Visiting Fellow Program

Trade and Transport Connectivity in Central Asia Regional Economic Cooperation Region

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Disclaimer

Under the Visiting Fellow Program, the CAREC Institute issued research grants in 2023 to support scholars and researchers to produce targeted knowledge products that would add to the body of knowledge on regional cooperation in the CAREC region.

Scholars were encouraged to conduct research on CAREC integration topics and carry out comparative analyses between (sub)regions to obtain insights for promoting and deepening regional integration among CAREC member countries particularly, as anticipated in the CAREC 2030 strategy and stated operational priorities.

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Abstract

In today's world of expanding international trade, the significance of the transportation sector remains crucial. This is particularly evident in the Central Asian Regional and Economic Cooperation (CAREC) region, where many member countries are landlocked, relying heavily on road and rail transport. This study examines regional trade to explore the potential for enhanced regional integration through bilateral trade.

Importantly, the study formulates the segmental transport comparative efficiency (STCE) framework, a novel approach to analyze the comparative efficiency of bilateral transport connectivity within the region. The findings indicate significant variation in the comparative efficiency of transport connectivity among different country pairs in the region. Some countries face extended delays at border crossing points (BCPs) or slower speeds owing to inferior infrastructure quality, resulting in longer transit times. For example, Pakistan and Afghanistan display relatively poor connectivity with other regional countries, primarily attributed to longer border clearance procedures. Conversely, China stands out for its more efficient connectivity, largely owing to its infrastructure facilitating higher average travel speeds. These disparities in the comparative efficiency of bilateral transport connectivity among regional countries have implications for the trade of various products. Notably, the competitive efficiency of the trade in fruit and vegetables ranks the lowest. In this way, the STCE framework serves as a valuable tool for pinpointing areas requiring policy support to enhance trade flow within the CAREC region.

Furthermore, the study discusses how transport costs impact specific products within regional trade. In this context, the study examined HS four-digit products within the textile sector. These products were categorized into raw cotton, yarn, and fabrics based on their level of value addition. The calculations highlight a significant disparity in the relative transportation cost as a proportion of commercial value. Specifically, transportation costs are three times higher for yarn and five times higher for raw cotton when compared to fabrics.

Keywords: Regional integration, regional trade, transport efficiency, trade cost, Central Asia Regional Economic Cooperation (CAREC)

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Abbreviations

ADB	Asian Development Bank
BCP	border crossing point
CAREC	Central Asia Regional Economic Cooperation
CEPII	Center for Prospective Studies and International Information
CPMM	Corridor Performance Measurement and Monitoring
e-SPS	electronic sanitary and phytosanitary
IMAR	Inner Mongolia Autonomous Region
STCE	segmental transport comparative efficiency
SWD	speed with delay
SWOD	speed without delay
TCD	time–cost–distance
TFI	trade facilitation indicator
TTFS	Transport and Trade Facilitation Strategy
UNCTAD	United National Conference on Trade and Development
US	United States
XUAR	Xinjiang Uygur Autonomous Region

1. Introduction

Trade facilitation encompasses a wide range of policies with the goal of simplifying, digitizing, and harmonizing customs procedures to minimize transaction costs at international borders. The simplification and harmonization of these procedures have been shown to reduce the time and expenses associated with processing essential trade documents (Grainger, 2011). Meanwhile, digital trade facilitation involves the electronic handling of trade procedures, often remotely, which results in cost reductions (Duval & Mengjing, 2017). Furthermore, enhancements in transport corridors and the adoption of digital technologies in border clearance procedures have the potential to significantly reduce shipping costs and transit times. These improvements play a crucial role in connecting remote areas to economic hubs (Kalyuzhnova & Holzhacker, 2021), underscoring the importance of trade facilitation in strengthening regional integration. In the context of international trade, where tariff reductions have become prevalent as a result of negotiations within the World Trade Organization, trade facilitation has emerged as a top policy priority. It serves as a critical mechanism for ensuring the smooth flow of goods and services across borders, making it a central component in facilitating international trade within the evolving global landscape.

In the Central Asia Regional Economic Cooperation (CAREC) region, several landlocked countries face geographic challenges that impact regional integration and increase the costs of bilateral trade. This is especially pronounced as intraregional trade relies heavily on rail and road transport. Landlocked countries, in particular, bear the burden of elevated trade costs, stemming from transit country fees and additional requirements at border crossings. When one of the trading partners is landlocked, bilateral trade can decrease by 13 percent to 35 percent, and this decline further intensifies when both partners are landlocked (Mazhikeyev et al, 2015). The time and costs incurred at border crossing points (BCPs) significantly hinder bilateral trade within the CAREC region (Kim et al, 2022; Samad et al, 2023). Prolonged border procedures, in particular, pose a considerable obstacle to trade (Oberhofer et al, 2021), disproportionately affecting perishable goods owing to their sensitivity to transaction time (Zaki, 2015). Considering the substantial contribution of the agricultural sector to regional exports, the importance of trade facilitation becomes even more pronounced in this context.

The establishment of the CAREC Transport and Trade Facilitation Strategy (TTFS) in 2007 marked a significant step toward enhancing trade facilitation and transport connectivity across the region. The strategy focused on the development of six priority CAREC corridors through infrastructure investments and trade facilitation measures. In 2008, the Asian Development Bank (ADB) devised the CAREC Corridors Performance Measurement and Monitoring (CPMM) methodology, guiding policies aimed at bolstering transport connectivity.

The CPMM data reveals significant disparities in both outbound and inbound border clearance costs and times at various BCPs. Additionally, cargo movement speed fluctuates across the corridor network owing to differences in infrastructure quality and traffic conditions. These variations result in diverse transportation cost impacts on bilateral trade flows among different country pairs within the region. Furthermore, there is substantial heterogeneity in export compositions across these countries. While China's exports include a significant share of capital goods, Mongolia, Afghanistan, and Azerbaijan rely heavily on raw material exports. In fact, in the CAREC region, excluding China, the proportion of raw materials exceeds 40 percent. Other countries, such as Pakistan and Uzbekistan, have developed labor-intensive industries like textiles. How do these disparities in terms of border clearance time and travel speed collectively influence transport connectivity between regional countries? Subsequently, how does the varying transport connectivity impact the trade of various products within the region? To address these questions, it is essential to analyze transport connectivity comprehensively, identify bottlenecks, and understand their ramifications on regional trade.

Against this backdrop, this study offers two notable contributions. First, it scrutinizes regional trade to assess the economic interdependence among regional economies. Beyond overall trade, the study explores the exports of raw materials and intermediate goods to underscore the necessity for value addition and the potential for intra-industry connections among regional nations. Secondly, the study introduces a novel approach—the segmental transport comparative efficiency framework—to analyze the comparative efficiency of transportation connectivity between regional countries.

The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) employs the time–cost–distance (TCD) approach as a methodology to support the analysis and enhancement of trade and transport connectivity in the Asia–Pacific region. This strategy concentrates on optimizing the movement of goods and people by taking into account three essential elements: time, cost, and distance. Lowering transport costs is vital for affordability in trade and transport. Efficiency and competitiveness in trade are boosted by shorter transit times. Reducing physical distance and enhancing connectivity between key locations—such as ports, logistics hubs, and economic centers—is a key goal of the TCD approach.

The TCD methodology, initially developed by Beresford and Dubey (1990) and further refined by Banomyong (2000), has been disseminated by UNESCAP. UNESCAP collaborates with member countries and stakeholders to implement the TCD approach, aiming to enhance trade and transport connectivity and promote sustainable economic growth in the region. As an example, this approach has been applied in a baseline study on trade and transport facilitation in Bangladesh (UNESCAP, 2017). Expanding upon the TCD approach, the present study formulates a method to assess transportation efficiency against a benchmark based on best practices. This involves comparing border crossing times and travel speeds in various regional countries, taking into account the minimum existing border clearance times and the maximum existing travel speeds. This method provides a standardized way to measure transport connectivity comparatively among regional countries.

The findings reveal considerable differences in transport efficiency between country pairs in the region. Some nations experience extended delays and slower speeds owing to subpar infrastructure, leading to lengthier transit times. Pakistan and Afghanistan, for example, have relatively poor connectivity with other regional countries, primarily owing to extended border clearance procedures. In contrast, China stands out for its efficient connectivity, based on its infrastructure that enables higher travel speeds. These variations in transport efficiency affect the trade of various products, with fruit and vegetables being the least competitive. The STCE framework is instrumental in identifying areas that need policy support to enhance trade within the CAREC region. Moreover, the study examines how transport costs impact specific products in regional trade. It focuses on HS four-digit textile sector products, categorizing them into raw cotton, yarn, and fabrics based on their value addition. The analysis highlights a significant gap in transportation costs relative to commercial value. Specifically, transportation costs are three times higher for yarn and five times higher for raw cotton compared to fabrics.

The remainder of this study is organized as follows. Section 2 provides an overview of regional trade as a context for the subsequent sections. Section 3 analyzes trade facilitation in the CAREC region using CPMM indicators, and evaluates the comparative efficiency of bilateral transport within the region. Section 4 delves into the product-specific effect of transportation. Section 5 concludes the study.

