia) are shown in Table 3-7:

Table 3-7 Average commercial road traffic and waiting time per BCP.

	2008	2009	2010	2011	2012	2013	2014*
Incoming (AADT)	370	324	390	389	424	455	446
Outgoing (AADT)	406	379	413	433	459	467	467
Average weighted waiting time incoming (min)	74	76	60	42	38	40	31
Average weighted waiting time outgoing (min)	94	74	57	28	21	19	19

** First nine months data*

Source: TTFSEE II Monitoring data, WB

3.2.3.3 Serbia

In Serbia time for processing exports was reduced from 32 to 11 days in 2006, whereas import time from 44 to 12 days, which supposed substantial gains for the government and the private sector, according to OSCE-UNECE Handbook (2012).

According to some information collected from stakeholders, in Gradina (Serbia, border with Bulgaria) the processing time is around 5-6 min, with and without TIR. The likelihood for a TIR truck to be flagged for inspection is 10-15%, and 30-40% without TIR.

3.2.3.4 Georgia

According to the stakeholders requested in Georgia, the following table (Table 3-8) shows the maximum, minimum and average time in transit and import in customs, excluding the waiting times before entering the Customs zone. Average time corresponds to 7 min, while minimum and maximum times in transit are 2 and 24 minutes respectively, and 2 and 26 minutes in import.

Table 3-8 Time spent in transit, import and average

Procedure	Min	Max	Average
Transit	2 min	24 min.	7 min
Import	2 min	26 min.	7 min
Average	2 min	26 min	7 min

Considering the times spent in inspection, the physical examination takes longer than the rest of methods, with an average of 3 hours and 16 minutes, while weighing is the shortest method with an average of 2 minutes.

Table 3-9 Time spent in custom's control and inspection

Procedure	Min	Max	Average
K9	11 min	37 min	19 min
Weighing	1 min	3 min	2 min
X-ray	2 min	6 min	3 min
Physical examination	5 min	6 h and 20 min	3 h and 16 min
Average	1 min	7 h and 10 min	10 min

3.2.3.5 Azerbaijan

TRACECA has currently a project to harmonize the border-crossing procedures of CAREC (Central Asia Regional Economic Cooperation) member and to align them with the European Union's practices in several areas targeted, being some of them custom procedures and border control.

Some of the plan projects in the country involved the improvement of railway connections to promote intermodality as well as better roads. The aim is to create efficient and effective transport and trade corridors, since the country is a node of connection between Europe and Asia. Baku is the capital and the trade and transport center of the region, as well as the home for the largest Caspian seaport.

Besides, TIR trucks often have cargo weight inspections and random police checks along the route. This is due to the maximum allowed weight for a TIR truck (for instance 42 tons in Turkey vs. 37 tons in Azerbaijan).

3.3 Restrictions, legal issues and bilateral/multilateral agreements

Black sea region represents an important region on strategic transport and trade routes and energy corridors in Eurasia. Members of the BSEC today cover an area of approximately 20 million square kilometers with 340 million people. This represents large economic potential. According to the data from 2012 (Noyan and Guney, 2012), the region represents 7.6% of the overall world economy and its total GDP amounts to around 3.4 trillion USD.

Considering economic development in the region it can be noticed that it is relatively encouraging. That is especially for Bulgaria, Romania and Turkey. These three countries represent the economic leaders in the Black Sea region, and also the fastest growing economies. However, despite general positive trends, economic development still remains below desired levels and the pace differs between each country.

Several concerns exist and they are valid for all BSEC members and are problematic for the region's development as a whole. These factors which limit market access include weakness in the:

- Rule of law: On paper, legislation looks effective, but implementation and enforcement are often weak.
- Corruption: This is a widespread problem in Black Sea region. High levels of corruption in public administration and the judiciary remain a primary concern for business seeking a fair and predictable economic climate.
- Politics: Populist and nationalist trends in Black Sea countries are still present. So, it is necessary to take into account the impact of these trends on economic reform of region, development and openness for foreign investments.
- Agriculture dependent economies: Agriculture has a significant share of GDP of Black Sea countries. This makes the economy dependent on rural development and may hinder economic growth.
- Free trade agreements: Regional cooperation in trade is still constrained by national policies. There is a need to promote free trade agreements (like CEFTA is for example) and to facilitate cooperation, which would improve all economies in the region.
- Energy: Energy diversification represents major challenges in the region. Finding new routes for the transportation of Caspian oil through the Black Sea area will help the region develop economically while decreasing Europe's dependence on Russian energy.

- Infrastructure: Black sea region is very rich with energy resources. Exploiting natural resources will need further development of transportation infrastructure and communication systems.

Transport, trade and economic development, communications and information technology and customs matters represent most active fields of cooperation within the BSEC region. It is remarkable the needs of cooperation among all transport modes for promoting sustainable multimodal transit corridors as stated in the UN General Assembly (2015). Two projects within the BSEC region are of major significance for achieving this goal. These are Black Sea Ring Highway project and the project on the development of transport links in the region. These projects will increase intra BSEC trade as well as tourism, infrastructure and transport investments and economic prosperity within the Black sea region.

The area of trade represents the field with highest potential for cooperation. Various initiatives have been launched within BSEC to contribute to improvement of trade situation. An example of this is the cooperation between BSEC and United Nations Development Programme on this matter. In the field of road transport facilitation a pilot project on the establishment of a BSEC Permit system for the road transit of goods has been launched in 2010.

BSEC is viewed by the international community as an anchor of cooperation in the Black Sea area today (Noyan and Guney, 2012). Germany, Austria, France, Italy, Poland, the Czech Republic, Slovakia, Belarus and Croatia, as well as non-European countries such as the United States, Egypt, Tunisia and Israel have Observer status in BSEC. The UK, Hungary, Montenegro, Iran, Jordan, Japan, Slovenia and the Republic of Korea, on the other hand, as well as various regional organizations, have Sectoral Dialogue Partnership status. The European Union is also an Observer in BSEC. A partnership in the area of environment has been launched in 2010, while partnerships in transport and energy are being considered within the framework of the Black Sea Synergy. BSEC, which has Observer status in the UN General Assembly, has very close and fruitful working relations with the UN system and its specialized agencies. BSEC has Cooperation Agreements with the UN Economic Commission for Europe (UNECE), UN Environment Programme (UNEP), UN Industrial Development Organization (UNIDO) and the UN Development Programme (UNDP). It also has close relations and active cooperation with the UN Food and Agriculture Organization (FAO), World Trade Organization (WTO), World Bank, UN Office on Drugs and Crime (UNODC) and the International Organization for Migration (IOM).

3.4 Current state of TIR adoption

3.4.1 Existing Custom Procedures

In relation to customs, the project is divided in two areas, first related to procedures and the second one related to ongoing developments. The project team has examined the on-going process of promoting harmonization and simplification of customs and border crossing procedures, and the level of introduction of common standards of simplified and efficient customs procedures in conformity with the national legislations. Besides, border crossing procedures, ICT for customs, single window concept and different mechanisms used for exchanging information among the customs administrations of the BSEC region have been explored.

A customs import clearance process typically consists of a number of steps:

- Cargo declaration by carrier to Customs;
- Temporary storage of arriving goods;
- Customs import goods declaration;
- Preparation and submission of the goods declaration by the importer/broker;
- Validation and acceptance of the goods declaration;
- Automated risk management / channeling;
- Checking the goods declaration and supporting documents;
- Assessment of the goods declaration;
- Physical inspection of the goods (optional);
- Collection of duties/taxes by customs (optional, by commercial banks);
- Release of the goods by customs;
- Delivery of the goods to the importer;
- Post-clearance auditing of importer by customs (optional).

Cooperation among the agencies operating at borders is crucial not only to improve efficiency, but also to generate important savings. Such coordination has been initiated in several countries as best practices. In the European Union it is quite used the term Integrated Border Management (IBM), by which all the agencies and relevant authorities involved in border security and trade facilitation are coordinated and cooperate for establishing effective, efficient and integrated border management systems to an open, secure and controlled borders. There are two types of IBM: Domestic cooperation between border agencies within one country and international cooperation between neighboring countries. There are three main pillars for cooperation:

- Intra-service cooperation: Internal cooperation and management of processes, information and resources in both, vertical and horizontal (local, central, regional vs. units of the same level)

- Intra-agency cooperation: Cooperation at local level (borders)
- International cooperation: Cooperation at local level between officials on either side of a border and cooperation between neighboring states.

The World Bank has extended the definition by referring to Coordinated Border Management and Collaborative Border Management, in the sense that border agencies and the international trading community need to work together to achieve common aims that benefit all parties.

Customs are currently working in policy development for domestic cooperation due to the amount of duplicities and paperwork generated when cooperation in missing. The Single Window concept arise as a facility that allows parties involved in trade and transport to lodge standardize information and documents with a single entry point to fulfill all the regulatory requirements in import, export or transit.

The main International Conventions that contain elements of cooperation are the following:

- WCO International Convention on the Simplification and Harmonization of Customs Procedures (Kyoto Convention, 1974);
- UNECE International Convention on Harmonization of Frontier Control of Goods (Geneva, 1982);
- Customs Convention on the International Transport of Goods under cover of TIR Carnets (TIR Convention, 1975);
- International Convention on Mutual Administrative Assistance for the Prevention, Investigation and Repression of Customs Offences (Nairobi, 1977);
- International Convention on the Harmonized Commodity Description and Coding System (Brussels, 1983);
- WCO Convention on Temporary Admission (Istanbul, 1990);
- Convention on the Contract for the International Carriage of Goods by Road (CMR, Geneva, 1956).

Several studies have shown that border crossing times vary over the course of a few hours to a few days. UNESCAP study (2015) on transit traffic in Asia and the Pacific points out that the average border-crossing times in Europe are in the 30-40 minutes range and the ECE recommendation for border stopping time is 60 minutes for international shuttle trains and 30 minutes for combined transport. TRACECA railroad study reckoned that inspections by both railways and customs should be completed within the overall time span of two hours. In the case of total transit trains with bulk cargo, this should be reduced to 90 minutes. Both transport modes, road and rail, are affected by long delays at border crossings but, rail delays tend to be longer than waiting times for road transport.

Government agencies are in most of the cases present at border crossings to control compliance with national legislation governing immigration, taxation, environment and health protection, customs and trade policy, transport services and vehicles, as well as other regulations. These control measures apply to drivers, means of transportation and goods, and include document checks, weighing, scanning and measuring of vehicles, as well as physical inspection of the goods. All these operations take time, in particular for those agencies involved that do not collaborate by sharing documents and information.

The lengthy physical inspection of shipments and cargo at border crossings seems to be the major bottleneck in the clearance processes. Often there is no effective risk management system in place that allows the border staff to target their inspections on specific, high and medium risk cargo and means of transportation, while clearing the other cargo and trucks faster without physical inspection. Numerous border crossing points lack equipment for non-intrusive controls, such as scanning or weighing of containers.

Finally, many of the border clearance process requirements are duplications: identical cargo and vehicle documents need to be presented and are reviewed and stamped by various agencies in a sequential process. Processes are not optimized from the overall perspective of achieving a faster border crossing clearance through joint operations and sharing of data.

Frequently, transport operations such as breaking up of containers and change of trucks are also undertaken at border crossings, where the unloading and loading operations add to the congestion if there is no dedicated storage and handling space.

BSEC countries are party to the TIR Convention that puts in place a common customs transit clearance procedure and a transit guarantee, the so-called TIR Carnets. The TIR Convention and its application by Customs authorities are crucial for the BSEC region. The effectiveness of the TIR system rests upon the use and acceptance of TIR Carnets as Customs declaration and customs guarantee. TIR Carnets are issued by a national association, usually transport association, and are recognized by customs as guarantee for the shipment in transit.

Considering the potential of the regional trade in the BSEC region it is obvious that an increase in the number of transactions will affect the management of customs operations. Efficient ICT systems may make the work for border management staff much easier. ICT also contributes to efficiency of border crossings. Use of ICTs facilitates better management of very complex operations on border crossings.

