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| RESEARCH ARTICLE

The Impact of Shanghai Cooperation Organization Membership on Pakistan's Manufacturing Exports: A Difference-in-Differences Gravity Analysis

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| ABSTRACT
This study examines the impact of Pakistan's membership in the Shanghai Cooperation Organization (SCO) on its manufacturing export performance, employing a Difference-in-Differences (DID) framework within a gravity-type trade model. Using panel data covering pre- and post-integration periods, the analysis compares Pakistan's manufacturing exports to SCO member countries with those to non-SCO trading partners to identify the causal effect of SCO accession in 2017. Descriptive evidence indicates a gradual but more stable growth in manufacturing exports following SCO membership, with notable sectoral variation across industries. Empirical results reveal a positive and statistically significant effect of SCO membership on Pakistan's manufacturing exports, confirming that regional integration has enhanced trade performance beyond pre-existing trends. The validity of the DID approach is supported by pre-treatment parallel trend tests, while robustness checks including placebo tests and Poisson Pseudo-Maximum Likelihood (PPML) estimation confirm the consistency of the findings. Heterogeneity Sectoral analysis shows stronger export growth in healthcare-related products, whereas traditional sectors such as textiles, minerals, and rubber exhibit relatively modest gains, reflecting ongoing structural constraints. Overall, the findings suggest that SCO integration has contributed positively to Pakistan's manufacturing export expansion, though the benefits remain uneven across sectors. The study underscores the importance of complementary domestic policies, industrial upgrading, and trade facilitation measures to fully realize the export potential offered by regional economic integration.

| KEYWORDS

SCO; Manufacturing Exports; Difference-in-Differences; Regional Integration; Gravity Model; Pakistan

| ARTICLE INFORMATION

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1. Introduction

Regional economic integration has become a defining feature of the contemporary global trading system, particularly for developing economies seeking to enhance export competitiveness, diversify production structures, and integrate into regional and global value chains (Sada & Ikeda, 2021; Savinsky, 2020; Ullah et al., 2021). Through preferential trade arrangements, institutional coordination, and trade-facilitating mechanisms, regional blocs aim to reduce transaction costs, expand market access, and promote sustainable economic growth. While the trade effects of established regional groupings such as the European Union, ASEAN, and NAFTA have been widely examined, empirical evidence on newer and emerging regional organizations remains comparatively limited (Ahmad et al., 2024; Khan et al., 2025; Shah Zaib, 2023).

The Shanghai Cooperation Organization (SCO), established in 2001, has gradually evolved from a security-oriented alliance into a broader framework emphasizing economic and trade cooperation. With Pakistan's accession as a permanent member in 2017, the

SCO expanded to include a substantial share of the global population, natural resources, and emerging markets. In recent years, the SCO has promoted economic initiatives such as regional transport corridors, trade facilitation measures, and large-scale infrastructure projects under the Belt and Road Initiative (BRI) and the China–Pakistan Economic Corridor (CPEC). With a collective GDP exceeding USD 23 trillion, the SCO represents a significant economic bloc with strong potential for trade expansion, investment flows, and regional connectivity, led by major economies such as China and Russia alongside strategically located members including Pakistan and Central Asian states (Aslam & Tariq, 2021a; Khan & Edwin, 2024; Nawaz et al., 2024).

Pakistan's participation in regional organizations carries particular economic and strategic importance due to its geographic position at the intersection of South Asia, Central Asia, and Western Asia. Regional integration offers Pakistan opportunities to enhance economic cooperation, strengthen diplomatic ties, and address shared challenges related to trade, infrastructure connectivity, and regional stability (Bhowmik et al., 2021; Chaudhary & ABE, 2000; Khalid et al., 2020). As a resource-rich country with access to key land and sea routes linking the Arabian Sea with Central Asia, Pakistan holds significant potential to function as a regional trade and transit hub, reinforcing its emphasis on bilateral and multilateral economic cooperation (Masood et al., 2023; Zahra et al., 2022).

Many previous studies focus on total trade flows without differentiating between key sectors like agriculture and manufacturing, which are vital to Pakistan's economy. These aggregate analyses fail to capture nuances in sectoral trade performance, limiting their utility for policymakers aiming to promote targeted trade diversification and growth strategies. While some literature discusses the broader opportunities and future cooperation under the SCO, often remain theoretical and lack empirical validation (Ayusi & Nurhasanah, 2020; Gul et al., 2022). Additionally, future trade planning, export policy formulation, and industrial strategy development require forward-looking assessments and evidence-based recommendations. However, the literature is lacking in data-driven projections and strategic policy proposals that consider Pakistan's comparative advantage and potential role in strengthening intra-SCO trade. However some researchers in their studies have analyzed in a context of new perspectives, regional security and trade openings with SCO bloc (Mir Sherbaz Khetran, 2019; Rab & Zhilong, 2018). However, these studies are qualitative nature and hardly any study has assessed empirically, the implication of pre and post integration outcome within SCO on exports of Pakistan.

