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A Dynamic Economic Resilience Model: A Case Study of a Regional Integration Organization in Eurasia

Iman Bastanifar+ and Asma Shirkhani

Department of Economics, University of Isfahan, Isfahan, Iran

Abstract In recent years, sanctions, the Covid-19 pandemic, and military conflicts among countries, have underscored the significance of economic resilience in the push towards globalization through joint cooperation between countries. This research aims to measure the economic resilience index for the period 2000-2021, with a focus on the countries of the Shanghai Cooperation Organization. Additionally, the study investigates the impact of trade, production capacities, financial development, and the distance between the capital of each country and China's capital on the economic resilience index. The findings indicate that India has the highest average resilience at 63.2, while Pakistan has the lowest at 28.1. The results of fully modified, dynamic and robust ordinary least squares panel show that the economic resilience can be improved through increased production capacity, trade, and financial development. However, it decreases with an increase in the distance of trade. Therefore, international transport corridors should not be taken for granted.

Keywords: Economic Resilience, Productive Capacities, Trade, Financial Development, Distance, SCO

JEL Classifications: F13, F15, F51, F64

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I. Introduction

The imposition of sanctions on countries like Iran, Russia, and China, the outbreak of pandemics such as Covid-19, and military conflicts including Russia-Ukraine war, Palestine-Israel, and Yemen-Saudi Arabia conflicts have had a substantial impact on the regional and global economy (Hufbauer and Jung 2020, Ceylan, Ozkan, and Mulazimogullari 2020). As a corollary, Covid-19 and military conflicts have given rise to certain economic, commercial, and monetary destruction, as well as the loss of production capacity, labor force, resources, and livelihoods (Khudaykulova, Yuanqiong, and Khudaykulov 2022). The repercussions of these shocks are widely cognized not only by the parties directly involved with but also by the trading partners and surrounding countries (Khudaykulova, Yuanqiong, and Khudaykulov, 2022). This situation reflects the

+Corresponding Author: Iman Bastanifar
Associate Professor, Department of Economics, University of Isfahan, Isfahan, Iran. E-mail: i.bastanifar@ase.ui.ac.ir
Co-Author: Asma Shirkhani
Ph.D. Student, Department of Economics, University of Isfahan, Isfahan, Iran. E-mail: asma.shirkhani2018@gmail.com
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overall state of the world economies, with some countries able to achieve sustainable economic growth, while others appear to be trapped in a downward spiral. According to the United Nations report in 2023, resilience is one way to overcome the world's hardships and achieve sustainable economic growth. (TSDGR,2023). Therefore, the concept that economic resilience is crucial for achieving sustainable development is intriguing and has garnered the interest of researchers, international organizations, and local authorities (Ahmed and Trabelsi 2022, Feng, Lee, and Peng, 2023, Lee et al. 2021, Saputro and Suwito 2022). Additionally, both theoretical and empirical efforts, such as this study, to enhance the literature on resilience in economics can make it easier for policy makers worldwide to achieve a sustainable economy.

Economic resilience refers to the ability of maintaining production levels near capacity even after a shock occurs(Duval and Vogel 2008). Resilience can be measured by means of two dimensions: first, the ability of an economy to absorb shocks. The focus on SCO countries is due to the fact that developing countries, such as those in the SCO are more vulnerable to shocks than developed countries (Gnangnon 2021b). If the post-shock production reduces significantly and the absorption becomes slow, then the economy is considered to be less resilient (Guillaumont 2009). Second, the speed at which it can return to equilibrium after a shock. For instance, the time it takes to recover and achieve stability can vary depending on the type of shock experienced, whether it is economic, political, social, or natural shocks. This perspective is supported by Briguglio in 2016. As defined by Guillaumont (2009), economic resilience stands for the ability to withstand and manage threats to growth of unexpected shocks that often accompany economic, political, social, or natural shocks. Briguglio (2016) distinguished between types of economic residences: deliberate policy-induced economic resilience and inherent economic vulnerability. The very distinction is grounded upon the integration of four sub-indices such as economic stability, market efficiency, social development and good governance. According to the macroeconomics literature, economic stability includes indicators such as inflation, unemployment, real gross domestic product and individual levels of income. (Glyfason, 1999; Mankiw and Scarth, 2001). Market efficiency refers to all the considerations, economic regulations and structural changes that make an economy more competitive (Read, 2012) Social development is a process of changing social structures that leads to overall development. This process can be achieved by enhancing human development (J& A, 1999). Good governance refers to the capacity and autonomy of governments in developing human rights, political stability, combating corruption and terrorism and creating laws (Fukuyama, 2013).

