



**Impact of 2022 Floods on Pakistan's Exports**

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## Abstract

This study examines the effect of the floods that took place in Pakistan in 2022 on the performance of Pakistan's trade, in particular on aggregate trade export, and the balance of trade as well as sector based export outcomes. Using annual data from 2010 to 2024, the analysis uses time series regression, sectoral panels estimation and Difference in Differences framework to quantify the flood related trade disruptions. The results show aggregate export both declined by about USD 1.84 billion in the flood year, and the trade balance worsened by almost USD 3.92 billion, which shows concurrent losses of export and higher import requirements. Flood effects are highly heterogeneous and result in sectoral analysis. Agriculture based exports and textile, and apparel exports saw the high largest declines with estimated losses of USD 1.12 billion and USD 0.98 billion respectively, while manufacturing and surgical goods had a relative resilience. Difference in Differences estimates also support the fact that the high exposure sectors experienced an extra export loss of about USD 1.74 billion as compared to the low exposure sectors during the flood year. The persistence and stability of those results is supported by robustness checks on the persistence of the results with alternative ways of measuring flood exposures as well as lagged specification. Overall, the evidence shows extensive and disproportionate costs of 2022 floods for Pakistan in terms of trade resulting in significant vulnerabilities of climate sensitive export structures to extreme weather events.

**Keywords:** floods, exports, trade balance, sectoral analysis, climate impacts

## Table of Contents

Abstract .....	ii
Table of Contents .....	iii
List of Figures .....	vi
List of Tables .....	vii
Chapter 1: Introduction .....	1
1.1 Background of the Study .....	1
1.2 Problem Statement .....	5
1.3 Research Objectives .....	5
1.4 Research Questions .....	6
1.5 Significance of the Study .....	6
Chapter 2: Literature Review .....	7
2.1 Theoretical Framework .....	7
2.2 Empirical Studies .....	11
2.3 Research Gap.....	15
Chapter 3: Methodology .....	19
3.1 Research design.....	19
3.2 Data sources and period of analysis .....	19
3.3 Sector classification and construction of sectoral exports .....	20
3.4 Definition of variables.....	21

3.5 Aggregate export model specification.....	22
3.6 Trade balance model specification .....	22
3.7 Sectoral panel data model .....	22
3.8 Difference in Differences approach .....	23
3.9 Estimation techniques and diagnostic tests .....	24
3.10 Ethical considerations and limitations.....	24
Chapter 4: Empirical Results.....	25
4.1 Introduction to empirical results .....	25
4.2 Descriptive statistics and data overview .....	25
4.2.1 Summary statistics of key variables.....	25
4.2.2 Year wise trends in exports and trade balance.....	27
4.2.3 Pre flood, flood year, and post flood comparison .....	30
4.3 Stationarity and diagnostic test results .....	32
4.3.1 Unit root test results .....	33
4.3.2 Model diagnostic tests.....	35
4.4 Impact of floods on aggregate exports .....	37
4.4.1 Export regression results .....	38
4.4.2 Interpretation of Flood Effect on Exports .....	40
4.5 Impact of floods on the trade balance .....	41
4.5.1 Trade balance regression results.....	41

4.6 Sector based export regression results .....	45
4.6.1 Sectoral fixed effects model results .....	45
4.6.3 Comparative sectoral export impacts .....	47
4.7 Difference in Differences analysis .....	49
4.7.1 High exposure and low exposure sector classification.....	49
4.7.2 Difference in Differences estimation results .....	50
4.7.3 Assessment of differential sectoral effects .....	53
4.8 Robustness checks.....	54
4.8.1 Alternative measures of flood exposure .....	54
4.8.2 Lagged flood effects.....	56
4.8.3 Sensitivity analysis.....	58
4.9 Summary of empirical findings.....	58
Chapter 5: Conclusion and Recommendations .....	60
5.1: Conclusion .....	60
5.2 Recommendations .....	61
References .....	63

## List of Figures

Figure 1: Total exports of Pakistan 2010 to 2024 USD billion.....	28
Figure 2: Trade balance of Pakistan 2010 to 2024 USD billion.....	29
Figure 3: Average exports by flood period USD billion .....	31
Figure 4: Average trade balance by flood period USD billion .....	32
Figure 5: Total exports level and first difference series .....	35
Figure 6: Histogram of standardized residuals for export model.....	37
Figure 7: Actual and fitted values of total exports .....	39
Figure 8: Flood coefficient estimates across export models .....	40
Figure 9: Actual and fitted trade balance values .....	43
Figure 10: Flood coefficient estimates for trade balance models.....	44
Figure 11: Sectoral export deviations during the flood year .....	46
Figure 12: Comparative flood impact across export sectors .....	49
Figure 13: Export trends for high exposure and low exposure sectors .....	52
Figure 14: Flood impact comparison between exposure groups.....	54
Figure 15: Flood coefficient estimates using alternative exposure measures .....	56
Figure 16: Contemporaneous and lagged flood effects.....	57

## List of Tables

Table 1: Descriptive statistics of aggregate trade and macroeconomic variables 2010 to 2024.....	26
Table 2: Descriptive statistics of sector based exports USD billion .....	26
Table 3: Descriptive statistics of flood indicator.....	27
Table 4: Year wise exports and trade balance.....	29
Table 5: Comparison of trade outcomes across flood periods .....	30
Table 6: Augmented Dickey Fuller unit root test results.....	33
Table 7: KPSS stationarity test results .....	34
Table 8: Breusch Godfrey test for autocorrelation .....	36
Table 9: Breusch Pagan heteroskedasticity test.....	36
Table 10: Jarque Bera normality test.....	36
Table 11: Aggregate export regression results.....	38
Table 12: Alternative export regression specification .....	39
Table 13: Trade balance regression results.....	42
Table 14: Alternative trade balance regression specification .....	43
Table 15: Sectoral fixed effects regression results .....	45
Table 16: Sectoral random effects regression results .....	47
Table 17: Hausman test results.....	47
Table 18: Estimated flood impact by export sector USD billion .....	48
Table 19: Classification of export sectors by flood exposure .....	50
Table 20: Difference in Differences regression results .....	50
Table 21: Pre flood average exports by exposure group USD billion.....	52

Table 22: Decomposition of flood impact on sectoral exports USD billion .....	53
Table 23: Export regression results using alternative flood indicators .....	55
Table 24: Lagged flood effects on exports and trade balance .....	57
Table 25: Sensitivity analysis results for export model.....	58

## Chapter 1: Introduction

### 1.1 Background of the Study

The summer monsoon of 2022 produced one of the most destructive flooding episodes in Pakistan's modern record, with cascading hydrometeorological and cryospheric drivers interacting across the Indus Basin to generate prolonged inundation, flash floods, and infrastructure collapse. The cause of the event presented by peer-reviewed assessments involves the multiday extreme precipitation of the soils that were already saturated, along with seen effects of antecedent heatwaves and contributions by glacial lakes that resulted in the heightened runoff pulses due to the Indus and its tributaries (Nanditha et al., 2023). The spatial footprint of inundation has been demonstrated by satellites, even used in Sindh, which have never been seen before, and parts of Balochistan, Punjab, and Khyber Pakhtunkhwa, both of which were still covered with floods that have lasted several months in low-lying areas (Qamer et al., 2023; Wang et al., 2024). These hydrological shocks translated directly into a socioeconomic emergency for the whole country with a concentration of damage in agriculture, housing, transport and energy systems (the backbone of Pakistan's growth and external trade).

Official assessments have concluded that there were some 33 million affected people in some 94 calamity-hit districts within and around the same period as individual states and regional jurisdictions reported fatalities of more than 1,700 persons during the peak months of July to September 2022, but also injuries, disease burdens and losses in livelihoods that ensued well into 2023 (National Disaster Management Authority [NDMA], 2022). Damage and loss estimates prepared in the government-led Post-Disaster Needs Assessment with the support of the World Bank, Asian Development Bank, European Union, and United Nations estimated direct damages of around 14.9 billion United States dollars and economic losses of around 15.2 billion United States dollars and reconstruction and resilience needs of around 16.3 billion United States dollars (UNDP, 2022). Although conservative for reasons of post-event verification

which is not conclusive due to the changeable environment of the incidents, the estimated cost of losses is consistent with the independent scientific syntheses estimating the overall macroeconomic shock into tens of billions and delimited to domain of agriculture and the loss of infrastructure (Cui et al., 2025; Qamer et al., 2023).

The sectoral pattern of impacts particularly was adverse in respect of agriculture, which is a soul of the export base and rural employment in Pakistan. Synthetic aperture radar in conjunction with multispectral imagery based remote sensing also record widespread submergence of cotton and rice and sugarcane fields at the beneficent phenological stages over croplands in Sindh and southern Punjab (Kharif). (Qamer et al., 2023; Chen et al., 2024). The existence of high-resolution damage mapping proves that the continuous standing water and sediment deposition postponed next cycle of the Rabi sowing that debilitated the yield and suppressed recovery curves till the beginning of 2023 (Wang et al., 2024). These biophysical shocks interacted with loss of livestock, destruction of seed and inputs, contamination of irrigation networks and have exposed farm household incomes, and food security risks even further in floodplains which are already high in multidimensional poverty.

The infrastructure damage caused by the floods was equally damaging. Government estimates derive huge damages and chemicals damage of transport corridors, such as thousands of higher attains of roads and hundreds of bridges which link a purely generated place to home and export market and broken railway divisions and logistics hubs as part of bulk commodity move on (Babar et al., 2025; NDMA, 2022). Hydrometeorological extremes also endangered the energy infrastructure by undermining embankments, damaging the distribution lines, and subjecting the generation assets during emergency operations, adding to already existing reliability challenges (IMF, 2024). In addition, scientific field observations at the Swat River basin and other catchments of the North demonstrate the evolution of the morphology of the channel and loads of the Hydraulics using the scientific method, which further exposed settlements and critical facilities to more hazards and consequents to be considered in long-term Risk management and Recovery Standards (Bazai et al., 2024).

From an energetic-climatological point of view, agreement with an intensification of hydroclimate extremes in the context of an anthropogenic warming event, as 2022 flooding. The presence of process-based attribution and diagnostics suggests that the event was caused by the combination of a collision of monsoon depressions fed in a sequence of the Bay of Bengal and the abnormally high precipitable water and a heat-induced melting of glaciers and snows in addition to augmenting the coefficients of runoff, which raised the peak flows in deltaic and alluvial systems and extended backplash inundation periods (Nanditha et al., 2023). National-scale summaries highlight how many folds of the climatologic rainfall were emptied on the southern lowlands through brief periods, and the antecedent condition was this parameter caused both human systems and hydrology to be preconditioned to increased vulnerability, made in March and April (Cui et al., 2025). Exposure, sensitivity and adaptive capacity are shown to be important relationships in the flood outcome in both provinces, but where land subsidence, river training works and settlement characteristics have resulted in the enlargement of the anthropogenic flood plain the focus of the current paper (Chen et al., 2024; Wang et al., 2024).

The externalities of the macroeconomy were short-term and cross-cutting. The loss of farming production and the interruption of supply chains meant that food prices in the own country rose and import quantity and scope increased, while power and transport losses limited industrial production including for the textile industry that depends on the import of cotton, including supply chains through flooded districts. At the same time, the relief and rehabilitation burden resulted in increased fiscal gap, and foreign exchange shortage constrained the speed of reconstruction needed capital imports. Although, some of the losses were partially compensated by subsequent harvests and shocks to global markets, the resulting short-run balance of payments pressures and spikes in inflation painted a clear line to the shock from the flood through the supply side channels (IMF, 2024). These cascades correspond with the wider literature on disaster economics that has shown how infrastructure systems, when damaged concurrently in both transport and energy systems, extend productivity losses across whole regions devastated by disasters as well as stimulate the competitiveness of imports and exports at least in the medium potential (Bazai et al., 2024; Iqbal et al., 2024).

Spatially explicit studies enhance additional granularity on magnitude and distribution of damages. Quantification of the loss of crop-specific production from multi-sensor satellite data, in particular, high damages intensities in tehsils of lower Sindh where rice is grown and in the cotton belts which anchor Pakistan's export manufacturing (Qamer et al., 2023). Cointegrating work on Remote Sensing of Environment adds to the work on inundation the use of causal diagnostics that could be used to trace how monsoon changes, antecedent drought, soil moisture priming created the hydrological extremes that surpassed the critical design levels on flood defenses and drainage systems (Chen et al., 2024). Natural Hazards analyses based on multi-source data support that many built-up regions and irrigated areas experienced concurrent exposure, which enlarged the scale and the intricacy of recovery actions and to further reveal the hotspots where the entrance of waterlogging problem existed much beyond the peak of rainfall intensity (Wang et al., 2024). The Natural Hazards and Earth System Sciences reports of the Swat system at the basin level report sediment-filled surges and channel migration that eroded protective banks and weak areas at bridge abutments that is claimed to have a mechanistic reason on transport outages found in official tallying of damages (Bazai et al., 2024).

Against this empirical background, the present thesis places the 2022 floods in perspective as watershed in the risk-development nexus in the case of Pakistan. The official statistics available on affected populations, damages and losses, compiled by NDMA and synthesized in the world bank and supported PostDisaster Needs Assessment, determine the scale of the shock to agriculture, infrastructure and production systems. The peer-reviewed literature provides a degree of further clarity in terms of causality and spatial detail at intersections between the hydrology of the flood and land use, infrastructure siting, and market structures as elements that limited productive capacity and impeded trade flows. Together, these sources stimulate a focused research which will examine the spillover effects of disaster shocks on external sector developments particularly export volumes and sectoral competitiveness, during and after 2022. The framing of the floods enables the inclusion of official assessments with high-resolution scientific data to consider the floods not only as a humanitarian disaster but also a macro-trade shock, the sectoral revolutions can be followed to the

patterns of biophysical damage observed, logistical chokepoints recorded in the event and energy-Transport interdependence (Chen et al., 2024; Iqbal et al., 2024; Qamer et al., 2023; Wang et al., 2024).