Considering BSEC countries current level of ICT technologies applied for customs operations is satisfactory. Many countries (Azerbaijan, Albania, Turkey, Serbia, Bulgaria, and Greece) have implemented Single Window system which helps to increase efficiency and improve interactions between different controlling authorities. It also greatly reduces the time required to cross borders and clear goods and vehicles through customs. Azerbaijan also implemented e-customs project encompassing three subsystems (OSCE, 2012):

- A unified computer aided manufacturing system for the customs office;

- A management system for internet information resources;
- An internal portal and internet system.

Custom clearance procedures rely actively on the following advanced information technologies of electronic data interchange over the Internet:

- Early notification of customs authorities;
- Electronic declaration of goods,
- Remote customs clearance using e-declaration.

Romanian customs administration has developed and put at the disposal of economic operators an IT system (Romanian Customs Declaration Processing System) allowing the automated processing of import and export customs declarations.

Albania made exporting easier by implementing electronic risk based inspection system which reduced the time for border compliance. Albania also uses ASYCUDA world electronic data interchange system for custom clearance of imports.

4 Approach and results

4.1 TIR as a trade facilitator for intermodal transport operations

Considering the information collected and analyzed in Chapter 3, we build a model that would help us understand the role of TIR as a facilitator in the intermodal transport operations in the BSEC region. The model will be based on the following scenario from Serbia to Azerbaijan:

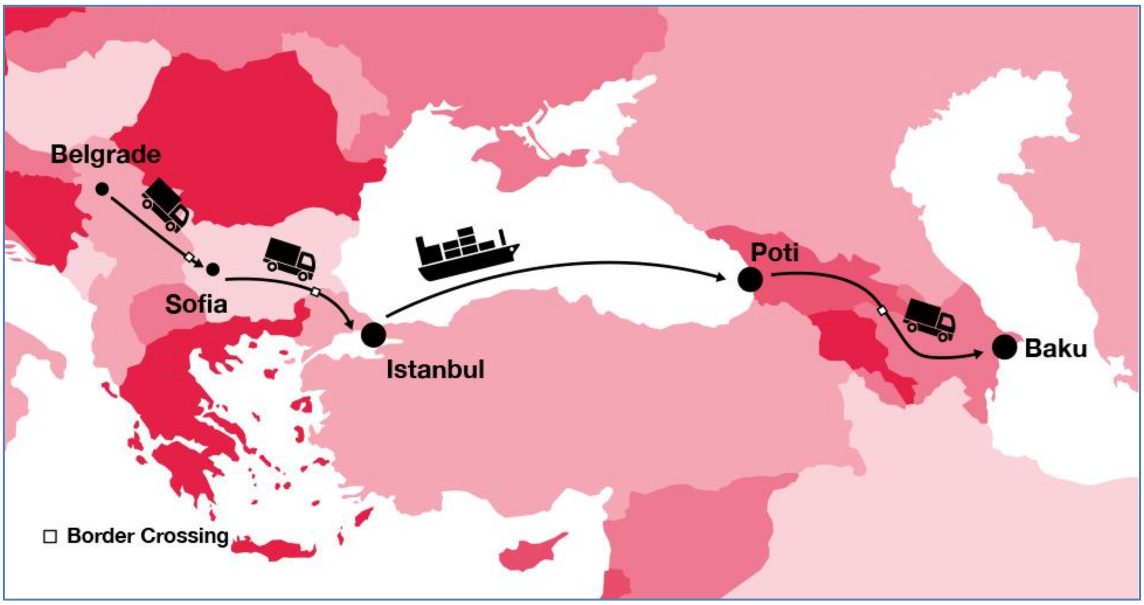

Figure 4-1Serbia- Azerbaijan - Intermodal transport flow

In general terms there are some data requirements for building a model:

- Basic economic country data: This will reflect the economic capacity and basic determinants of this capacity for the future. Such data includes for instance trade volumes, common borders, tariffs as well as transport costs and distances. Transport costs and distances should ideally be based on real travel distances. If possible, costs should be differentiated by mode and on an aggregated level with variations for product types. Effects of non-physical barriers are also frequently converted into time or costs effects as delays at border crossings effectively amount to increasing the distance and cost of trading.
- Bilateral trade data: To allow for segmentation of trade flows by type of products. A historic dataset to be available if a forecast of future trade flows should be made.
- Transport flow and modal split data: This consists of trade data by mode of transport and distance moved. This data is needed to understand the characteristics of existing transport flows – which products are moved over which distance by which mode- and to forecast future trade flows based on this data.

- Specific data reflecting mode availability, infrastructure capacity and services. This is qualitative information such as border closures, freight services interruptions or unavailability, or lack of physical connections by road, rail or water. All these factors limit the availability of a specific mode on a specific route.

4.2 Model setup and data description

4.2.1 Approach

Secondly, we describe the model in detail. Later, we specify the data elements required for the model, and the sources for data collection. Finally, we present the experimental design and the results of the sensitivity analysis. The results from this section are used in the following chapter to make general recommendations for the successful deployment of the TIR intermodal system within the BSEC region.

In what follows, we describe the details of the model to quantify the benefits of the TIR Carnet usage in intermodal transport within the BSEC region. The main complexity in intermodal transport, compared to road transport only for instance, stems from the fact that the switch from one mode to another may not be as smooth if the trip is not well planned, if there is not enough “slack time” introduced to mitigate operational risks at intermodal terminals and/or border crossings, and if movements are not synchronized. Consequently, in addition to the “direct savings” in time/cost to be obtained from TIR usage in a road transport (single mode) case, the model will consider issues such as “misses” due to delays at intermodal facilities and how TIR usage can alleviate the severity of such undesirable delays.

With this model, we aim to estimate the reduction in the total transport time and related transport/inventory/other costs incurred in intermodal transport as a result of TIR usage. In doing so, we will compare the total time it takes to ship (intermodal) goods from origin to destination with and without TIR carnets. The difference will yield estimates as to what the value of the TIR usage is, and we subsequently quantify the resulting cost reductions. In addition, we also consider the “transport time independent” costs of financial guarantees with and without TIR usage. The benefits emanating from the financial guarantees provided by the TIR system might prove to be significant compared to the potential “direct time/cost savings” mentioned above.

4.2.2 Assumptions and data description

The objective of the model developed in this study is to quantify the benefits of the TIR usage in intermodal freight transport within the BSEC region. In doing so, we propose a simplified configuration of a typical intermodal freight transport, detailing the stages and activities involved. The operations that will potentially be affected by the TIR usage are highlighted. Particular attention will be given to the time required and costs incurred at each stage. The model output is to provide estimates of the potential direct and indirect benefits of the TIR usage within this context.

The approach we follow in developing the model has the following two main tasks:

1) To construct a model to quantify the benefit of TIR usage for "a unit load" (e.g. one container) on a particular lane (e.g., Serbia-Azerbaijan) given the transport mode combination (e.g. road--seaborne-road transport). Depending on the origin & destination pair and the modes involved over the course of the trip, the model calculates the time and cost savings for a unit load comparing transport with and without the TIR carnet. This will form the basis for task 2 defined below. The benefits for "a particular unit load" will be multiplied by the number of "unit loads of the same kind" (same origin/destination, modes, product characteristics) as explained in task 2.
2) To provide estimates of the TIR benefits at a macro level for the BSEC region as a whole. This will be done using the output of the first task as defined above and general assumptions in regards to macro factors such as "trade volumes", "average duration of border crossing activities" in the BSEC region.

As mentioned above, in order to be able to identify the transport operations that are potentially affected by TIR system, the model needs to properly define intermodal freight transport and the main stages involved.

Intermodal freight transport is described as "the movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes" (United Nations, 2001). In this study, cases where at least one leg of the whole journey is via road transport will be considered as this is a requirement for the TIR system. We use the same approach taken in the paper by Janic (Transportation Research Part D, 2007), and consider the following stages involved in an illustrative typical intermodal transport with two transshipments to be able to provide an in-depth analysis of the potential benefits of TIR usage:

i. Picking up the goods at the origin and moving those (via road) to the "first intermodal terminal" (e.g., Serbia) and export declaration;
ii. Border processing (e.g., Bulgaria – Turkey) and transshipment at the "first intermodal terminal" of the load to a different mode (e.g., from truck to the non-road transport mode (e.g., sea shipping on the Black Sea);
iii. Transportation between the "first and second intermodal terminals" by the same mode in stage ii;
iv. Border processing (e.g., Turkey – Georgia) and transshipment at the "second intermodal terminal" from the same mode in stage iii to a different mode (e.g., trucks);
v. Distribution from the "second intermodal terminal" to the destination zone (e.g., Azerbaijan) by the same mode in stage iv (i.e.., truck) and import declaration.

Initially, we conjecture that the potential intermodal benefits of the TIR system are realized in border crossing activities, export and import declarations, mainly in stages (i), (ii), (iv), and (v). The model allows for detailed time/cost study at each stage, and therefore quantifies the benefits of holding a TIR carnet. Extensive data collection is necessary in order to complete the tasks defined above. Publicly available data and interviews with relevant stakeholders (IRU, BSEC, transportation service providers, WCO TRS data) will be the source of such data.

In order to make the model more realistic, but keeping it tractable at the same time, we make the following assumptions in our analysis:

- We only analyze the reduction in the total transport times/costs as a result of the TIR usage for the transport operator and exclude the analysis of the impact of these reductions on the shipper or the buyer of the transport service.
- We assume that transport operators have high service levels in terms of on-time delivery. That is, they plan in advance to make sure that deliveries at the final destination (buyer's premises) are made within the stipulated amount of time in most cases. We model this by introducing a parameter representing the on-time delivery performance. Further sensitivity analysis on this parameter is going to show whether the benefit from TIR usage is significantly more pronounced for transport operators providing high service levels or not.
- The costs in our model are defined for the "transport operator" (not the shipper or the buyer of the goods). However, we do define the "inventory cost" as well, which depends on the value of the goods and the time they spend in-transit. The average transportation time and the variance affect the level of inventories a buyer would keep at his facilities. The longer and more variable the transport time (lead time) is, the higher inventory levels will be. In our model, we do not include safety stock calculations (inventories kept to protect against variability in transport times) for the sake of simplicity. But, we report the inventory related costs for the in-transit (or pipeline) inventory. As mentioned before, this will be defined by the total time spent for transportation, and the value of the goods. This cost is usually borne by the shipper or the buyer in a transport contract depending on the incoterms. Even though it is not the transport operator who incurs this in-transit (pipeline) inventory cost, we believe it is important to present the results for this as well. The shippers and/or buyers might request that the transport operators hold TIR Carnets if there are significant reductions in the aforementioned "inventory costs" as a result of a reduction in transport times.
- Any cost that would be included regardless of whether the transport operator holds a TIR Carnet or not will be excluded from the cost function. Specifically, the following will not be included in the cost functions in our model:

  - Transportation costs between intermodal terminals (even in the case of a container missing the originally scheduled departure at an intermodal facility, we assume that the cost of transport with the next available shipment option will cost the same);

- ➢ The cost of transshipment at intermodal terminals (expected loading and unloading of the container from one mode of transport to another, and other necessary operations).

- ❖ In order to simplify the analysis, we assume that the transportation times on different modes and the times it takes for mode shifts once goods are cleared (time required for operations performed to move the container from one mode of transport to another one, which is independent of TIR usage) at intermodal terminals are deterministic, and do not depend on whether TIR Carnet is used or not. However, we model randomness in the Customs Clearance and border crossing times which might happen at intermodal terminals, as this is the focus of our study where the TIR Carnet makes a difference (i.e., a potential reduction in time required for Customs Clearance and border crossing with TIR Carnet).