This research intends to add to the existing literature on economic resilience in multiple ways. Firstly, the economic resilience of the Shanghai Cooperation Organization (SCO) is measured using the literature presented byBriguglio (2016) and Briguglio et al. (2014). The SCO is a political, economic, and security alliance that spans over three-fifths of Eurasia. It is the largest regional organization in the world in terms of geographical scope and population. The precursor

to the SCO was the Treaty on Deepening Military Trust in Border Regions in Shanghai, signed by China, Kazakhstan, Kyrgyzstan, Russia, and Tajikistan, known prominently as the Shanghai Five group. It was established on April 26, 1996 but it was not until the year 2000 that concerns regarding human rights and social stability began to grow at the Dushanbe summit. This prompted the creation of a new organization aimed at fostering deeper political and economic cooperation. Currently, the organization has expanded its membership to nine countries with others participating who were previously observers or partners. The membership of India, Iran, and Pakistan in the SCO could potentially mark a significant shift in the global power dynamics. This in fact adds to the importance of the organization simply because it was previously led mainly by the United States (Gill 2001). The organization is also viable to play a pivotal role in regulating the geopolitical order of trade. The influence is remarkably great that even Joe Biden the US President recommended the establishment India-Middle East-Europe Economic Corridor (IMEEC) in September 2023 at the Group of 20 meeting in India. This corridor is to improve connectivity and promote economic integration between Asia, the Persian Gulf, and Europe. Through this project, the United States intends to diminish the growing influence of its global rival, China, in the Middle East and Europe, which have traditionally been a territory under the influence of the USA. The economic and political importance of the IMEEC, however, may add fuel to the fire of heightened tensions in the region (Johny 2023) due to its impact on the benefits received by certain member countries of the International North South (INSTC) such as Iran and Russia. Moreover, as trade relations among SCO members continue to grow, there are concerted efforts to circumvent sanctions, particularly within the energy sector (ÖZCAN 2023). Secondly, we intend to examine the impact of several factors such as trade, production capacities, financial development, and distance on the economic resilience index of SCO countries. These factors are vital for developing and emerging countries like Russia and Iran that deal with conflicts and sanctions imposed by the European countries and the USA. These countries need to develop their production capabilities and capacities and pursue new financial development so as to bypass the sanctions and overcome their macroeconomic obstacles such as inflation and unemployment.

Considering what we depicted so far, the article addresses two main inquiries: 1. What is the level of resilience among membership of the SCO? 2. what are the effects of trade, production capacities, financial development, and distance (between countries' capitals and China's capital) on their resilience?

In order to answer the first question, authors apply the Morris method. This method, is used to calculate the dimensions of important indexes such as the Human Development Index by the United Nations. The index measures the dimensions of different factors by including maximum and minimum levels of the indexes (Javani et al 2015& UNDP,2024). Regarding the second question, authors employ a fully modified, dynamic and robust ordinary least squares panel

method to demonstrate the impact of trade, production capacities, financial development, and distance on the resilience index.

The article is structured into five sections. Section 2 focuses on the theoretical foundations and background of the research. Section 3 introduces the model and the methods utilized to estimate it. Section 4 will describe and discuss the findings. Finally, section 5 will conclude the research.

II. Literature Review

Globalization has been an increasingly dominant trend in international relations. It is aimed at making connections between nations and countries all across the world (Fan 2023) where trade serves as crucial strategic factor deepening the pillars of globalization (Zhang 2023a). It provides an intricate cooperative networks within which countries come to various economic and trade agreements to enhance their economic and trade activities (Masood et al. 2023). In recent decades, however, with the decrease in trade restrictions, there has been a significant shift in global trade. This very trade liberalization has occurred through two main approaches, namely (a) through multilateral agreements such as the General Agreement on Tariffs and Trade (GATT) and (b) through the formation of regional trade agreements or trade blocks between a few nations (Carbaugh 2007, Masood et al. 2023). However, the trend of globalization is influenced by sanctions. Understanding economics sanction theory requires consideration of three different issues. Firstly, researchers must understand the link between international political goals and the process of economic policy decision making. Secondly, the impact of economic policy and the economic effects and outcomes resulting from sanction policies should not be taken for granted. Thirdly, examining how political issues may evolve due to the economic impact of sanctions is crucial (Felbermayre et al, 2021).

Sanctions have largely and negatively been consequential to the GDP, trade, and foreign investments of target countries which are able to lower their economic resilience (Gutmann, Neuenkirch, and Neumeier 2023). However, there are various theories and approaches to investigate economic resilience and its spatial determinants (Terzo 2021). As Cainelli, Ganau, and Modica (2019) put forth, in economic geography, the evolutionary approach carries particular relevance and identifies resilience as both a short-term ability to absorb an external shock and a long-term ability to develop new paths of economic growth and development (Martin and Sunley 2015, Boschma 2017). Economic resilience, thus, is defined as the capacity of a country to react to shocks. The capacity as such depends on policy choices (Gnangnon 2021b).

Not all regions are equally hit by global shocks. Some regions are particularly hit hard by a global shock, others to a smaller extent. Yet, there are some other regions that do not appear

to be affected at all. The recovery from a global shock also differs from region to region, such that it is by now a well-grounded fact that regions also differ in shock sensitivities; that is to say, some regions are more resilient than others (van Bergeijk, Brakman, and van Marrewijk 2017). Researchers have noticed the importance of interregional and international links, however, so far, little empirical attention has been paid to the dimension of international economic resilience (Hu, Li, and Dong 2022, Feng, Lee, and Peng 2023, Watson and Deller 2022).