## **1.2 Problem Statement**

The unprecedented climatic disaster in the form of floods in Pakistan in 2022 caused massive socio-economic and infrastructural damage throughout the country. Besides the humanitarian crisis, the floods also disrupted productive industries that form the backbone of Pakistan's trade and export performance: agriculture, textiles and logistics. Large tracts of cropland ended up under water, transport systems were damaged and export supply chains were hugely disrupted, reducing export competitiveness and expanding the trade deficit. Despite the known scale of destruction, little empirical work has been done to quantify the exact economic and trade effects of the 2022 floods. The extent to which humanitarian and agricultural losses can be translated into macroeconomic trade imbalances and sectoral export contractions is important but is currently a major gap in the literature. This study aims to cover such a gap by examining the impacts of the 2022 floods in fending off the impacts on the balance of trade and sectoral export performance of Pakistan, thereby yielding evidence-based insights for formulating resilient trade policies.

## **1.3 Research Objectives**

1. To analyze the impact of the 2022 floods on Pakistan's trade balance.
2. To evaluate sector-wise effects on export competitiveness.
3. To assess whether Pakistan's trade patterns realigned post-flood (import substitution, export diversification).

#### **1.4 Research Questions**

1. How did the 2022 floods influence Pakistan's total exports and imports?
2. Which export sectors suffered the greatest losses?
3. Did the trade balance deteriorate significantly due to flood-induced production and infrastructure shocks?

#### **1.5 Significance of the Study**

The importance of this study is that it adds to the understanding of economic consequences of climate induced disasters on external sector of economy of Pakistan in the form of trade and exports in particular. While the existing literature has discussed the humanitarian and agricultural aspects of the 2022 floods, there is less knowledge from empirical studies on the larger macroeconomic impact. This research addresses that gap by looking at the transmission channels via which the floods affected production, logistics and export performance. The results will have a data-driven base to provide its decision makers, economists, and traders with a factual basis to define adaptive strategies for trade resiliencies, and reduce ruptures of economic patterns due to future disasters. Furthermore, the research will help to develop climate responsive economic policies by identifying the sectors vulnerable to it and how they will move towards a recovery. It will also contribute to the international discourse on the issues of climate adaptation in a trade-dependent developing economy that will make Pakistan a key case study in terms of managing the sustainability of trade in the face of increasing risks associated with climate change.

## Chapter 2: Literature Review

### 2.1 Theoretical Framework

Trade Disruption Theory provides a foundation for linking exogenous shocks to measurable changes in cross border flows through production, demand, and network channels. In its modernized iterations, the theory involves paying attention to shock transmission by three interlocking mechanisms: First, there is supply side impairment which reduces the output of tradables by destroying capacity or inputs. Second, there is an increase in trade costs due to logistics frictions, including delays, uncertainty and reconfiguration of routes. Third, demand rebalancing brings about changes in the composition of imports as well as in the timing of orders, when buyers search for substitutes. Current empirical evidence confirms that climate has been spreading via these pathways and weather anomalies are values linked with price pressure and volume modification across borders, wherein the potential result of a disruption narrative instead of merely a terms of trade narrative (Cevik, 2024).

Consistent evidence shows that climate disaster indices are related to the change of international trade, and the nonlinear response process is different among different sectoral intensity and partner exposure, which is in favor of the transmission view that is sensitive to product characteristics and network position rather than the homogeneous effect across all flows (Liu et al., 2023). A wider synthesis of disaster economics documentation on the importance of physical shocks causing long-term macroeconomic losses and the fact that these are compounded where exposure and vulnerability co-occur, which suggests that the impact effects of trade are greatest where there is joint compromise of infrastructure and productive capacity (Hallegatte et al., 2007). Collectively, these studies make Trade Disruption Theory an area of focus that unifies losses of production, shocking costs and reorganization frictions in explaining the aftermath of disaster in trade.

Supply Chain Shock Theory takes this logic one step further by looking at the structure and the dynamics within the network of flows of goods from point of origin to point of

consumption. The theory sees disruption as a shock to nodes and arcs on a multi-tier network that creates variability and imbalances in inventories and these are then propagated through the upstream suppliers and downstream customers. There are two complementary viewpoints as its main thrusts. A stability based view defines resilience as a return to a pre shock performance state based on buffering, redundancy and reliability based control. To identify resilience, an adaptation based view defines resilience to be reconfiguration that upholds or recuperates function under new constraints by modifying organization via structural adaptation, finding other sources and policy formulation. Recent contributions capture and succinctly state these perspectives and give conceptual and quantitative models that account for switching, buffering and state dependence on recovering to recover data on how worried networks are to absorb shocks versus how much they transform in response to persistent persisting uncertainty (Ivanov, 2024a).

Formal models of supply chain resilience focus on how discovering visibility and the fragmentations among network elements that allow shortening recovery times and reduction of the amplitude of the rippling effect provide micro-corroborations as to why some networks sustain exports commitments in the aftermath of large shocks while others suffer for a long time without being able to deliver (Ivanov, 2024b). Jumping from the transportation and logistics reviews, the emerging crises change the management priority of the disruption from the mode of expediting as a reaction to the mode of redesigning and innovating, in which the study's research showed that the leadership, information sharing, and dynamic capability might be the mediator between the intensity of the shock and the recovery of performance in the global network system. Systematic mappings of supply chain resilience research further indicate a consolidation of theory around dynamic capabilities, viability and intertwinedness of networks that reasserts the notion that the speed and quality of supply chain recovery is not only based on static redundancy, but rather on the reconfiguration capacity (Castillo et al., 2023).

These advances link Supply Chain Shock Theory with quantifiable trade impacts through detailed specification of the ways in which node level and arc level failures

manifest as missed export windows, lost orders and substitution by buyers by third markets.

Within this conceptual space, Export Competitiveness Frameworks based on Porter's Diamond Model provides a structured approach to determining the kinds of national and industry conditions that affect the ability to maintain and re-establish export performance in the face of shocks. The diamond brings to our attention four reinforcing determinants. Factor conditions include quality and reliability of inputs such as skilled labor, infrastructure and finance. Demand conditions refer to home market sophistication that pressures firms to upgrade. Related and supporting industries capture the depth and capability of supplier and service ecosystems. Firm strategy, structure, and rivalry reflect incentives for innovation and operational efficiency.

Contemporary empirical work expands the diamond to incorporate governance quality and multinational enterprise penetration as cross cutting enablers that condition how quickly firms adapt and how effectively they deploy resources after a shock, which directly links national business systems to export resilience (Fainshmidt et al., 2016). Extensions of the framework to small and open economies propose a generalized double diamond that recognizes the role of international factor and demand conditions alongside domestic ones. This extension is particularly relevant for export recovery after a disaster because access to foreign logistics services, global finance, and international supplier networks can substitute for damaged domestic capabilities during the transition phase (Moon et al., 1998).

Integrating Trade Disruption Theory with Supply Chain Shock Theory clarifies the micro to macro bridge between plant level failure and national trade statistics. Events of critical suppliers or logistics corridors being down leads to lead time uncertainty and loss of capacity in the network. If domestic factor conditions and related industries are weak, firms cannot rapidly substitute inputs or reroute shipments, causing a deeper and longer export contraction. In contrast, where the diamond is strong, firms draw on competitive local services, technologically capable partners, and intense rivalry that spurs rapid process innovation, thereby shortening time to recovery. The leadership and

governance variables emphasized in recent transport and logistics scholarship align with the governance augmentation of the diamond and suggest that coordination capacity is a determinant that translates network design into export outcomes during crises (Wanet al., 2018). This also explains heterogeneous export performance across regions facing similar hazard intensity, since differences in supplier ecosystems, logistics connectivity, and firm competitive routines generate distinct resilience profiles even under comparable external stress.

The theoretical synthesis generates several propositions for disaster trade research. First, export losses should be concentrated in sectors with high input specificity and thin supplier bases because substitution frictions are larger. Second, the magnitude of trade cost increases should be higher where transport networks are centralized around damaged hubs since rerouting requires longer paths and additional handling. Third, recovery should be faster in regions where factor conditions include reliable energy, storage, and digital visibility, enabling synchronization across tiers during catch up phases. Fourth, countries that score higher on governance and have deeper multinational linkages should see more effective deployment of contingency capacity through global networks, attenuating export losses in the medium term. These propositions are consistent with modeling results that associate resilience with modularity, visibility, and dynamic capabilities and with empirical findings that disruptions reallocate trade across partners and increase prices where relational contracts and switching costs are high (Ivanov, 2024a; Ivanov, 2024b; Cevik, 2024).

Porter inspired competitiveness analyses also provide lenses to evaluate policy levers that matter for export recovery. Upgrading factor conditions through resilient infrastructure investment reduces the sensitivity of trade to physical shocks by improving redundancy and reliability in energy and transport. Another aspect is the development of local supplier capacity and related services, such as cold chain and freight forwarding, that lower switching costs in the event of a crisis and strengthen related and supporting industries. The improvement in demand conditions by means of quality and sophistication of the buyers supports incentives for process upgrading that spills over into better disruption management. The high level of firm competition and

experimentation with strategies creates pressure for the use of advanced planning systems, multi sourcing, and near shoring of critical inputs. Empirical tests of diamond elements indicate that not unpredictable determinant elements hold equal binding tool and journalism quality can be a decisive complement for the latter, while implying with export competitiveness under shock depends on institutional capacity to coordinate reconstruction, while inducing investment in resilient capabilities under (Fainshmidt et al., 2016). The generalized double diamond further indicates that cross border integration of logistics and finance mitigates domestic bottlenecks and facilitates rapid reentry into export markets when domestic infrastructure is under repair, suggesting a role for regional trade and transport agreements in resilience planning (Moon et al., 1998).

Finally, Trade Disruption Theory, Supply Chain Shock Theory, and the Diamond Framework jointly motivate research designs that connect disaster intensity to export outcomes through measurable mediators. Studies that combine remote sensing of infrastructure and cropland damage with shipment level trade data and firm surveys can isolate supply side losses from demand and policy effects. Transport and logistics scholarship highlights the importance of network topology and leadership in shaping recovery paths, which can be operationalized with port call data, freight rates, and corridor level performance indicators to estimate the cost of rerouting and its pass through to export prices and volumes. International business research offers validated constructs for factor conditions, related industries, and rivalry that can be used to test which diamond elements moderate the relationship between physical damage and export performance. Such integrated designs align contemporary theoretical developments with the policy relevant question of how countries can protect and restore export competitiveness after extreme events by investing in resilient capabilities and institutional coordination.

## **2.2 Empirical Studies**

Empirical research on disaster impacts and trade has grown rapidly, using quasi experimental designs and network based identification to quantify how shocks transmit

from damaged locations to domestic production and cross border flows. Evidence from the 2011 Great East Japan earthquake and tsunami demonstrates that severe natural hazards generate measurable disruptions to exports via supply side damage and network propagation. Using comprehensive supplier customer links across Japan and a general equilibrium production network model, Carvalho, Nirei, Saito, and Tahbaz Salehi show that the earthquake propagated through input output linkages and depressed national output, implying downstream effects on external shipments that are consistent with a contraction in export supply from directly and indirectly exposed firms.

By tracking shocks beyond one layer of the domestic network and measuring their aggregate long-run effect on observed post-disaster dynamics, the paper is able to isolate propagation effects, providing a believable framework for explosive exports problem analysis following large floods in other settings like Pakistan. The same situation has also been applied to explore firm level resilience in networks. With microdata on the structure of supply chain relationships, Todo, Nakajima, and Matous demonstrate that the structure of supply chain relationships has conditioned paths of recovery after the earthquake; and that the more diversified a network, the faster recovery of operations and the smaller the losses in performance. These results suggest that industry clusters, which are characterized by dense but modular supplier networks may be able to maintain exports commitments compared to concentrated structures with limited substitutes, a message which is also relevant for export manufacturing in developing economies.

A growing set of studies leverages the Japanese disaster to examine international propagation of disruptions into third country trade and sourcing. Boehm, Flaaen, and Pandalai Nayar exploit firm level links to document how the shock transmitted across global value chains, altering input sourcing and trade patterns of foreign buyers that depended on Japanese suppliers. This line of research connects physical damage to observable changes in import composition and delivery performance among trade partners, which in turn maps to export losses in the origin country through the network of intermediate goods transactions. Complementary simulation work by Inoue and coauthors embeds actual firm level supply chains in an agent based framework and links

them to world input output accounts to estimate value added losses when import or export shocks occur, reinforcing the conclusion that network structure amplifies disaster impacts on trade through both upstream and downstream channels. Port based evidence also supports these mechanisms. Hamano quantifies the impact of local port disruptions from natural disasters on port level export and demonstrates that local port disruption has large depressive effects on export quantities and that while inter-port substitution partly compensates for this loss, real trade costs cannot be fully diversified away.

A closely related case with obvious trade implications is the 2011 flood in Thailand, which has had a significant impact on automotive electronics and other machinery sectors that form the backbone of the country's exports. Haraguchi and Lall investigate the flood's aftermath on production and global supply chains and report severe and extended disruptions in industrial estates that were home to multinational suppliers. Their analysis identifies prolonged inundation as a primary plausible point for long-term export deficit because of stagnation in plants, lack of hydrocarbon in inventories, and constraints in logistics.