- ❖ We assume that the transport operators introduce some “slack time” (denoted by the acronym **BCS** later in the document, standing for **B**order **C**rossing **S**lack) into their operations allowing enough time for Customs Clearance and border crossing, to be able to deliver on time. We assume that this “slack time” depends on the on-time delivery performance that the transport operator promises. . For example, if a transport operator knows that border crossing activities will take anywhere from 1 hour to 10 hours, then this operator would introduce a “slack time” of 10 hours for border crossing to ensure a 100% on-time delivery performance. That is, they will plan to arrive at a border 10 hours before the required time to make sure that there is absolutely no delay. This slack time would apparently go down with reduced on-time delivery performance. This slack time will be different if the TIR Carnet is used as the time required for border crossing activities are likely to be lower when TIR system is used. We explain how these slacks are calculated later when we present the model. Our approach is to introduce “individual buffers” for each border crossing. That is, the transport operator “plans” transport operations based on BCS values determined for each border crossing along the route. For instance, in our case study, if the BCS for the border crossing activities between Serbia and Bulgaria is equal to one day, then that means everything will go according to the initial plan as long as the truck spends less than one day at the border. Similar BCS values are determined for each border crossing separately. Although this obviously leads to excessive slack compared to the case of “pooling” these slacks and introducing a common BCS for all the border crossings combined, it is important to have individual slacks for planning purposes. Our model provides the resulting on-time delivery performance using a simulation model for given service levels for individual border crossings.

- ❖ We assume that any delay at a border crossing between countries A and B will not have an effect on the subsequent border crossing times until final destination (i.e., the BCS values are set at the beginning of the journey and do not depend on what happens along the way. This is of course a simplifying assumption to make the model tractable, however, not far from reality assuming that the firms respond to delays and try to stay on schedule one way or another. We also assume that if the actual border crossing time is less than the slack allowed, the container still waits for the "scheduled" departure according to the original plan.

- We also assume that the transport operators introduce another "slack time", which serves as a buffer for the time required for the additional wait/operations at the intermodal facility for modal shift (denoted by **AMSS**: **A**dditional **M**odal **S**hift **S**lack). This buffer is on top of the deterministic transport times and modal shift times at the intermodal facilities excluding border crossing activities, and serves as a risk mitigation strategy in cases where border crossing activities take longer than planned and containers need to spend more time at intermodal terminals. In other words, we assume that the AMSS serves as a proactive measure taken to minimize the impact of potential delays in cases where synchronization failures happen and containers have to wait at intermodal terminals for the next available departure when the border crossing activities take longer than expected. This aspect makes the "intermodal transportation" significantly more complicated compared to road transport only. To minimize the effect of such undesirable potential delays, transport operators prefer to maintain higher levels of service (on-time delivery), especially for intermodal transport. Therefore, one would expect increasing BCS values to further mitigate such risks. Clearly, the AMSS will be set to zero if the on-time delivery performance of the transport operator is 100%. However, in all other cases (which is the situation in almost all practical cases), AMSS will be positive as long as there is a modal shift.
- We assume that the "transport operator" sets the promised due date, D, to the sum of the deterministic transport times and the sum of the slacks (BCS and AMSS) defined above. Consequently, the final delivery will be delayed only if the "actual total time spent at border crossings exceeds the total slack times." We remind the reader that in the extreme case of a transport operator aiming 100% on-time delivery would never experience any delays.
- We consider a "typical" product and run the model with a basic set of parameters to perform sensitivity analysis. That is, we do not take the "nature of the product" (e.g., dangerous/hazardous goods versus normal goods) into account when calculating the Customs Clearance and inspection times. This additional complexity could be easily handled by adding a superscript of "product type" to the parameters/variables.
- We assume that the potential benefits of TIR procedure in terms of speeding up border crossing operations are marginal in case there already are existing bilateral agreements or certificates (e.g., common transit conventions, AEO certificates, etc.).

- In cases where there are no other bilateral agreements or certificates facilitating border crossing activities and reducing the time required, we assume that the TIR procedure will help the transport operator clear Customs and cross borders faster. Consequently, following benefits may be realized:
  - Direct reduction in time required for Customs Clearance;
  - Reduction in inspection rates and times: Customs Authorities are legally bound to physically inspect containers only if there are indicators of irregularities, and such irregularities are less frequent because of the seals required for TIR usage. Thus, one potential benefit of TIR procedure is being subject to less inspection. Our model has a parameter that defines the likelihood of inspection at border crossings, both with and without TIR Carnet. This leads to a reduction of total time spent at border crossing as a result of either the reduced likelihood of being subject to lengthy inspections or the reduction in inspection time as the container has not been tempered with throughout the journey because of the seal required for TIR usage (cargo verification in the absence of a seal is known to take longer);
  - Possibility of avoiding long queues at intermodal terminals at border crossings (e.g., congestion at a port) by jumping ahead in the queue (e.g., TIR benefits in green lanes).

We next define the variables and parameters used to estimate the expected time and cost savings with the TIR usage.

Variables and Parameters:

Random Variables:

$\boldsymbol{BCT_{AB}^{TIR}}$: The time it takes to cross the border (random variable) for a container with TIR

$\boldsymbol{BCT_{AB}}$: The time it takes to cross the border (random variable) for a container without TIR

Input Parameters:

$\boldsymbol{\mu_{XAB}^{TIR}}$ and $\boldsymbol{\sigma_{XAB}^{TIR}}$: Average time and standard deviation of time for Customs clearance and border crossing (from Country A to Country B) when there is no additional inspection for a container with TIR Carnet (mostly documentation issues, jumping the lines because of holding a TIR carnet, green lanes, etc.). This includes the time a truck/ship/train waits in a queue to be processed.

$\boldsymbol{\mu_{XAB}}$ and $\boldsymbol{\sigma_{XAB}}$: the same as above, but for a container without TIR Carnet

$\boldsymbol{\mu_{YB}^{TIR}}$ and $\boldsymbol{\sigma_{YB}^{TIR}}$: Average and standard deviation of additional time it takes for containers flagged for inspection (manual or machine) for a container with TIR Carnet at the Customs of Country B

$\boldsymbol{\mu_{YB}}$ and $\boldsymbol{\sigma_{YB}}$: the same as above without TIR Carnet

$\boldsymbol{\alpha_B}$: the probability of a normal container without any certificate (TIR Carnet, AEO, etc.) to be flagged for inspection at the Entry Customs of Country B

$\boldsymbol{\alpha_B^{TIR}}$: the same as above for a container with TIR

$\boldsymbol{S_{AB}}$: The set of pairs of countries where border crossings happen during the trip (from Country A to Country B)

$\boldsymbol{S_E}$: The set of countries of entry, including the destination country (i.e., all countries except for the origin country)

SL: On-time delivery performance for planning purposes (specifically used to set the BCS values), measured by the percent of time the border crossing activities are completed within the "planned" amount of time

$\boldsymbol{SL^{Final}}$: the actual on-time delivery performance, measured by the percent of time goods are delivered at the final destination within the stipulated amount of time (before due date).

$\boldsymbol{AMSS_{AB}}$: Average additional time a container needs to spend at an intermodal terminal involving countries A and B along the route, in case the *BCS* is not large enough and border crossing activities take longer than planned.

Decision Variables:

$\boldsymbol{BCS_{AB}^{TIR}}$: Slack time introduced by transport operator for the border crossing activities between countries A and B along the route holding a TIR Carnet – *fixed number* set at the beginning of the journey for planning purposes

$\boldsymbol{BCS_{AB}}$**:** Slack time introduced by transport operator for the border crossing activities between countries A and B_along the route without TIR – *fixed number* set at the beginning of the journey for planning purposes

$\boldsymbol{AMSS^{TIR}}$: Slack time that needs to be included in the promised delivery date by the transport operator for activities at all the intermodal facilities along the route in cases of synchronization issues for a container with TIR – *calculated using the simulation model and equal to the sum of the "additional" time required for modal shift at the intermodal terminals in case of synchronization failures (happens when the border crossing slack is not sufficiently large to cover for the border crossing activities, i.e., BCS<BCT).*

$\boldsymbol{AMSS}$: The same as above for a container without TIR

$\boldsymbol{D^{TIR}}$: The *inflated* promised due date by which the goods must be delivered to the buyer for a container with TIR

$\boldsymbol{D}$: The *inflated* promised due date by which the goods must be delivered to the buyer for a container without TIR

In what follows, we present the relationships between the parameters and variables defined above that will help us quantify the benefits of TIR usage.

First of all, based on the secondary data and communications with experts in the field, we make the following assumption about the parameters defined above:

$$\boldsymbol{\mu_{XAB}^{TIR} \leq \mu_{XAB}\,;\quad \sigma_{XAB}^{TIR} \leq \sigma_{XAB}}$$
$$\boldsymbol{\mu_{YB}^{TIR} = \mu_{YB};\quad \sigma_{YB}^{TIR} = \sigma_{YB}}$$
$$\boldsymbol{\alpha_{B}^{TIR} \leq \alpha_{B}}$$

Regarding the time required for inspection, we have decided to use the same numerical values for $\boldsymbol{\mu_{YB}^{TIR}}$ and $\boldsymbol{\mu_{YB}}$. However, one can always assume that the inspection times are also reduced for containers with a seal (case of TIR procedure), and analyze the benefits with the adjusted values for these parameters. Moreover, we assume that the likelihood of inspection is lower with TIR usage.

In order to realistically represent most situations and be able to perform numerical analysis, we assume that the border crossing times (*BCT*) are normally distributed random variables. That is, the time required for a container with and without TIR for border crossing would then be:

$$BCT_{AB}^{TIR} \sim Normal(Mean = \mu_{XAB}^{TIR} + \alpha_{B}^{TIR}\mu_{YB}^{TIR}, Variance = (\sigma_{XAB}^{TIR})^2 + (\alpha_{B}^{TIR}\sigma_{YB}^{TIR})^2)$$

$$BCT_{AB} \sim Normal(Mean = \mu_{XAB} + \alpha_{B}\mu_{YB}, Variance = (\sigma_{XAB})^2 + (\alpha_{B}\sigma_{YB})^2)$$

As briefly discussed in the assumptions, we model situations where the transport operator introduces slacks (buffer) for unexpected/unplanned circumstances, specifically related to border crossing/import/export related activities. A separate slack time is introduced for each border crossing individually. Consequently, the BCS values are calculated using the following expressions:

$$BCT_{Total}^{TIR} = \sum_{\forall(A,B)\in S_{AB}} BCT_{AB}^{TIR} \text{ and } \quad BCS^{TIR} = \sum_{\forall(A,B)\in S_{AB}} BCS_{AB}^{TIR} \text{ and}$$

$$BCT_{Total} = \sum\nolimits_{\forall(A,B)\in S_{AB}} BCT_{AB} \quad \text{and} \quad \text{BCS} = \sum\nolimits_{\forall(A,B)\in S_{AB}} BCS_{AB}$$

$$SL = Pr\{BCT_{AB}^{TIR} \leq BCS_{AB}^{TIR}\} \Rightarrow BCS_{AB}^{TIR} = F_{TIR,AB}^{-1}(SL)$$

$$SL = Pr\{BCT_{AB} \leq BCS_{AB}\} \Rightarrow BCS_{AB} = F_{AB}^{-1}(SL)$$

The $F^{-1}_{TIR,AB}$ function is the inverse of the Cumulative Distribution Functions (CDF) for the variable BCT^{TIR}_{AB} for a transport operator using TIR. Here, we assume that the transport operator would like to achieve the same service level (SL) with or without TIR.