In economics, the concept of 'economic resilience' has usually been associated with that economic vulnerability. The theory of economic vulnerability refers to a country's ability to withstand external shocks (Farrugia2004). Vulnerability is not a singular case; it focuses on the consequences of events and depends on the local, social and geopolitical factors in regions (Biswas & Nautiyal, 2023).

It is prominently considered in macroeconomic sense, from both national and regional perspectives (including in the economic geography field for the regional perspective) (Gnangnon 2021b, Liu et al. 2023, Zhang 2023b, Du et al. 2023). Economic Resilience' has been defined by Briguglio et al. (2014) as the policy-induced ability of an economy to recover from or adjust to the negative impacts of adverse exogenous shocks, and to take advantage from positive shocks. Such policies involve enhancing macroeconomic stability, increasing market efficiency, improving governance, and expanding social development. Put differently, economic resilience encompasses both the ability to recover quickly from a shock and to withstand the effect of a shock.

However, despite the undeniable significance of economic resilience in regional and international economy, scant attention has been paid to undergoing empirical studies on economic resilience. Among the few studies, for instance, Ngouhouo and Nchofoung (2021) measured and analyzed the economic resilience of sub-Saharan African (SSA) countries between 2006 and 2015. The results show that few of them show sustainable resilience characteristics, while most countries are still in uncontrolled (or very fragile) vulnerability. In this connection, Gnangnon (2021b) investigated the effect of production capacity on economic resilience in 118 developing countries during the period 2000-2018. The results showed that the development of production capacities is associated with greater economic resilience. Mai, Zhan, and Chan (2021) state that the uneven geography of economic resilience, generally considered, depends on local-specific attributes such as economic structure, human actions, and institutional arrangements. They showed that the (re) production of space, as measured by fixed-asset investment in urban space, was found to have a consistently positive and significant effect on economic resilience across the cities. Hao and Qu (2023) presented a comprehensive index system for measuring regional economic resilience (RER) based on provincial panel data in China extending from 2008 to 2019. They investigated the effect of the financial driver (FD) on RER from stage, path, and non-linear perspectives. Their findings showed that at both national and regional levels, FD and RER

show an upward trend and the effect of FD on RER has an "inverted U" shape.

According to Kehinde et al. (2012), countries that engage in international trade tend to be more productive compared to those that only produce for the domestic market. Relatedly, Grossman and Helpman (1991) demonstrated that trade enhances the transfer of new technologies, and promotes technological progress, and boosts productivity. The revenues and benefits as such are contingent upon the level of economic openness. This consensus assumes that trade boosts productivity through reducing resource misallocation and facilitating technological development. For this to happen, the pressure of international competition can force governments to modify programs that may lead to an increase in economic growth (Rajan and Zingales 2003). Accordingly, international agreements and trade liberalization in developing countries are often implemented with the expectation of boosting economic growth (Zahonogo 2016). In this context, a country's economic development and production systems depend on its production capacity and capabilities (Kurniawan and Managi 2019).

Financial development and trade are vital for a country's long-term growth (KUMAR, SOOMRO, and KUMARI 2022). The significance of financial development in any economy cannot be overstated (Yinusa, Akinlo, and Adejumo 2022). Financial development encompasses factors, policies, and institutions that facilitate effective financial intermediation in markets, as well as broad and deep access to capital and financial services (Valickova, Havranek, and Horvath 2015). Research shows that strong financial sectors drive growth in developing economies such as China and India (Kandil et al. 2017). However, the growth of an economy is dependent on the simultaneous development of both financial and real sectors (Ibrahim and Alagidede 2018). In order to bear a stronger impact on economic growth, the financial sector must grow in conjunction with other sectors of the economy (Yinusa, Akinlo, and Adejumo 2022).

The literature on the relationship between trade openness and economic resilience has provided, on the one hand, that greater trade openness can expose countries to shocks, and hence increase their vulnerability to external shock and result in higher output volatility (Bekaert and Harvey 1997, Montalbano 2011). This is particularly the case with countries featured with a high degree of trade specialization, including low value-added products. This state may also occur when there is a high degree of uncertainty in global financial markets (Haddad et al. 2013, Bonciani and Ricci 2020). In this scenario, it is clear that greater trade openness, achieved through lower trade barriers, would be associated with lower economic resilience Gnangnon (2021b). On the other hand, a higher level of trade openness along with the associated low trade barriers may not only fail to affect the developing countries' size of shocks but may also reduce their size of exposure to shocks (Montalbano 2011). As a result, trade openness could lead to lower output volatility when countries diversify their export product baskets or their economic structure (Balavac and Pugh 2016, Calderón and Schmidt-Hebbel 2008). In this context, trade openness can be associated with a higher level of economic resilience.

Many researchers have investigated the trade potential among countries using the gravity model approach. For example, Masood et al. (2023) showed that distance significantly and negatively affects Pakistan's trade with South Asian countries. Similarly, Karagoz and Saray (2022) concluded that the distance hurts trade between Turkey and Asia-Pacific countries. Tang et al. (2023) compared China's trade relations with the Association of Southeast Asian Nations (ASEAN) and with the European Union (EU) in terms of trade volume and structure, trade complementarity index, and factors affecting bilateral trade flows. The results showed that distance affects China's trade with the EU, but not with ASEAN. Ansarinasab and Bidmal (2023) have demonstrated that the distance between Iran and Shanghai countries does not have a significant impact on trade. However, to the puzzle yet to resolve is the impact of distance to economic resilience of SCO alongside other key variables such as production capacity, trade and financial development. Thus said the present paper attempts to provide a reliable explanation for this inquiry.