2. An Overview of Regional Trade

In the latter half of the 21st century, trade liberalization rapidly integrated the global economy by reducing barriers and fostering investments, resulting in increased economic interaction among member economies (Ma, 2022). Regional integration refers to a primarily state-led process of building and sustaining institutions and partnerships by neighboring countries aimed at promoting economic, political, and social cooperation (Börzel & Risse, 2016). In today's global economy, trade serves as a crucial tool in promoting economic growth and sustainable development (Xu et al, 2020). The economic interdependence of a region can be gauged using the intraregional trade share—that is, the volume of trade within a region as a percentage of the region's volume of total trade. Given this, this study presents an overview of regional trade as a starting point.

Table 1 provides insights into the exports of the CAREC member countries. In 2022, the combined total exports of all CAREC countries were USD3,519.77 billion, whereas exports within the region amounted to USD103.60 billion. The regional share as a percentage of total exports was 2.94 percent.

Noticeably, China dominates both in terms of total exports and regional exports, contributing significantly to both the regional and the within-region shares. The value of regional exports of China is USD58.5 billion, which is less than 2 percent of China's total exports but constitutes over 56 percent of total exports of the CAREC region. In contrast, Afghanistan has the lowest total exports and a small share within the region. Mongolia and Turkmenistan have high regional shares, as over 80 percent of their exports remain with the CAREC region. This indicates their overwhelming dependence on regional trade. Similarly, countries like the Kyrgyz Republic, Tajikistan, and Uzbekistan have high regional shares compared to their total exports, suggesting their relatively stronger integration within the region. However, out of the 22 billion exports of Azerbaijan, its regional exports remain below USD1 billion. After China, Kazakhstan and Pakistan are the other large exporters of the CAREC region; they have a significant share in trade with the region. Overall, the less than 3 percent share of regional exports reflects limited regional integration. This underlines the need for trade facilitation policies to improve regional integration.

Table 1: Regional trade—country shares

Country	Total exports (billion USD)	Regional exports (billion USD)	Regional share (%)	Share within region (%)
Afghanistan	0.77	0.23	30.38	0.22
Azerbaijan	22.21	0.93	4.19	0.90
China	3,368.22	58.54	1.74	56.50
Georgia	4.24	1.39	32.68	1.34
Kazakhstan	59.82	16.55	27.67	15.98
Kyrgyz Republic	1.66	0.68	40.74	0.65
Mongolia	9.24	7.64	82.69	7.38
Pakistan	28.68	4.11	14.33	3.97
Tajikistan	1.47	0.63	42.58	0.61
Turkmenistan	9.39	7.63	81.27	7.36
Uzbekistan	14.08	5.28	37.47	5.09
Total	3,519.77	103.60	2.94	100.00

Notes: Author calculations based on trade data from Direction of Trade database of the International Monetary Fund for 2022. Regional shares are calculated in percentage terms as 100 × (regional exports/total exports). Shares within the region are calculated in percentage terms as 100 × (regional exports of a country/sum of the regional exports).

Moving beyond the perspective of aggregate trade, the study delves into regional trade based on different product categories: capital goods, consumption goods, intermediate goods, and raw materials.[1] Given the large share of China in regional trade, Table 2 presents trade data for the whole CAREC region, and the CAREC region excluding China. With exports of USD38.9 billion, consumer goods make up the largest category in the regional trade. Second, capital goods constitute a significant portion of the total exports of the CAREC region. Third, only 12 percent of regional exports comprise raw materials.

However, a different narrative emerges when considering the CAREC region without China. In the CAREC region excluding China, the value of capital goods in regional exports diminishes to a mere USB1.6 billion, representing approximately 5.6 percent of total regional exports. Conversely, raw materials constitute over 40 percent of exports in the region without China. It is worth noting that the landlocked countries within the region are disproportionately affected by elevated bilateral trade costs arising from border-clearance and transportation charges. This underscores the potential for considerable benefits by prioritizing the value-added processing of raw materials within the region before they are exported. Importantly, the processing of raw materials enhances their commercial value, resulting in reduced transportation costs as a proportion of the traded commodity's unit value. While China's exports include a substantial share of capital goods, Mongolia, Afghanistan, and Azerbaijan rely heavily on raw material exports. Similarly, Turkmenistan and Pakistan export a significant portion of consumption goods. To escape the low value-added export trap, effective value chain management is vital. Facilitating the movement of raw materials and intermediate goods across the region can play a key role (Ahmed & Masood, 2021).

Table 2: Regional trade—product category shares

Categories	CAREC region		CAREC without China	
	Exports (Billion USD)	Share (%)	Exports (Billion USD)	Share (%)
Capital goods	21.40	21.74	1.59	5.61
Consumer goods	38.91	39.52	5.66	20.03
Intermediate goods	25.90	26.31	9.49	33.61
Raw materials	12.23	12.42	11.51	40.75

Notes: Author calculations based on Comtrade data for 2022.

In addition to raw materials, a significant portion of regional trade comprises intermediate goods, which play a pivotal role in fostering regional integration through intra-industry linkages. Trade in intermediate goods offers possibilities of economic interdependence through collaboration, specialization, and leveraging complementary strengths among the regional economies. Therefore, value-added trade in intermediate goods is the main driver of global value chain participation (Laget et al, 2020), which leads to a more integrated and resilient regional economy.

Going on, the study examines the regional trade at HS-2 level products.[2] Table 3 lists most trade products which collectively constitute around 87 percent of total regional trade. Noticeably, mineral fuels constitute a significant portion of the region's exports, with an export value of USD9.8 billion. Among manufactured goods, electrical equipment, vehicles and parts thereof, footwear, plastics, ceramic products, and fertilizers signify industrial capabilities of the regional economies.

[1] These categories are based on the Stage of Processing classification of the United National Conference on Trade and Development (UNCTAD).

[2] For more information on the Harmonized System (HS) of product classification, see https://wits.worldbank.org/referencedata.html

Furthermore, manufacturing goods include several products of the textile and apparel industry. Similarly, iron and steel, copper, and aluminium are among the most traded metals. Finally, agricultural trade in the region includes cereals, cotton, vegetables, and fruit.

Table 3: Most traded products in the CAREC region

Products	Value (billion USD)	Products	Value (billion USD)
Mineral fuels	9.80	Rubber and articles thereof	1.31
Nuclear reactors and boilers	9.55	Toys, games, and sports requisites	1.27
Electrical machinery and equipment	9.44	Inorganic chemicals	1.25
Apparel and clothing (not knitted)	7.66	Man-made staple fibers	1.11
Vehicles and parts thereof	4.94	Optical and photographic apparatus	1.08
Iron and steel	4.10	Aluminum and articles thereof	0.96
Ores, slag, and ash	4.10	Products of the milling industry	0.87
Apparel and clothing (knitted)	4.09	Articles of leather	0.84
Footwear	3.56	Textiles: made up articles	0.82
Plastics and articles thereof	3.29	Metals: miscellaneous products	0.81
Copper and articles thereof	3.22	Ceramic products	0.76
Man-made filaments of textiles	2.94	Cotton	0.74
Iron or steel articles	2.27	Fertilizers	0.72
Cereals	1.79	Glass and glassware	0.60
Organic chemicals	1.57	Vegetables	0.56
Fabrics: knitted or crocheted	1.45	Tools and cutlery	0.50
Furniture	1.41	Fruit and nuts	0.48

Note: Based on data from the Comtrade database, export values are measured in billion USD for the regional exports at HS two-digit products. The listed products collectively constitute around 87 percent of total regional exports in 2022.

3. Regional Transport Connectivity

As trade in goods relies entirely on the transportation sector, the significance of transport efficiency has increased alongside the increasing volume of trade in today's world (Brancaccio et al, 2020). Efficient trade facilitation, crucial for integration and competitiveness, leads to reduced costs and improved cross-border trading efficiency (Portugal-Perez & Wilson, 2012). This impact is amplified by streamlined logistics, facilitating market access for producers both domestically and internationally (Azhgaliyeva et al, 2021). Moreover, infrastructure upgrades exert the most substantial influence on trade volume, followed by improvements in logistics and customs processes (Felipe & Kumar, 2012); thus, the benefits of enhanced trade facilitation are particularly pronounced in boosting trade, especially within the region. Notably, the quality and quantity of infrastructure play a pivotal role in trade dynamics (Karymshakov & Sulaimanova, 2021). Hence, prioritizing improved trade facilitation efficiency becomes a pivotal policy goal for the CAREC countries, as it contributes significantly to trade stimulation and economic growth.

Concerning the trade effect of transportation cost in the CAREC region, Kim et al. (2022) show that reducing time by 10 percent at the inbound border increases trade among the CAREC countries by 1 percent to 2 percent. They further showed that the trade impact of the reduction in time and costs at the inbound border was higher than that at the outbound border. A subsequent study by Samad et al. (2023) reinforced the same findings. Given the importance of the transportation system in regional trade flows, this study compares the country-wise performance related to trade facilitation, subsequently offering an analysis of the comparative efficiency of bilateral transportation connectivity in the CAREC region.