Below, we present an illustration of the algorithm used to calculate the AMSS values using the simulation model for a simple example. Assume in this simple example that there are two border crossings (two intermodal terminals and three countries A, B, and C) along the route. Then, we have the following steps to calculate AMSS within the simulation model:

- *Start*
- *Set AMSS=0 at the beginning*
- *Generate a random variate representing the BCT_{AB}*
- *If $BCT_{AB} < BCS_{AB}$, then AMSS=0*
- *If $BCT_{AB} > BCS_{AB}$, then generate a random variate representing $AMSS_{AB}$ and update: $AMSS=AMSS+AMSS_{AB}$*
- *Generate a random variate representing BCT_{BC}*
- *If $\max(BCT_{AB}, BCS_{AB}) + BCT_{BC} + AMSS_{AB} < BCS_{AB} + BCS_{BC}$, then do not update AMSS*
- *If $\max(BCT_{AB}, BCS_{AB}) + BCT_{BC} + AMSS_{AB} > BCS_{AB} + BCS_{BC}$, then generate a random variate representing $AMSS_{BC}$ and update: $AMSS=AMSS+AMSS_{BC}$*
- *End.*

As explained in the assumptions section, we use the following relationship to define ***D*** values:

$$D = ETT + BCS + AMSS$$

$$D^{TIR} = ETT + BCS^{TIR} + AMSS^{TIR}$$

"*ETT***"** is the expected (deterministic) transport times and time it takes for modal shift operations at intermodal terminals, which is the same with and without TIR procedures. Therefore, in our numerical analysis we only report *ΔD*= $\Delta D = (BCS - BCS^{TIR}) + (AMSS - AMSS^{TIR})$, which is the difference between the *D* and D^{TIR}. Again, we remind the reader that for a transport operator with a service level of 100% (i.e., SL=1), then the AMSS terms will disappear (equal to zero).

We use the following notation to define the total time and cost savings for the transportation provider:

- *Expected Time (Actual) Savings with TIR Usage: ΔT*
- *Expected Reduction in the Promised Delivery Date with TIR Usage: ΔD*
- *Expected Cost Savings with TIR Usage: ΔC*

We first look at the expected actual time savings. Calculation of ΔT is unfortunately not very straightforward. The reason is that when the BCT is less than the BCS (reserved time for border crossing activities), we assume that the container waits until the "scheduled" move according to the original plan. Therefore, we use the simulation model to estimate the ΔT, which is the difference in the actual time it takes to deliver the final product to the customer for containers with and without TIR carnets.
We now turn our attention to the expected cost savings. Note that, we only consider the parts of the transport that are affected by the TIR usage. As mentioned before, the transport times between intermodal facilities and the costs of operations at the origin/destination/intermodal facilities are deterministic, and therefore excluded from the subsequent analysis. We have the following 2 major cost components (for the "transport operator") in this model:

1. Transport costs related to Customs Clearance and extra delays at intermodal facilities.

2. TIR Carnet price for the countries involved along the route, denoted by ***CTU*** (**C**ost of **T**IR **U**sage per container).

Also, as mentioned before, we believe that what is generally referred to as "inventory cost" in the literature is quite important to look at. This is usually borne by the shipper or the buyer, although in some rare cases the transport operator might be assuming the in-transit inventory holding costs. However, regardless of who incurs this "inventory cost" (cost related to the value of goods held in transit), it is critical to know how this changes with TIR usage as the transport operator can estimate the value of more reliable faster transportation to the customer (shipper or buyer) and offer better rates in a competitive transport procurement market, and increase/sustain its market share.

Moreover, there are other indirect benefits of the TIR usage. We also analyze whether there are savings in relation to the costs related to duties/tariffs due taking the financial guarantee provided by the TIR system in Chapter 4.

We remind the reader that, similar to the calculation of the benefits of TIR procedures regarding the total transport time, we follow the same approach for the "cost analysis". That is, we only focus on the cost components that would change with the use of TIR system, and report those in the "***ΔC***". In doing so, we introduce the following additional variable:

- **TCR**: **T**ransportation **C**ost **R**ate per unit time (this reflects an overall average cost of driver, fuel, demurrage/detention at the intermodal terminals etc. that would be incurred throughout the journey)

As a result, combining all the cost components, the expected cost savings in our model, ***ΔC,*** will be estimated using the following expression:

$$\Delta C = (\Delta T)(TCR) - CTU$$

Also, the savings in “inventory related costs (for either the buyer or the shipper depending on the incoterms defined in the purchase contract) is given as follows:

$$\text{Inventory Cost Savings} = h \times \Delta T$$

With “***h***” being the “daily holding cost”, which is the product of the daily holding cost rate (a number between 0 and 1) multiplied by the total value of goods in a container. As ***ΔT*** gives the expected time savings with the TIR procedure, the equation above will give the expected savings due to holding the same amount of inventory for a reduced amount of time in-transit.

One potential side benefit of the reduction in total transport time might be the increase in the utilization of the transportation fleet of the transport operator. We present the results on the utilization, using a very rough approximation relating the total transport time to utilization of a container.

The model simulates this system for different values of the variables defined to get an average estimate for the time and cost savings of TIR usage.

4.3 Model Validation

In order to ensure that the model has high face validity, we confirm with the potential users/providers of the TIR system that the assumptions, definitions, data are realistic. It is of grave importance that the model produces realistic results, and is able to predict accurately the impact the TIR usage will have on intermodal transport. For instance, some examples to model parameters that need to be validated are the time it takes for Customs clearance at an intermodal platform (port), length of the trip, demand volumes, inspection rates for TIR carnet holders, etc. Validation is performed via discussions of the model assumptions and parameters with stakeholders such as IRU, BSEC, transportation service providers (e.g., DB Schenker) that already use TIR, Customs, Port Authorities.

4.4 Design of scenarios

Clearly the benefits of holding a TIR carnet heavily depend on the characteristics of a particular shipment. Several factors such as the number of border crossings in route, value of goods, distance traveled, number of times transport modes are changed (change of hands), quality/efficiency of service at intermodal transport points, and finally the origin and destination among others determine how beneficial (marginal improvement as a percentage) TIR will be for a particular shipment. It is possible that the benefits are marginal for certain cases, while in others there could be significant positive impact. Sensitivity analysis using this model in order to show the effect of certain parameters on the benefits of TIR is presented in this section. In order to provide the range of benefits (best case and worst case scenarios) and to relate the magnitude of these benefits to the shipment characteristics, we consider different cases reflecting the diverse transportation alternatives within the BSEC region. In doing so, we do the following:

- Run the model with different values (e.g., using means and standard deviations for border crossing times) for parameters such as:
  - Operational efficiency at intermodal terminals (time/cost of handling) ;
  - Efficiency in coordination of change of modes and frequency of regular services scheduled at most of the non-road transport operators (e.g., daily departure of trains, ships) -- these are factors that might cause potential delays (times) at intermodal terminals due to lack of synchronization of transshipment activities (problems with change of modes);
  - Time/Costs required for Customs clearance and border crossing;
  - Physical inspection rate for TIR carnet holders;
  - Length of queues at intermodal terminals (e.g., congestion at ports), borders and effect of “Green Lanes”;
  - Time/Costs for document handling and preparation;
  - Inventory holding costs (costs of goods tied up in transportation);
  - Value of goods and guarantees required while in-transit – more critical for intermodal transport because of longer journeys and more actors involved, and guarantees per mode of transport may vary.

Ideally, one needs to look at the following factors to estimate the impact of TIR system at a macro level within the BSEC region:

- Trade volume within the BSEC region and the share of intermodal transport ;
- Containerization rate;
- LCL/FCL (Less than Container Load/Full Container Load) market shares (as TIR usage with LCL might be limited as no goods can be loaded/unloaded without breaking the Customs seal);
- Impact of improved operations at intermodal terminals on the trade volume, exports/imports;
- Impact of other competing agreements (multilateral, bilateral);
- Approval costs of vehicles and containers for TIR compliance on a regular basis;
- Changes in Customs duties and tariffs.

However, due to difficulties in obtaining relevant and accurate data and lack of time for an extensive simulation study analyzing all combinations of transport operations among BSEC countries, we only focus on the “trade volume” and the “share of intermodal transport” for the estimation of macro level impact of TIR system. Due to similar reasons, we merely present the procedure to estimate the aggregate impact of TIR system in the BSEC region.

4.5 Expected short/term impact of TIR benefits on stakeholders

This section discusses the benefits of the TIR system in the short and long term on stakeholders. Shippers, transportation service providers, intermodal platforms (e.g., dry ports, ports, rail terminals), and Customs are some of the major stakeholders. It is important to show the potential benefits for at least a majority of the stakeholders in order to guarantee a sustainable uptake of the TIR system. The objective here is to identify TIR's potential in removing bottlenecks preventing the smooth movement of transit cargoes. In particular, the model provides estimates on the following measures for shipments with and without the TIR carnet to show the quantitative/qualitative impact:

- Total time spent at border crossings and total lead time (expected reduction in door-to-door time for the shipment with TIR, as there are ideally no Customs inspection at border along the way and no need to deposit financial Customs guarantees at each of the borders);
- Reliability (improved reliability in terms of on-time delivery);
- Total cost of shipment (direct and indirect costs such as costs for transportation, document preparation, Customs duties/tariffs, inventory holding costs, etc.);
- Utilization of transportation resources (improved utilization because of reduction in lead times).

5 Financial guarantee model

Customs duties and other charges applicable to goods are temporarily suspended when goods are released for common/Union transit. In order to ensure the payment of duties and other charges when a (customs) debt is incurred in the course of a transit operation, the holder of the procedure is required to furnish a guarantee.

The supply chain operator (normally the transport carrier) that is responsible to issue the guarantee have at disposal three options: furnish the guarantee as 1) a cash deposit, or 2) using a guarantor covering a single transit operation ("guarantor single transactions" option), or 3) using a comprehensive guarantee covering several operations ("guarantor aggregated transactions" option). The individual guarantee by a guarantor may be provided in the form of vouchers that the guarantor issues to the holders of the procedure and in the form of guarantor's undertaking. The comprehensive guarantee consists instead on agreeing on annual budget that is supposed to cover the entire operations that a company is expecting to perform during a year. This option is a kind of simplification of the standard rules and normally is subject to an authorization. Finally, an operator has the option to purchase TIR carnets and use the attached vouchers to automatically cover the necessary guarantees at the country borders.

Hence, this section will develop and explain four models used to estimate the potential cost of financial guarantees of companies based in Serbia and moving cargo to Azerbaijan:

1. Cash deposit.
2. Guarantor Single Transactions.
3. Guarantor Aggregated Transactions.
4. TIR Carnet.

The underlying assumptions taken in the expounded models in this section are the following:

- **Transport means**. The total amount traded in monetary units (USD and €) is assumed to be transported exclusively by road.
- **Amount of shipments**. The total amount of shipments performed between Serbia and Azerbaijan has been computed exclusively by using the amount of Supplementary Customs Documents related to exports from Serbia, Dimitrovgrad and Belgrade customs post, to Bulgaria. Statistics available is based on data from January 2009 to December 2009. The assumption in the model is that all the shipments exiting Serbia are destined to Azerbaijan.
- **Deposit Rates.** Interest rates for cash deposit have been initially computed by using available statistics from the World Bank.
- **Lending Rates.** Lending interest rates have been derived by benchmarking prices offered for financial guarantee by Serbian customs brokers.