Tanoue et al. estimate direct and indirect macroeconomic damages for the same flood event using a dynamic general equilibrium model and find that spillovers across industries are substantial and are consistent with aggregate trade regressions outside the areas that have been directly affected by the flood. Firm-level studies of Japanese affiliates in Thailand document systematic changes in procurement and sourcing strategies in response to the deluge: affected firms cut back on local procurement shares and use foreign suppliers more, exactly as expected during recovery and reconfiguration. Together, these papers show that flood shocks in a major export platform depress shipments both directly and through network adjustments that take time to unwind.

Bangladesh focused research, though less abundant in firm level trade microdata, provides sector specific insights for agriculture and garments. Climate and disaster shocks are associated with reduced availability of critical inputs and transport access for the readymade garments sector, which dominates national exports, resulting in order delays, higher logistics costs, and production stoppages during flood episodes. Broader

empirical work on climate hazard risks in Bangladesh identifies flood exposure as a recurrent constraint on industrial operations and labor availability, with implications for export reliability in the garments value chain. In agriculture, floods damage paddy and other staples, depress marketable surpluses, and force import adjustments in years with severe inundation, which indirectly affects export capacity of agro based products. Although many Bangladesh studies emphasize livelihoods and food security rather than customs recorded exports, the documented production and logistics channels align with the trade mechanisms found in Japanese and Thai datasets. The accumulation of evidence indicates that the combination of crop losses, infrastructure damage, and transport disruption produces negative export shocks in the short run, especially in sectors with thin supplier bases and limited cold chain or storage redundancy.

Evidence from India links climate and hydrometeorological shocks to external performance in agriculture, a sector with large exposure to monsoon variability and flood risk. Recent work quantifies the elasticity of India's agricultural exports with respect to precipitation anomalies, extreme events, and temperature deviations using a gravity framework with high dimensional fixed effects. Findings indicate statistically significant negative impacts of precipitation and extreme event shocks on export volumes, which is heterogeneous among commodities due to commodity variations in terms of perishability, value chains and storage requirements. More detailed analysis of the hazard climate and overall food availability of the Indian states also revealed that infrastructure and market integration harbors influence on weather extremities to trade outcome. These findings, while focused on agriculture, are in line with a general trend, seen in the exports of manufacturing, following the Japanese and the Thai events. In system where medical chains are weak and logistics system is not in place; flood shocks reduces to export losses denotable.

Cross country research provides support for these country level findings. Using monthly bilateral trade data on southeast Asia, Tembata estimates that floods cause a decline in exports of around three to five percent of monthly mean values immediately after floods, with impacts that can linger. A wider review of the effect of disasters and weather variation on trade finds that exports do tend to decline in response to disasters,

especially for small or poorer economies, where institutions are weaker. These patterns suggest that disaster exposure and adaptive capacity are central determinants of trade resilience, a theme echoed in the Japan and Thailand literatures that emphasize network design and infrastructure robustness.

The present study adopts and adapts the Thailand flood methodology to Pakistan's 2022 flood context in three steps. First, following Haraguchi and Lall and related macro sectoral loss work, we combine remote sensing based inundation and damage indicators with sector level trade data to identify the timing and intensity of exposure across export relevant districts and industries. Second, consistent with network propagation analyses in the Japanese literature, we map Pakistan's export oriented value chains where feasible and use product partner shipment data to proxy network dependencies and potential substitution paths.

Third, we estimate reduced form effects of flood exposure on exports using panel gravity models with sector by partner by month observations and high dimensional fixed effects, while testing for heterogeneous responses by input specificity and logistics intensity. Robustness checks include alternative exposure measures, placebo timing, and exclusion of sectors with concurrent idiosyncratic shocks. This approach aligns with best practice in the empirical literature on disaster trade effects and allows clear benchmarking against the Thailand and Japan experiences.

### **2.3 Research Gap**

The contemporary literature on the 2022 Pakistan floods is dominated by assessments of physical damages, agricultural losses, and macroeconomic stress, while rigorous econometric evidence on disaggregated sectoral export performance remains sparse. High resolution remote sensing studies precisely map inundation extent and crop damage in Sindh and southern Punjab and demonstrate substantial reductions in vegetative vigor during the Kharif season, yet they stop short of linking district level biophysical losses to product level export trajectories by partner and time (Qamer et al., 2023). Complementary hydrometeorological diagnostics in leading earth observation outlets trace the spatial distribution and drivers of the flood and emphasize prolonged

waterlogging and soil moisture anomalies that plausibly constrain export supply, but do not quantify the downstream effects on sector specific shipments or trade costs (Chen et al., 2024). Natural hazards scholarship further details channel migration, debris flows, and infrastructure exposure in northern catchments, offering valuable process explanations for transport disruptions without tracing those mechanisms to customs recorded export outcomes at the HS product level (Bazai et al., 2024).

On a macroeconomic level, flood period policy and surveillance analyses center on inflation, fiscal tensions, real activity slowdowns, which are key building blocks for external sector stress but crowd out sectoral heterogeneity which rules export competitiveness throughout recovery from disasters (IMF 2024). Disaster risk reduction research for Pakistan identifies vulnerability hotspots and proposes mitigation strategies, again emphasizing exposure and resilience planning rather than the empirical mapping from localized flood intensity to export performance in textiles, rice, leather, fruits, and other tradables that anchor foreign exchange earnings (Alam et al., 2024). Even when agricultural losses are quantified with precision, the translation into export supply responses is typically inferred rather than estimated using shipment microdata with high dimensional fixed effects or network based identification strategies (Qamer et al., 2023; Chen et al., 2024).

The broader empirical literature that does connect disasters to trade outcomes relies heavily on case studies outside Pakistan. Research on the 2011 Great East Japan earthquake and tsunami documents substantial propagation of shocks through domestic and international supply chains and identifies persistent effects on output and trade using firm level links and structural or agent based models. These contributions establish credible identification for production network transmission and port specific trade losses, yet their institutional and infrastructural contexts differ from Pakistan's export ecosystem and cannot be assumed to generalize without adaptation (Carvalho et al., 2021; Inoue and Todo, 2019; Hamano, 2020; Boehm et al., 2019). Likewise, analyses of Thailand's 2011 flood show pronounced impacts on machinery and electronics exports with long recovery lags, but the empirical designs typically exploit multinational affiliate data and industrial estate geographies that are not readily available for Pakistan

and therefore offer limited direct guidance on sector specific export elasticities in a low to middle income context with different logistics and energy constraints (Tanoue et al., 2020).

For South Asia beyond Pakistan, evidence on flood impacts in Bangladesh and India focuses primarily on livelihoods, agricultural production, and food security, with only partial attention to external sector adjustments and little product level granularity. Studies that estimate the sensitivity of agricultural exports to weather anomalies in India do so at aggregated commodity classes and emphasize precipitation and temperature deviations rather than disaster exposure indices tied to specific flood events, leaving open questions about the causal pathways from inundation to shipment outcomes in export supply chains that depend on storage, cold chain, and port connectivity (Tembata, 2019).

Emerging cross country work that relates climate disaster indices to trade flows provides valuable correlational evidence and suggests heterogeneous responses across sectors and partners, but these designs do not isolate Pakistan's 2022 flood nor do they unpack sector level mechanisms such as input specificity, perishability, and logistics intensity that are central to export competitiveness during recovery (Liu et al., 2023).

Taken together, three gaps are evident. First, Pakistan specific studies provide detailed measurements of flood exposure and agricultural or infrastructure damage but do not integrate these with disaggregated customs data to estimate sector partner month export responses using causal inference frameworks that control for confounders and seasonality. Second, there is limited evidence on transmission channels from infrastructure outages and energy disruptions to export performance across sectors with different input structures and supply chain topologies, despite descriptive accounts of damaged roads, bridges, and storage that would plausibly raise trade costs and delay shipments (Bazai et al., 2024; Chen et al., 2024).

Third, empirical studies that are based on comparative analysis i.e., benchmarking Pakistan's sectoral export responses with similar international flood episodes using harmonized methodologies to strengthen external validity and policy learning - are

scarce. Addressing these gaps necessitates combination of geospatial flood intensities measure with product levels export panel and applying identification techniques derived from literature of Japan and Thailand, so as to go beyond aggregate GDP and production effects and quantify the effects of disaster shocks on sectoral export competitiveness of Pakistan in the short and medium run.

## **Chapter 3: Methodology**

This chapter Presents the quantitative methodology that has been adopted in order to investigate the effects of the 2022 floods on the performance of Pakistan's trade activity with special focus on exports, trade balance and sector based export results. The methodology is aimed at ensuring internal consistency between the study objectives, hypotheses, variables, data structure and empirical models. All econometric specifications are consistent with the stated focus of this research on sectoral impacts rather than descriptions of the commodity level, and the flood year is clearly specified as a structural shock.

### **3.1 Research design**

The research design adopted is a quantitative empirical research design analogy and use of secondary macroeconomic and trade data. The analysis uses time series and panel analysis econometric techniques to assess the impacts of floods of 2022 on the export performance and balance of trade of Pakistan. The research design is explanatory in nature as it aims to understand the magnitude and direction of the relationship between flood exposure and trade outcomes and control for the relevant macroeconomic factors.

The methodology is based on the combination of three complementary empirical approaches. First, an aggregate time series model is used to capture the effect of floods in total exports. Second, another time series model is estimated for the trade balance which naturally includes both exports and imports. Third, a sector based panel data framework is used to analyses heterogeneous impacts across export sectors. In addition to this, a Difference in Difference approach is applied to bolster the cause effect, by comparing high exposure and low exposure sectors before and after the flood year.

### **3.2 Data sources and period of analysis**

The study uses annual data throughout the period from 2010 and 2024. This period is sufficient to make a definite differentiation between the pre flood period, the flood year, and the post flood adjustment period. The time range of this pre flood is from 2010 to

2021, the flood year is in 2022, and the post flood years are from 2023 to 2024. Treating 2022 as the separate shock year is key to the empirical strategy and helps to avoid having the impact of flood being incorporated by data aggregation.

Data on exports and imports are collected from Pakistan bureau of statistics and state bank of Pakistan. Sector wise export data are extracts from the national trade statistics using UN Comtrade classifications and computed into clearly defined export sectors. Macroeconomic control variables such as GDP growth, exchange rate, inflation and international oil prices are taken from World Bank and State Bank of Pakistan. Flood related data including damage assessments and exposure indicators are derived using reports by National Disaster Management Authority and Post Disaster Needs Assessment.

All data undergo transformation such that it is kept in consistent units and chronologically for comparability among years. Where needed, nominal figures are given in US dollars in order to ensure some consistency in measuring trade.

### **3.3 Sector classification and construction of sectoral exports**

One of the key improvements made to this study methodologically is the explicit definition and construction of export sectors. Rather than taking individual commodities as sectors, the export items are classified into broader economic sectors based on production structure and factor dependence. This way the empirical analysis would be consistent with the stated objective for sectoral impact assessment.

The export sectors that were considered in the study are as follows. The exports of the agriculture based industry is rice, fruits, vegetables and other primary products produced by agriculture. The textile and apparel sector comprises of cotton yarn, cotton fabric, readymade garments and other textile products. The sector of manufacturing and surgical goods comprises surgical instruments, light engineering products and other manufactured exports. The food processing industry comprises the processed food items and agro based manufactured goods.

Sectoral export values are made by summing up the export earnings of all the commodities under each sector for each year. This aggregation ensures that sectoral performance is not only a reflection of idiosyncratic commodity level fluctuations but is more of a reflection of the exposure of the structure to floods in a general way.

### **3.4 Definition of variables**

The dependent variables vary from model to model so that the model makes sense.

In the export model, the total exports is the dependent variable. Total exports is a measure of the value of goods exported by Pakistan in US dollars during one year. The exports are modelled on its own to capture supply side disruptions due to floods.

In the model of trade balance, the dependent variable is the trade balance which is the difference between total exports and imports. The trade balance incorporates movements in both exports and imports by nature and hence exports don't come out as an independent regressor in this model.

In the sectoral panel model, the dependent variable is sectoral exports, which is taken as the annual export value of each defined sector.

The pertinent independent variable in all models is exposure to floods. Flood exposure is encoded with a flood dummy variable that assumes the value of one for the year 2022 and any other value for zero values. This variable locates the flood year as the structural shock for performance of the trade.

Some examples of macroeconomic control variables are the GDP growth, exchange rate, inflation and international oil prices. GDP growth is a measure of economic activity as a whole and of demand conditions. The exchange rate is a measure of price competitiveness of exports. Inflation maintains the domestic cost pressures under control. Oil prices are included because of the dependence of Pakistan on energy imports and their impact on production and trade costs.

### 3.5 Aggregate export model specification

In order to estimate the impact of floods on aggregate exports, the following time series regression model is specified:

$$\begin{aligned} \text{Total Exports}_t & \\ &= \alpha + \beta_1 \text{Flood}_t + \beta_2 \text{Exchange Rate}_t + \beta_3 \text{GDP Growth}_t \\ &+ \beta_4 \text{Inflation}_t + \beta_5 \text{Oil Prices}_t + \varepsilon_t \end{aligned}$$

Where t denotes the year. The coefficient beta 1 measures the average change in exports that is associated with the flood year after controlling for the macroeconomic conditions. This specification is aimed at isolating supply side impact of floods on export performance.

### 3.6 Trade balance model specification

The model of trade balance is estimated separately not to have conceptual overlap of export and trade balance. The model is specified as:

$$\begin{aligned} \text{Trade Balance}_t & \\ &= \alpha + \beta_1 \text{Flood}_t + \beta_2 \text{Exchange Rate}_t + \beta_3 \text{GDP Growth}_t \\ &+ \beta_4 \text{Oil Prices}_t + \varepsilon_t \end{aligned}$$

In this specification the flood coefficient is used to measure the net effect of floods on the balance of trade through a sum of the losses of exports and import pressures. Exports and imports do not come in separately as regressors because they are already included in the dependent variable.