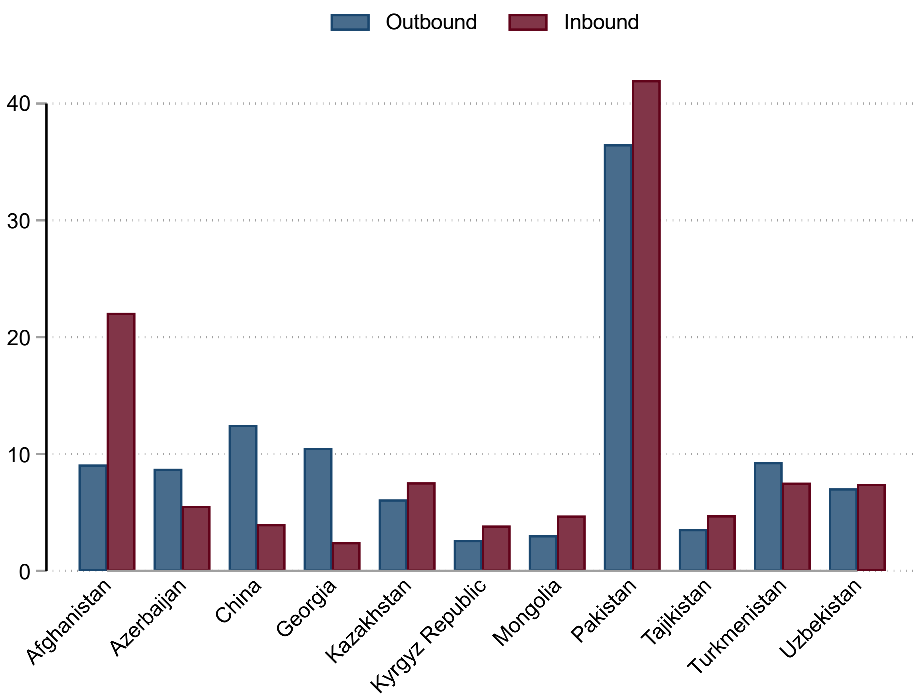
3.1 The CPMM Indicators: A Graphical Overview

In 2007, CAREC member countries created the CAREC Transport and Trade Facilitation Strategy (TTFS) to enhance economic growth through improved trade and transport. This strategy focused on six priority corridors, involving infrastructure investments and trade facilitation (see Appendix 1 for more detail on the corridors). In 2008, ADB introduced the Corridors Performance Measurement and Monitoring (CPMM) methodology to provide evidence-based evaluation of the corridor performance, identifying delays and costs, and addressing issues concerning regional cooperation.

Under the CPMM program, data related to different trade facilitation indicators (TFIs) is maintained from 2010 to 2022 (see Appendix A2 for details on the TFIs). While data is available for both rail and road transport, the current study focuses on road transport as it is the most important mode of transport in the region. There are two major aspects of the looking at trade facilitation across the corridors network of the CAREC region. First, the time spent and cost incurred at the BCPs. Second, travel speed and related cost to traveling along the corridors. In the following, this study compares the CAREC member countries for their performance related to trade facilitation.

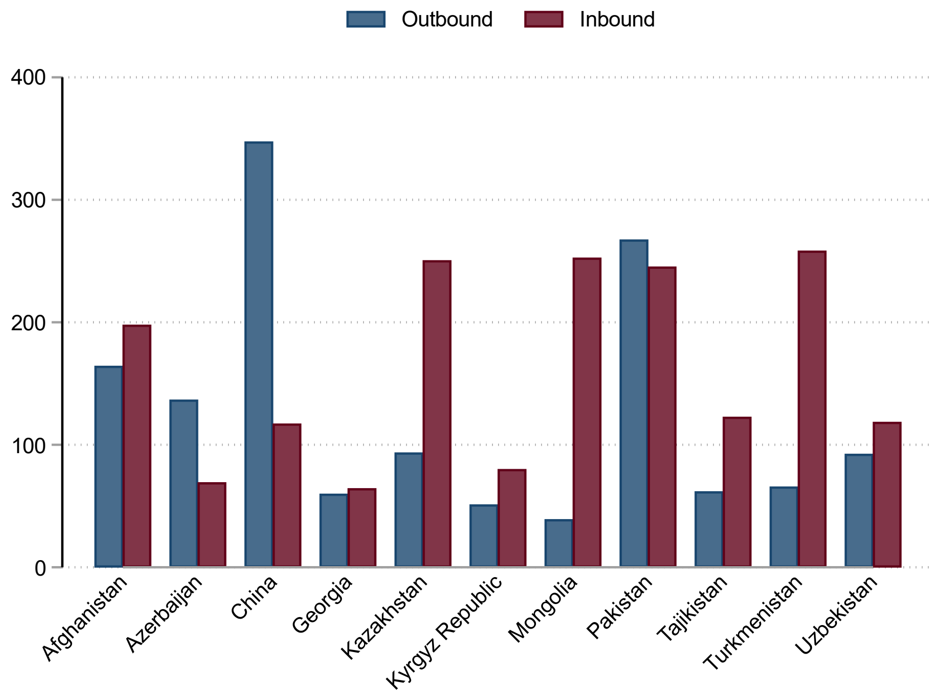
The average time and cost required for border-clearance procedures are depicted in Figure 1 and Figure 2, respectively. The CPMM database offers annual data for different indicators from 2010 to 2022. However, for an overall comparison among the regional countries, the mean value of time (and cost) for each country is taken over the period 2010 to 2022.

Figure 1: Average time for border clearance (hours)



The cost and time related to outbound border clearance can be different to that of inbound crossing. Customs controls, loading and unloading, road and bridge tolls, as well as escort and convoy costs are identified as major sources of fees and payments (Asian Development Bank, 2021). For Georgia and China, the outbound time is relatively more than the inbound time for border clearance. Similarly, outbound time is slightly more than inbound time for Azerbaijan and Turkmenistan. For the rest of the CAREC members, inbound time is more than outbound time. Regarding border clearance time, Pakistan and Afghanistan are performing the worst in the region. As trade from Pakistan is connected to central Asia via Afghanistan, Pakistan faced severe difficulty in trade connectivity. Concerning cost, outbound border clearance cost is particularly high for China and Pakistan. Similarly, Afghanistan and Azerbaijan also require slightly higher outbound cost at the BCPs. On the other hand, Kazakhstan, Mongolia, Pakistan, and Turkmenistan show high costs in inbound border procedures.

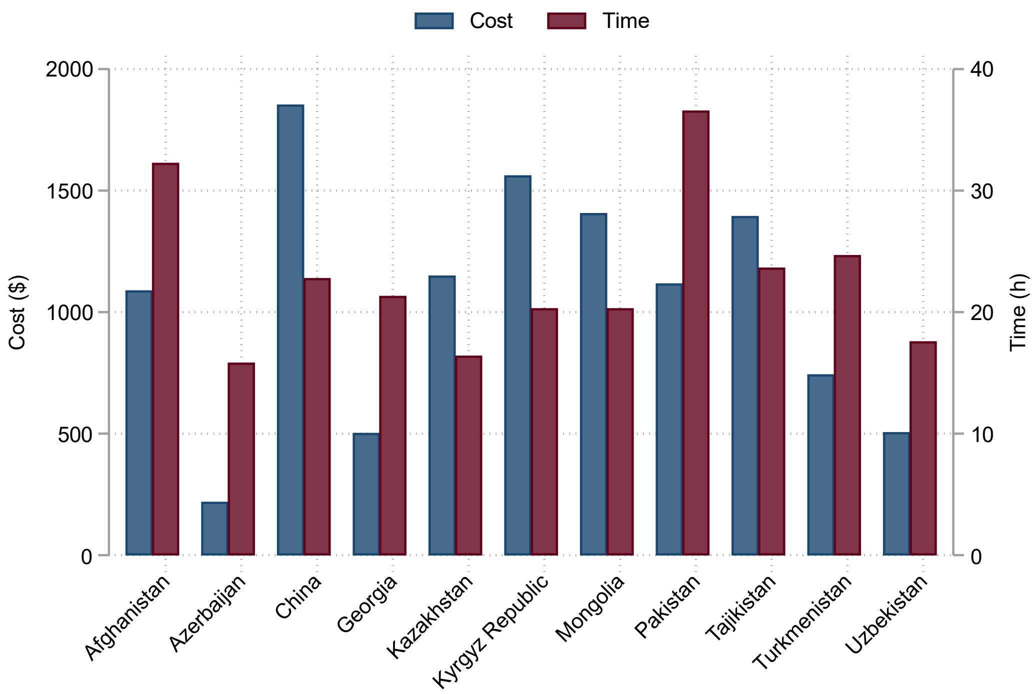
Figure 2: Average cost for border clearance (USD)



In addition to BCPs, the cost and time required to travel along transport corridors differs among the regional countries. This depends on infrastructure quality, traffic intensity, and fuel prices (which are in turn affected by currency exchange rates) of the corresponding countries. Regarding this, the indicator TFI3 measures the average cost incurred on a cargo of 20 tons while traveling 500 kilometers along a corridor. In addition to the cost of traveling along the corridor, Figure 3 also shows the average time and cost of moving 20 tons of cargo over 500 kilometers along a corridor.[3] The chart shows a great variation among the CAREC members in relation to the time and cost of traveling along corridors.