Against this background, this study empirically examines the impact of SCO membership on Pakistan's manufacturing exports using a Difference-in-Differences (DID) framework combined with the gravity model of trade. Exploiting Pakistan's accession to the SCO in 2017 as a quasi-natural experiment, the analysis compares manufacturing exports to SCO and non-SCO partners before and after membership. Focusing on key manufacturing industries healthcare products, rubber and plastics, mineral products, and textiles and garments at the HS 4-digit level, the study provides a sector-specific assessment of SCO-induced trade effects.

By adopting a robust econometric strategy and a sectoral perspective, this paper contributes to the literature on regional integration and trade in several ways. First, it provides causal evidence on the trade effects of SCO membership for a developing economy. Second, it extends existing research by focusing specifically on manufacturing exports, rather than aggregate trade flows. Finally, the findings offer important policy insights for Pakistan regarding industrial strategy, export diversification, and the effective utilization of regional trade arrangements.

2. Literature Review

The Shanghai Cooperation Organization (SCO) has emerged as an increasingly important regional bloc with growing economic relevance, supported by abundant natural resources, diversified industrial bases, and expanding infrastructure networks. Although initially focused on security cooperation, the SCO's economic agenda has gradually strengthened, fostering trade linkages and economic interdependence among member states. Empirical studies indicate that intra-SCO trade is largely driven by major economies such as China and Russia, reflecting their strong industrial capacity, energy resources, and well-established trade networks (Abudukeremu et al., 2024). Nevertheless, research on the SCO's trade effects remains limited compared to traditional regional blocs, particularly at the sectoral level.

Pakistan's accession to the SCO in 2017 marked a significant step in its regional economic and strategic integration. Owing to its geographic location and trade potential, Pakistan is viewed as an important regional actor capable of enhancing trade cooperation and connectivity among SCO members. Existing studies emphasize that SCO membership provides Pakistan with opportunities to strengthen political, security, and economic ties with China, Russia, and Central Asian economies (Mumtaz et al., 2025; Raza & Lin, 2024; Rehman et al., 2025). In particular, initiatives such as the China–Pakistan Economic Corridor (CPEC) have enhanced Pakistan's

strategic importance within the SCO by improving infrastructure, transport networks, and regional trade connectivity linking South Asia, Central Asia, and China (Opoku-Mensah et al., 2023).

Manufacturing exports play a pivotal role in Pakistan's trade structure and economic performance, contributing significantly to export earnings, employment generation, and industrial development. The sector is dominated by textiles and garments, followed by chemicals, pharmaceuticals, plastics, rubber products, and selected mineral-based manufactures (Aslam & Tariq, 2021b). Despite its potential, Pakistan's manufacturing sector faces persistent structural challenges, including low technological intensity, limited diversification, supply-side constraints, and high production costs. As a result, Pakistan remains weakly integrated into regional and global value chains. Regional trade arrangements such as the SCO are therefore viewed as important platforms for improving market access, reducing trade barriers, and enhancing manufacturing export competitiveness.

Overall, the literature suggests that Pakistan's manufacturing sector holds substantial potential to drive export-led growth if structural challenges are addressed and regional integration opportunities are effectively utilized. However, existing studies largely overlook the causal impact of SCO membership on Pakistan's manufacturing exports, particularly at a disaggregated sectoral level. This study addresses this gap by providing empirical evidence on the manufacturing export effects of SCO membership, thereby contributing to the broader literature on regional integration and trade performance.

3. Methodology and Data

This study applies a Difference-in-Differences (DID) framework combined with an augmented gravity model to examine the impact of Shanghai Cooperation Organization (SCO) membership on Pakistan's manufacturing exports. The DID approach allows for the identification of the causal effect of Pakistan's accession to the SCO by comparing export performance before and after membership, while controlling for time-invariant heterogeneity and common macroeconomic shocks. To capture sector-specific dynamics, the analysis focuses on key manufacturing industries classified health care products (HS 28-32), rubber and plastics products (HS 39-40), mineral products (HS 25-27), and textiles and garments (HS 52 and HS 61-63). These sectors are selected due to their strategic importance in Pakistan's manufacturing export structure and their varying degrees of trade responsiveness to regional integration. By integrating the DID estimator within a gravity-based trade framework, the study controls for standard bilateral trade determinants such as economic size, distance, and shared borders while isolating the effect of SCO membership on Pakistan's sectoral manufacturing exports.

The Difference-in-Differences (DID) method is a widely applied econometric approach for estimating the causal impact of policy interventions or institutional shocks by comparing changes in outcomes between treatment and control groups across pre- and post-policy periods. When combined with the gravity model of trade, DID enables the analysis to distinguish between structural trade determinants and policy-induced effects, providing a more precise understanding of how regional integration affects trade flows. The DID gravity based technique which is previously used in many panel data literatures(Ghossein et al., 2021; Imomnazar, 2018; Mahmood et al., 2022; Yu et al., 2020; Zhang et al., 2025; Zhou et al., 2023). These all combine gravity model variables with DID to evaluate their respective studies.