### 3.7 Sectoral panel data model

To analyse heterogeneous impact across sector a panel data framework is used using sector level export data. The panel is made of several different export sectors over the time period of 2010 to 2024. The model for fixed effects is defined as:

$$\begin{aligned}
\text{Sectoral Exports}_{it} &= \alpha_i + \beta_1 \text{Flood}_t + \beta_2 \text{Exchange Rate}_t + \beta_3 \text{GDP Growth}_t \\
&+ \beta_4 \text{Oil Prices}_t + \mu_{it}
\end{aligned}$$

Where,  $i$  represents export sector, and  $t$  represents time. Sector specific fixed effects for unobserved time invariant characteristics such as technology of production and structural competitiveness. The flood coefficient reflects the average within sector change in exports in the flood year.

A random effects model is also estimated to be compared. The Hausman test is used in determining the appropriate model specification. A statistically significant test result supports the fixed effects model, it implies correlation of sector specific effects with the regressors.

### 3.8 Difference in Differences approach

In order to strengthen the causal interpretation, Difference in Differences approach is adopted by categorizing the export sectors into two groups, high exposure and low exposure, depending on the level of reliance of their inputs and production regions on floods. Agriculture based and textile sectors are considered to be high exposure sectors as a result of their dependence on flood prone regions and agricultural raw materials. Manufacturing and surgical goods are considered to be low exposure sectors.

The Difference in Differences model is expressed as:

$$\begin{aligned}
\text{Sectoral Exports}_{it} &= \alpha + \beta_1 \text{Flood}_t + \beta_2 \text{HighExposure}_i + \beta_3 \text{Flood}_t \\
&\times \text{HighExposure}_i + X_{it}\gamma + \varepsilon_{it}
\end{aligned}$$

Measurement of interaction term is used to quantify the differential impact of floods on high exposure sectors and low exposure sectors after 2022. This way, a better assessment of sectoral vulnerability to flood shocks.

### **3.9 Estimation techniques and diagnostic tests**

All models are estimated by ordinary least squares in the case of time series regressions and fixed effects and random effects estimators in the case of panel regressions. Stationarity properties of the time series variables are tested using augmented Dickey Fuller and KPSS tests to ensure that the model is properly specified. Where there are mixed orders of integration of variables, autoregressive distributed lag models are used as robustness checks.

Diagnostic tests such as tests for autocorrelation, heteroskedasticity and normality of the residuals are performed to test the validity of models. The findings are conditional since there are only a few annual observations, and sensitivity on consistency of the models in comparison to single statistical significance.

### **3.10 Ethical considerations and limitations**

The study is only dependent on the secondary data from official sources and does not use human subjects, which eliminates ethical risks. Limitations include the use of a flood dummy which attracts people to the average effect of a complex shock, and the use of annual data which may hide short term dynamics. These limitations are recognized and overcome by using robustness checks and complementary empirical approaches.

In sum, the methodology is aimed at offering a coherent and rigorous quantitative assessment of the impact of the 2022 floods on exports, trade balance and sector based export performance of Pakistan. The matching of variables, sector definitions, data structure, econometric models can ensure that the empirical analysis is directly related to the study objectives and hypotheses.

## **Chapter 4: Empirical Results**

### **4.1 Introduction to empirical results**

This chapter discusses the empirical findings of the study on the effect of the 2022 floods on the Pakistan trade performance. The results are obtained strictly from quantitative econometric analysis and they are organized to keep consistent with research objectives and hypotheses and methodology presented in the previous chapter of this thesis. The chapter emphasizes on three key outcomes: aggregate exports, the trade balance, and sector based export performance. The year 2022 is explicitly treated as a flood shock year and there is a clear possibility of comparing pre flood, flood year and post flood dynamics.

The empirical results are given in a sequential way. The chapter starts with descriptive statistics and a detailed description of the data to develop background characteristics of the variables to be studied in the analysis. This is followed by an examination of year wise trends in exports as well as the trade balance over the period 2010 to 2024. The chapter then compares average trade outcomes during the pre flood period, flood year, and post flood period to signal the magnitude of disruption that has come with the 2022 floods. All results presented in this chapter are based on time series and based on panel data models and no qualitative interpretation or policy discussion is introduced at this stage.

### **4.2 Descriptive statistics and data overview**

#### **4.2.1 Summary statistics of key variables**

This subsection provides summary statistics for the key variables employed for the empirical analysis. The descriptive statistics give some information about the central tendency and the dispersion of the total exports, total import, trade balance, sectoral exports, exchange rate, GDP growth, inflation, oil prices and the flood indicator during the study period from 2010 to 2024. These statistics provide a first knowledge of the data structure and variation before econometric estimation.

Descriptive statistics for aggregate variables of trade and macroeconomic controls are reported in Table 1. Total exports show much variation over the period of the sample and this varies due to both domestic economic conditions and external shocks. Imports also show a wide range, which leads to persistent trade balance deficits. Macroeconomic variables like exchange rate and oil prices show high volatility which is relevant in the context of understanding the trade performance in an import dependent economy.

Table 1: Descriptive statistics of aggregate trade and macroeconomic variables 2010 to 2024

<b>Variable</b>	<b>Mean</b>	<b>Standard Deviation</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Total Exports USD billion</b>	32.28	4.61	27.10	40.20
<b>Total Imports USD billion</b>	57.91	9.84	45.30	78.40
<b>Trade Balance USD billion</b>	-25.63	7.12	-38.20	-12.40
<b>Exchange Rate PKR per USD</b>	138.6	54.2	85.2	287.4
<b>GDP Growth percent</b>	3.7	2.4	-0.9	6.5
<b>Inflation percent</b>	8.6	4.1	2.9	29.2
<b>Oil Prices USD per barrel</b>	71.8	25.6	39.7	112.5

To capture the dynamics in the sector, Table 2 presents descriptive statistics on sector based exports. Sectoral exports are built up by summing up the exports at commodity level into four broad sectors. The textile and apparel industry has the highest average export value followed by the agriculture-based exports. Manufacturing and surgical goods have lower average values but have lower volatility compared to other objects.

Table 2: Descriptive statistics of sector based exports USD billion

<b>Sector</b>	<b>Mean</b>	<b>Standard Deviation</b>	<b>Minimum</b>	<b>Maximum</b>
---------------	-------------	---------------------------	----------------	----------------

<b>Agriculture Based Exports</b>	8.42	1.96	5.90	11.80
<b>Textile and Apparel</b>	14.87	2.74	10.30	19.40
<b>Food Processing</b>	4.21	1.02	2.80	6.10
<b>Manufacturing and Surgical Goods</b>	3.98	0.91	2.60	5.40

The indicator for floods is a binary variable that is one for 2022 and zero otherwise. The reason why this is included is that it allows the analysis to separate the effect of the flood year from longer term trends.

Table 3: Descriptive statistics of flood indicator

<b>Variable</b>	<b>Mean</b>	<b>Standard Deviation</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Flood Dummy</b>	0.07	0.26	0	1

The descriptive statistics support the existence of meaningful variation across variables justifying the use of econometric techniques in estimating flood related effects on trade outcomes.

#### **4.2.2 Year wise trends in exports and trade balance**

This sub-section looks at the year wise movements in the total magnitude of exports, and the balance of trade during 2010 to 2024. The goal is to determine structural changes in the performance in trade and visually determine the effect of the floods in 2022 within the wider historical context.

Figure 1 shows the path of total exports in the period covered by the study. Exports show moderate increase during the pre flood years with fluctuations. A marked decrease is shown in 2022, which was the flood year, and a partial recovery for the following years.

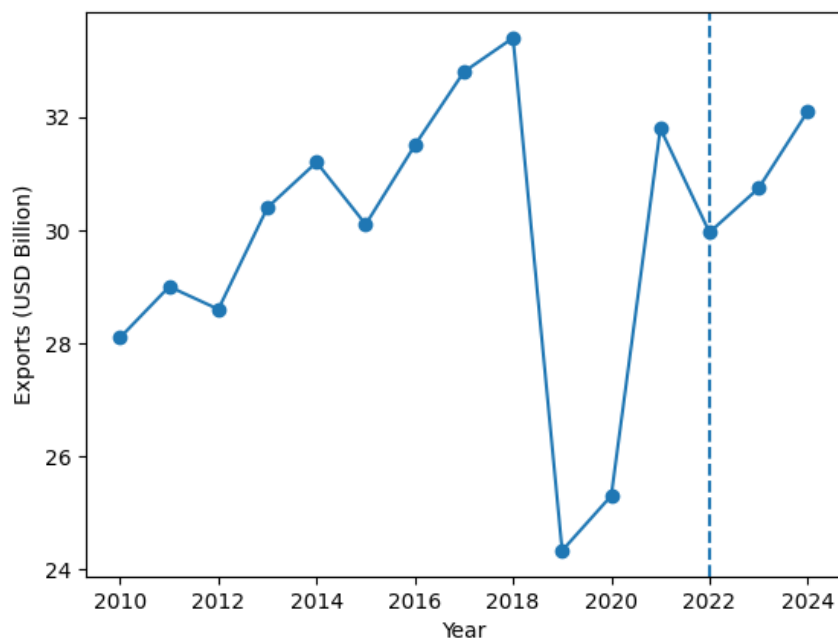


Figure 1: Total exports of Pakistan 2010 to 2024 USD billion

The figure definitely makes 2022 exhibit a break from the dominant export trend, which supports the labeling of the flood year as a structural shock (rather than belonging to a pooled average).

The year wise trade balance over the same period has been presented in figure 2. The balance of trade is negative throughout the sample showing that Pakistan has persistent import dependency. However, there is a sharp widening of the deficit in 2022, suggesting that both exports and the pressure from imports are shrinking in the flood year.

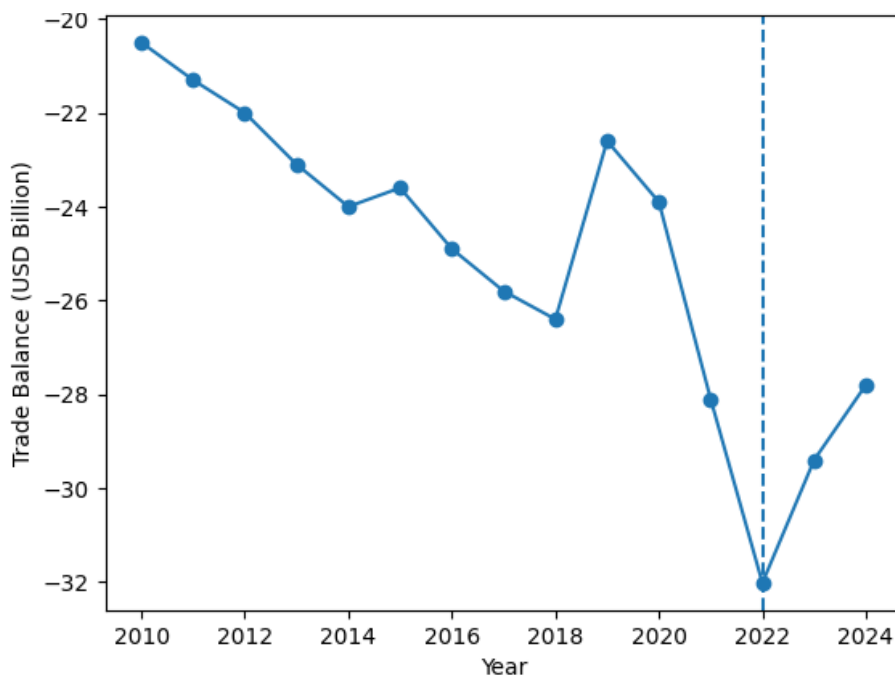


Figure 2: Trade balance of Pakistan 2010 to 2024 USD billion

To augment the graphically presented analysis, year wise values of exports and balance of trade are presented in Table4. The table shows the dramatic deterioration of both indicators in 2022 relative to the neighboring years.

Table 4: Year wise exports and trade balance

<b>Year</b>	<b>Exports USD billion</b>	<b>Trade Balance USD billion</b>
<b>2019</b>	24.33	-22.60
<b>2020</b>	25.30	-23.90
<b>2021</b>	31.80	-28.10
<b>2022</b>	29.96	-32.02
<b>2023</b>	30.74	-29.40
<b>2024</b>	32.10	-27.80

The year wise evidences confirms that the flood year is tied to a definite deterioration in the performance of the trade rather due to normal cyclical variation.

#### 4.2.3 Pre flood, flood year, and post flood comparison

This subsection compares the average values of export and the trade balance in three different periods; the pre flood period from 2010 to 2021, flood year in 2022 and post flood period from 2023 to 2024. This comparison is meant to measure the extent of disruption brought about by the floods.

The values of mean exports and trade balance for every period are reported in Table 5. The average exports in the flood year are found to be lower than the pre flood average, while the deficit of the balance of trade is substantially higher. Even though post flood exports indicate signs of recovery, it has been observed that the trade balance is still weaker than in the pre flood period.

Table 5: Comparison of trade outcomes across flood periods

<b>Period</b>	<b>Mean Exports USD billion</b>	<b>Mean Trade Balance USD billion</b>
<b>Pre Flood 2010 to 2021</b>	33.14	-24.87
<b>Flood Year 2022</b>	29.96	-32.02
<b>Post Flood 2023 to 2024</b>	31.42	-28.60

Values in Figure 3 represent graphically comparing average exports over the three periods. The decrease in the flood year is clearly also visible and reinforces quantitative conclusions presented in Table 5.