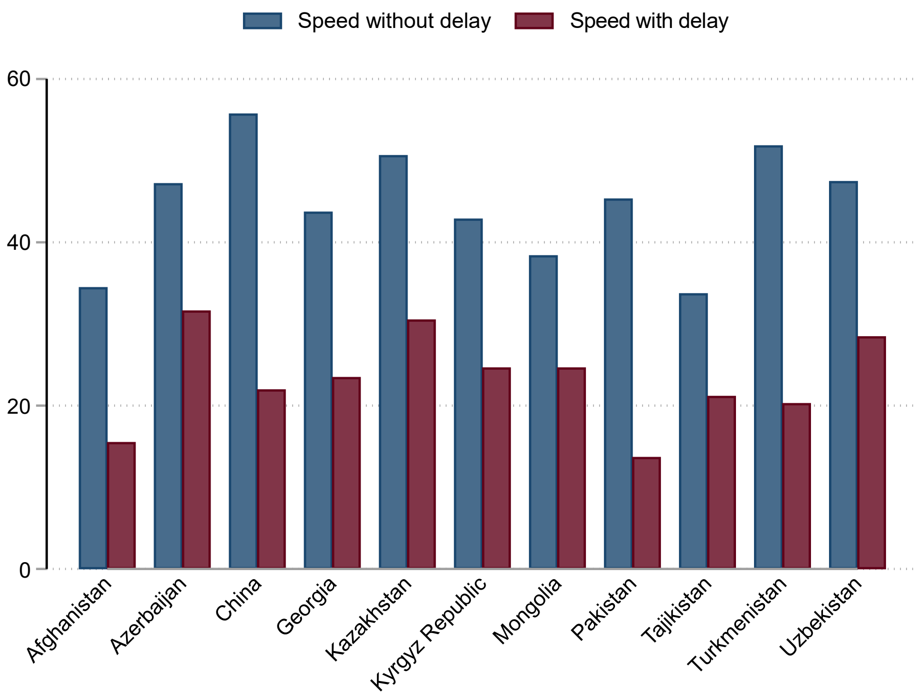
[3] The time is induced from the speed indictor in the CPMM database.

Figure 3: Average cost and time of traveling along corridor



Regarding speed, the CPMM offers two indicators. Speed with delay (SWD) is the ratio of distance traveled to the total time spent on the journey, including the time the vehicle was in motion and the time it was stationary. In contrast, speed without delay (SWOD) is calculated based on the net traveling time excluding delays. As shown by Figure 4, China, Kazakhstan, and Turkmenistan have the highest SWOD value.

Figure 4: Average speed of traveling along corridor (km/h)



Next, we analyze the changes in the TFIs for each country using the compound annual growth rate (CAGR). CAGR is a useful me

tric that allows us to calculate and compare annual growth rates, taking into account the compounding effect. This means it considers fluctuations in growth over time and provides a more accurate representation. The formula provided below measures CAGR as a percentage where TFI_f is the final value of a TFI, TFI_i denote its initial value, and t is the number of time intervals.

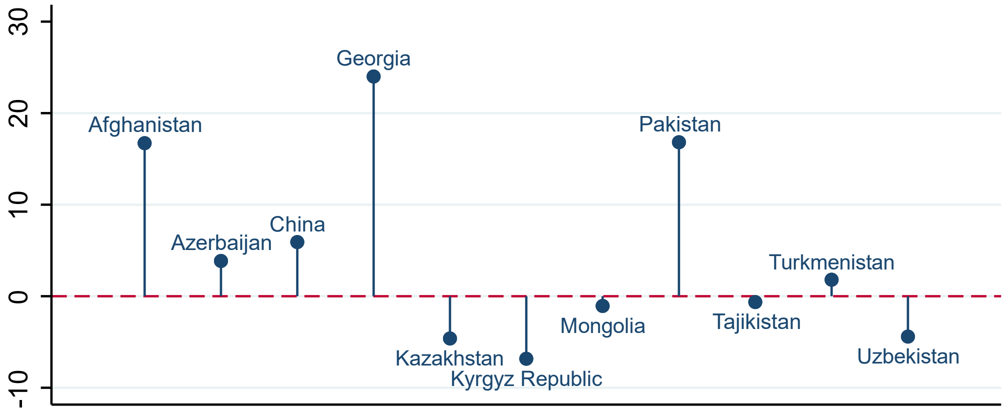
$$\mathrm{CAGR} = \left[\left(\frac{\mathrm{TFI_f}}{\mathrm{TFI_i}}\right)^{1/t} - 1\right] \times 100$$

Figure 5 displays the CAGR for the time required for inbound and outbound border clearance for CAREC members during the period 2011 to 2022.[4] While Georgia shows a substantial increase in border clearance time, Afghanistan and Pakistan also exhibit concerning increases in clearance time. These findings underscore the significant challenges in trade facilitation within the region and emphasize the importance of addressing these issues to reduce border clearance times and promote efficient trade flows.

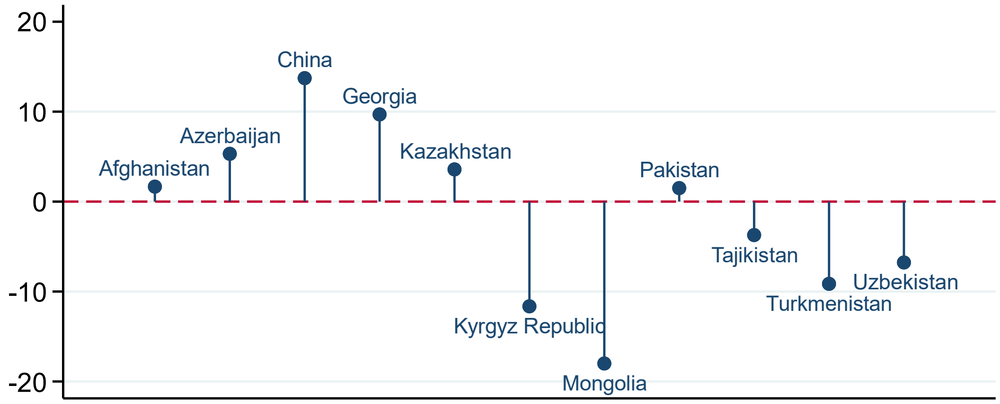
[4] The CAGR is calculated for the period 2011 to 2022, with 2011 serving as the initial time period owing to some missing values in 2010.

Figure 5: Compound annual growth rate (percent) for border clearance time and cost

(a) Border clearance time CAGR 2011-2022



(b) Border clearance cost CAGR 2011-2022

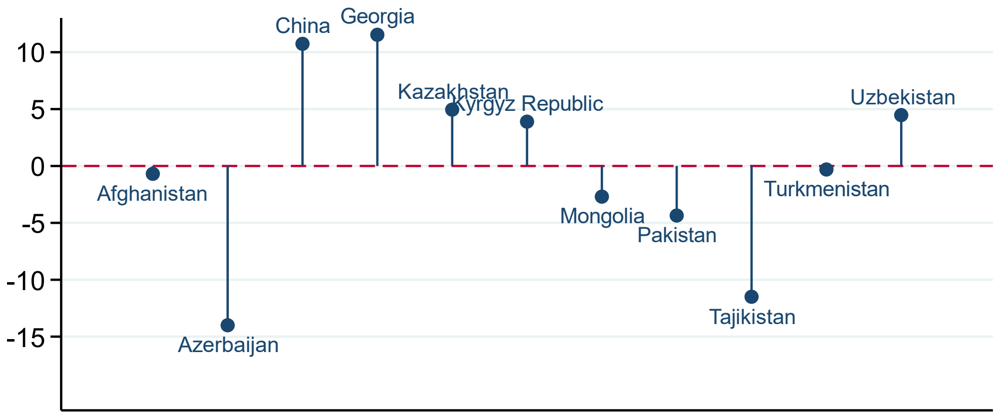


Similarly, Figure 5 illustrates changes in border clearance costs. China stands out with the highest CAGR value, indicating a substantial increase in border clearance costs, while Mongolia experienced the most significant decline, which is a desirable outcome. The Kyrgyz Republic and Turkmenistan also demonstrate significant negative CAGRs, highlighting the positive impact of reducing border clearance expenses. However, it is essential to consider the potential influence of the COVID-19 pandemic since 2020, which may have contributed to cost fluctuations.