The specification for difference in difference, we generate two dummies with country dummy and time dummy. Country dummy there is two groups, those country which are participants (integrated to SCO) are treatment group and other those country which are not participants (not integrated to SCO) are control group. Similarly, in time dummy, separate pre and post integration time with SCO, as Pakistan became the SCO permanent member in 2017, so (pre-2011-2016=0 & post-2017-2023=1). By incorporating the standard gravity variables such as GDP, population, distance, border, and common language the combined model enhances the robustness of the empirical estimates and ensures that the identified SCO effect reflects genuine policy influence rather than external shocks or omitted variable bias. The combined Gravity-DID model for Pakistan's trade is formulated as follows:

$$MEX_{it} = \alpha + \beta Treated_{it} \times T_{it} + \sum \gamma Control_{it} + \nu_i + \delta_t + \varepsilon_{it} \qquad (1)$$

In Equation 1 where $\mathrm{MEX_{it}}$ show the manufacturing exports flow of Pakistan as a dependent variable. Treated is a dummy variable used to differentiate SCO members (treatment group) from those in the non-SCO members (control group). Treated value is 1 for countries in the SCO and 0 for those non-SCO members. T represents time dummy variable representing year of integrating with SCO. After the integration years a country given the number is 1, and for year before integration, given 0. Treated × T is the interaction term for evaluating SCO effects. The subscription, i, j and, t denotes countries and time, respectively. The positive and significant coefficient of β shows SCO has a significant effect on Pakistan's exports Pakistan with SCO members. ∑ combine set of

independent gravity variables. α, represents the intercept term, v, represents country fixed effects, δ, represents time fixed effects, and ε, denotes the error term in the model.

A positive and statistically significant coefficient **β** indicates that SCO membership had a trade-enhancing effect on Pakistan's manufacturing exports relative to non-member countries, after accounting for global trade dynamics and country-specific characteristics.

Accordingly, in consistent with Equation 1 the following equation specify the models for manufacturing exports.

$$AEX_{ijt} = \alpha + \beta_1 SCO_{ijt} + \beta_2 GDP_{it} \times \beta_2 GDP_{jt} + \beta_3 POP_{ijt} \times \beta_3 POP_{ijt} + \beta_4 DIST_{ijt} + \beta_5 LNG_{ijt} + \beta_6 BDR_{ijt} + vi + \delta t + \varepsilon it \quad (2)$$

Where the variable SCO (replacing the interaction term Treated × Time) is the key DID variable capturing Pakistan's manufacturing export response after integration with the SCO.

3.1 Data Source and Descriptions

In this study the dataset employed comprises of a balanced panel of 32 countries, with both treatment and control groups, observed over 13 years (2011–2023). The data used in this study was sourced from several reputable databases, including the World Indicator Trade Solution, WITS, International Trade Center, ITC, World Development Indicators, WDI and the CEPII database. To assess market size, consumption, and demand potential between Pakistan and its trading partners, the study applied data on gross domestic product, GDP and population from the WDI. In addition, information on linguistic similarities, border commonalities, and geographical distance data was obtained from the CEPII database. For further details on the selected variables, their sources, and descriptions, please refer to Table 1.

Table 1. Description of Variables and Data Sources

Symbol	Variable	Source	Expected Sign
MEX_{ijt}	Exports value to each Partner country j	ITC-WITS	Dependent Variable
SCO_{ijt}	DID variable capturing SCO effect	SCO website	+
$GDP_{it} \times GDP_{jt}$	GDP of both trading partners	WDI	+
$POP_{it} \times P0P_{jt}$	Population of both partners	WDI	+
$DIST_{ijt}$	Distance between i & j	CEPII	–
LNG_{ijt}	=1 if both i & j share a common language	CEPII	+
BDR_{ijt}	=1 if Pakistan shares a border with j	CEPII	+

Source: Author's calculation

4. Results and Discussion

This chapter includes first descriptive analysis to evaluate Pakistan pre and post Manufacturing exports performance with SCO followed by the comprehensive empirical analysis. Before diving into the empirical results, a descriptive analysis provides a preliminary overview of manufacturing export trends and patterns. This includes an examination of manufacturing exports before and after Pakistan's integration into the SCO, highlighting general shifts in trade volume and direction. The analysis also compares

average manufacturing exports to SCO countries in the periods before and after 2017, offering an initial gauge of the impact of regional integration. Additionally, product-wise and country-wise export trends are assessed to identify which specific manufactured goods and destination markets experienced the most notable changes. These insights serve as a foundation for the empirical discussion that follows, helping to contextualize the statistical findings and guide trade policy recommendations.