- **Georgian financial guarantees.** Financial guarantees in Georgia are considered to be null for all cargo except bulk. This information was unveiled during interviews and observations performed in Georgia, customs post Sarpi. The information was verified by means of follow up interviews with Georgian Revenue Services and analysis of legislative material. As it was explained, the freedom of transit is ensured by Article 230 of the Tax Code of Georgia and secondary legislation[2]. Hence, "transit in Georgia is free of any customs duties and does not require a guarantee in a form of surety, deposit or other monetary or non-monetary means". Additional interviews with customs brokers in Serbia confirmed that transit in Georgia is free of any duties and taxes, except for bulk cargo.
- **Azerbaijan financial guarantees.** Interviewed experts confirmed that all cargo products are free of duties and taxes in Azerbaijan as well.
- Cargo value and product category. Data collected from the World Trade Organization show that there are totally 72 types of products that are exported from Serbia to Azerbaijan, for a total 6,930,935 (thousands of USD). In order to limit the analysis but still keeping it significant in terms of results, it was decided to apply the Pareto principle and select merely products accounting for the 80% of the traded value between the countries of interest (*Figure 5-2*). The selected products and related traded values are given in *Table 5-10*.according to interviewed experts, TIR carnets are normally not used for transport of military cargo, hence product category (9306) has not been considered in the analysis (Table 5-10).
- **Duty rates** used for the analysis have been computed by using the tariffs analysis database available from the World Trade Organization. The data available consists of the WTO's Integrated Database (IDB) and Consolidated Tariffs schedules (CTS). The computed duty rates have been identified by extracting applied duties rates averaged on the HS (Harmonize System) subheadings (2-digits) of the products considered in this study (see Table 5-10), and for each of the countries transited, i.e. Bulgaria, Turkey, Georgia and Azerbaijan.
- **Transiting times** have been estimated by considering:
  - The necessary travelling times to cross the selected countries. This item was computed by using google maps routing services. These times were slightly inflated considering 1) the necessary rest to be taken by truck drivers every 4-5 hours and 2) the slower trucks' average speed compared to normal cars.
  - The administrative time to file the necessary documents for issuing financial guarantees and request reimbursement where applicable.

[2] Instruction on Movement and Clearance of Goods across the Customs Territory of Georgia, approved by Order No. 290 of 26 July 2012 of the Minister of Finance of Georgia and Instruction for Implementation of Procedures Related to Entering Goods the Customs Territory of Georgia / Leaving the Customs Territory of Georgia and Declaration, approved by Order No. 12858 of 1 August 2012 of the Director General of the Georgia Revenue Service.

Table 5-10. Selected products and values traded from Serbia to Azerbaijan (values are in 1000 USD from 2015, Kg = Kilograms, N.Q.=Not Quantifiable, product codes based on H4 nomenclature). Data extracted from WITS (2016).

Product Code	Definition	Quantity	Short Name	Value (in 1000 USD)	CUM %
9306*	Bombs, grenades, torpedoes, mines, missiles and similar munitions of war and parts thereof; cartridges and other ammunition and projectiles and parts thereof, including shot and cartridge wads.	48683	Kg	1 813 432	26,16%
4911	Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans.	7	Kg	968 581	40,14%
3004	Pharmaceutical Products.	239602	Kg	785 791	51,48%
7309	Reservoirs, tanks, vats and similar containers for any material (other than compressed or liquefied gas), of iron or steel, of a capacity exceeding 300 l, whether or not lined or heat-insulated, but not fitted with mechanical or thermal equipment,	38918	Kg	394 502	57,17%
8414	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof.		N.Q.	327 503	61,89%
8703	Vehicles other than railway or tramway rolling- stock, and parts and accessories thereof.	15	Item	270 603	65,80%
3601	Propellent Powders	16000	Kg	260 651	69,56%
8207	Interchangeable tools for hand tools, whether or not power- operated, or for machine-tools (for example, for pressing, stamping, punching, tapping, threading, drilling, boring, broaching, milling, turning or screw driving), including dies for drawing.	10128	Kg	242 167	73,05%
9207	Musical instruments; parts and accessories of such articles.		N.Q.	216 333	76,17%
8479	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof..		N.Q.	206 761	79,16%

**=* *TIR carnets are normally not used for transport of military cargo, hence product category (9306) has not been considered in the analysis.*

Table 5-11. Estimated times in days for road and sea transport, as well as administration of financial guarantees (travelling times were estimated by using google maps, na = not applicable).

	Serbia	Bulgaria	Turkey	Georgia	Azerbaijan
Road Transport	0,06	0,19	0,21	0,29	0,42
Sea Transport	0	na	3,54	na	na
Financial guarantee administration	0,08	0	1	2,04	0.04
Tot	0,14	0,19	4,75	2,33	0,46

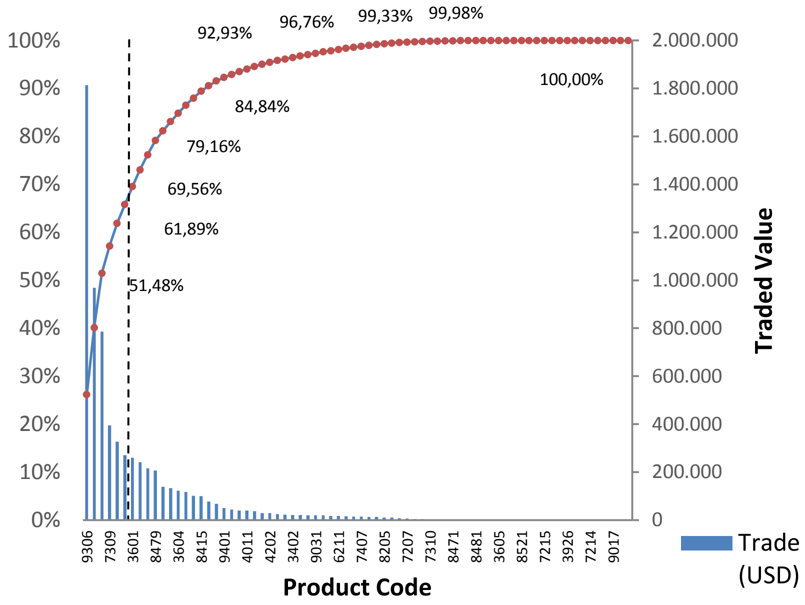

Figure 5-2. Trade Serbia to Azerbaijan in value (2015, in 1000 USD).

Cash Deposit

In case of cash deposit, the transport or logistics companies in charge of the shipments, are assumed to deposit their own financial resources into the bank accounts of the national customs transited. The economic model to compute the costs for using the cash deposit approach is given in the following formula.

$$CDC_{Serbia-Azerbaijan} = \frac{S \cdot \sum_{c=1}^{3} TT_c}{N \cdot 365} \cdot DIR \cdot \sum_{p=1}^{9} \sum_{c=1}^{3} \left[\left(VAT_{c,p} + DR_{c,p} \right) \cdot TV_p \cdot TT_c \right]$$

Where:

$CDC_{Serbia-Azerbaijan}$ = Annual Cash Deposit Costs on route Serbia to Azerbaijan [€/company].

TT_c=Transit time for country c considered in the route [days], note Azerbaijan not included due to freedom of transit regime. Georgian duties and taxes considered only for bulk cargo.

TV_p= annual traded values in € of each product p considered in the study [€] (see Table 5-10).

$VAT_{c,p}$= Value added Tax in each country c, for each product p [%].

$DR_{c,p}$= Duty Rates in each country c, for each product p [%].

DIR= Deposit Interest Rate in Serbia [%], deducted from Serbian customs brokers rates issued for financial guarantees.

N = number of transport companies based in Serbia and assumed to be operating on the route Serbia to Azerbaijan [number of transport companies].

S = annual export shipments from Serbia [number of shipments per year].

c = countries selected for this study, {1=Bulgaria, 2=Turkey, 3=Georgia}.

$p = 1\ to\ 9$, corresponding to products selected for this study in

To calculate the annual cost savings, the following data were used:

- ❖ Annual trade values per product (see Table 5-10).
- ❖ Deposit interest rate 7% (World Bank, 2016b).
- ❖ Number of major companies operating in Serbia set to 107, as observed in available european yellow pages.
- ❖ Number of annual export shipments, from Belgrade and Dimitrovgrad, 99 311 (Upravacarina, 2016).
- ❖ VAT and Duty Rates as reported in WTO tariffs database (WTO, 2016).

Guarantor Single Transactions

Using a guarantor means that a company has the option to request loans from national banks, insurance companies, or customs brokers in order to cover the necessary fees to be deposited in the customs' bank accounts. In case the guarantor is used for individual transactions, a company uses a guarantor for each time the company performs an export from Serbia to Azerbaijan. Hence the model that has been developed and applied is the following:

$$GSTC_{Serbia-Azerbaijan} = \frac{2}{73} \cdot \frac{S \cdot LIR}{N} \cdot \sum_{p=1}^{10} \sum_{c=1}^{3} \left[\left(VAT_{c,p} + DR_{c,p} \right) \cdot TV_p \right]$$

Where:

$GSTC_{Serbia-Azerbaijan}$ = annual Guarantor Single Transaction Costs on route Serbia to Georgia [€/company].

TV_p= annual traded values in € of each product p considered in the study [€] (see Table 5-10).

$VAT_{c,p}$= Value added Tax in each country c, for each product p [%].

$DR_{c,p}$= Duty Rates in each country c, for each product p [%].

LIR= Lending Interest Rate in Serbia [%]. This value was calculated by using fees of Serbian customs brokers as a reference. According to interviews, customs brokers charge about 35-40€ for a value of maximum 20 000€ and a time limit of maximum 8-10 days. This corresponds to a potential lending interest rate of about 9%.

$N =$ number of transport companies based in Serbia and assumed to be operating on the route Serbia to Azerbaijan [number of transport companies].

$S =$ annual export shipments from Serbia [number of shipments per year].

$c =$ countries selected for this study, {1=Bulgaria, 2=Turkey, 3=Georgia}.

$\mathrm{p} = 1 \text{ to } 9$, corresponding to the 9 products selected for this study in Table 5-10.

To calculate the annual cost savings, the following data were used:

- ❖ Annual trade values per products (Table 5-10) as reported by WTO in 2015.
- ❖ Lending interest rate 9%.
- ❖ Number of major companies operating in Serbia set to 107, as observed in available European yellow pages.
- ❖ Number of annual export shipments, from Belgrade and Dimitrovgrad, 99 311 (Upravacarina, 2016).
- ❖ VAT and Duty Rates as reported in WTO tariffs database (WTO, 2016).

Guarantor Aggregated Transactions

In case an operator chooses this option, a total amount loaned from the guarantor (a bank, an insurance company, a customs broker etc.) has to be agreed upon and related costs paid. The guarantor on its turn monitor all transactions performed by the company's carriers. Thereafter the guarantor uses and refill the agreed budget respectively every time an amount need to be deposited to customs' bank accounts, or the other way round, when the customs administrations reimburse the deposit. Using a guarantor for aggregated transactions performed yearly, the economic model is changed in order to consider to total amount of VATs and Duty Rates that need to be disbursed by companies to national customs on a yearly base. Hence, the economic model is the following:

$$GATC_{Serbia-Azerbaijan} = \frac{2 \cdot S}{N \cdot 73} \cdot LIR \cdot \sum_{p=1}^{9} \sum_{c=1}^{3} \left[\left(VAT_{c,p} + DR_{c,p} \right) \cdot TV_p \right]$$

Where:

$GATC_{Serbia-Azerbaijan}$ = annual Guarantor Aggregated Transaction Costs on route Serbia to Azerbaijan [€/company].

LIR= Lending Interest Rate in Serbia [%]. This value was calculated by using fees of Serbian customs brokers as a reference. According to interviews, customs brokers charge about 35-40€ for a value of maximum 20 000€ and a time limit of maximum 8-10 days. This corresponds to a potential lending interest rate of about 9%.

TV_p= annual traded values in € of each product p considered in the study [€] (see Table 5-10).

$VAT_{c,p}$= Value added Tax in each country c, for each product p [%].

$DR_{c,p}$= Duty Rates in each country c, for each product p [%].

N = number of transport companies based in Serbia and assumed to be operating on the route Serbia to Azerbaijan [number of transport companies].

c = countries selected for this study, {1=Bulgaria, 2=Turkey, 3=Georgia}. Azerbaijan not included because of freedom of transit conditions.

$\mathrm{p} = 1 \text{ to } 9$, corresponding to the 9 products selected for this study in Table 5-10.

To calculate the annual cost savings, the following data were used:

- Annual trade values per products (Table 5-10) as reported by WTO in 2015.
- Lending interest rate 9%.
- Number of major companies operating in Serbia set to 107, as observed in available European yellow pages.
- VAT and Duty Rates extracted from WTO tariffs database (WTO, 2016).