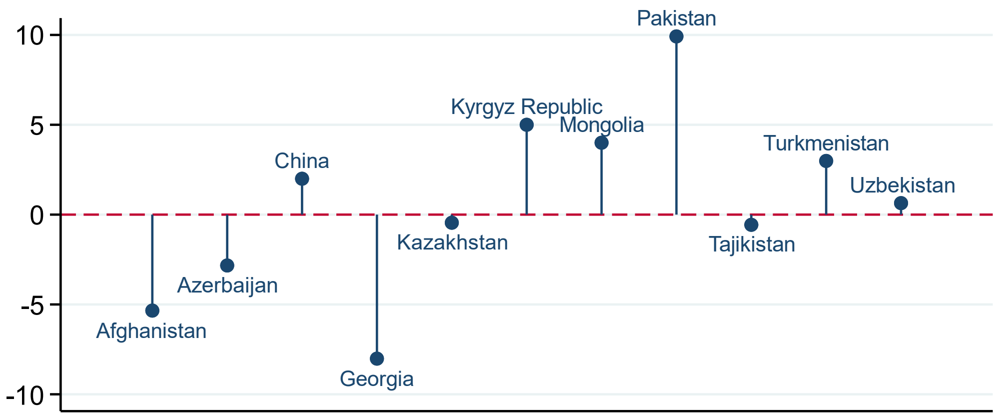
Figure 6 presents the CAGR values related to the cost and speed of traveling along a corridor in the region. Azerbaijan leads with a remarkable negative CAGR value, signifying a substantial reduction in costs, closely followed by Tajikistan. Pakistan and Mongolia also exhibit favorable trends with CAGRs of -4.35 and -2.69, respectively, indicating reduced travel expenses. Regarding travel speed, Pakistan excels with a notable positive CAGR of 9.92, reflecting a significant improvement in speed. Mongolia and the Kyrgyz Republic also show positive trends, both with CAGRs of 4.52, signifying increased travel speeds. China and Turkmenistan make moderate improvements with positive CAGRs of 1.99 and 2.99, respectively.

Figure 6: Compound annual growth rate (percent) for travel cost and speed

(a) Travel cost CAGR 2011-2022



(b) Travel speed CAGR 2011-2022



3.2 Comparative Efficiency of Bilateral Transport Connectivity

Bilateral transportation time and cost depends on three major factors: (a) the geographic distance between two countries; (b) the quality of transport infrastructure and traffic intensity conditions which determine speed of traveling; and (c) the time and cost required for border clearance procedures at the country of origin, destination, as well as any transit country involved. Analyzing a system of transport consisting of multiple segments necessitates a method to account for all these differences along routes between country pairs. To address this, the present study uses a novel approach, the segmental transport comparative efficiency (STCE) framework, which stems from the time–cost–distance (TCD) method of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP).[5] The STCE framework can be used to evaluate the comparative efficiency of bilateral transport efficiency in time and cost. While cost is more susceptible to exogenous factors such as fuel prices and exchange rates, the present study opts time as the parameter for measuring comparative efficiency. Essentially, the STCE approach compares the actual time spent to the

[5] The cost/time methodology has been elaborated in Beresford and Dubey (1990), further refined by Banomyong (2000) and later disseminated by UNESCAP.

benchmark values for all segments of transportation between a country pair. A stepwise explanation of the STCE framework is outlined below.

The total time T_{ij} required to travel from country of origin i to destination country j has two components: time required for border clearance B_{ij}, and time spent while traveling along the route R_{ij}, as shown by Equation (1).

$$T_{ij}=B_{ij}+R_{ij} \tag{1}$$

Equation (2) breaks down the two components of total time. The terms within the first set of parentheses represent the time required at all BCPs encountered along the route. Specifically, it encompasses the sum of the outbound time at the BCP of origin i, the inbound and outbound time spent at the BCPs in any transit countries r, and the inbound time at the BCP of destination j. This summation ranges from zero to N transit countries. For instance, consider trade from Turkmenistan passing through Uzbekistan to reach Kazakhstan. Similarly, Afghanistan and Uzbekistan serve as transit countries for trade between Pakistan and Kazakhstan. Notably, the lower limit of r is set to zero, signifying that there are no transit countries in cases where the countries are adjacent to each other.

The second pair of parentheses capture the travel time along different sections of the route. This component of time depends on the portion of total bilateral distance travelled in the origin, transit, and destination countries, as well as the traveling speed in each of these countries. Travel time within each segment is calculated by dividing the respective part of the bilateral distance by the speed indicator—SWOD, which measures the speed without delay.

$$\begin{aligned} T_{ij} = &\left(\mathrm{BCPout}_i + \sum\nolimits_{r=0}^{N} \mathrm{BCPin}_r + \sum\nolimits_{r=0}^{N} \mathrm{BCPout}_r + \mathrm{BCPin}_j\right) \\ &+ \left(\frac{d_i}{\mathrm{SWOD}_i} + \sum\nolimits_{r=0}^{N} \frac{d_r}{\mathrm{SWOD}_r} + \frac{d_j}{\mathrm{SWOD}_j}\right) \end{aligned} \tag{2}$$

The parts of total bilateral distance travelled in the origin d_i, transit d_r, and destination d_j are calculated as the weighted sum of total bilateral distance D_{ij}. In this way, the distance components d_i, d_{r1}, … d_{rn}, and d_j sums to total distance D_{ij}. The weights are calculated as the ratio of the internal distance of the country D_i to the sum of the internal distances of all countries involved—namely, origin, transit, and destination countries, as shown in Equation (3). Note that half of the internal distance for transit countries is taken to reduce the relative weights for them. The reasoning is that the cargo is likely to pass through the transit country taking possibly the minimum distance.

$$d_i = \left(\frac{D_i}{D_i + \sum_{r=0}^{N} 0.5D_r + D_j}\right) D_{ij} \tag{3}$$

Concerning the benchmark time T_{ij}^{b}, it shows total time required for border clearance and traveling along the route using the benchmark values, as shown by Equation (4). Three benchmark values are taken: benchmark for outbound border clearance time BCPout^{b}; benchmark for inbound border clearance time BCPin^{b}; and a benchmark for traveling speed SWOD.^{b} Instead of an ad hoc value for the benchmark, the study opts the existing minimum value of outbound and inbound border clearance time BCPs in the corridor network. Similarly, the maximum value among the existing speeds along corridors is opted as the benchmark speed.

$$T_{ij}^{b} = B_{ij}^{b} + R_{ij}^{b} \tag{4}$$

Equation (5) expands the two components of total benchmark time. Regarding the border clearance time, it is the sum of the benchmark time for inbound and outbound time for all BCPs involved. As there is no transit country in the case of adjacent origin and destination countries, the value of r is zero. In this way, it is only one outbound and one inbound benchmark time. The second term captures the traveling time calculated as total bilateral distance D_{ij} divided by benchmark speed.

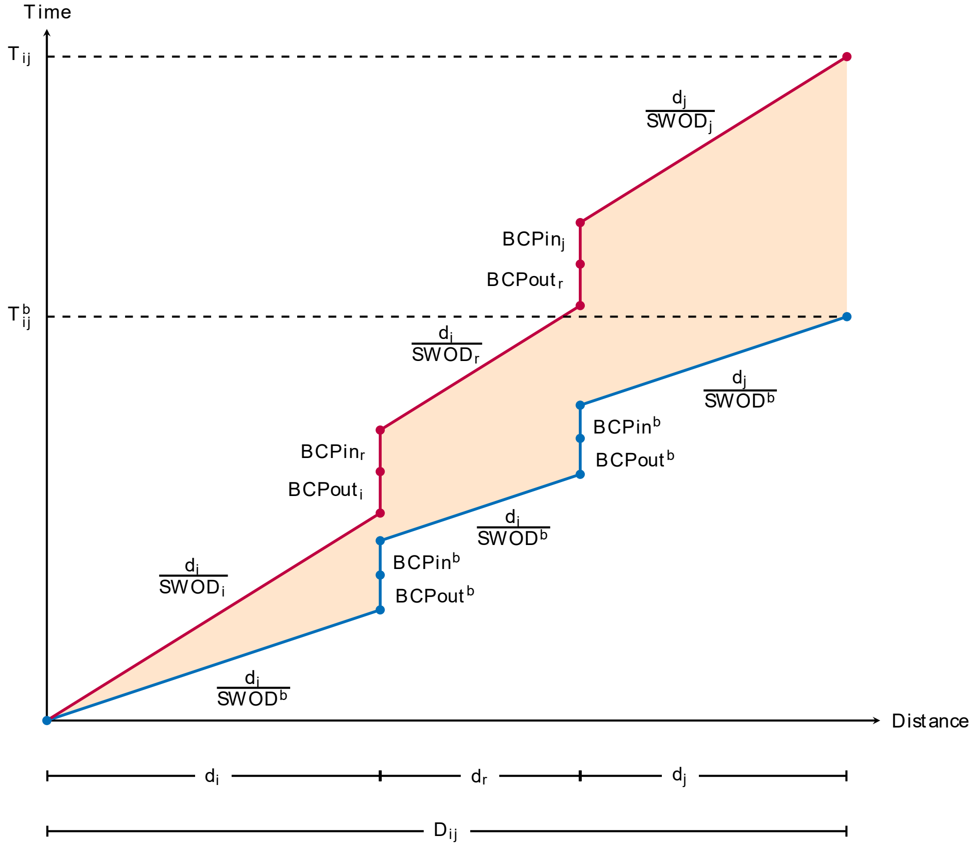
$$T_{ij}^{b} = \left([n+1]\,BCPout^{b} + [n+1]\,BCPin^{b}\right) + \left(\frac{D_{ij}}{SWOD^{b}}\right) \tag{5}$$

Finally, the efficiency E_{ij} is the ratio of benchmark time to actual time. In percentage term, efficiency ranges from 0 to 100, as given by Equation (6).

$$E_{ij} = \left(\frac{T_{ij}^{b}}{T_{ij}}\right) \times 100 \tag{6}$$

In Figure 7, the STCE approach is illustrated assuming one transit country r between the origin I and destination j. Bilateral distance D_{ij} is taken on the horizontal axis where d_i, d_r, and d_j denote the parts of distance travelled in the origin, transit, and destination countries, respectively. Traveling time is shown on the vertical axis. The two curves in the diagram show the traveling of cargo: the upper curve shows the relationship between actual distance and time; whereas the lower curve shows the relationship between distance and benchmark time for the various segments of the transportation. At any distance, the difference between the two curves show time spent in excess of the benchmark level, thus capturing the efficiency loss of the bilateral transport connectivity.