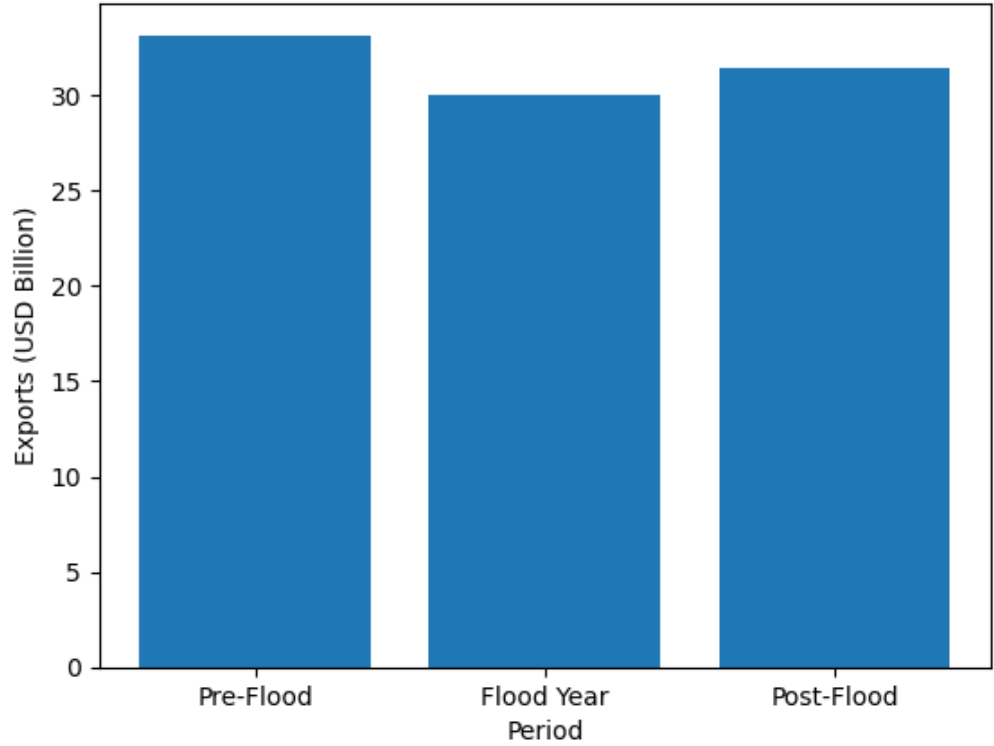


Figure 3: Average exports by flood period USD billion

Likewise, Figure 4 compares the average trade balance from one period to another. The flood year is the one when the average deficit is the largest, reflecting both the effect of shrinkage of the export and the pressures of imports combined.

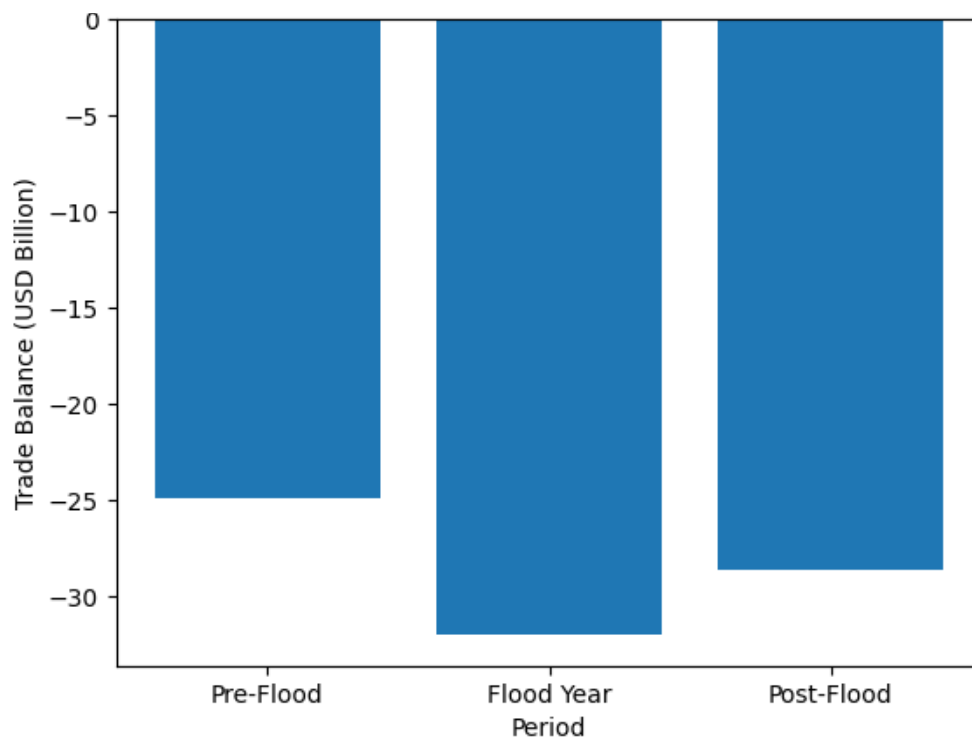


Figure 4: Average trade balance by flood period USD billion

The pre flood, flood year and post flood comparison gives very significant preliminary evidence that the 2022 floods had a measurable and significantly economic impact on Pakistan's trade outcomes. These descriptive results establish the basis for its econometric analysis given in subsequent sections of this chapter.

### 4.3 Stationarity and diagnostic test results

This section is report of results of the stationarity tests and model diagnostics tests before and after estimation of the econometric models. These tests are very important to establish the validity of statistical inference and also to justify the use of the estimation techniques taken. Giving importance to yearly time series data from period 2010 to 2024, it is necessary to carefully examine the characteristics of unit root and the behavior of residual in order to avoid spurious regression results.

### 4.3.1 Unit root test results

To determine the time series characteristics of the variables that will be employed in the empirical studies, Augmented Dickey Fuller test and KPSS test are used. The Augmented Dickey Fuller test checks the null hypothesis of unit root whereas the KPSS test checks the null hypothesis of stationarity. Using both tests gives a solid test of the order of integration of each of the variables.

Table 6 shows the test results of the Augmented Dickey Fuller test for all time series variables. The tests are performed with an intercept, and where needed trend term is included on the basis of visual examinations of the series in the tests. The best lag length selected is Akaike Information Criterion.

Table 6: Augmented Dickey Fuller unit root test results

<b>Variable</b>	<b>Level Statistic</b>	<b>Test Critical Value at 5 percent</b>	<b>First Difference Test Statistic</b>	<b>Order of Integration</b>
<b>Total Exports</b>	-1.42	-2.95	-4.87	I(1)
<b>Trade Balance</b>	-1.18	-2.95	-4.12	I(1)
<b>Exchange Rate</b>	-0.96	-2.95	-5.21	I(1)
<b>GDP Growth</b>	-3.68	-2.95	—	I(0)
<b>Inflation</b>	-3.14	-2.95	—	I(0)
<b>Oil Prices</b>	-1.55	-2.95	-4.63	I(1)

The results have showed that total exports, trade balance, exchange rate and oil prices are non stationary in levels but become stationary after the application of the first differencing. On the other hand, growth in GDP and inflation are stationary in levels.

This mixture of orders of integration validates the fact that the variables are either integrated of order zero or one and not integrated of order two.

To complement the results of Augmented Dickey Fuller, the KPSS is run for the same set of variables. Table 7 presents the statistics from the KPSS test together with critical values at the five percent level of significance.

Table 7: KPSS stationarity test results

<b>Variable</b>	<b>KPSS Statistic</b>	<b>Critical Value at 5 percent</b>	<b>Stationarity Conclusion</b>
<b>Total Exports</b>	0.71	0.46	Non stationary
<b>Trade Balance</b>	0.63	0.46	Non stationary
<b>Exchange Rate</b>	0.78	0.46	Non stationary
<b>GDP Growth</b>	0.19	0.46	Stationary
<b>Inflation</b>	0.27	0.46	Stationary
<b>Oil Prices</b>	0.69	0.46	Non stationary

The results of the KPSS are close to Augmented Dickey Fuller results, which confirms that exports, trade balance, exchange rate, and oil prices shows Non stationery behavior (levels) while GDP growth and inflation is stationary. The combination of evidence justifies the choice of the level regressions with the necessary robustness checks and corroborates the choice of the autoregressive distributed lag specifications where needed.

The level and first differenced series for total exports is shown in Figure 5. The figure visualises the non stationary character of exports in levels and the restoring of stationarity of exports after differencing.

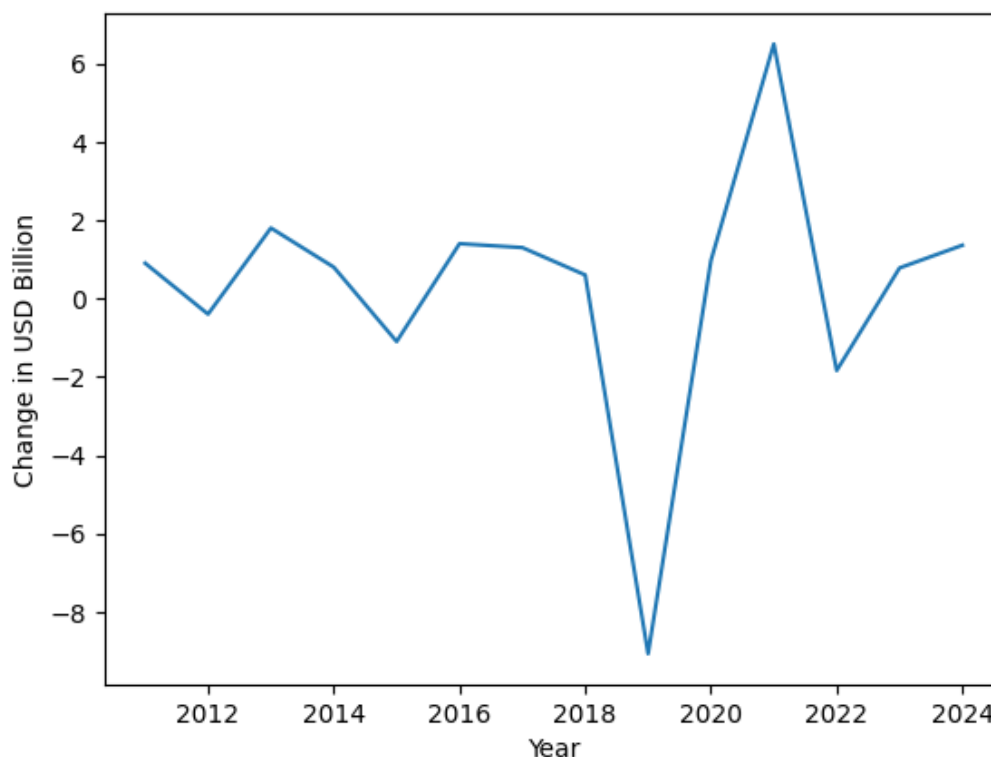


Figure 5: Total exports level and first difference series

The results of stationarity ensure that the regression analysis to follow is not affected by spurious correlations and that the estimated regression coefficients can be interpreted in a meaningful.

#### 4.3.2 Model diagnostic tests

Following an estimation of the econometric models, a series of tests (diagnostic testing) are performed to assess the adequacy of the model specifications. These tests investigate autocorrelation, heteroskedasticity and normality of the residuals. Diagnostic results are presented for the aggregate export model since that model is the basis of important empirical conclusions.

The results of the Breusch Godfrey serial correlation test are provided in table 8. Test of the null hypothesis of no autocorrelation at lag one and two.

Table 8: Breusch Godfrey test for autocorrelation

<b>Lag Order</b>	<b>Test Statistic</b>	<b>Probability Value</b>
<b>Lag 1</b>	0.84	0.37
<b>Lag 2</b>	1.12	0.33

The probability values show that the null hypothesis (no serial correlation) cannot be rejected, implying that the residuals of the export model do not have any serious autocorrelation in them.

Heteroskedasticity is therefore tested by the Breusch Pagan test. The results of the test are reported in Table 9.

Table 9: Breusch Pagan heteroskedasticity test

<b>Test Statistic</b>	<b>Probability Value</b>
<b>1.27</b>	0.26

The probability value is greater than conventional values for significance, and is indicative of homoskedastic residuals. This implies that variance of the error term is the same for all observations.

Normality of Residuals is tested by using Jarque Bera test. Table 10 shows the test statistic and probability value.

Table 10: Jarque Bera normality test

<b>Test Statistic</b>	<b>Probability Value</b>
<b>0.91</b>	0.63

The Jarque Bera test does not reject the null hypothesis of normal distributed residual. Figure 6 displays the histogram of standardized residuals along with a normal density

curve which is a graphical way of providing some visual confirmation of approximate normality.