III. Empirical Model and Variables

The study analyzed the economic resilience of the member countries of the Shanghai Cooperation Organization, including Iran, India, Russia, China, Pakistan, Kazakhstan, Tajikistan, and Kyrgyzstan by examining the impact of trade and production capacities. The research is grounded upon the data derived from 2000 to 2021 and relied on equation 1.[1)]

$$ER_{it} = f(PCI_{it},\ TRADE_{it},\ FD_{it},\ DISt_{ijt}) \quad (1)$$

Equation 2 represents the regression form of Equation 1; where it ε_{it} represents the error terms.

$$ER_{it} = B_0 + B_1 PCI_{it} + B_2 TRADE_{it} + B_3 FD_{it} + B_4 DISt_{ijt} + \epsilon_{it} \quad (2)$$

ER_{it} represents the economic resilience of country 'i' in the year 't'. PCI is the abbreviation of the production capacity index, introduced by the United Nations to show the ability of countries to produce goods and services (UNCTAD, 2006). The index applies 46 indicators in eight categories including Information and Communication Technology (ICT), structural change, natural capital, human capital, energy, transport, private sector and institution. (UNCTADSTAT,

1) Owing to the lack of access to the data of Uzbekistan, this country has been removed from the statistical sample.

2021). TRADE, presents the total value of exports and imports divided by GDP as presented by the World Bank(https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS). FD refers to the financial development of a country in a given year. It shows the efficiency, depth and accessibility of the financial market and institutions. It is typically measured by the International Monetary Fund (https://data.imf.org/?sk=f8032e80-b36c-43b1-ac26-493c5b1cd33b&sid=1480712464593).

DISt shows the distance between capitals of countries. The method of measuring the variables of the research model is presented below.

Economic Resilience (ER): To introduce and measure economic resilience, four indicators have been proposed, including macroeconomic stability, good governance, microeconomic market efficiency, and social development (Briguglio et al. 2014, Briguglio 2016). The Morris method has been utilized in this research to measure the economic resilience of member countries of the Shanghai Cooperation Organization based on sub-indexes in Table 1.

Table 1. *Economic Resilience Index Components*

sub-index	Constituent variables, unit	Source
Economic Stability	Inflation, (Percent)	https://fred.stlouisfed.org/series/fpcpitotlzgpaK
	Unemployment, (Percent)	
	Private debt, loans and debt securities (Percent of GDP)	https://data.imf.org
	General government gross debt (Percent of GDP)	
Market efficiency	Business regulation	https://www.fraserinstitute.org/economic-freedom/map?geozone=world&page=map&year=2021
	Labor regulation	
	Credit regulation	
	Legal system & property rights	
	Judicial independence	
Social Development	Human Development Index	https://hdr.undp.org/data-center/human-development-index#/indicies/HDI
Good Governance	Control of Corruption	https://databank.worldbank.org/source/worldwide-governance-indicators
	Government Effectiveness	
	Political Stability and Absence of Violence/Terrorism	
	Regulatory Quality	
	Rule of Law	
	Voice and Accountability	

(Source) Prepared by Authors

Table 1 shows the variables and data sources used to estimate the coefficients of Equation2. More information about the data employed for panel estimations can be found in online Appendix 1. According to Table 1, in order to calculate the sub-indexes, data for constituent variables should be used through the Morris imbalance index method. The greater number of sub-indexes a country has, the greater economic resilience it receives. It is assumed that all

sub-indexes and constituent variables carry equal weight.

The Morris imbalance index is calculated through the equation 3.

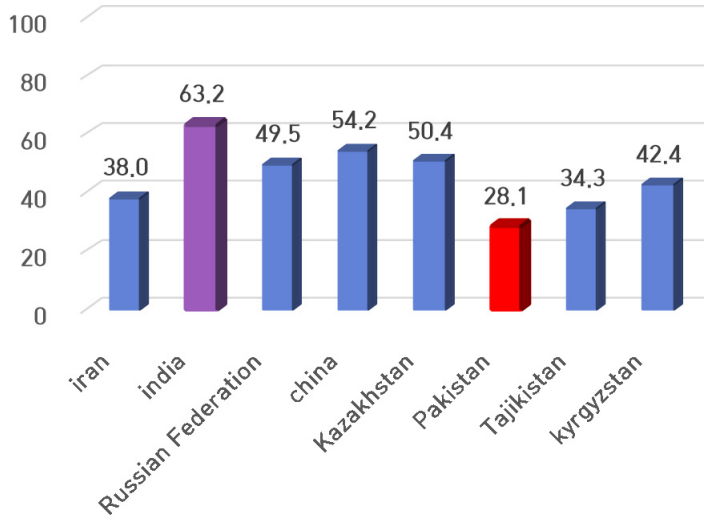
$$y_{ij} = \frac{X_{ij} - X_{i\,\min}}{X_{i\,\max} - X_{i\,\min}} \times 100 \quad (3)$$