TIR Carnet

As established in the TIR Convention, companies have the possibility to cover customs duties and taxies throughout a journey, by exploiting the international guaranteeing chain managed by the International Road Transport Union (IRU). Hence, the TIR carnet can be used by companies both as a customs declaration as well as a guarantee for the duties and taxes suspended when cargo is transiting a country. National offices throughout the world has the responsibility to sell and distribute TIR Carnet. For instance, in Serbia, the ministry of transport in cooperation with the chambers of commerce have this responsibility.

The economic model for the cost calculation associated with the TIR Carnet is quite trivial. The costs for the suspended levied duties and taxes does not depend anymore on the value of the cargo, nor on the transit time, or any loans borrowed from banks or insurance companies. Operators need merely to purchase a TIR Carnet and automatically financial guarantee will be covered.

$$\mathrm{TCC} = \left\| \frac{S}{N} \right\| \cdot \mathrm{TCP}$$

Where:

TCC =TIR Carnet Annual Costs [€].

TCP =TIR Carnet Price [€].

S = annual export shipments from Serbia [number of shipments per year].

N = number of transport companies based in Serbia and assumed to be operating on the route Serbia to Azerbaijan [number of transport companies].

To calculate the annual costs of using TIR Carnets, the following data were used:

- TIR Carnet with 14 Vouchers Price €106,81 (UNECE, 2016).
- Number of major companies operating in Serbia set to 107, as observed in available European yellow pages.
- Number of annual export shipments 99 311 (Upravacarina, 2016).

6 Results

In this chapter, we present the findings from the numerical analysis performed in order to quantify the benefit of the use of TIR procedure in intermodal transport. The simulation model is run under different scenarios to observe the impact of certain key parameters. The ultimate goal is to gain insights from the numerical tests and provide a set of recommendations regarding the role of the TIR system in the development of intermodal transport of goods in the BSEC Region. We believe that the results and recommendations from this report will form the basis of future detailed studies of the same.

First, we present the values of the parameters that we use in our "base case scenario" (we only present the base case values of the parameters that we vary in the sensitivity analysis; all the others are included in the Appendix). Then, we change certain parameters one at a time keeping all others the same to perform sensitivity analysis and see how robust our results are. With this sensitivity analysis, we aim to understand how results change with respect to the parameters, and identify those which are most critical. More time needs to be spent for careful data collection for these critical parameters to ensure reliable results.

The base case values for the major parameters that we vary in our numerical analysis are as follows:

SL	α ratio	TIR Factor	Container Value	TCR	Variability in BCT
1,00	0,68	0,54	62811,18	13,00	7,00

Table 6-1 Base case values

In the above table, "α ratio" denotes the "$\boldsymbol{\alpha_B^{TIR}/\alpha_B}$" and the "TIR Factor" is the "$\boldsymbol{\mu_{XAB}^{TIR}/\mu_{XAB}}$". The "Container Value" is used to calculate the "h" to determine the holding costs. Finally, the variability in BCT represents the "$\boldsymbol{\sigma_{XAB}}$". We obtain the values of all the parameters from Tables 2.5, 2.6, and 2.9 from this report and through personal communication with transport operators, Customs Authorities, Chamber of Commerce of the relevant countries, and secondary data from internet (e.g., WorldBank database).

The results for the base case scenario are as follows:

Delta D	Delta Time	Delta Cost	Holding Cost	Delay % with TIR	Delay % without TIR	BSC difference	BCT Difference	Total time TIR	Total time no TIR	Improvement in utilization with TIR
91,37	91,37	1081,07	131,04	0,00	0,00	91,37	41,12	274,09	365,46	33,34

Table 6-2 Results for the base case scenario

The results clearly show that there are significant benefits to using the TIR system. The reduction in actual transport time is approximately 92 hours (about 4 days) when we compare shipments with and without the TIR Carnet. There are significant direct cost savings, as well as indirect savings (reduction in holding cost in Euros due to reduced transport time). The BCT values are significantly lower (close to 2 days) and the time spent in border crossings are "less" relevant in determining the total transport time. The slack times are also approximately 4 days lower with TIR compared to without TIR. That is, the transport operator could promise a due date which is 4 days earlier compared to the case without TIR, which probably will position a particular transport operator ahead of its competitors. Finally, we observe that due to lower total transport time, the transport operator would be able to substantially increase the utilization of the container (i.e., the same container can be used to transport goods more times in a given year). The improvement in utilization is significant, around 33%.

In what follows, we present our results varying parameters that are major determinants of the TIR benefits. We start with investigating the impact of the "service level", as measure by SL:

SL	Delta D	Delta Time	Delta Cost	Holding Cost	Delay % with TIR	Delay % without TIR	BSC difference	BCT Difference	Total time TIR	Total time no TIR	Improvement in utilization with TIR
1,00	***91,37***	***91,37***	***1081,06***	***131,03***	***0,00***	***0,00***	***91,37***	***40,61***	***274,09***	***365,46***	***33,34***
0,99	68,46	68,39	782,22	98,08	0,03	0,03	68,55	41,47	247,82	316,21	27,64
0,97	62,74	62,56	706,42	89,89	0,09	0,07	63,31	40,19	242,99	305,54	25,90
0,95	61,14	60,63	681,45	87,37	0,15	0,14	60,53	41,91	240,73	301,37	25,42
0,90	56,70	56,13	622,94	82,06	0,26	0,26	56,25	40,93	239,78	295,91	23,99
0,80	49,85	49,32	534,38	75,66	0,52	0,48	51,07	40,22	243,33	292,65	21,43
0,70	47,97	48,32	521,39	75,95	0,70	0,72	47,34	41,18	246,48	294,81	20,99

Table 6-3 Results for Service Level

It turns out that the higher the service level is (larger SL), the more beneficial the TIR system becomes. This is to be expected as transport operators providing excellent service regarding on-time delivery would allow higher slacks to make sure delays do not happen. The TIR system helps reduce these slacks, and therefore as the SL goes up, the reduction in these slack values are more pronounced. Therefore, we conclude that TIR usage will help transport operators deliver reliable service to their clients, which is crucial and especially challenging in intermodal transport. Due to possible synchronization failures at intermodal terminals, transport operators need to be careful with the slacks and make sure that the "delay %" as shown in the table above is at an acceptable level. We observe that a typical transport operator with a 95% on-time delivery needs to choose SL=0.98 when determining the slacks.

α ratio	Delta D	Delta Time	Delta Cost	Holding Cost	Delay % with TIR	Delay % without TIR	BSC difference	BCT Difference	Total time TIR	Total time no TIR	Improvement in utilization with TIR
0,40	92,13	92,13	1090,86	132,12	0,00	0,00	92,13	41,91	273,33	365,46	33,71
0,50	91,86	91,86	1087,38	131,73	0,00	0,00	91,86	40,93	273,60	365,46	33,57
0,60	91,59	91,59	1083,85	131,34	0,00	0,00	91,59	41,52	273,87	365,46	33,44
0,68	***91,37***	***91,37***	***1081,06***	***131,03***	***0,00***	***0,00***	***91,37***	***41,42***	***274,09***	***365,46***	***33,34***
0,70	91,31	91,31	1080,27	130,95	0,00	0,00	91,31	40,87	274,15	365,46	33,31
0,75	91,23	91,18	1078,57	130,76	0,00	0,00	91,17	41,21	274,29	365,47	33,24
0,80	91,03	91,03	1076,65	130,55	0,00	0,00	91,03	41,08	274,43	365,46	33,17
0,90	90,75	90,75	1072,98	130,14	0,00	0,00	90,75	41,01	274,71	365,46	33,04
0,99	90,50	90,50	1069,64	129,77	0,00	0,00	90,50	39,94	274,96	365,46	32,91

Table 6-4 Results for likelihood of additional inspection

We observe that the effect of “likelihood of additional inspection” at border crossings is marginal and the TIR benefits are decreasing in the ratio “$\boldsymbol{\alpha_B^{TIR}/\alpha_B}$” as expected. The results are quite robust with respect to the ratio “$\boldsymbol{\alpha_B^{TIR}/\alpha_B}$”. That is, the benefit of the TIR usage is not very sensitive to the changes in this ratio. This observation is somewhat expected as we assume that the time for additional inspection is the same with and without TIR and small compared to the overall border crossing time in general. We discovered during the data collection that it is quite difficult to estimate this ratio. For certain countries (e.g., Georgia) the likelihood is the same (with and without TIR are treated the same), while in some others (e.g., Serbia) this ratio is equal to 0,35 (big improvement with TIR). Moreover, when the countries along the route are members of the common transit system, the benefit of having TIR in terms of reduction in border crossing times are also marginal (which makes the ratio equal to 1 as well, such as between Serbia and Bulgaria), if any. We also did not come across any rigorous statistical analysis about this issue, and therefore the fact that the results are robust is good news in the sense that estimation errors in relation to this ratio do not affect the insights generated significantly.

TIR Factor	Delta D	Delta Time	Delta Cost	Holding Cost	Delay % with TIR	Delay % without TIR	BSC difference	BCT Difference	Total time TIR	Total time no TIR	Improvement in utilization with TIR
0,54	***91,37***	***91,37***	***1081,05***	***131,03***	***0,00***	***0,00***	***91,37***	***40,75***	***274,09***	***365,46***	***33,34***
0,60	79,57	79,57	927,63	114,11	0,00	0,00	79,57	35,32	285,89	365,46	27,83
0,65	69,73	69,73	799,75	100,00	0,00	0,00	69,73	31,25	295,73	365,46	23,58
0,70	59,90	59,90	671,87	85,90	0,00	0,00	59,90	26,25	305,56	365,46	19,60
0,75	50,06	50,06	543,97	71,79	0,00	0,00	50,06	22,82	315,40	365,46	15,87
0,80	40,22	40,22	416,07	57,68	0,00	0,00	40,22	18,79	325,24	365,46	12,37
0,90	20,54	20,54	160,25	29,46	0,00	0,00	20,54	9,34	344,92	365,46	5,96
0,99	2,83	2,83	-70,00	4,06	0,00	0,00	2,83	2,20	362,63	365,46	0,78

Table 6-5 TIR benefits

As expected, the TIR benefits change dramatically in response to changes in the “TIR Factor”, which is the ratio between the average time it takes for border crossing activities with TIR and without TIR (i.e., $\boldsymbol{\mu_{XAB}^{TIR}/\ \mu_{XAB}}$). In other words, it measures the reduction in border crossing times (excluding time required for additional inspections) with the use of TIR Carnet. In our base case scenario (TIR factor=0.54), we assumed that the time it takes to complete border crossing activities (without inspection) with TIR Carnet is almost half as much compared to that of without the TIR Carnet. We conjecture that this is due to less errors in documentation, the fact that the container is perceived to be more secure because of the seal, the financial guarantee, and the possibility to jump the queues to minimize the wait time at borders. However, the data regarding this factor is also somewhat lacking, and there is no clear evidence of to what extent TIR Carnet helps reduce the border crossing time. Therefore, a transport operator considering the use of TIR system to reduce BCT needs to be sure of the value of the TIR factor to make sure that use of TIR Carnets is economically viable. Note that, the cost increases actually when the TIR Factor=0.99, because of the carnet price. However, we note that even for large values of this factor (e.g., 0.9), that is when the TIR Carnet reduces the border crossing times only by 10%, TIR benefits still can be substantial (a 160€ reduction in cost per container).