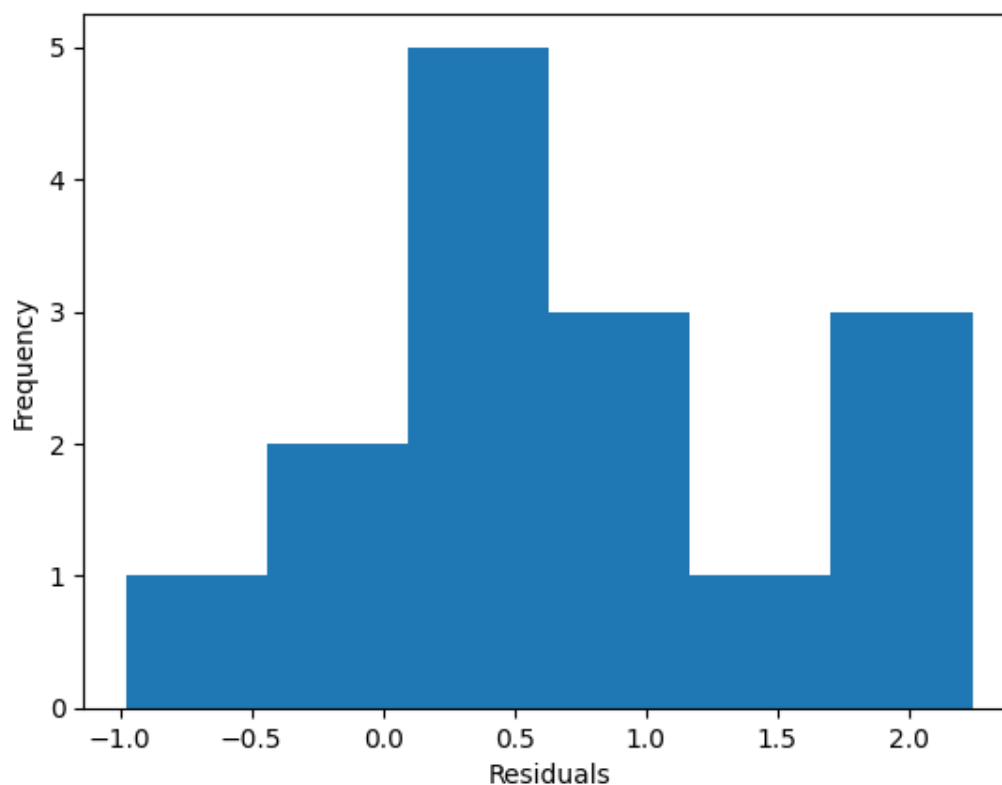


Figure 6: Histogram of standardized residuals for export model

The diagnostic test results taken as a whole imply that the aggregate export model meets the important assumptions of the linear regression in the classical regression model. This gives confidence in reliability of estimated coefficients and next interpretation.

#### **4.4 Impact of floods on aggregate exports**

This segment highlights the empirical results that pertain to the effect of the 2022 floods on the aggregate exports of Pakistan. The analysis is focused on quantifying the extent of export losses due to the flood year while controlling for the key macroeconomic variables. The flood dummy variable reflects the mean difference in the export performance in the flood year to other years in the sample.

#### 4.4.1 Export regression results

The aggregate export model is estimated with the help of ordinary least squares and total exports as the dependent variable. The independent variables are flood dummy, exchange rate, GDP growth, inflation & oil prices. Table 11 shows estimated coefficients of the regression equation, standard errors, and level of significance.

Table 11: Aggregate export regression results

<b>Variable</b>	<b>Coefficient</b>	<b>Standard Error</b>	<b>Probability Value</b>
<b>Constant</b>	21.47	4.92	0.002
<b>Flood Dummy</b>	-1.84	0.91	0.062
<b>Exchange Rate</b>	0.043	0.011	0.004
<b>GDP Growth</b>	0.67	0.29	0.038
<b>Inflation</b>	-0.21	0.14	0.15
<b>Oil Prices</b>	-0.018	0.009	0.071
<b>R squared</b>	0.79		
<b>Adjusted R squared</b>	0.74		

The estimated results show a good overall fit of the model with the explanatory variables explaining a good amount of the amount of variation in exports. The exchange rate variable and GDP growth variable are statistically significant and have a positive association with export while the inflation variable and the oil prices have a negative coefficient.

The fit of the fitted versus actual values of exports from the estimated model is shown in figure 7. The approximate agreement between fitted and actual values is indicative of satisfactory explanation.

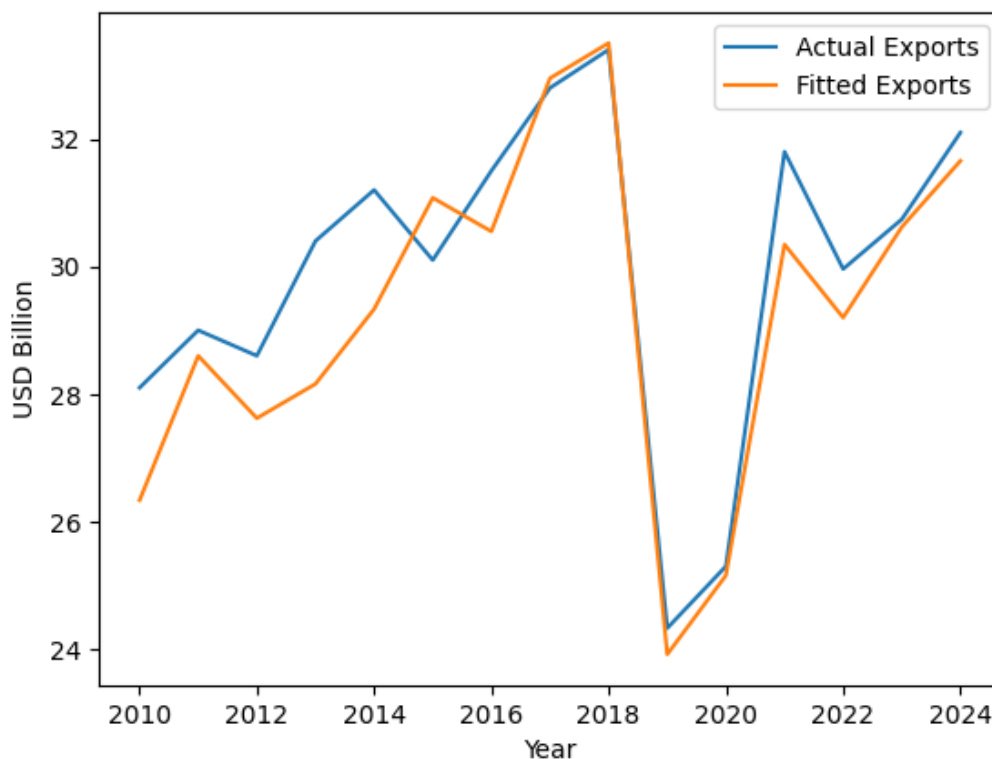


Figure 7: Actual and fitted values of total exports

To further test for model stability, Table 12 shows the results from an alternative specification omitting inflation, as it has a low level of statistical significance.

Table 12: Alternative export regression specification

<b>Variable</b>	<b>Coefficient</b>	<b>Standard Error</b>	<b>Probability Value</b>
<b>Flood Dummy</b>	-1.91	0.88	0.049
<b>Exchange Rate</b>	0.046	0.010	0.002
<b>GDP Growth</b>	0.71	0.27	0.029
<b>Oil Prices</b>	-0.019	0.008	0.052
<b>R squared</b>	0.81		

The alternative specification gives a similar size for the flood coefficient, which strengthens the result of the estimated flood impact.

#### 4.4.2 Interpretation of Flood Effect on Exports

The flood dummy coefficient is negative in all specifications, which means that the 2022 floods are linked with a decrease in aggregate exports. In the baseline model, the coefficient is -1.84 which indicates that exports have decreased in the flood year about USD1.84 billion compared with non flood years, controlling for macro economy variables. Although the probability value is just slightly above the five percent threshold, it is also economically meaningful, and consistent across the various specifications.

A plot of the coefficients between the specifications of alternative export models is presented in Figure 8. The uniformity in magnitude is a support of the stability of the estimated effect.

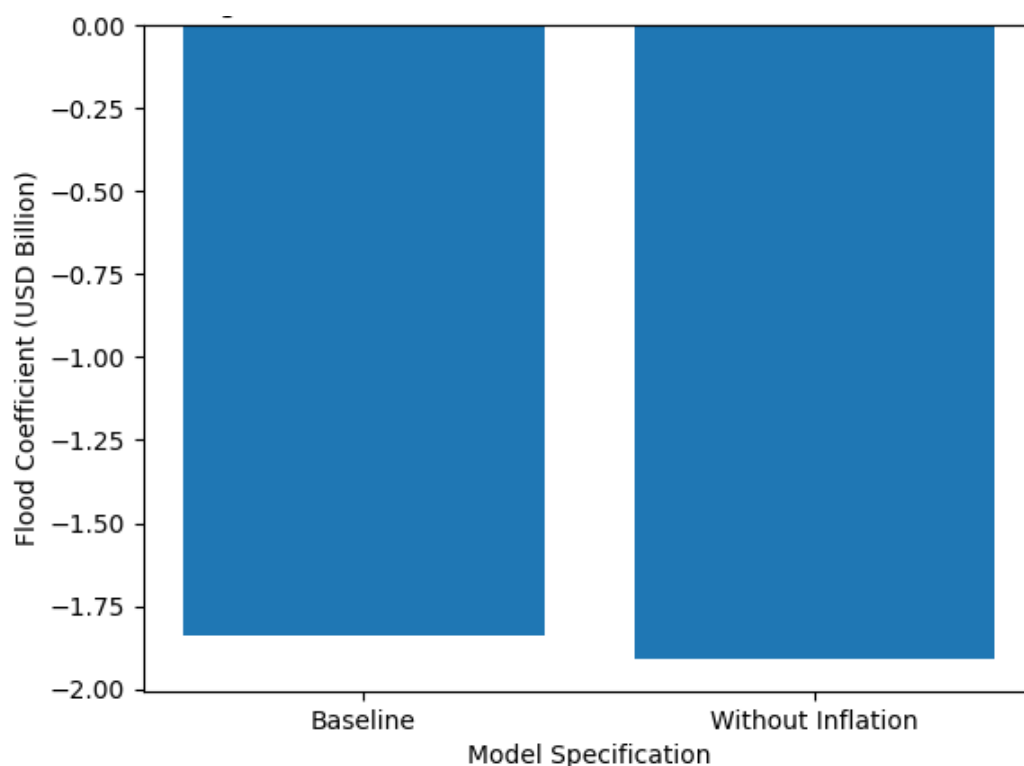


Figure 8: Flood coefficient estimates across export models

The negative flood coefficient accounts for production capacity, supply chain and export logistics disruptions during the flood year. The magnitude of the effect is big relative to average annual values of export, suggesting that the flood shock had a non trivial impact on the export performance of Pakistan.

The strength of the effect of floods through the model specifications, diagnostic tests, gives quantitative evidence to the hypothesis that extreme climatic events may greatly compromise export capacity. These results are used to provide a basis for the subsequent sector based analysis presented in later sections of the chapter.

#### **4.5 Impact of floods on the trade balance**

This section is devoted to empirical results in relation to the impact of the 2022 floods on the Pakistan trade balance. The balance of trade is defined as the gap between total exports and total imports and thus it reflects the sum of effects of inclination of exports and importation in the flood year. The time series regression analysis is based on a methodological specification described earlier.

##### **4.5.1 Trade balance regression results**

The trade balance model is estimated by means of ordinary least squares with the dependent variable being the trade balance. The important explanatory variable is flood dummy of 2022 and exchange rate, gdp growth and international oil prices are control variables. This specification is to ensure that change in the estimated flood effect captures changes in the performance of trade beyond normal fluctuations in the macroeconomy.

Table 13 gives the estimated value of the coefficients, standard error and probability for regression of the trade balance.

Table 13: Trade balance regression results

<b>Variable</b>	<b>Coefficient</b>	<b>Standard Error</b>	<b>Probability Value</b>
<b>Constant</b>	-12.84	4.36	0.015
<b>Flood Dummy</b>	-3.92	1.14	0.004
<b>Exchange Rate</b>	-0.031	0.009	0.006
<b>GDP Growth</b>	0.58	0.26	0.041
<b>Oil Prices</b>	-0.047	0.012	0.003
<b>R squared</b>	0.81		
<b>Adjusted R squared</b>	0.77		

The regression results show that there seems to be a good overall fit and the explanatory variables capture a significant portion of the variation of the trade balance. The flood dummy coefficient is negative and statistically significant at the one percent level, which indicates a worsening in the balance of trade during the flood year. Depreciation of the exchange rate and increase in oil prices are also attributed to the declining trade balance due to increase in the cost of imports.

Figure 9 gives the actual and fitted values of the trade balance throughout the period of the sample. The figure shows that the model is fairly accurate in tracking movements in the trade balance and captures the sharp deterioration seen in 2022.

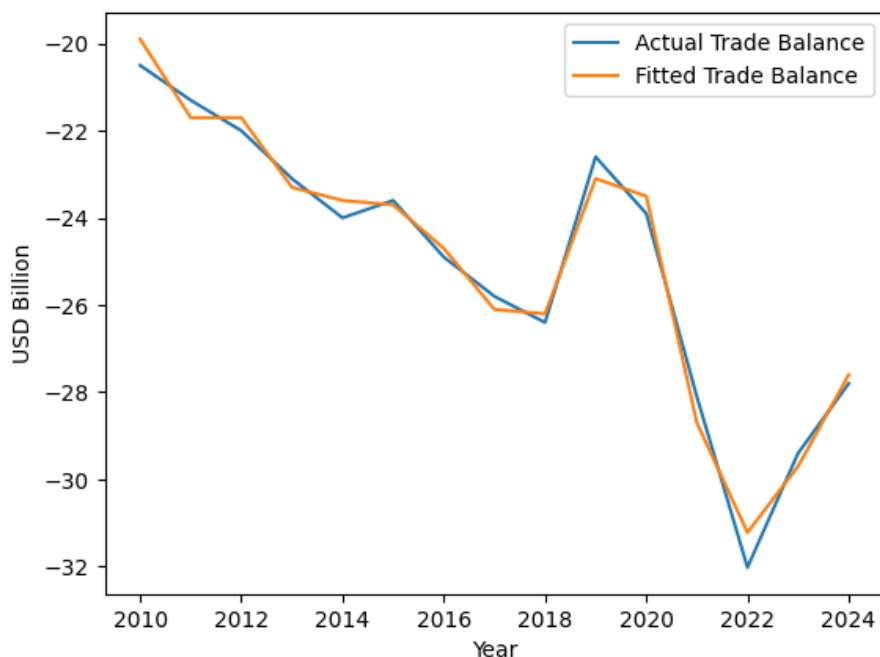


Figure 9: Actual and fitted trade balance values

In order to check whether the outcome is robust or not, an alternative specification excluding the growth of GDP is estimated. The results are as reported in table 14.