4.1 Pre and Post Overview of Pakistan Manufacturing Exports

Table 2. provides a comparative picture of Pakistan's manufacturing exports to SCO member states before and after Pakistan's permanent integration into the organization in 2017. In the pre-integration phase (2010–2016), exports rose gradually from USD 1,192,728 in 2010 to USD 1,292,194 in 2016. However, the annual growth rates during this period remained relatively modest, fluctuating between 1.19% and 1.63%, reflecting slow but stable expansion. In the post-integration period (2017–2023), manufacturing exports showed a continued upward trend, increasing from USD 1,310,101 in 2017 to USD 1,448,155 in 2023. Growth rates during this phase were also modest but relatively more consistent compared to the pre-integration era, ranging from 1.37% to 1.99%. The highest growth was recorded in 2019 (1.99%) and 2023 (1.98%), suggesting a gradual strengthening of Pakistan's manufacturing export performance in the SCO market. Overall, the comparison indicates that while both periods witnessed steady growth, the post-integration phase reflects slightly more stable and sustained improvements in manufacturing exports.

Table 2. Pakistan's Manufacturing Exports to SCO, Pre and Post Overview

Pre-Integration			Post-Integration		
Year	Exports to SCO	Growth Rate	Year	Exports to SCO	Growth Rate
2010	1192728	--	2017	1310101	--
2011	1210170	1.462362	2018	1331116	1.604075
2012	1229931	1.632911	2019	1357587	1.988632
2013	1246326	1.333002	2020	1376590	1.399763
2014	1261738	1.236595	2021	1395527	1.375646
2015	1276965	1.206827	2022	1420080	1.759407
2016	1292194	1.192593	2023	1448155	1.977001

Source: Author's calculations based on data from UN Comtrade (2023)

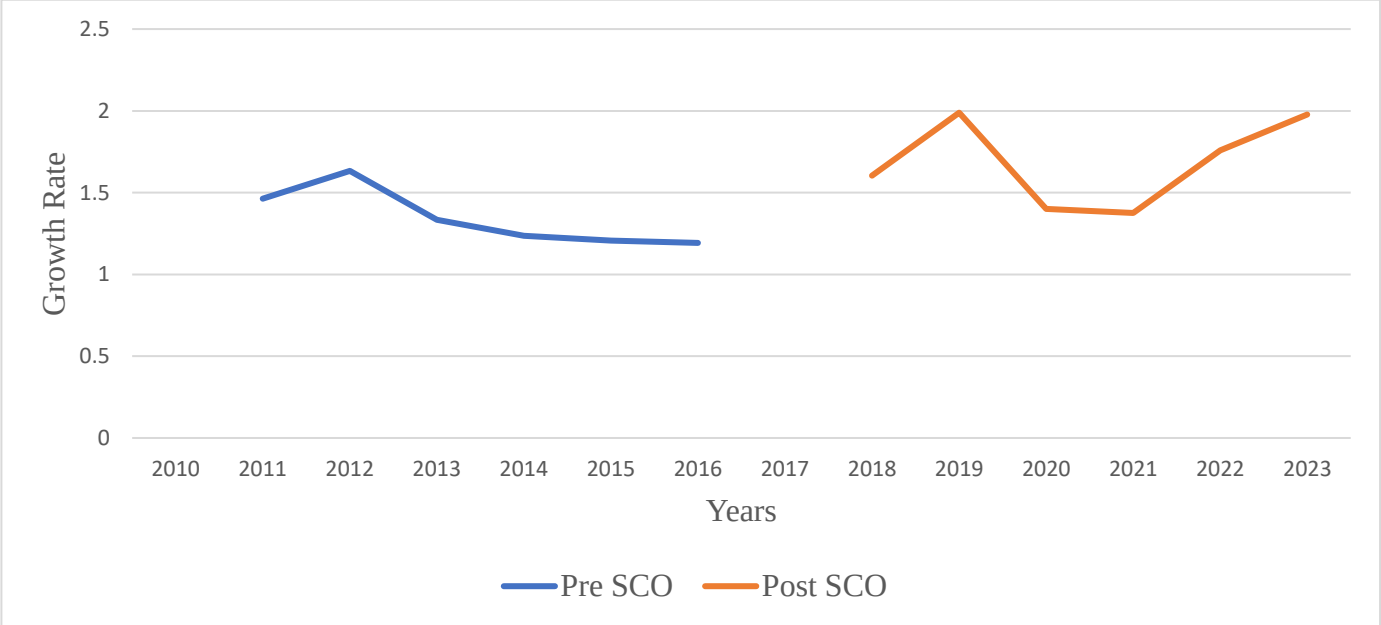

Figure 1. Comparison of pre-post overview of manufacturing exports

Source: Author's calculations, based on table 2.

4.2 Pakistan Export Growth Trends of Priority Sectors in Intra- SCO Trade

Table 3. revealing both absolute changes and growth rates of exports growth trends of priority sectors. The evaluation insights sectoral distinctions in performance, highlighting that which sector more active in growing its trade footmark within the SCO.