Container Value	Delta D	Delta Time	Delta Cost	Holding Cost	Delay % with TIR	Delay % without TIR	BSC difference	BCT Difference	Total time TIR	Total time no TIR	Improvement in utilization with TIR
62811,1807	***91,37***	***91,37***	***1081,06***	***131,03***	***0,00***	***0,00***	***91,37***	***40,93***	***274,09***	***365,46***	***33,34***
50248,94	91,37	91,37	1081,06	104,83	0,00	0,00	91,37	40,78	274,09	365,46	33,34
37686,71	91,37	91,37	1081,06	78,62	0,00	0,00	91,37	41,84	274,09	365,46	33,34
25124,47	91,37	91,37	1081,06	52,41	0,00	0,00	91,37	41,68	274,09	365,46	33,34
12562,24	91,37	91,37	1081,06	26,21	0,00	0,00	91,37	41,61	274,09	365,46	33,34

Table 6-6 Results when varying the value of items in a shipment

We remind the reader that when determining the value of an FCL (Full Container Load), we have divided the total trade value between Azerbaijan and Serbia by the total number of shipments. Apparently, this is a very rough approximation of the value of the goods in a container. Therefore, in the table above, we present the results when we vary the value of the items in a shipment. The only changing variable is the holding cost (other small differences are due to the randomness from different simulation runs as expected), and it is clearly linear in the value of the items. For cheaper goods, the difference in holding cost is much lower. As we explained in the assumptions, the holding cost is generally not borne by the transport operator. However, reduced holding cost will help the transport operator negotiate better rates with their clients.

TCR	Delta D	Delta Time	Delta Cost	Holding Cost	Delay % with TIR	Delay % without TIR	BSC difference	BCT Difference	Total time TIR	Total time no TIR	Improvement in utilization with TIR
13,00	***91,36***	***91,37***	***1081,04***	***131,03***	***0,00***	***0,00***	***91,37***	***40,61***	***274,09***	***365,46***	***33,34***
20,00	91,37	91,37	1720,68	131,03	0,00	0,00	91,37	41,63	274,09	365,46	33,34
25,00	91,37	91,37	2177,55	131,03	0,00	0,00	91,37	41,42	274,09	365,46	33,34
30,00	91,37	91,37	2634,42	131,03	0,00	0,00	91,37	40,45	274,09	365,46	33,34
40,00	91,37	91,37	3548,17	131,03	0,00	0,00	91,37	42,26	274,09	365,46	33,34
50,00	91,37	91,37	4461,87	131,03	0,00	0,00	91,37	41,50	274,09	365,46	33,34
75,00	91,37	91,37	6746,26	131,03	0,00	0,00	91,37	41,61	274,09	365,46	33,34

Table 6-7 Results with the variation of TCR

When determining the TCR (Transportation Cost Rate per hour), we take into account cost drivers such as the wage for the driver, detention/demurrage, rental cost of container, etc. These are also quite difficult to estimate and vary significantly from one country to another. The base case scenario assumes a value of 13 €. However, we believe that this value might be higher, especially when delays are experienced and there are extra charges. The table above shows the impact of this parameter. Clearly, this is one of the important parameters as the results are sensitive to the TCR. The cost savings are obviously increasing in TCR, and are quite significant in all the scenarios tested. We remind the reader that although the fact that cost savings of TIR usage increases in TCR (as there are reductions in total transport time with TIR in all cases studied), the main result from this exercise is that the transport operator would be able to find the cut-off value regarding TCR that would make the TIR Carnet option an economically viable one. If the TCR is very low (much lower than 13 in this case), TIR Carnets may not reduce the total cost.

Variability in BCT	Delta D	Delta Time	Delta Cost	Holding Cost	Delay % with TIR	Delay % without TIR	BSC difference	BCT Difference	Total time TIR	Total time no TIR	Improvement in utilization with TIR
11,00	120,05	120,05	8897,13	172,16	0,00	0,00	120,05	40,88	307,73	427,78	39,01
9,00	105,71	105,71	7821,65	151,60	0,00	0,00	105,71	40,46	290,90	396,62	36,34
7,00	***91,37***	***91,37***	***6746,26***	***131,03***	***0,00***	***0,00***	***91,37***	***41,63***	***274,09***	***365,46***	***33,34***
5,00	77,04	77,04	5671,07	110,48	0,00	0,00	77,04	41,24	257,28	334,32	29,94
3,00	62,71	62,71	4596,48	89,93	0,00	0,00	62,71	41,36	240,52	303,23	26,07

Table 6-8 Results for the variability in BCT

In the table above, we vary the standard deviation of the time required for border crossing activities without inspection. It is well known that border crossing activities are significant compared to the total transport, and more importantly they are the most “variable” component. Therefore, it is crucial to see how the TIR benefits change with respect to the variability in the BCT values in general. The TIR benefits seem to increase as the border crossing times exhibit more variability. Therefore, the value of the TIR system is significantly larger to transport operators for routes with new border crossings (less information about the BCT) and highly variable border crossing times in general. Finally, note that the increase is not linear in the standard deviation, and hence the simulation is useful to quantify the benefits for given mean and standard deviation for the BCT values.

So far, we presented the results for a particular route from Serbia to Azerbaijan. In order to estimate the impact of TIR system in the BSEC region as a whole, our simplified approach (mainly due to lack of data available) is as follows:

1. *Calculate the average difference in BSC and BCT by dividing the results we get from the base case scenario by 4 (there are 4 border crossings in our case study, on the way from Serbia to Azerbaijan).*
2. *Similarly calculate the reduction in total transport time (ΔT) by dividing the number obtained by 4.*

3. *Determine the total number of containers (annual) flowing between any two countries in the BSEC region considering all possible pairings (e.g., Turkey with all its neighbors).*
4. *Estimating the share of intermodal transport in containerized transportation (ro-ro included) in the BSEC region.*
5. *Multiplying the numbers obtained in the four steps above to estimate the savings in transport times for any pairing (border crossing) within the BSEC.*
6. *Adding the numbers obtained in step 5 above over all possible pairings (border crossings) within the BSEC region to get the overall benefit of the TIR Carnet in BSEC.*

Once the data elements defined above are obtained, the calculations are pretty straightforward and an estimate on how TIR procedures can help facilitate the intermodal transport in the BSEC region as a whole can be determined.

6.1 Financial guarantees

Figure 6-3. comparison of Cash Deposit Costs (CDC), Guarantor Single Transactions Costs (GSTC), Guarantor Aggregated Transaction Costs (GATC) and TIR Carnet Annual Costs (TCC).Figure 6-3 summarizes the results from the models developed in chapter 5 of this document. It can be observed that the three models' cost functions. i.e. Cash Deposit Costs (CDC), Guarantor Single Transaction Costs (GSTC) and Guarantor Aggregated Transaction Costs (GATC), increase linearly with the total amount of taxes and duties to be guaranteed. The slopes of the lines tell clearly that among the three options, the most convenient for companies is the cash deposit, followed by the aggregated transaction and finally the single transaction. Though, it has to be noticed that very often companies, especially small sized ones, can hardly have the financial capabilities to afford alone the guarantees. At the same time, large enterprises, being often multinational companies, might have access to more attractive interest rates or investments that could significantly increase the opportunity costs of the cash deposit option. Hence, while CDC seems to be an attractive option, it can still be considered a special case that does not materialize often as a valid option for companies. Likewise, the second option, GATC, is feasible only if the company has been authorized by the local agency and if it can show stable and reliable forecasts of potential transactions along one year. Obviously, potential biases in the forecasts may cause additional costs that are not considered in the present version of model. Hence, it can be argued that the GSTC is probably the most used option for companies. Finally, the TIR carnet annual costs are constant up to a maximum value of 100 000 €[3], and considering a carnet with 14 vouchers. The total cost of this option is about €98 474.

Examining Figure 6-4, where a sensitivity analysis is run on the total amount of taxes and duties from Serbia to Azerbaijan, it is possible to notice three cut-off points in correspondence of 42 000€, 59 500€ and 73 500€ (average container values). This implies that, considering merely the benefits of financial guarantees, the TIR carnet is

[3] starting 1st July 2016 the financial guarantee for TIR carnet has been increased from 60 000€ to 100 000€ for the following countries: Serbia, Azerbaijan, Armenia, Iran, Bosnia and Herzegovina, as well as Kyrgyzstan.

definitely a valuable alternative starting from containers with an average value of 42 000€ and above. The benefits are given by the respective regions in the diagrams between the cost functions GSTC-TCC, GATC-TCC and CDC-TCC. For instance, comparing the GST option, benefits would range between 2 000€ and 140000€ per company. The cut off points with the alternatives GATC and CDC have higher values, respectively 59 500€ and 73 500€, however, as it was discussed above, it has to be kept in mind that these alternatives are considered less feasible or probably used less frequently by companies.

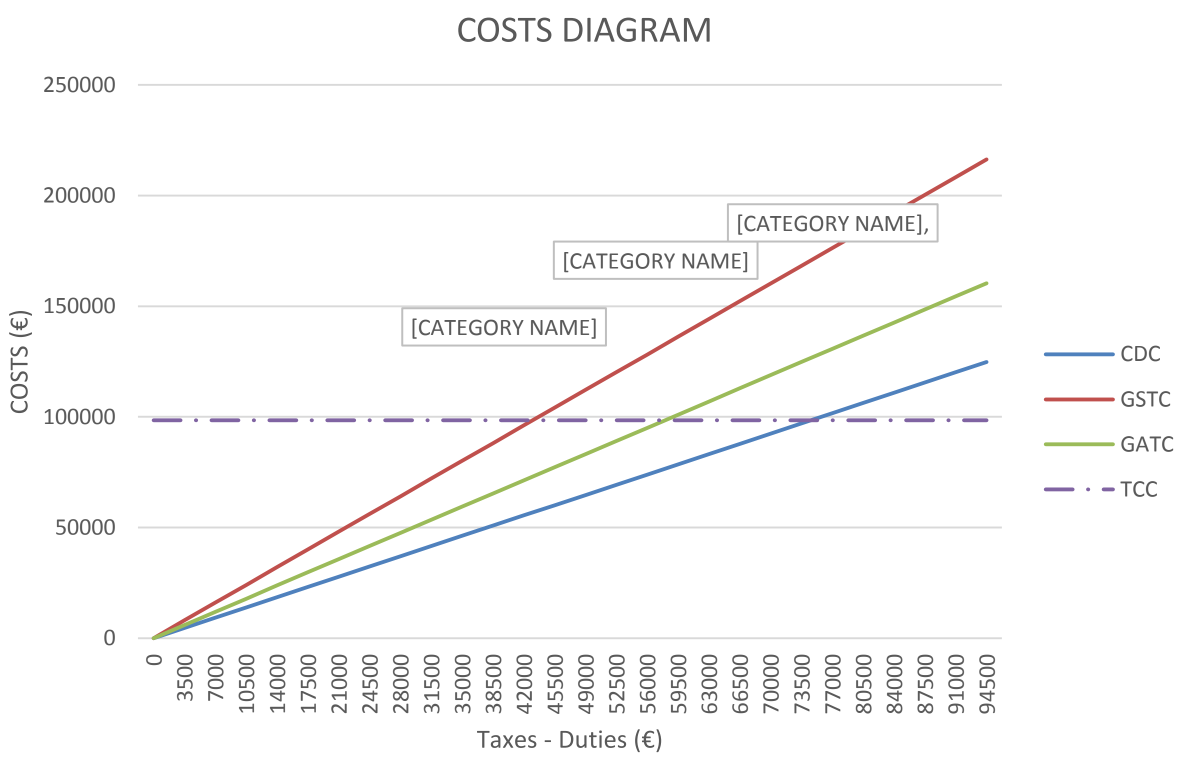

Figure 6-3. comparison of Cash Deposit Costs (CDC), Guarantor Single Transactions Costs (GSTC), Guarantor Aggregated Transaction Costs (GATC) and TIR Carnet Annual Costs (TCC).