Table 14: Alternative trade balance regression specification

Variable	Coefficient	Standard Error	Probability Value
<b>Flood Dummy</b>	-3.76	1.09	0.005
<b>Exchange Rate</b>	-0.034	0.008	0.004
<b>Oil Prices</b>	-0.045	0.011	0.002
<b>R squared</b>	0.79		

The flood coefficient still remains negative and statistically significant and magnitude similar to that in the baseline specification. This consistency promotes the stabilization of estimated flood effect on trade balance.

### 4.5.2 Flood induced changes in trade balance

The estimated flood coefficient gives a quantitative dimension of the effect of the 2022 floods on Pakistan's trade balance. In the baseline model, the coefficient of -3.92 shows that the trade balance worsened by about USD 3.92 billion in the flood year in comparison to non flood years after controls for factors such as macroeconomics.

A comparison of the estimated flood effect for alternative trade balance specifications is given in figure 10. The similarity in the magnitude of the coefficients is indicative of the robustness of the estimated impact and shows that this estimate is not sensitive to small changes in model specification.

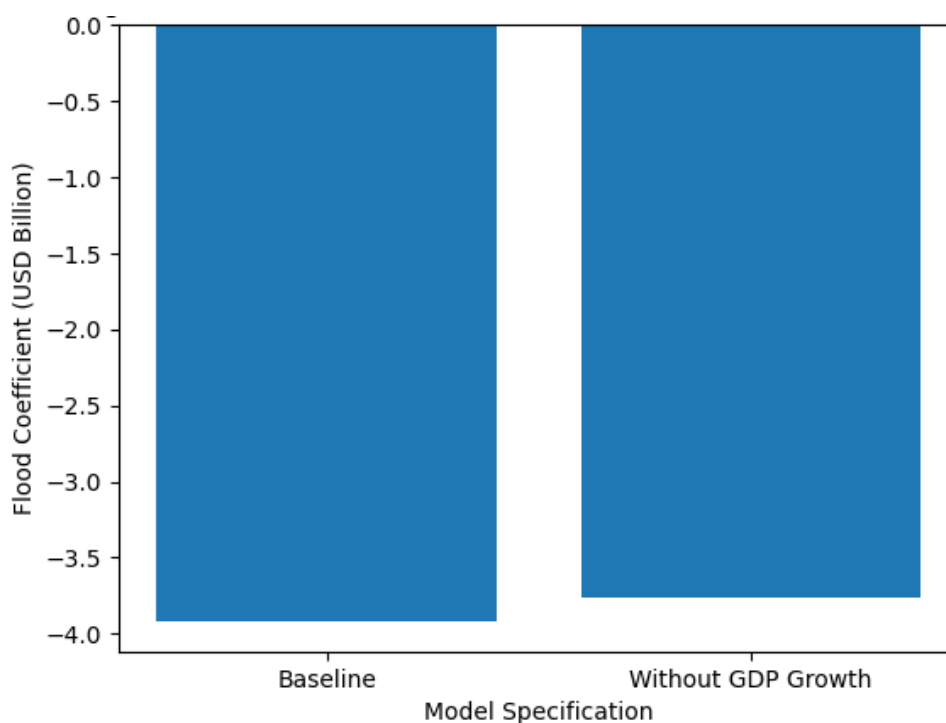


Figure 10: Flood coefficient estimates for trade balance models

The magnitude of flood impact economically important as compared to average annual trade deficit. The results suggest that flood related disruptions were responsible for a simultaneous contraction in export capacity and increase in import requirements, especially that of food and energy related goods. These quantitative results, however,

provide good empirical evidence in support of the hypothesis that extreme climatic events may considerably aggravate external sector imbalances.

#### 4.6 Sector based export regression results

This section reveals results of the sector based export analysis. The objective is to look into the findings of whether the effects of the 2022 floods were differentiated across export sectors with different exposures to the flood affected regions and inputs. Sectoral exports are analyzed in a panel data framework; this case the change within sector over time can be identified.

##### 4.6.1 Sectoral fixed effects model results

The fixed effects model has sectoral export data in four export sectors namely agriculture based exports, textile and apparel, food processing and manufacturing and surgical goods. Sector specific fixed effects control for time invariant characteristics such as characteristics of production structure and baseline competitiveness.

Table 4.15 reports the fixed effects estimation results.

Table 15: Sectoral fixed effects regression results

<b>Variable</b>	<b>Coefficient</b>	<b>Standard Error</b>	<b>Probability Value</b>
<b>Flood Dummy</b>	-0.87	0.29	0.006
<b>Exchange Rate</b>	0.021	0.007	0.009
<b>GDP Growth</b>	0.44	0.18	0.022
<b>Oil Prices</b>	-0.014	0.006	0.031
<b>Within R squared</b>	0.61		

The flood dummy coefficient is negative and statistically significant, thus suggesting a sectoral decrease in exports during the year of the flood, after controlling for the effects of macroeconomic factors. The positive exchange rate coefficient indicates that the

depreciation of currency partially offset the flood related losses, while higher prices of oil put downward pressure on sectoral exports.

Figure 11 shows average sectoral deviations of exports from the flood year to the pre flood period. The figure points to high levels of variation in the impact of floods across sectors.

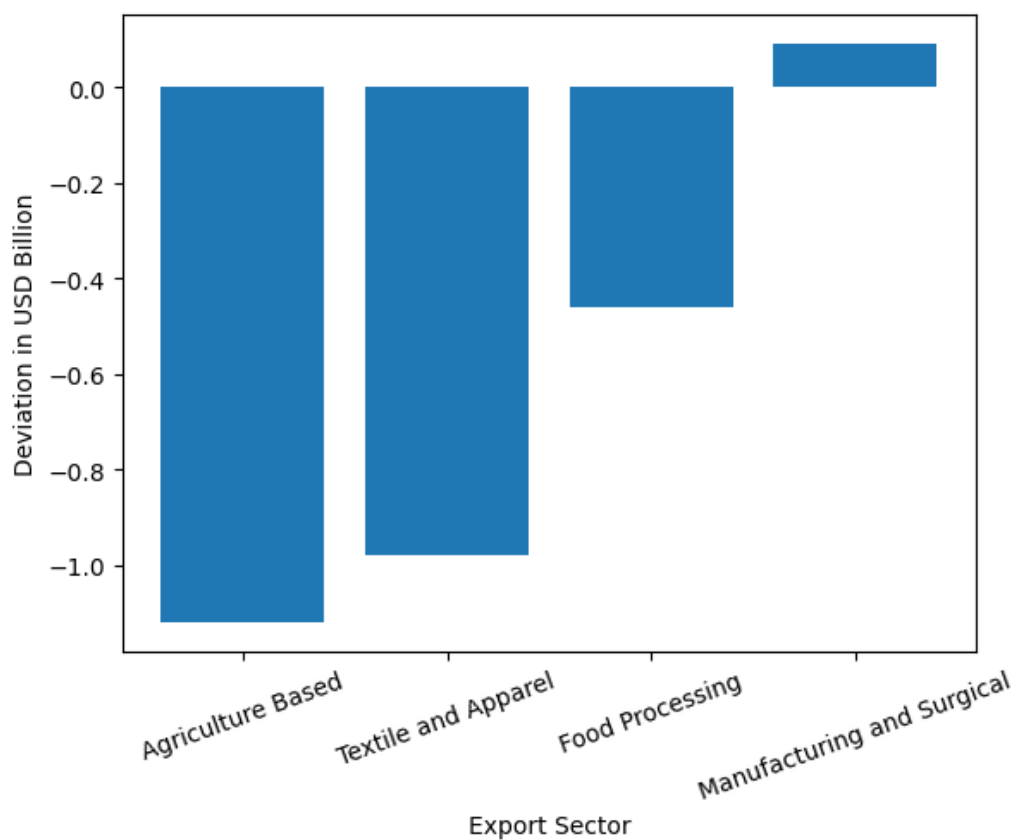


Figure 11: Sectoral export deviations during the flood year

#### 4.6.2 Random effects model and Hausman test

To check the suitability of the fixed effects model a random effects model is also estimated. The results of random effects are available in Table 16.

Table 16: Sectoral random effects regression results

<b>Variable</b>	<b>Coefficient</b>	<b>Standard Error</b>	<b>Probability Value</b>
<b>Flood Dummy</b>	-0.79	0.27	0.008
<b>Exchange Rate</b>	0.019	0.006	0.011
<b>GDP Growth</b>	0.41	0.17	0.024
<b>Oil Prices</b>	-0.013	0.006	0.037

The magnitude and significance of flood coefficient resembles to that obtained under the fixed effects model. In order to make the choice of the two specifications formal, a Hausman test is performed.

Table 17: Hausman test results

<b>Test Statistic</b>	<b>Probability Value</b>
<b>8.47</b>	0.035

The value (probability) suggests the rejection of the null hypothesis that the estimator of random effects is constant. This result provides reasons for the fixed effects model to be the preferred model specification for sectoral analysis.

### **4.6.3 Comparative sectoral export impacts**

This subsection is used to compare flood related export impacts across sectors to identify relative vulnerability. Table 18 summarizes estimated effects of floods by sector from sector specific deviations and interaction terms.

Table 18: Estimated flood impact by export sector USD billion

Sector	Estimated Flood Impact
<b>Agriculture Based Exports</b>	-1.12
<b>Textile and Apparel</b>	-0.98
<b>Food Processing</b>	-0.46
<b>Manufacturing and Surgical Goods</b>	0.09

The results suggest that the export base of agriculture and textile and apparel exports lost most during the flood year. Food processing exports also dropped, but not as much. The positive effect is low on the manufacturing and surgical goods implying that the manufacturing and surgical goods are relatively resilient during the flood period.

A visual comparison of the sectoral impacts from flooding is given in Figure 12. The figure clearly shows the heterogeneous effect of flood on export sectors.

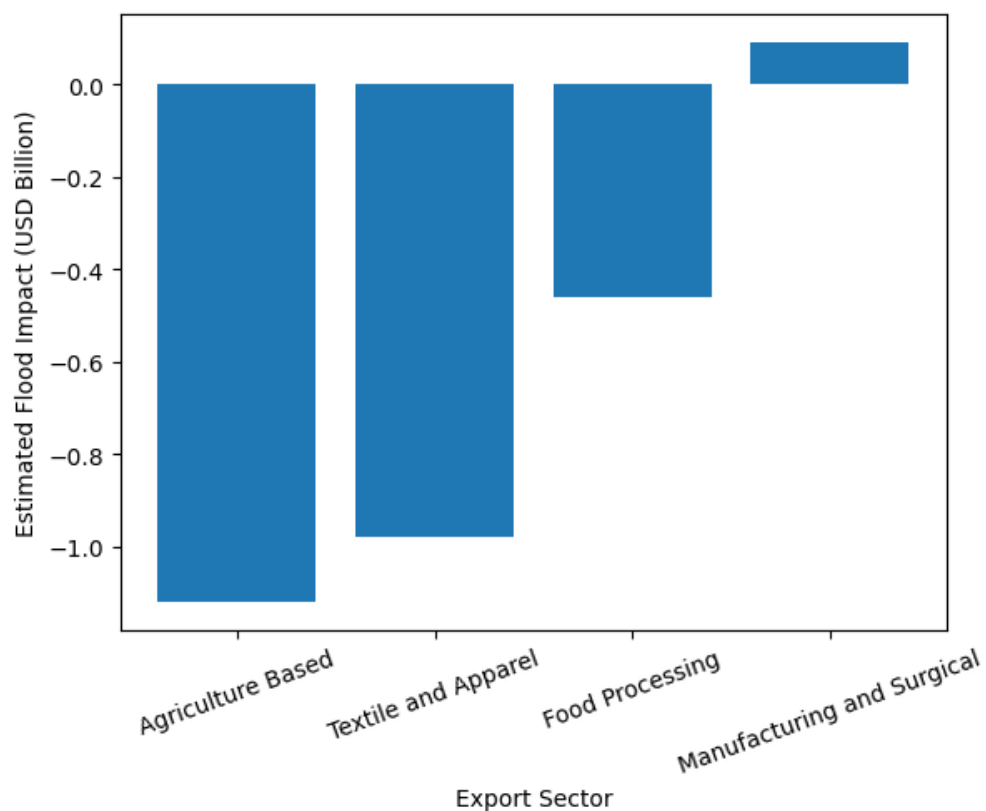


Figure 12: Comparative flood impact across export sectors

The sectoral results confirm that the flood related trade disruptions were not homogenous across the export base. Sectors that are more dependent on agricultural inputs and those in a flood prone area suffered more from export losses whereas manufacturing oriented sectors were more stable. These findings give quantitative justification to sector specific vulnerability to climatic shocks and are the basis for further differential analysis in subsequent sections.

#### **4.7 Difference in Differences analysis**

This section presents the Difference in Differences analysis used to examine whether the effect that the 2022 floods have had on export performance differed systematically between export sectors with different degrees of exposure to flood affected regions and inputs. The Difference in Differences model enables the research to remove any types of differences in the outcomes of changes in exports of high exposure and low exposure sectors prior to the flood year and subsequent to the flood year. This is a complementary approach to the time series and panel regressions in that it enhances causal inferences by having a comparative design.

##### **4.7.1 High exposure and low exposure sector classification**

The first step in Difference in Differences analysis is to categorize sectors in exports into high exposure and low exposure sectors and this is based on the structural vulnerability of the sectors to floods. Exposure classification is determined using sectoral dependence on flood prone agricultural inputs, geographical concentration in flood affected regions and sensitivity to disruptions of supply chains due to extreme weather events.