Table 3. Export Growth Trends of Pakistan's Priority Sectors in Intra-SCO Trade (2019–2023)

Sectors	2019	2023	Absolute Change	Growth Rate
Agri-based Products	771300	1037162	265862	34.4693
Health care	33426	44694	11268	33.7103
Textile and Garments	1018436	1134567	116131	11.4029
Mineral	223305	244567	21262	9.52151
Rubber and Plastics	25854	27595	1741	6.73397

Source: Author's calculations based on data from UN Comtrade (2023)

The healthcare sector emerged as the strongest contributor to Pakistan's export growth, rising from USD 33,426 million in 2019 to USD 44,694 million in 2023, reflecting expanding opportunities in pharmaceuticals and medical products within the SCO region after COVID-19. Textiles and garments, although dominant in value, recorded moderate growth of 11.4 percent, indicating increasing regional competition. Mineral exports also grew modestly, suggesting stable but limited demand and the need for value addition. Rubber and plastic exports showed the weakest performance, reflecting intense competitive pressures. Overall, the mixed sectoral trends highlight the importance of diversifying Pakistan's export structure beyond traditional sectors to strengthen trade integration within the SCO.

The empirical analysis of Pakistan's exports to SCO countries is structured around several key stages. First, the pre-treatment trends are examined through an event study framework to validate the parallel trends assumption, ensuring the strength of the DID approach. Building on this, the baseline regression results are presented to evaluate the effect of SCO integration on performance of agricultural export. To strengthen the reliability of these findings, a set of robustness checks is conducted. These include a placebo test using the log-linear model to verify the absence of spurious effects, and alternative estimations applied the PPML technique to address issues of zero trade value and hetero. Finally, the analysis extends to sectoral wise heterogeneity within manufacturing exports response to SCO integration.

4.3 Descriptive Statistics

Table 4. reports the descriptive statistics for the model examining Pakistan's manufacturing exports to SCO and non-SCO countries. The SCO mean (0.415) again confirms balanced observations between treatment and control groups, ensuring internal validity of the DID design. The GDP and population variables show similar means (36.63 and 34.46), reflecting that Pakistan's manufacturing exports are oriented toward economically diverse markets. The mean distance (11.53) indicates broad geographical coverage, while border (0.545) and language (0.454) dummies highlight the continued role of proximity and cultural familiarity in shaping manufacturing trade patterns. The mean value of manufacturing exports (12.68 in log terms) lies between total and agricultural exports, showing manufacturing's relatively higher export intensity and value-added contribution. The moderate standard deviation (1.91) reveals meaningful variability across destinations, suitable for econometric estimation. This dispersion reflects differences in industrial competitiveness and market access, consistent with theoretical expectations of the gravity model. The variation also signals the potential influence of SCO-driven initiatives Pakistan's manufacturing export expansion.

Table 4. Descriptive Statistics for the variables

Variables	Mean	Standard Deviation	Minimum	Maximum	Observations
SCO (Dummy)	0.415	0.493	0	1	416

GDP (ln)	36.626	1.987	35.543	38.766	416
Population (ln)	34.461	1.087	32.768	36.786	416
Distance (ln)	11.525	1.870	6.753	11.545	416
Language (Dummy)	0.454	0.497	0	1	416
Border (Dummy)	0.545	0.497	0	1	416
Total Exports	12.684	2.312	7.845	21.253	416

Source: Author's Calculations based on Study Data

4.4 Multicollinearity Assessment

VIF results for manufacturing exports in Table 5. indicate the multicollinearity is not a problem in the model. All VIF values remain well below the common threshold of 10, with most variables ranging between 1.2 and 4.2. GDP (4.19) and population (3.22) show relatively higher VIF values compared to other predictors, which is expected given their close association, but these levels are still acceptable and do not pose estimation problems. Other variables such as SCO membership (1.24), distance (1.67), language (1.45), and border (1.62) demonstrate very low multicollinearity. The mean VIF value of 2.08 further supports that the explanatory variables in the manufacturing export model are sufficiently independent, ensuring the reliability of regression estimates.

Table 5. Multicollinearity Assessment VIF

(Variables)	(VIF)	(1/VIF)
SCO	1.24	0.864309
GDP	4.19	0.437890
Population	3.22	0.345662
Distance	1.67	0.263790
Language	1.45	0.768907
Border	1.62	0.654387
Mean VIF	2.08	--

Source: Author's Calculations based on Study Data

4.5 Pre-Treatment Trends (Parallel Trends Assumption)

Before estimating the baseline Difference-in-Differences (DID) model, a pretreatment event study was conducted to test the parallel trend assumption, which is a critical prerequisite for the validity of DID inference. This test examines whether the treated and control groups exhibited similar export trends before Pakistan's accession to the SCO. The confirmation of this assumption provides a strong foundation for attributing any post-treatment effects specifically to SCO integration, rather than to pre-existing differences between the groups.

The graph Figure 2. illustrates the pre-treatment trends in manufacturing exports for Pakistan (a future SCO member) compared to non-SCO countries from 2011 to 2017. The blue line represents the manufacturing export trends of countries outside the SCO, showing a steady and moderate increase over the years. In contrast, the red dashed line reflects Pakistan's manufacturing export trend prior to its SCO membership, which closely mirrors the trend of non-SCO countries. Both lines exhibit similar growth patterns with minor fluctuations and no sharp deviations. The vertical dashed line at 2017 marks the point of Pakistan's SCO accession, and the alignment of trends before this point reinforces the Parallel Trends Assumption. This indicates that, prior to joining the SCO, Pakistan's manufacturing export performance was comparable to that of non-member countries, validating the suitability of the DID approach.