Figure 7: Schematic diagram of segmental transport comparative efficiency framework



Given that the CAREC member countries differ in terms of time required at outbound BCPs, inbound BCPs, as well as in terms of infrastructure quality and traffic congestion conditions that affect traveling speed, the comparative efficiency of bilateral connectivity is calculated based on the STCE framework.

Based on Equation (6), the comparative efficiency of transport connectivity between country pairs is shown in Table 4. The findings offer insights into the interconnections of countries in the region regarding trade efficiency. Efficiency scores vary significantly among different country pairs. Some pairs exhibit notably high efficiency with minimal delays, efficient border clearance, and robust infrastructure, promoting favorable conditions for trade and transportation. In contrast, certain country pairs encounter challenges that impede cargo movement, possibly owing to lengthy border clearance or insufficient infrastructure. Specifically, the trade route from Kazakhstan to Turkmenistan exemplifies high comparative efficiency in transport connectivity, whereas the route from Pakistan to Tajikistan represents a poorly connected scenario. Meanwhile, the trade routes from Uzbekistan to Georgia and from the Kyrgyz Republic to Mongolia serve as examples of moderately connected country pairs. Pakistan and Afghanistan, in general, have relatively poor connectivity with other regional countries, primarily owing to extended border clearance procedures. In contrast, China stands out for its efficient connectivity, based on its infrastructure that enables higher travel speeds.

Table 4: Comparative efficiency of transport connectivity

	Afghanistan	Azerbaijan	China	Georgia	Kazakhstan	Kyrgyz Republic	Mongolia	Pakistan	Tajikistan	Turkmenistan	Uzbekistan
Afghanistan	62	60	79	59	59	58	61	28	49	57	53
Azerbaijan	49	85	81	63	73	60	64	38	55	63	59
China	67	78	100	76	81	84	70	82	82	76	79
Georgia	48	51	76	78	65	57	62	40	54	57	56
Kazakhstan	50	80	90	74	91	75	69	39	63	75	69
Kyrgyz Republic	47	63	94	62	74	77	67	35	69	65	68
Mongolia	56	66	87	65	69	67	69	52	65	66	66
Pakistan	25	40	89	43	40	36	54	81	30	35	33
Tajikistan	35	58	91	59	62	69	65	29	61	58	59
Turkmenistan	41	65	80	64	70	62	64	33	54	93	60
Uzbekistan	39	63	86	62	67	65	65	31	56	64	85

Note: The table displays origins along the rows and destinations along the columns. The efficiency scores are standardized on a scale of 0 to 100, corresponding to theoretical minimum to maximum values, respectively. Instances of comparative efficiency falling below 50 are shown in red shading, while the green shading shows values of comparative efficiency at 80 or above.

The STCE approach is straightforward and systematic in two key aspects. First, it does not require parameter estimation through econometric methods. Instead, it compares the existing parameters of border clearance time and travel speed with corresponding benchmark values. Second, it focuses on comparative efficiency rather than absolute efficiency, which can be conceptually and empirically challenging. Comparative efficiency directly informs about the connectivity of country pairs, emphasizing those less connected than others. Additional details regarding the STCE approach can be found in Appendix A3.

There are three interesting points to consider from the viewpoint of method. First, the comparative efficiency values for intra-country transport are also shown along the diagonal of the table. As transport within a country does not involve any BCPs, the efficiency therefore shows the ratio of actual traveling speed in the country to the benchmark speed. China has the highest value of SWOD, which also represents the benchmark value for speed by definition; therefore, the comparative efficiency value is 100 percent for transport within China.

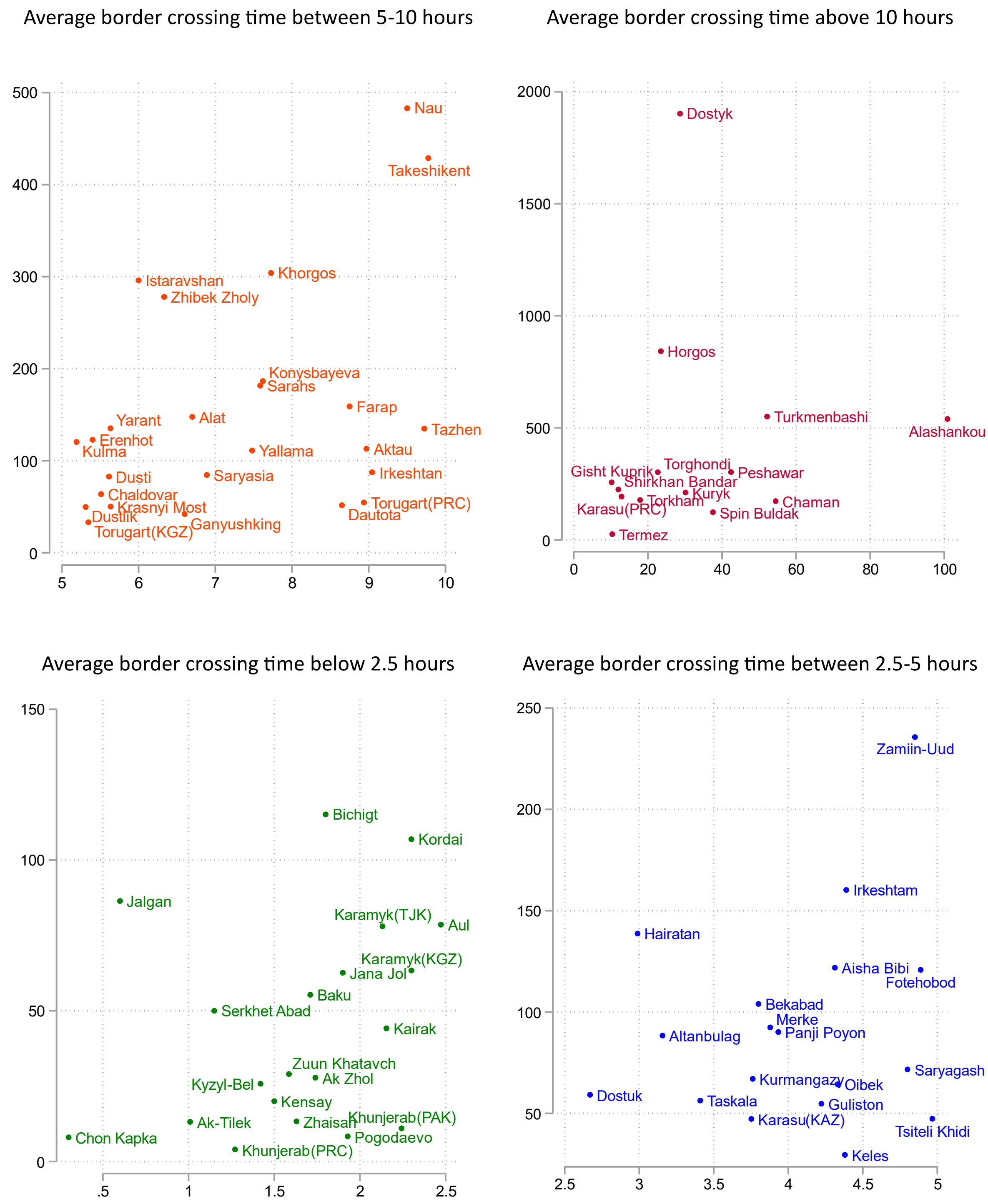
Second, the STCE framework applies the measure of distance weighted by the population data of the main agglomerations of the countries.[6] In this way, it captures bilateral distance more comprehensively, instead of simply considering the distance between the outbound BCP of origin and the inbound BCP of destination.

Third, as there are 11 member countries, there are a total of 11 × 10 = 110 country pairs. The comparative efficiency value is directionally asymmetric. That is, the comparative efficiency of transport connectivity from Kazakhstan to Uzbekistan is 69, whereas the value for moving from Uzbekistan to Kazakhstan is 67. This difference stems from the difference in the time required for outbound and inbound border clearance at their respective BCPs.

To identify the BCPs with higher time and cost, Figure 8 portrays scatter charts of the BCPs across the CAREC corridor network. Some BCPs exhibit significant inefficiencies in terms of both the time and cost required for border clearance. Among these, BCPs with an average border clearance time exceeding 10 hours include Alashankou, Chaman, Dostyk, Gisht Kuprik, Horgos, Karasu (PRC), Kuryk, Peshawar, Shirkhan Bandar, Spin Buldak, Termez, Torghondi, Torkham, and Turkmenbashi. Among other BCPs—namely, Istaravshan, Khorgos, Nau, Takeshikent, Zamiin-Uud, and Zhibek Zholy—although their average border clearance time is less than 10 hours, the cost of border clearance exceeds USD200.