In this formula, y_{ij} indicates the unbalanced index for the i-th variable in the j-th country. X_{ij} stands for the i-th variable in the j-th country and $X_{i\,\min}$ is the minimum value of the i-th variable among the countries. It is also $X_{i\,\max}$ the maximum value of the i-th variable among the countries. The important point in this method is that the indicators used must align in the same direction. However, since the resilience level is opposite to some constituent variables such as inflation, unemployment, private and government debt, in cases where the indicators do not align, the stability index is calculated in an inverted form using the formula above to ensure alignment. Equation3 indicates the dimension of each variable for each country, which ranges between zero and 100, when compared to the total amount of the variable across all countries. The presence of the minimum and maximum values in Equation 3, makes it dimensionally relative. This method is crucial for measuring the dimensions of vital variables such as health, income, and education indexes that are necessary for the Human Development Index (UNDP,2024). In the next step, the final coefficient is calculated using equation 4, in which 'n' represents the number of variables studied across continents. For example, in the case of economic stability, n equals four. The coefficient of the Morris index fluctuates between zero and 100; to the extent that it is closer to 100, the level of the index is higher (Ghaffary Fard, AbuNoori, and Nazari 2022).

$$D.I = \frac{\Sigma_{i=1}^{n} Y_{ij}}{n} \quad (4)$$

According to Equation4, the economic resilience of each country can be measured by the DI for each year, calculated using y_{ij} from Equation3. The results of D.I or Economics Resilience (ER) are listed in online Appendix 1. From 2000 to 2021, the average economic resilience of Shanghai countries is shown in Figure 1. India has the highest average resilience at 63.2, while Pakistan has the lowest at 28.1.

Figure 1. Average economic resilience of Shanghai countries



(Source) Calculated by Authors

Distance (DIS): Generally, inasmuch as the geographical distance goes higher among the two countries, there will be more risk of trade and cost of transportation. The impact of distance on international trade is analyzed in gravity models and recursive network planning, revealing that greater distances result in higher transaction costs. (Khan et al. 2024, Bastanifar et al. 2024). The higher cost and risk do not appear to be advantageous for the realization of trade collaboration among these countries. As described in previous studies (Ganbaatar et al. 2021, Soloaga and Wintersb 2001), the formula of relative distance is as follows:

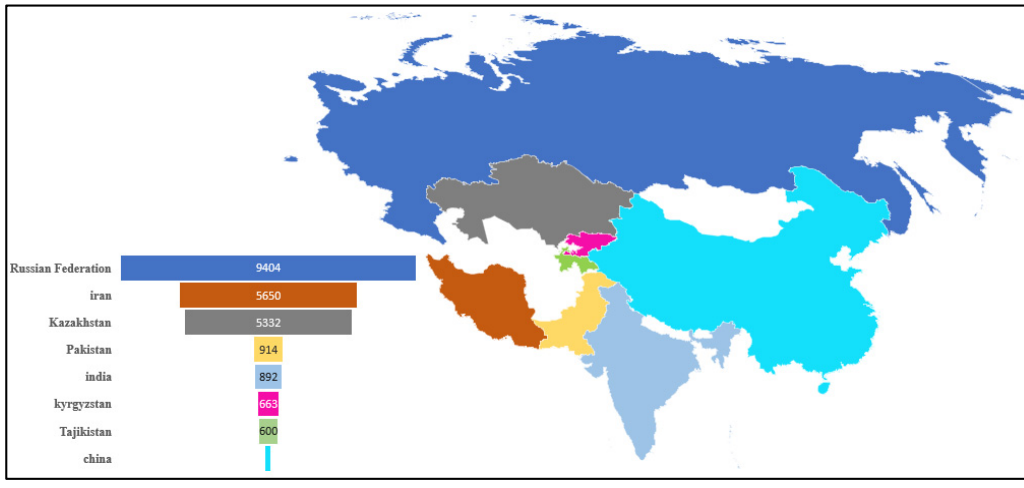
$$Dist_{ijt} = \frac{GDP_{it}}{GDP_{jt}} \times Dis \tag{5}$$

In this formula, $Dist_{ijt}$ is the geographical distance between 'i' country and its transaction partner's 'j' state in year 't'. Dis represents the absolute distance between the capitals of two countries (i and j).

Geographical distance does not account for the benefits of economies of scales in transportation, which lead to lower costs of trade (Haralambides, 2019). The advantages of relative distance shift focus from absolute geographical distance to economic factors such as the relative GDP of countries. This approach not only considers the relative trade ability of countries in terms of GDP, but also takes in to account other components of GDP such as consumption and investment that are crucial for macroeconomic policy making.