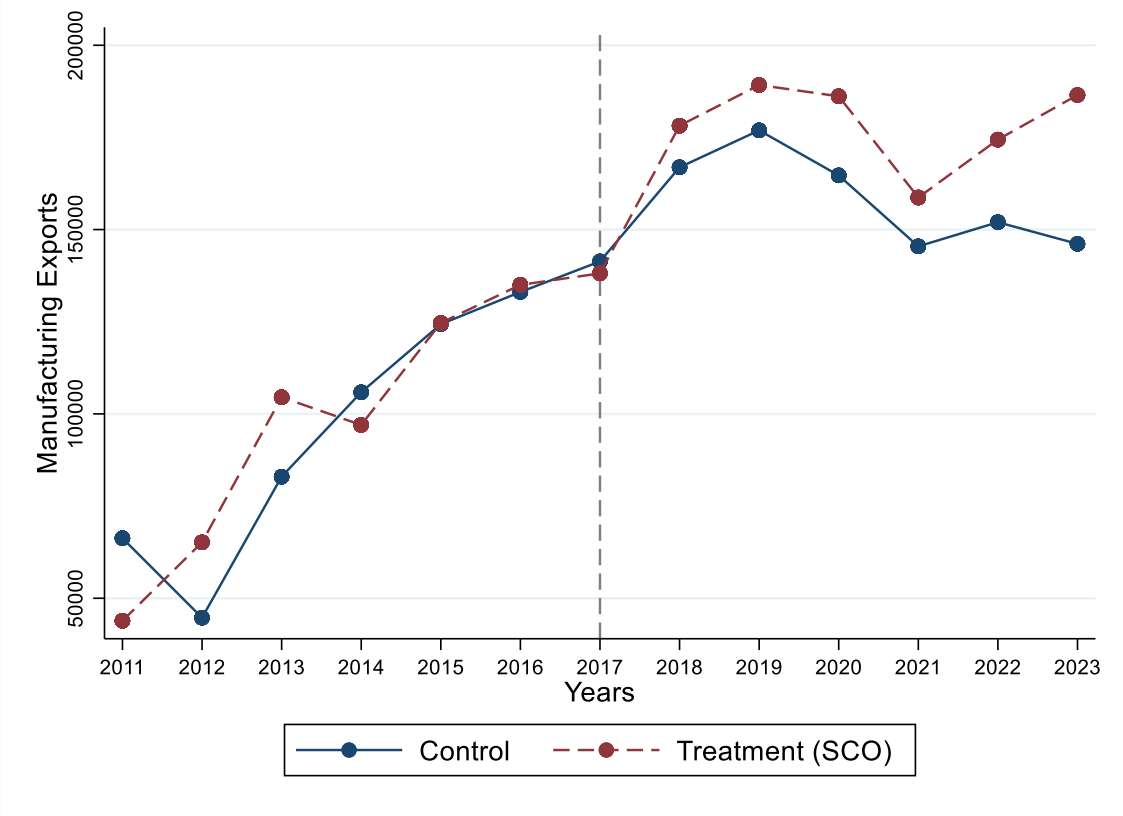

Figure 2. Graphical Representation of Parallel Trend Assumption

Source: Author's Calculations based on Study Data (Stata generated)

4.6 Baseline DID Results for Manufacturing Exports

The baseline DID estimation for manufacturing exports investigates how Pakistan's industrial trade performance has evolved under SCO integration. Manufacturing exports, being more sensitive to competitiveness, infrastructure, and trade facilitation measures, provide an important perspective on whether integration benefits extend beyond primary goods. By comparing the both groups control and treatment for pre and post integration pe, results reveal whether Pakistan's manufacturing exports experienced significant improvements, stagnation, or vulnerabilities in the SCO framework.

Table 6. Baseline DID Results

VARIABLES	Baseline Result
SCO_{ijt}	0.384***
	(0.248)
$GDP_{it} \times GDP_{jt}$	0.482***
	(0.074)
$POP_{it} \times P0P_{jt}$	0.235***
	(0.092)
$DIST_{ijt}$	-0.112
	(0.139)
LNG_{ijt}	0.506***
	(0.512)
BDR_{ijt}	0.098***
	(0.303)
Const	22.13***
	(2.343)

Observations	416
R squared	0.535
Country FE	Yes
Time Effect	Yes

"Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1"

The coefficient for SCO in Table 6. (0.384) statistically positive and significant with 1% level indicating that SCO membership has a positive and significant impact on manufacturing exports. Specifically, the coefficient suggests that after Pakistan's integration into the SCO in 2017, manufacturing exports to SCO countries increased, highlighting the benefits of regional economic cooperation through the SCO for Pakistan's manufacturing sector. The R-squared value (0.535) indicates that approximately 53% of the variations in manufacturing exports is explained by the explanatory variables. A moderate fit model effectively explains a significant portion of the variability in manufacturing exports. Furthermore, the findings are align with prevailing empirical studies (Bano & Mujahid, n.d.; Ghossein et al., 2021; Shahzad et al., 2024; Zhou et al., 2023) investigated that regional trade cooperation incline to enhance trade flows among member states.