[6] The distance data is taken from the CEPII database. See Mayer and Zignago (2011) for detail on the methodology of population weighted distances.

Figure 8: Comparing the time and cost of border crossing points



Note: The chart is based on data from the CPMM database of ADB. For time and cost, the average is taken for the respective values for inbound and outbound border clearance. Border clearance time on the horizontal axis and border clearance cost on the vertical axis.

Trade facilitation is crucial for reducing barriers as the digitizing processes cuts costs, boosts transparency, and curbs unofficial payments. A recent report on the United Nations' biennial Global Survey on Digital and Sustainable Trade Facilitation (United Nations, 2022) reveals a 67 percent average implementation rate of trade facilitation measures in the CAREC region. China leads in the region with its trade facilitation implementation rate of 91 percent, followed by Azerbaijan (86 percent) and Georgia (83 percent). Conversely, Tajikistan (51 percent) and Afghanistan (42 percent) lag. Specific measures needing attention include advance tariff rulings, border control delegation, electronic refunds, and SPS certificate digitization. Ensuring timely notifications about tariff policy changes is crucial for firms to adjust business strategies.

Based on the World Bank's World Development Indicators database for 2021, among the CAREC members, Afghanistan had the highest reliance on agriculture, forestry, and fishing sectors, contributing 33.48 percent to its GDP, followed by Uzbekistan at 24.62 percent. Other countries like Pakistan (22.67 percent), Tajikistan (22.45 percent), and the Kyrgyz Republic (13.78 percent) also displayed notable economic dependence on these activities. Given the significance of the agriculture sector in several CAREC economies, electronically issuing and exchanging SPS certificates among trading partners is notably important. Similarly, incorporating trade facilitation measures to handle emergencies like the COVID-19 impact is essential. Furthermore, adopting a single window system for finance access and tailored support for small and medium-sized enterprises is crucial for effective trade facilitation.

3.3 Product Specific Effect of Transportation

As shown by the comparative efficiency analysis based on the STCE framework above, the ease of connectivity between the CAREC members differs. This has implications for trade flows of various products across the region. Suppose a larger share of the regional trade of a product is shipped between a country pair for which transport connectivity is relatively poor; the trade of that product will be facing more impedance. More systematically, this can be shown as follows:

$$\mathrm{E}_{\mathrm{k,REG}} = \sum_{ij} \sigma_{k,ij} \times E_{ij} \tag{7}$$

Where $E_{k,REG}$ is the comparative efficiency of the regional trade of product k; $\sigma_{k,ij}$ is the share of product k traded between county pair ij; and E_{ij} is the comparative efficiency of transport connectivity between the country pair. In other word, it is the sum of the comparative efficiency of country pairs weighted by the share of trade shipped between them. This allows country pairs to have an impact on the cumulative efficiency measure proportional to their trade shares. That is, country pairs with larger trade shares have a proportionally larger contribution to the cumulative efficiency, and vice versa. However, one caveat in calculating product-specific comparative efficiency is because of the differing units of measurement. While the CPMM data is based on average container size in tons, trade data is available in value (USD) as well as in quantity. However, traded quantity of all products is not measured in kilograms (or tons). Therefore, a selection of goods is considered for which trade quantity is applicable in kilograms.[7] Table 5 shows the comparative efficiency for various products. The efficiency for the fruit and vegetable trade is lowest among the products presented in the table. This implies that countries that trade a lot of fruit and vegetables with each other tend to have lower comparative efficiency scores. These delays are particularly detrimental to the quality of perishable goods.

[7] Other units include KW/H for electrical energy, items for vehicles and live animals such as horses, liters for goods such as ethyl alcohol and beverages, and carats for the dust and powder of natural or synthetic precious stones.

Table 5: Product-specific time efficiency of transport

Code	Product description	Efficiency
8	Edible fruit and nuts	50.7
7	Edible vegetables	56.6
17	Sugars and sugar confectionery	65.2
10	Cereals	67.2
31	Fertilizers	74.9
70	Glass and glassware	76.3
72	Iron and steel	76.8
73	Articles of iron or steel	77.3
74	Copper and articles thereof	88.9

Note: Trade quantities are aggregated from HS four-digit products and are based on trade data of the CAREC countries for 2022 taken from the Comtrade database.

As shown in Table 2, raw materials constitute a large portion of regional trade. Specifically, while looking at the CAREC region without China, the share of raw materials is over 40 percent. Other countries—including Pakistan and Uzbekistan—have developed some labor-intensive industries, such as textiles. As transport connectivity in landlocked countries is difficult in general, the impact of transport cost is more severe in the case of raw materials. Highlighting the relationship between trade cost and the commercial value of trade goods requires a look along the value chain of products. For expositional purposes, the study presents an example of the textile sector. Textiles is a diverse sector with a long value-added chain involving multiple steps ranging from ginning of raw cotton, making yarn and fabrics, to finished apparels. Table 6 shows the split of HS-52 into four-digit level subproducts, and groups them into three categories in terms of value addition—namely, cotton, yarn, and fabrics.

Table 6: Grouping the HS four-digit products of cotton in terms of value addition

Code	Product description	Group
5201	Cotton, not carded or combed	Cotton
5202	Cotton waste (including yarn waste and garnetted stock)	
5203	Cotton, carded or combed	
5204	Cotton sewing thread, whether or not put up for retail sale	Yarn
5205	Cotton yarn (other than sewing thread), containing 85 percent or more by weight of cotton, not put up for retail sale	
5206	Cotton yarn (other than sewing thread), containing less than 85 percent by weight of cotton, not put up for retail sale	
5207	Cotton yarn (other than sewing thread) put up for retail sale	
5208	Woven fabrics of cotton, containing 85 percent or more by weight of cotton, weighing not more than 200g/m^2	Fabrics
5209	Woven fabrics of cotton, containing 85 percent or more by weight of cotton, weighing more than 200g/m^2	
5210	Woven fabrics of cotton, containing less than 85 percent by weight of cotton, mixed mainly or solely with man-made fibers, weighing not more than 200g/m^2	
5211	Woven fabrics of cotton, containing less than 85 percent by weight of cotton, mixed mainly or solely with man-made fibers, weighing more than 200g/m^2	
5212	Other woven fabrics of cotton	

Next, Table 7 presents the value and quantity of the three groups for the CAREC region in 2022. The calculations of data in the table are rather intuitive. The table estimates show that transport cost is on average 2.57 percent of the commercial value of raw cotton, whereas it is only 1.42 percent for the trade of yarn. Similarly, the impact of transport cost on fabrics is almost one-fifth compared to that of raw cotton.

Table 7: Transport cost as percent of commercial value

	Cotton	Yarn	Fabrics
Trade value (USD)	156,98,311	459,097,953	269,009,671
Trade quantity (20 tons)	428	6,908	1,502
Average commercial value (USD/20 tons)	36,719	66,460	179,082
Average cost of traveling 500km (USD)	945	945	945
Traveling cost as share of commercial value (%)	2.57	1.42	0.53

Note: Data of trade value and quantity is taken from Comtrade database to calculate regional aggregate for 2022. Cost of traveling 500km along a corridor (USD) is taken equal to the value of TFI3 in 2022 for the CAREC region.

Mongolia's primary exports encompass ores, mineral oils, animal hair, horsehair yarn, and edible fruits. In a similar vein, Afghanistan's major exports comprise fruit, vegetables, coffee, oilseeds, cotton, cereals, and carpets. However, this export profile—primarily comprising raw materials—is significantly affected by high transportation costs. Processing raw materials enhances their commercial value, thereby resulting in reduced transportation costs as a proportion of the traded commodity's unit value. This underscores the potential for considerable benefits by prioritizing the value-added processing of raw materials within the region before they are exported.

The CPMM provides comprehensive data on the performance of the six corridors within the region. However, enhancing its value could involve incorporating traffic flow details. For example, gauging traffic intensity—measured by container volume at a BCP—would differentiate between delays owing to extended border procedures or traffic congestion. Addressing the former suggests streamlining trade processes, while the latter requires investing in physical infrastructure—such as, road widening to tackle traffic queues. Likewise, supplementing the details on the nature of traded commodities would be valuable to customize the corridors along specific routes. For instance, constructing logistics infrastructure like cold chains to facilitate perishable goods trade, and establishing processing units for raw material value addition.

4. Conclusion and Policy Recommendations

Several of the CAREC member countries are landlocked, which poses a geographic disadvantage in terms of the regional integration and bilateral trade cost. The intra-trade of the region depends on rail and road transportation. Nevertheless, road transportation remains the predominant trade mode where the time and expenses related to border crossings are substantial barriers to trade. Major factors contributing to these hindrances include customs checks, loading and unloading procedures, road and bridge tolls, along with escort and convoy expenditures. Similarly, cargo movement becomes slower owing to poor infrastructure quality and congestion. Prolonged border clearance procedures add further to the duration of traveling between countries.