Given that China is the largest trading, partner of almost all Shanghai members, with a significant amount of exports and imports, and the majority of analysts predicting that China's real GDP will surpass that of the United States by 2030, it can be argued that China will become the largest economy in the world (Economy 2022). On this account, we use the distance data to the capital of this country as a business partner. The distance data between countries 'i' and 'j' were obtained from the Research and Expertise on World Economy (CEPII) database. Finally, Equation 5, GDP_{it} represents the GDP per capita (in constant 2015 dollar units) of country 'i' in the year 't'. It also GDP_{it} represents the GDP per capita of country 'j' (China) in the year 't'. The GDP data of country 'i' and 'j' came from the World Bank database for the period 2000- 2021. Figure 2 displays the average distance between the capital cities of countries and Beijing. Russia has the longest distance while Tajikistan has the shortest.

Figure 2. Average distance between the capital of SCO member countries and the capital of China



(Source) Prepared by Authors

Production capacity index (PCI): Productive capacities are defined as "the productive resources, entrepreneurial capabilities and production linkages which together determine the capacity of a country to produce goods and services and enable it to grow and develop" (Gnangnon 2021a). On February 8, 2021, the United Nations Conference on Trade and Development (UNCTAD) introduced the Comprehensive Index of Productive Capacities (which covers most of the world's countries). This indicator covers eight areas, including human capital, physical capital (energy infrastructure; transport infrastructure; information and communication technology, i.e., ICT), private sector, institutions, structural change in production and natural resources (UNCTAD 2021). This is a variable that is expressed as a percentage and varies between 0 and 100. The value of 0 indicates the absence of a productive capacity, while the value of 100 indicates

a high level of productive capacity. This indicator was made available to the public some time ago and has been used in a number of economic and econometric studies (Sylvain and Jules 2023, Giombini, Grassetti, and Sanchez Carrera 2023). PCI_{it} can be expressed in the form of an algebraic equation as follows:

$$PCI_{it} = \sqrt[N]{\prod_{i=n}^{N} X_i^{PCI}} \tag{6}$$

The PCI_{it}, is a geometric average of continent variables of market efficiency in Table 1 for each country. In Equation 6, t, represents time and N, represents the total number of continent variables and i represents a specific continent variable using a proxy for market efficiency. X, represents the score of each continent variable. Principal Component Analysis[2] (PCA), calculated by the United Nations, is used in this research. (Oluc et al., 2023).

Financial development (FD): Financial development has been approximated in the empirical literature since the 1970s using two measures of financial depth: the ratio of private credit to GDP and, to a lesser extent, the ratio of stock market capitalization to GDP (Ashour, Sayed, and Abbas 2023, Yu and Latif 2023). However, financial development is a multidimensional process, and the diversity of financial systems among countries suggests that several indicators should be considered to measure it. Svirydzenka (2016) defined the financial development index as a combination of depth (size and liquidity of markets), access (ability of individuals and companies to access financial services), efficiency (ability of institutions to provide financial services at a low cost and with stable revenues, etc.), considering institutions (including banks, insurance companies, mutual funds, and pension funds) and financial markets (including stock and bond markets). Therefore, in this research, we will be utilizing the financial development index, which has been normalized between zero and one. This index is provided by the International Monetary Fund (IMF) and is based on Svirydzenka's (2016) perspective.

Based on the data presented in Table 2, the average level of economic resilience and production capacity are 45.01 and 41.04, with standard deviations of 11.30 and 8.25, respectively. Additionally, the average level of financial development is 32.34, which is also low. However, the average level of trade is higher at 62.61, indicating an improvement in this variable among these countries.

2) PCA is a method used to reduce the dimensionality of data. For more information about PCI and PCA please refer to the report titled "UNCAD UNCTAD PRODUCTIVE CAPACITIES INDEX" (UNCTAD 2021).

Table 2. *Descriptive Statistics*

Descriptive statistics	ER	PCI	TRADE	FD	DISJ
Mean	45.02	41.05	62.62	32.35	2932
Maximum	67.32	60.30	175.35	67.43	14062
Minimum	23.58	24.80	24.70	5.31	0
Std. Dev.	11.30	8.25	32.03	17.01	3540
Observations	176	176	176	176	176

Note: *1% level of significance; **5% level of significance; ***10% level of significance
(Source) Calculated by Authors

The most widely used estimator for the co-integration coefficients is the FMOLS (Fully Modified Ordinary Least Square) estimator developed by Phillips and Hansen (1990) and by Pedroni (2001) for panel data. The DOLS (Dynamic Ordinary Least Square) estimator developed by Kao and Chiang (2001), based onSaikkonen (1991) and Stock and Watson (1993), is commonly applied as well. Both estimators can avoid the problems of endogeneity and serial correlation. To understand the FMOLS estimators, the following panel regression model Pedroni (2001) is considered:

Imagine a panel of i=1,...,N members for a cointegrated system.

$$\begin{aligned} y_{it} &= a_i + \beta X_{it} + \mu_{it} \\ x_{it} &= x_{it-1} + \epsilon_{it} \end{aligned} \tag{7}$$

$\xi_{it} = (\mu_{it}, \epsilon_{it})$, represents that the vector error process is stationary. Ω_i, is an asymptotic covariance matrix.