The baseline regression results indicate that SCO membership has had a positive impact on manufacturing export, to SCO countries. The significant SCO coefficient indicates manufacturing exports, have increased following its integration into the SCO, demonstrating the positive effect of regional economic cooperation. Key determinants such as the economic size, population, distance, shared language, and border relationships all contribute to explaining variations in manufacturing trade with SCO countries. The positive treatment effect for SCO membership aligns with expectations that regional cooperation and improved trade agreements within the SCO framework have facilitated trade in agricultural products. These results underline the importance of regional trade integration for enhancing Pakistan's agricultural sector, particularly through SCO-driven policies that foster stronger economic and political ties between Pakistan and its SCO partners.

4.7 Tests of Robustness

To reinforce the estimation consistency and soundness of the baseline findings, the study conducts some additional tests which are crucial for the robustness of the baseline results and offer extra endorsement for the decisions examined through this analysis. These additional tests include Placebo Test (Randomly Assigning Treatment), and alternative estimation techniques. By examining to this robustness, the study reinforces the credibility and consistency of the results from the regression analysis.

Placebo Test

The Placebo test applied to confirm the consistency and soundness of the findings obtained from the DID model, which estimates the Pakistan's effect of its accession to the SCO on exports. The placebo test helps assess whether the observed treatment effect could be due to random chance rather than the actual treatment.

Table 7. Placebo Test Results

VARIABLES	Original DID	Placebo
Placebo Treatment		0.363
		(0.241)
Placebo DID		-0.477
		(0.303)
DID	0.384***	
	(0.248)	
$GDP_{it} \times GDP_{jt}$	0.482***	0.344***
	(0.058)	(0.070)
$POP_{it} \times P0P_{jt}$	0.235***	0.346***
	(0.061)	(0.074)
$\mathrm{DIST_{ijt}}$	-0.112	0.076
	(0.132)	(0.148)

VARIABLES	Original DID	Placebo
LNG_{ijt}	-2.506***	-2.725***
	(0.729)	(0.820)
BDR_{ijt}	1.498***	1.255***
	(0.410)	(0.461)
Const	-22.13***	-20.99***
	(2.006)	(2.350)
Observations	416	416
R squared	0.535	0.428

"Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1"

Table 7. provides the Placebo Test results for Pakistan's manufacturing exports, the coefficient for placebo treatment is statistically insignificant signifying that no spurious effect detected during the false treatment period. This lack of a significant placebo effect suggests that the observed increase in manufacturing exports after Pakistan's SCO membership in 2017 can be confidently attributed to the actual treatment (SCO membership) rather than to other unrelated factors.

The fact that the placebo did coefficient also shows no statistically significant effect reinforces the conclusion that the positive effect observed for Pakistan's manufacturing exports post-2017 is genuine. This further strengthen the robustness of DID model ensuring that the increase in manufacturing exports cannot be explained by pre-existing trends or random fluctuations. Such an approach aligns with established methodologies in the DID literature, including (Callaway & Sant'Anna, 2021; Eichengreen et al., 2021; Ferman, 2022; Hagemann, 2019).

Changes to Estimation Technique (PPML)

Further confirm the robustness of our results, the study applied different estimation techniques such as PPML to justify the consistency of the baseline DID estimations. PPML model is well-suited designed model for international trade data, particularly when dealing with zero trade flow and non-negative values. PPML more effective for issues like heteroskedasticity and zero trade data, contributing reliable estimations in spite of these challenges.

Table 8. PPML Results

VARIABLES	PPML
SCO_{ijt}	1.130***
	(0.211)
$GDP_{it} \times GDP_{jt}$	0.424***
	(0.084)
$POP_{it} \times P0P_{jt}$	0.488***
	(0.117)
DIST_{ijt}	-1.446***
	(0.167)
LNG_{ijt}	-3.764***
	(0.336)
BDR_{ijt}	0.147
	(0.257)
Const	-17.15***
	(3.015)
Observations	416
R squared	0.672

"Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1"

Table 8. provides the result of PPML assessment, confirm that the SCO membership on manufacturing-exports is not attained by model specification problems or the treatment of zero trade flows. The reliability between the two methods further strengthens the strength of the original findings, offering for more dependable conclusion regarding the role of SCO integration in promoting trade performance of Pakistan. The PPML model shows a little higher positive impact of SCO integration on exports than other estimations, with 0.672 R-squared value, displaying a well-adjusted model. The findings of PPML analysis reveals that the exports of Pakistan effect positively with SCO which clearly align the studies which are evaluate that the regional cooperation enhance the trade flow of members (Bhowmik et al., 2021; Ullah et al., 2021) in contrast with (Bano & Mujahid, 2021).