Another important fact to consider is that while the TIR carnet offers already significant benefits alone, these benefits should be cumulated with the savings derived from the shorter lead times secured at country borders (as demonstrated in the first part of this section). Hence, by considering a pessimistic scenario where the TIR carnet brings a reduction of waiting time at country borders of about 10%, the computed benefits of 160€ per container can be added to the saved costs for not using other financial guarantee options like the Cash Deposit (CD), the Guarantor Single Transaction (GST) and the Guarantor Aggregated Transaction (GAT). Figure 6-4 expounds clearly that for any amount of taxes and duties to be guaranteed to customs agencies, the benefits of TIR carnets always overwhelms the its costs, no matter which financial guarantee option the company is using a priori. Obviously, the diagram applies to guarantee values of up to 100 000€ which is the value limit offered by TIR carnets. As a result, the combined annual benefits range from about 50 000€ to about 200 000€ per company.

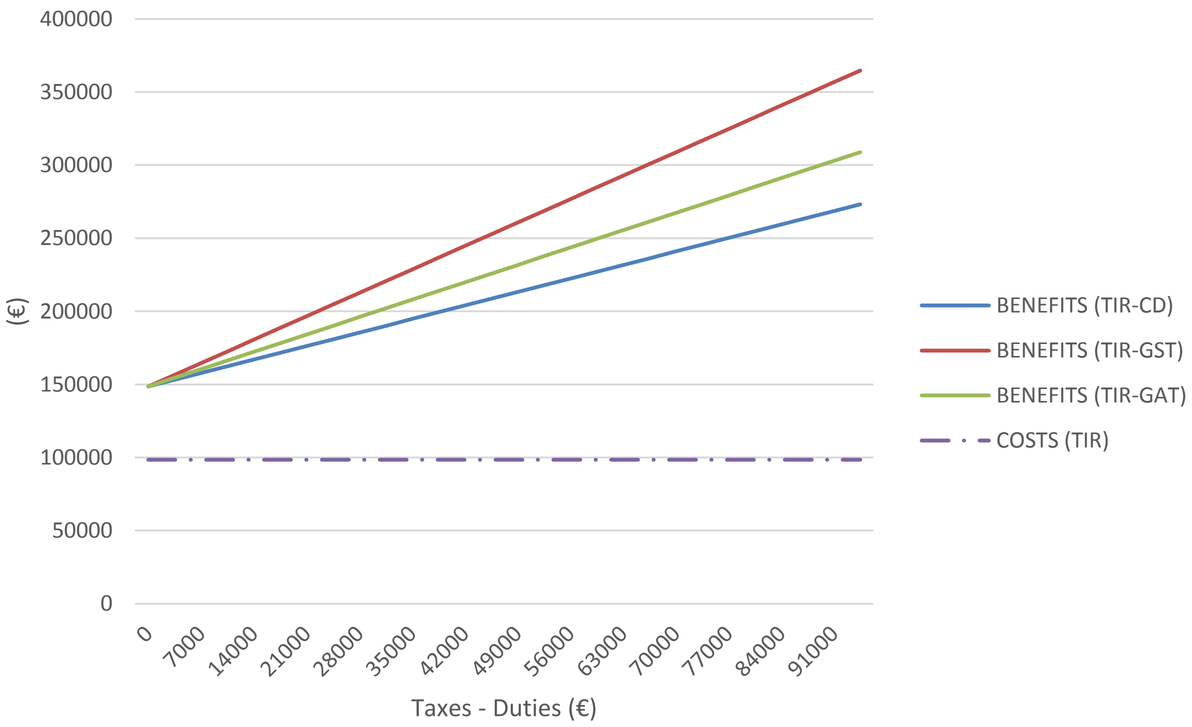

Figure 6-4. Cumulated benefits for companies switching to TIR carnet from options Cash Deposit (CD), or Guarantor Single Transaction (GST) and Guarantor Aggregated Transaction (GAT).

7 Conclusions and Recommendations

7.1 Conclusions

Below, we present a brief summary of the conclusions we derive both from our model/simulation and the research we carried out:

- TIR system leads to a reduction in the actual time required for border crossing activities (e.g., 41 hours less in our case study). Consequently, the total transport time smaller and more predictable with the TIR system, considerably facilitating intermodal transport and making it more attractive
- TIR Carnets also lead to lower *Border Crossing Slack Times* (e.g., 91 hours less in our case study), allowing the transport operator promise an earlier due date to the client (shipper/buyer), and thus improving its competitive advantage
- The reduction in total transport times increases the transportation fleet utilization (e.g., an improvement around 33% in the container utilization in the base case scenario of our simulation model). This will further reduce the costs of the transport operator, which is not included in the model in this report.
- The TIR system is even more beneficial for transport operators striving to offer highly reliable service (on-time delivery). On-time delivery is especially more challenging in intermodal transport, therefore the value of the TIR Carnet is significantly larger for professional transport operators leading the sector
- Transport operators may be able to negotiate better rates with their clients (shippers/buyers) as a result of reduced in-transit inventory holding costs.
- In most cases, time and cost savings are positive and significant in our case study
- The results do not seem to be sensitive to the “likelihood of inspection at Customs with TIR”, and therefore even if there is no positive discrimination for containers with TIR Carnets, the benefits are still significant.
- More attention needs to be paid to factors such as TIR Factor, variability in border crossing times, TCR as the results seem to heavily depend on these parameters.
- In addition to the results we obtained from our model and simulation, we also conclude the following based on this research:
    a. Reduced *Border Crossing Times* will in turn lead a reduction in congestion at intermodal terminals and border crossings. As a result, trade volume is expected to increase within the region.
    b. TIR also offers operational benefits such as improved security, less damage, and reduced risk of fraud. In the case of electronic TIR, not only are the administrative burden less pronounced and the border crossing processes faster as a result of sharing in real time, but also the frequency of informational errors are lower due to single transit document for the transportation

c. TIR system has the potential to facilitate international trade, while protecting the national revenue interests of the signatory nationals and also improve Customs Revenues.

The TIR carnet brings additional benefits, if compared to costs of available options to furnish financial guarantees to customs agencies, i.e. Cash Deposit (CD), Guarantor Single Transaction (GST), and Guarantor Aggregated Transaction (GAT). In this report it was shown that by considering the benefits of the TIR carnet guarantee option alone, companies will reach substantial savings in case they are moving cargo from Serbia to Azerbaijan with an average value over 42 000€ per container (compared to GTS). The range of the benefits in this case will be between approximately 2 000€ and 140 000€ per company. Yet, it has to be noticed that a single TIR carnet will not bring benefits alone, but it will cumulate several monetary benefits, including those derived from shorter waiting times at country borders. Hence, considering a pessimistic scenario where waiting time at country borders account for a 10% reduction, the combined annual benefits will range between 50 000€ and about 200 000€ per company.

The additional sensitivity analysis performed in this study unveil that the benefits of financial guarantees offered in the TIR carnet, are very much dependent on the total amount of duties and other charges as well as the transiting time. This comes because the TIR carnet price is independent from these factors, contrarily to the other options available to companies, i.e. DC, GST and GAT. Hence, it can be argued, in general that 1) the TIR carnet should be the recommended choice in case of highly taxed cargo as well as 2) for long transit times

7.2 Recommendations

Based on the insights obtained in this report, we make the following recommendations to the stakeholders involved:

- There is a lack of quantitative data that shows the real impact of the TIR Carnet on border crossing times. Stakeholders involved such as Customs, transport operators, IRU need to spend significant effort to measure the effect of the TIR Carnet on border crossing times. Cooperation and collaboration among neighboring countries in the BSEC region should be ensured, in terms of creating databases and registering clearance times at border crossings to facilitate the calculation of the system benefits.
- Once such data is made available, transport operators are recommended to quantify the value of the TIR system using the model in this report. The results will help them promise earlier delivery dates and negotiate better transportation rates as a result of reduced in-transit inventory costs for the clients and improved container utilization.
- Building upon the results of this report, policy makers in the BSEC region should come up with estimates on reduced congestion levels and better logistics performance at intermodal terminals/borders to make the region more attractive for intermodal transport. This is especially important as the region lies

between Asia and Europe, and trade flows between these two continents are expected to increase in the near future.

- Further studies must be carried out to quantify the benefits of the TIR system in relation to improved Customs control processing, increased Customs revenues, reduced frequency of informational errors, less damage to goods, improved security. Although these are the often cited qualitative benefits of the TIR system, for the transport operators to adopt this system, it is crucial to have estimates as to what these benefits amount to from an economic perspective.

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APPENDIX

Data used for the case study (Serbia-Azerbaijan):

Country of entry:									
Serbia		**Bulgaria**		**Turkey**		**Georgia**		**Azerbaijan**	
Mu_YB^TIR	**3,5**	Mu_YB^TIR	**3,5**	Mu_YB^TIR	**24**	Mu_YB^TIR	**3,5**	Mu_YB^TIR	**2,293103448**
Mu_YB	**3,5**	Mu_YB	**3,5**	Mu_YB	**24**	Mu_YB	**3,5**	Mu_YB	**2,293103448**
Sigma_YB^TIR	**1,2**	Sigma_YB^TIR	**1,2**	Sigma_YB^TIR	**7**	Sigma_YB^TIR	**1,2**	Sigma_YB^TIR	**0,786206897**
Sigma_YB	**1,2**	Sigma_YB	**1,2**	Sigma_YB	**7**	Sigma_YB	**1,2**	Sigma_YB	**0,786206897**
Alpha_B^TIR	**0,042375**	Alpha_B^TIR	**0,0446802**	Alpha_B^TIR	**0,0532908**	Alpha_B^TIR	**0,034917**	Alpha_B^TIR	**0,022876655**
Alpha_B	**0,0625**	Alpha_B	**0,0659**	Alpha_B	**0,0786**	Alpha_B	**0,0515**	Alpha_B	**0,033741379**

Border Crossing:							
Serbia --> Bulgaria		**Bulgaria-->Turkey**		**Turkey--> Georgia**		**Georgia-->Azerbaijan**	
Mu_XAB^TIR	**12,96**	Mu_XAB^TIR	**12,96**	Mu_XAB^TIR	**12,96**	Mu_XAB^TIR	**8,491034483**
Mu_XAB	**24**	Mu_XAB	**24**	Mu_XAB	**24**	Mu_XAB	**15,72413793**
Sigma_XAB^TIR	**3,78**	Sigma_XAB^TIR	**3,78**	Sigma_XAB^TIR	3,78	Sigma_XAB^TIR	**2,476551724**
Sigma_XAB	**7**	Sigma_XAB	**7**	Sigma_XAB	**7**	Sigma_XAB	**4,586206897**
Mean BCT_AB^TIR	13,1083125	Mean BCT_AB^TIR	13,1163807	Mean BCT_AB^TIR	14,2389792	Mean BCT_AB^TIR	8,613243983
Variance BCT_AB^TIR	14,29098572	Variance BCT_AB^TIR	14,2912747	Variance BCT_AB^TIR	14,42755556	Variance BCT_AB^TIR	6,135064086
Mean BCT_AB	24,21875	Mean BCT_AB	24,23065	Mean BCT_AB	25,8864	Mean BCT_AB	15,90438793
Variance BCT_AB	49,005625	Variance BCT_AB	49,00625365	Variance BCT_AB	49,30272004	Variance BCT_AB	21,03711294
AMSS_AB Mean	**0**	AMSS_AB Mean	**48**	AMSS_AB Mean	**12**	AMSS_AB Mean	**0**
AMSS_AB Std Dev	**0**	AMSS_AB Std Dev	**16**	AMSS_AB Std Dev	**4**	AMSS_AB Std Dev	**0**
BCS_AB^TIR	29,23105834		29,23928955		30,43857927		19,17697823
BCS_AB	54,07469908		54,08679058		55,8327127		35,46583525

Number of Carnets (6 vouchers)	**1**
Service Level	
SL	**0,99999**
Costs	
TCR	**13**
h (hourly holding cost rate)	**2,28311E-05**
CTU	**106,8**
Value of the container (euros)	**62811**
alpha_ratio	**0,678**
mu_X_AB ratio	**0,54**
Georgia-Azerbaijan ratio	**0,655172414**
Total transport time (excluding BCT)	**166**

References

Websites:

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