β is a cointegrating vector. If y_{it} is integrated of order one, variables x_{it}, y_{it} with cointegrating vector β is defined to cointegrate for each member of the panel. In order to have specific fixed effects. The term a_i is applied. The first element of $\xi_{it} = (\mu_{it}, \epsilon_{it}^{'})$ is a scalar series and the second element is an m dimensional vector of the differences in the regressors. Since $\epsilon_{it} = x_{it} - x_{it-1} = \Delta x_{it}$, we can construct the following matrix in Equation 8:

$$\Omega_i = \begin{bmatrix} \Omega_{11i} \, \Omega_{21i} \\ \Omega_{21i} \, \Omega_{22i} \end{bmatrix} \tag{8}$$

In the matrix, Ω_{11i} represents the scalar long run variance of the residual μ_{it}. The $m \times m$ long run covariance among the ϵ_{it} can be shown by Ω_{22i}. An $m \times 1$ vector that gives the long run covariance between the residual μ_{it} and each of the ϵ_{it} can be observed by Ω_{11i}.

The FMOLS estimates the vector β using a nonparametric approach, that takes in to account

the potential presence of endogeneity and serial correlation that OLS is frequently unable to eliminate[3].

The DOLS estimator (Kao and Chiang 2001) is a parametric approach that corrects autocorrelation by adding the first lagged differences to the model. The estimated regression equation of the panel DOLS can be specified as follows:

$$y_{it} = a_i + x_{it}'\beta + \sum_{j=-q}^{q} C_{ij}\Delta x_{it-1} + \mu_{it} \quad (9)$$

Where β is the co-integration vector, C_{ij} is the coefficient of a lead or lagged of first difference explanatory variables and μ_{it} represents the error terms (Boubellouta and Kusch-Brandt 2021). FMOLS and DOLS can be used to examine the stability and robustness of results. Comparing the results from these two methods helps ensure that the obtained estimates are reliable in terms of stability and accuracy. Both DOLS and FMOLS have limitations, and advantages, as they are specifically designed for analysis long-run relationships among variables. DOLS, generally outperforms FMOLS and OLS when dealing with heterogeneous panel. However, FMOLS is founded to be more biased than OLS according to Monte Carlo simulations. Regarding the number of lags and leads, DOLS is more sensitive in selecting the appropriate amount. This estimator yields different outcomes when the number of lags and leads is reduced (Kao and Chiang, 2001).

In addition, the robust least squares (MM-estimation) approach is also used in order to know whether or not the data set under study suffers from outliers(Naz et al. 2019). Robust least square regression overcomes the limitation of traditional non-parametric and parametric method through minimizing the possible outliers from dependent variable (by using M-estimator) (Huber 1973), independent variables (by using S-estimator) (Rousseeuw and Yohai 1984), and from both (by using MM-estimator) (Yohai 1987). According to Yohai (1987), robust regression is a method used when the distribution of residuals is not normal or when outliers are present that can affect the model. It is an important tool for analyzing data that is impacted by outliers, ensuring that resulting models are resilient against their influence. When researchers create regression models and test the common assumption that regression assumptions are violated, transformations often fail to eliminate or weaken the impact of outliers, leading to biased predictions. In such cases, robust regression, which is resistant to the influence of outliers, is the best method to use. Robust regression hepls in detecting outliers and providing results that are not heavily influenced by them.The MM-estimation procedure involves estimating the regression parameter using S-estimation to minimize the scale of the residual from M-estimation,

3) To learn more about the technical aspects, authors are invited to refer to Pedroni (2001)

and then proceeding with M-estimation. The goal of MM estimation is to obtain estimates with a high breakdown value and greater efficiency. Breakdown value is a standard measure of the proportion of outliers that can be accommodated before these observations start to impact the model. The MM-estimator is the solution to:

$$\sum_{i=1}^{n}\rho_1(u_i)X_{ij}=0 \text{ or } \sum_{i=1}^{n}\rho\left(\frac{Y_i-\sum_{j=0}^{k}X_{ij}\hat{\beta}_j}{S_{MM}}\right)X_{ij}=0 \tag{10}$$

Where SMM is the standard deviation obtained from the residual of S-estimation and ρ is a Tukey's biweight function:

$$\rho(u_i)=\begin{cases}\dfrac{u_i^2}{2}-\dfrac{u_i^2}{2}+\dfrac{u_i^2}{2}, & -c\le u_i\le c\\ \dfrac{C^2}{6}, & u_i\leftarrow c \text{ or } u_i\rangle c\end{cases} \tag{11}$$

The main difference between the FMOLS and DOLS estimators and the Robust Least Squares estimator is that the former are dynamic specifications while the latter is a static specification.

IV. Results and Discussion

Table 3 presents the results of FMOLS, DOLS, and MM-estimation panel estimators. The results show that the variables PCI (production capacities) have coefficients of 0.518607, 0.553630, and 0.431385 in FMOLS, DOLS, and MM-estimation methods, respectively, showing a positive and significant impact on ER. Similarly, TRADE with coefficients of 0.147524, 0.143911, and 0.112985, and FD (financial development) with coefficients of 0.585773, 0.454185, and 0.409642 in all three methods, also demonstrate a positive and significant effect on ER. In contrast, the variable DISJ with coefficients of -0.000928, -0.000575, and -0.000447 in FMOLS, DOLS, and MM-estimation, respectively, shows a negative and significant impact on ER.