The present study analyzed trade among the regional countries. In addition, to aggregate trade by individual member countries, the study delves into the export of intermediate goods and raw materials to highlight the potential of intra-industry linkages between regional countries, and the need for value addition. This study offers a detailed examination of the comparative efficiency of transportation connectivity between the CAREC members. Moreover, the product-specific effect of transportation cost is analyzed. Based on the analyses, the study put forth the following policy recommendations:

a) Trade facilitation policies should specifically target the segments along bilateral transportation routes that exhibit comparatively lower efficiency. Notably, among the BCPs, those with an average border clearance time exceeding 10 hours include Alashankou, Chaman, Dostyk, Gisht Kuprik, Horgos, Karasu (PRC), Kuryk, Peshawar, Shirkhan Bandar, Spin Buldak, Termez, Torghondi, Torkham, and Turkmenbashi. Among other BCPs—such as, Istaravshan, Khorgos, Nau, Takeshikent, Zamiin-Uud, and Zhibek Zholy—although their average border clearance time is less than 10 hours, the cost of border clearance exceeds USD200. In comparison to BCPs located in peripheral areas, those in Uzbekistan, Turkmenistan, and Tajikistan hold greater significance as they serve as vital transit routes for most of the regional trade. Similarly, enhancing transportation infrastructure—such as, widening road corridors to alleviate congestion and increase travel speed—promises substantial long-term economic benefits for the region.

b) Enhancing the efficiency of border clearance procedures not only boosts regional trade but also strengthens CAREC's connectivity with neighboring regions, including South Asia, the Middle East, the Mediterranean, and Europe. In the context of transit trade, Afghanistan requires particular attention owing to the significantly extended border clearance times it encounters. CAREC Corridors 2, 3, 5, and 6 traverse Afghanistan and neighboring countries such as Pakistan, Tajikistan, Turkmenistan, and Uzbekistan. Corridor 5, in particular, plays a vital role in enabling Afghanistan's trade via Karachi and Gwadar seaports. However, the inefficiencies observed at Pakistan–Afghanistan BCPs like Chaman and Torkham impede Afghanistan's potential to become a key transit and trade hub for facilitating CAREC trade. To address these issues, regional cooperation on cabotage rules is of utmost importance, as it can streamline transport and vehicle standards and reduce the need for frequent transloading of trucks.

c) As agriculture sectors constitute a sizeable share in the economies of several CAREC countries including Afghanistan, Uzbekistan, Pakistan, and Tajikistan, there is a need to implement a trade facilitation measure particularly related to agricultural products. In this context, electronic issuance and online exchange of SPS certificates among trading partners is particularly important. Furthermore, given the perishable nature of the agricultural products, there is need to improve logistical infrastructure; in particular, the establishment of cold chains is valuable.

d) Furthermore, transport costs as a percentage of commercial value are particularly high in the case of raw materials. For example, the transport cost averages 2.57 percent of the commercial value of raw cotton, while it is only 1.42 percent for the trade of yarn. Similarly, the impact of transport costs on fabrics is almost one-fifth higher compared to that of raw cotton. This underscores the potential for considerable benefits by prioritizing the value-added processing of raw materials within the region before they are exported. In particular, exports of Mongolia, Afghanistan, and Azerbaijan mostly comprise raw materials. Therefore, prioritizing value addition should constitute a central pillar of trade policy for these economies.

Appendices

A1: The CAREC Corridors

Table 8: CAREC corridors and their geographic coverage

Corridor	Geographic coverage
Corridor 1:	Europe–East Asia (Kazakhstan, the Kyrgyz Republic, and XUAR)
Corridor 2:	Mediterranean–East Asia (Afghanistan, Azerbaijan, Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan, and XUAR)
Corridor 3:	Russian Federation–Middle East and South Asia (Afghanistan, Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan)
Corridor 4:	Russian Federation–East Asia (IMAR, Mongolia, and XUAR)
Corridor 5:	East Asia–Middle East and South Asia (Afghanistan, the Kyrgyz Republic, Pakistan, Tajikistan, and XUAR)
Corridor 6:	Europe–Middle East and South Asia (Afghanistan, Kazakhstan, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan)

Notes: IMAR = Inner Mongolia Autonomous Region; XUAR = Xinjiang Uygur Autonomous Region. Both are regions of the People's Republic of China.
Source: ADB 2014. CAREC Transport and Trade Facilitation Strategy 2020. Manila.

A2: Trade Facilitation Indicators (TFIs)

Table 9: The CPMM Trade Facilitation Indicators

Indicator	Brief description
TFI1: Time taken to clear a BCP	This TFI refers to the average length of time (hours) it takes to move cargo across a border from entry to exit of a BCP.
TFI2: Costs incurred at a BCP	This is the average total cost, in United States dollars, of moving cargo across a border from entry to exit of a BCP.
TFI3: Costs incurred while traveling along a corridor section	This is the average total cost, in United States dollars, incurred for 20 tons of cargo traveling 500km along a corridor within a country or across borders.
TFI4: Speed of travel along a corridor section	This is the average speed, in kilometers per hour (km/h), at which 20 tons of cargo travels 500km along a corridor within a country or across borders.
Speed without delay (SWOD)	SWOD is the ratio of the distance traveled to the time spent by a vehicle in motion between origin and destination. As a contrast to SWOD, the CPMM also measures speed with delay (SWD) which is the ratio of distance traveled to the total time spent on the journey, including the time the vehicle was in motion and the time it was stationary.

Note: For more details, see https://cpmm.carecprogram.org/about/indicators/

A3: An Explanatory Note on the STCE Approach

While the segmental transport comparative efficiency (STCE) approach is elaborated in Section 3.2 and depicted in Figure 3, additional explanation in the form of a numerical example is presented below. Assuming a population-weighted bilateral distance between the country of origin and the destination of 1,500 kilometers, with 600 kilometers traveled in the origin country, 500 kilometers in a transit country, and 400 kilometers in the destination country. We have provided travel speed and border clearance time data for each of these countries. The benchmark values for these parameters are as follows: a travel speed of 50 kilometers per hour, outbound border clearance time of 2.5 hours, and inbound border clearance time of 3 hours. The efficiency calculation is illustrated in Table 10.

Table 10: Numerical illustration of the STCE approach

	Actual Time (hr)		Benchmark Time (hr)	
Origin country	Travel speed = 48km/hr		Travel speed = 50km/hr	
	Distance traveled = 600km		Distance traveled = 600km	
	Travel time (= 600/48)	12.5	Travel time (= 600/50)	12
	Outbound BCP time	5	Outbound BCP time	2.5
Transit country	Inbound BCP time	4	Inbound BCP time	3
	Travel speed = 45km/hr		Travel speed = 50km/hr	
	Distance traveled = 500km		Distance traveled = 500km	
	Travel time (= 500/45)	12.5	Travel time (= 500/50)	10
	Outbound BCP time	4.5	Outbound BCP time	2.5
Destination country	Inbound BCP time	3	Inbound BCP time	3
	Travel speed = 40km/hr		Travel speed = 50km/hr	
	Distance traveled = 400km		Distance traveled = 400km	
	Travel time (= 400/40)	10	Travel time (= 400/50)	8
Total time		51.5	Total time	41
Efficiency (41/51.5) × 100 = 79.6 percent				

Table 4 provides a comparative efficiency analysis based on benchmark values derived from the actual CPMM data: the minimum outbound border clearance time, the minimum inbound border clearance time, and the maximum travel speed. Alternatively, when assuming a border clearance time of zero, indicating unrestricted movement across borders, the resulting comparative efficiency naturally decreases for each country pair compared to the values presented, as shown in Table 11. However, this adjustment also demonstrates the robustness and consistency of our estimates. The relative efficiency ranking across country pairs remains unchanged, highlighting their connectivity in a consistent manner. This approach offers a reliable representation of comparative efficiency, enabling the identification of country pairs with poor connectivity effectively.

Table 11: Comparative efficiency considering zero border clearance time

	Afghanistan	Azerbaijan	China	Georgia	Kazakhstan	Kyrgyz Republic	Mongolia	Pakistan	Tajikistan	Turkmenistan	Uzbekistan
Afghanistan	62	46	70	43	44	37	53	20	32	44	38
Azerbaijan	37	85	71	39	65	43	51	28	37	48	44
China	59	68	100	64	75	78	61	77	77	65	70
Georgia	35	32	64	78	53	40	48	29	35	41	40
Kazakhstan	38	70	84	60	91	57	57	28	43	64	55
Kyrgyz Republic	30	45	88	43	56	77	55	23	46	46	44
Mongolia	48	53	75	50	57	55	69	45	55	51	52
Pakistan	19	30	84	31	29	23	47	81	20	26	23
Tajikistan	22	39	85	39	43	46	55	20	61	35	32
Turkmenistan	32	50	69	45	59	43	50	24	33	93	45
Uzbekistan	28	47	76	44	53	43	51	22	31	48	85

Note: The table displays origins along the rows and destinations along the columns. The efficiency scores are standardized on a scale of 0 to 100, corresponding to theoretical minimum to maximum values, respectively.

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