4.8 Heterogeneity Analysis in Manufacturing Exports

Even though collective manufacturing exports offer a wide picture of Pakistan's performance with SCO members, however, it may hide the significant differences across industrial sub-sectors. Conducting a sub-sectoral heterogeneity analysis allows us to identify whether Pakistan's manufacturing gains from SCO integration are driven primarily by textiles or whether there is broader diversification across industrial categories. This approach highlights structural strengths and weaknesses, thereby offering more nuanced policy insights.

Table 9. Sub-Sectoral Heterogeneity Results

VARIABLES	Textile & Garments	Rubber & Plastics	Minerals & Metals	Health & Care
SCO × HS 52, 61-63	0.272* (0.301)			
SCO × HS 39-40		0.093** (0.362)		
SCO × HS 25-27			0.615*** (0.277)	
SCO × HS 28-32				0.874*** (0.398)
Constant	55.27*** (2.614)	49.83** (2.218)	62.45*** (2.737)	46.37** (2.119)
R-squared	0.651	0.608	0.694	0.576
Observations	416	416	416	416
Country FE	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes

"Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1"

The regression results in Table 9. reveal varying impacts of SCO membership across subsectors. Health and care show a strong positive effect (coef. 0.874, 1%), confirming their dominant role in manufacturing exports of Pakistan and the gains expanded to access to China, Russia, and Central Asia. Rubber and plastics also benefitted (coef. 0.093, 5%), reflecting gradual diversification beyond textiles. The largest effect appears in minerals and metals, with a coefficient of 0.615 (1%), underscoring their rising importance in SCO trade, driven by Chinese demand and Central Asian industrialization. Textile and garments products show modest gains (coef. 0.272, 10%), highlighting potential constrained by competition and regulatory barriers. Overall, the results suggest SCO integration reinforced Pakistan's strengths in textiles and minerals while opening diversification opportunities in rubber, plastics, and health sectors.

4.9 Limitations and Future Research

A key limitation of this study is that the heterogeneity analysis is confined to four selected manufacturing sectors and relies on HS 2-digit classification, which may mask finer product-level variations in export performance. Future research can address this limitation by extending the analysis to all manufacturing sectors and employing more disaggregated HS 4-digit and 6-digit data to provide deeper insights into product-specific trade effects of SCO membership. Second, while the DID approach controls for time-invariant unobserved factors, it may not fully capture the influence of non-trade SCO initiatives, such as security cooperation or investment flows, that indirectly affect exports. Third, the study focuses on the post-2017 period, which includes external shocks such as the COVID-19 pandemic that may have influenced trade outcomes. Future research could extend this analysis by incorporating firm-level data, examining export quality and technological intensity, or exploring the interaction between SCO membership, foreign direct investment, and manufacturing productivity in Pakistan.

5. Conclusion

This study investigated the impact of Pakistan's membership in the Shanghai Cooperation Organization (SCO) on its manufacturing exports using a Difference-in-Differences framework combined with a gravity model. The empirical results provide robust evidence that SCO accession in 2017 has had a positive and statistically significant effect on Pakistan's manufacturing export performance. Descriptive trends indicate more stable and sustained export growth in the post-integration period, while sectoral analysis reveals heterogeneous effects across manufacturing industries.

Among the analyzed sectors, healthcare products emerged as the most dynamic, suggesting that Pakistan has begun to exploit new export opportunities within the SCO market. In contrast, traditional sectors such as textiles and garments, minerals, and rubber and plastics exhibited relatively modest growth, indicating persistent structural and competitiveness challenges. The robustness of the results validated through parallel trend testing, placebo checks, and alternative PPML estimation confirms that the observed export gains are genuinely attributable to SCO membership rather than pre-existing trends or estimation bias. The heterogeneity analysis reveals that the impact of SCO membership on Pakistan's manufacturing exports is uneven across sub-sectors. Strong and statistically significant gains are concentrated in health and care products and minerals and metals, indicating that SCO integration has facilitated diversification beyond traditional textile exports. While textiles and garments show only modest improvements, the results highlight emerging opportunities in higher value-added and resource-based manufacturing sectors within the SCO market. Overall, the findings demonstrate that regional integration through the SCO has contributed positively to Pakistan's manufacturing exports, though the magnitude of the impact remains moderate and uneven across sectors.

5.1 Policy Recommendations

Based on the empirical findings, several targeted policy implications emerge. First, Pakistan should leverage the SCO framework more strategically by negotiating sector-specific trade facilitation measures, particularly for high-potential industries such as pharmaceuticals and healthcare products. Second, the relatively slow growth in textiles and other traditional manufacturing sectors highlights the need for industrial upgrading, product diversification, and value-added production to maintain competitiveness within the SCO region. Third, given the positive role of shared borders and market size, Pakistan should strengthen cross-border infrastructure, logistics, and customs cooperation with neighboring SCO members to further reduce trade costs. Finally, export promotion policies should be aligned with regional integration goals by supporting firms' participation in regional value chains, improving standards compliance, and enhancing technological capabilities in manufacturing.

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