According to the findings, the development of production capacities (PCI) has a positive impact on the economic resilience of Shanghai countries. This result aligns with Gnangnon (2021a) study. However, it does not manifest a surprising finding since the production capacities encompass production resources, entrepreneurial capabilities, and production links. Together, these factors determine a country's ability to produce goods and services, fostering sustainable growth and development (Sylvain and Jules 2023). Trade enhances economic resilience. Therefore, an important motivation for regional agreements is to reduce developing regions/countries'

dependence on unbalanced trade with developed regions through mutual trade (Pretorius et al. 2021). According to Sener and Delican (2019), trade, however import or export, is the driving force behind a country's growth and lays a positive impact on its economy. International trade can be a key factor in promoting sustainable development, specifically, economic resilience. This can be achieved by encouraging countries to specialize in producing goods and services in which they own capacities to mark a relative advantage and facilitate the transfer of resources among different countries (Belloumi and Alshehry 2020). The relationship as such has been confirmed by international organizations, such as the World Bank and the World Trade Organization (WTO). The results presented in Table 3 demonstrate a positive relationship between economic resilience and financial development (FD), consistent with the findings of Wang and Li (2022). According to Kushwah, Siddiqui, and Singh (2022), financial development refers to progress in the banking sector and the expansion of financial markets, which lead to financing, capital accumulation, and savings. These factors ultimately contribute to positive economic growth and resilience. The results indicate that economic resilience is affected either positively or negatively, depending on whether or not the distance between the capital of countries and the capital of China increases. Finally, the results show that the increase (or decrease) in the distance (DIS) between the capital of countries and the capital of China bears a negative (or positive) effect on economic resilience. Besides, the geographical distance between two economies also plays a pivotal role in determining trade and cultural flows. Longer distances can increase transportation costs as a result of smaller two-way flows. Our results are consistent with previous studies both theoretically and empirically, and largely confirm the conclusions of the gravity mode (Ganbaatar et al. 2021).

Table 3. *Panel FMOLS, DOLS and MM-Estimation Results*

Dependent variable: ER	Fully modified OLS			Dynamic OLS			MM-estimation		
	Coefficient	Std.Error	Prob	Coefficient	Std.Error	Prob	Coefficient	Std.Error	Prob
PCI	0.518607*	0.144598	0.0005	0.553630*	0.133473	0.0001	0.431385*	0.140948	0.0022
TRADE	0.147524*	0.042598	0.0007	0.143911*	0.038279	0.0002	0.112985*	0.021757	0.0000
FD	0.585773*	0.120531	0.0000	0.454185*	0.108120	0.0000	0.409642*	0.081211	0.0000
DISJ	-0.000928**	0.000375	0.0144	-0.000575***	0.000294	0.0518	-0.000447*	0.000166	0.0071
C	-			-			7.966077***	4.358923	0.0676
R^2	0.525915			0.508867			0.507072		
Adj-R^2	0.515969			0.500300			0.489401		
F ix	138.967356*		0.0000						
Hausman	9.987924**		0.0406						

Note: p-value is in parenthesis. *1% level of significance; **5% level of significance; ***10% level of significance.
(Source) Calculated by Authors

The findings based on FMOLS, DOLS and MM-estimation methods indicate similar directions and are very close to each other. This similarity shows the model's lack of sensitivity to estimation methods. Therefore, the accuracy of the model's elements is confirmed to a high degree, as it was not very ensitive to different estimation methods.

V. Conclusion

This study provided a significant contribution to the literature on economic resilience. Unlike the majority of studies that focus solely on advanced economies, this study investigated the level of resilience among membership of the SCO and the factors that impact the economic resilience of Shanghai countries. Figure 1 indicated the level of resilience among the countries. According to the information in Figure 1, India had a highest level of resilience with 63.7, while Pakistan had the lowest with 28.7, on the average between 2000 and 2021.In order to investigate the factors that impact the level of resilience, three different methods, namely FMOLS, DOLS, and MM-estimation were applied to analyze data from 2000 to 2021. As the results indicated, it is evident that economic resilience is positively influenced by an increase in production capacities, trade, and financial development. Conversely, countries that are geographically far away from China tend to exhibit lower economic resilience. This on the one hand indicates that the commercial and economic strategies of the Shanghai countries fail to leverage the potentials and capacities of the neighboring countries adequately and, on the other hand, they are heavily reliant on China. According to the results obtained from the estimation of patterns (especially in terms of distance), not all countries take advantage of the opportunity to join the Shanghai Group and do not make the best use of its geopolitical position; therefore, it is necessary to make a fundamental revision in the trade plan and portfolio of the countries based on the advantages of proximity and production capacities. Furthermore, countries should try to complete and use the INSTC because a major part of the geopolitical position of trade with China, India and Pakistan can be developed by completing this project.

Therefore, policy implications for economic integration should not ignore the role of resilience and distance among the countries. Additionally, future studies on economic integration topics can benefit from considering models for developing the literature on resiliency and distance.

A. Limitation

Owing to the lack of access to the data of Uzbekistan, this country has been removed from the statistical sample.

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