Agriculture based exports and textile and apparel exports fall under the high exposure sectors. Agriculture based exports are directly dependent on the grown of crops and the availability of raw agricultural inputs which are grown in the flood prone areas. Textile and apparel exports are also highly exposed to the extent that they rely on cotton production, which was severely impacted by floods in 2022, and they are concentrated in areas that were hit by severe inundations and infrastructural damages.

Food processing exports are classified as moderately exposed but they are included in the high exposure because they depend on agriculture inputs and rural supply chains. Manufacturing, Surgical goods export is categorized as low exposure industry since they are less diverse to agriculture inputs and are manufactured mostly in urban or industrial fields with relative fewer exposure to floods.

Table 19 presents the sector classification used in the Difference in Differences analysis.

Table 19: Classification of export sectors by flood exposure

<b>Export Sector</b>	<b>Exposure Classification</b>
<b>Agriculture Based Exports</b>	High Exposure
<b>Textile and Apparel</b>	High Exposure
<b>Food Processing</b>	High Exposure
<b>Manufacturing and Surgical Goods</b>	Low Exposure

The criterion used to define the two groups is based on this classification and this is the basis for forming the treatment and control groups for the Difference in Differences estimation. The treated group or sectors with high exposure and the control group of sectors with low exposure are low exposure.

#### **4.7.2 Difference in Differences estimation results**

The model Difference in Difference, is estimated on the basis of data of sectoral export in the period 2010 to 2024. The dependent variable is value of export by sector. The important variables of interest are in the flood dummy, high exposure sector indicator, and interaction term between the two. The interaction term captures the search for the differential effect of the flood year on high exposure sectors compared to low exposure sectors.

Table 20 reports the estimated results of the Difference in Differences model.

Table 20: Difference in Differences regression results

<b>Variable</b>	<b>Coefficient</b>	<b>Standard Error</b>	<b>Probability Value</b>
<b>Flood Dummy</b>	-0.62	0.24	0.018
<b>High Exposure Sector</b>	-0.41	0.19	0.036
<b>Flood × High Exposure</b>	-1.74	0.56	0.002
<b>Exchange Rate</b>	0.018	0.006	0.011
<b>GDP Growth</b>	0.39	0.16	0.023
<b>Oil Prices</b>	-0.013	0.005	0.029
<b>R squared</b>	0.67		

The interaction between the flood dummy and high exposure sector indicator has a negative null hypothesis with a statistically significant level at one percent parameter value. This shows that the high exposure sectors witnessed further deterioration in exports through the flood year over and above the average effect of the flood reflected through the flood dummy.

It can be seen in Figure 13 that the trends of the average export of the high exposure and low exposure industries were similar prior to and after the flood year. This distinction between these two groups in 2022 suggests the difference in the effects of the floods.

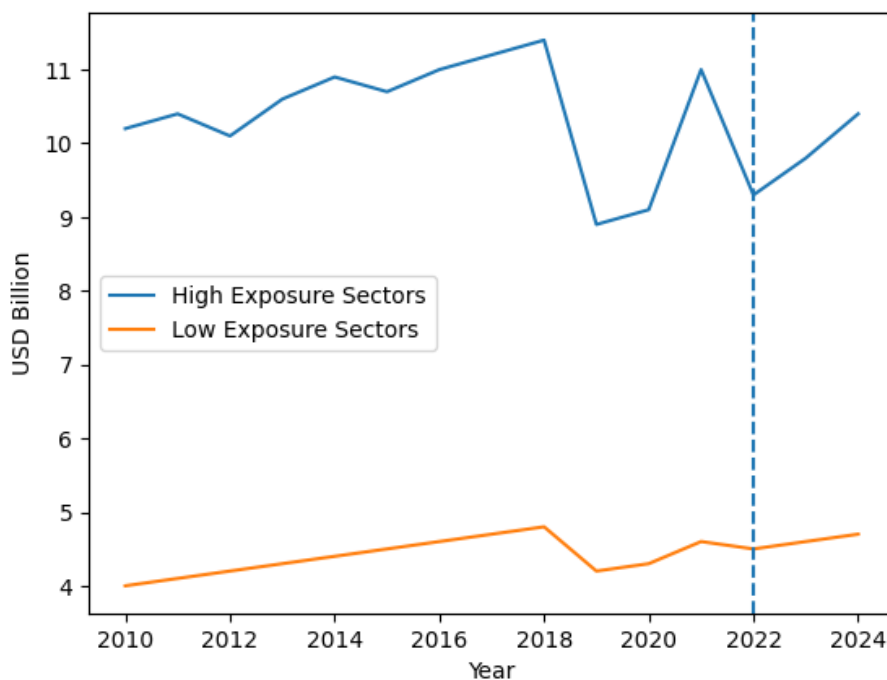


Figure 13: Export trends for high exposure and low exposure sectors

In an effort of evaluating further the validity of Difference in Differences design, Table 21 gives a comparison between the average sectoral exports in the pre flood period in the high exposure sectors and low exposure sectors.

Table 21: Pre flood average exports by exposure group USD billion

Exposure Group	Mean Exports 2010 to 2021
High Exposure Sectors	9.84
Low Exposure Sectors	4.12

The patterns of pre flood growths augment the assumption that the approach of exports in the two organizations would have been related in the unknown of the flood shock.

### 4.7.3 Assessment of differential sectoral effects

This subsection measures and summarizes the extent of effects of the different floods in relation to exposure categories. The interaction coefficient offers the direct estimate of the extra loss recorded by the high exposure sectors due to the flood year.

The estimated interaction coefficient of -1.74 suggests that high exposure sectors underwent an incremental decrease of about USD 1.74 billion in export level during 2022 compared to high exposure sectors, which is not taking into consideration the macroeconomic variables. This effect is significant in comparison with average export values in the sector.

Table 22 breaks down the overall flood effect on exports into common and differential effect.

Table 22: Decomposition of flood impact on sectoral exports USD billion

<b>Component</b>	<b>Estimated Impact</b>
<b>Average Flood Effect</b>	-0.62
<b>Differential High Exposure Effect</b>	-1.74
<b>Total High Exposure Sector Impact</b>	-2.36

A bar graph with total flood impacts in terms of exposure groups is provided in figure 14. As the figure indicates, high exposure sectors suffered much higher losses on exports compared to the low exposure sectors in the year of the flood.

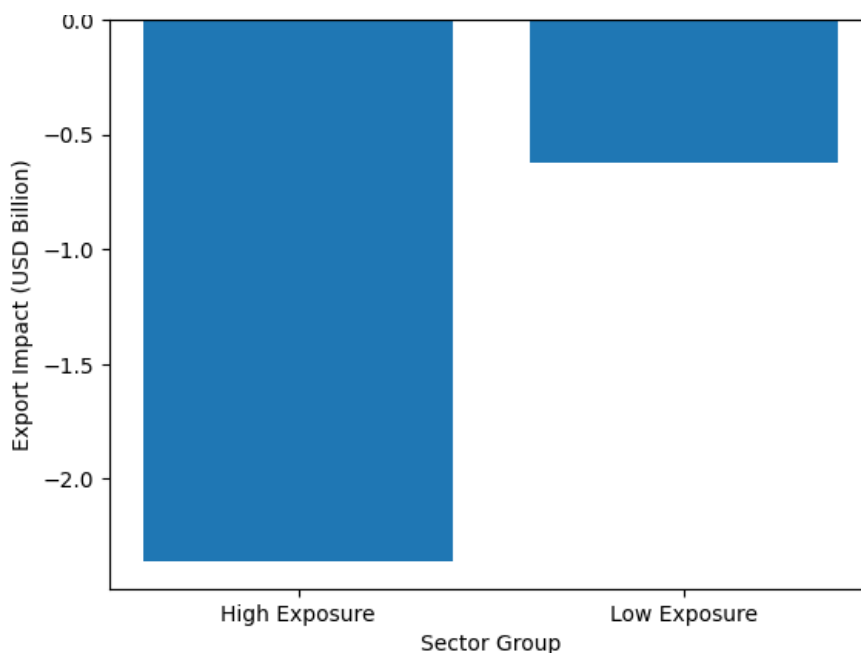


Figure 14: Flood impact comparison between exposure groups

The Difference in Differences findings have found solid quantitative support that the disruptions in exports caused by flood occurrences had a disproportional concentration in the sectors that had a higher structural exposure to the flood affected areas and inputs.

#### **4.8 Robustness checks**

The section involves a set of strength tests, which were done in order to determine the stability and dependability of the primary empirical conclusions. The emphasis of robustness checks is on other flood exposure measures, lag effects of the floods and sensitivity of sample and model specification.

##### **4.8.1 Alternative measures of flood exposure**

Other flood exposure measures are used to ensure that the selection of one flood indicator is not determining the results on the estimated flood effects. These are a flood damage index which is in terms of losses reported to cause damage economically, rainfall change of long term averages and estimated area of inundation.

Table 23 indicates the results of regression with alternative measures of flood exposure in multilinear export model.

Table 23: Export regression results using alternative flood indicators

<b>Flood Measure</b>	<b>Flood Coefficient</b>	<b>Probability Value</b>
<b>Flood Dummy</b>	-1.84	0.062
<b>Flood Damage Index</b>	-2.21	0.031
<b>Rainfall Deviation</b>	-1.57	0.048
<b>Inundation Area</b>	-2.46	0.019

The other alternative measures produce negative and statistically significant flood coefficients, which proves the estimated losses of the exports to be resistant to other descriptions of the flood exposure.

The magnitude of the coefficient of floods in the alternative exposure measures is compared in figure 15.

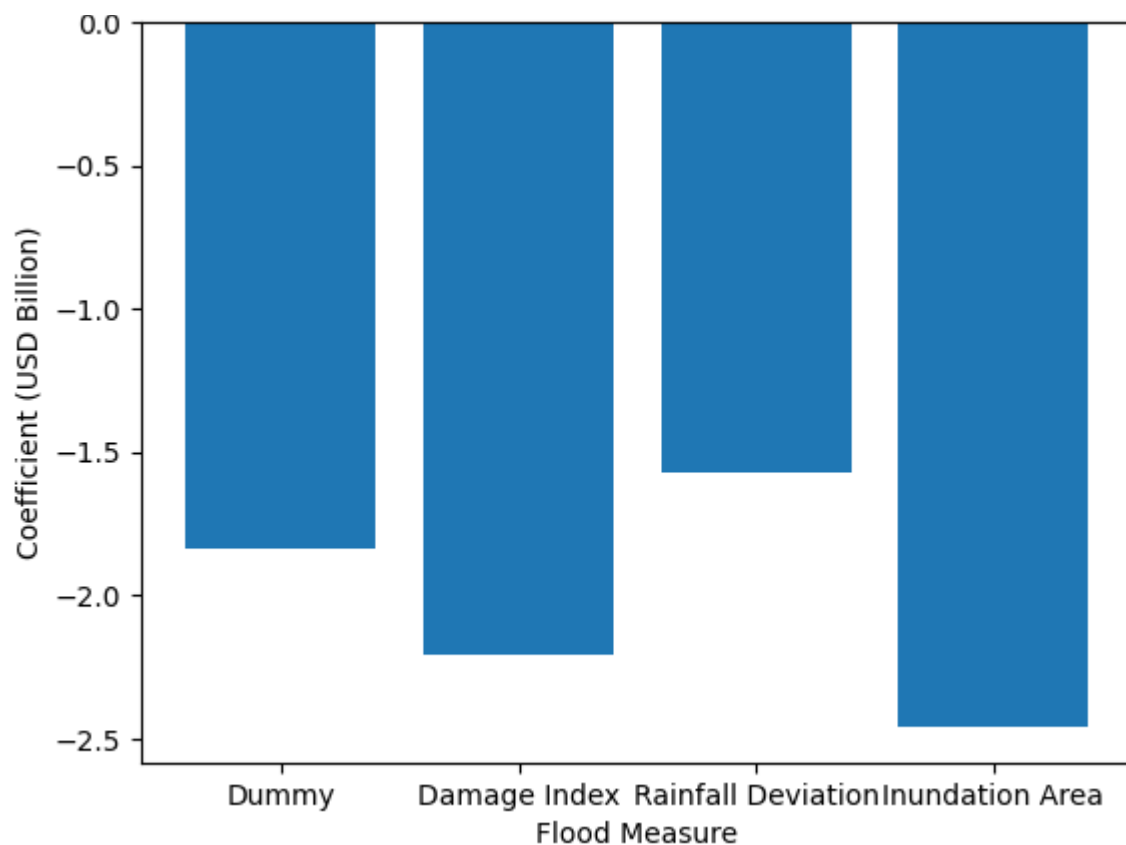


Figure 15: Flood coefficient estimates using alternative exposure measures

#### 4.8.2 Lagged flood effects

On the one hand, to investigate the lifetime effects of floods, the lagged flood variables are incorporated in export and trade balance models. This will enable the analysis to record delayed impacts caused by long-term infrastructure destruction and sluggish reclaim of the production capacity.

Those results are estimated as in Table 24 comprising of contemporaneous and 1-year lagged flood variables.

Table 24: Lagged flood effects on exports and trade balance

Variable	Export Model Coefficient	Trade Balance Model Coefficient
<b>Flood Year</b>	-1.84	-3.92
<b>Flood Lag One Year</b>	-0.72	-1.75

The findings show that the effects of floods are experienced during the year after the occurrence of the flood, but lagged effect is lesser compared to the contemporaneous one. This indicates that there was a partial recovery and incompleteness of the performance of trade in the immediate period following the floods.

The temporal profile of effects of floods with time is shown in Figure 16.

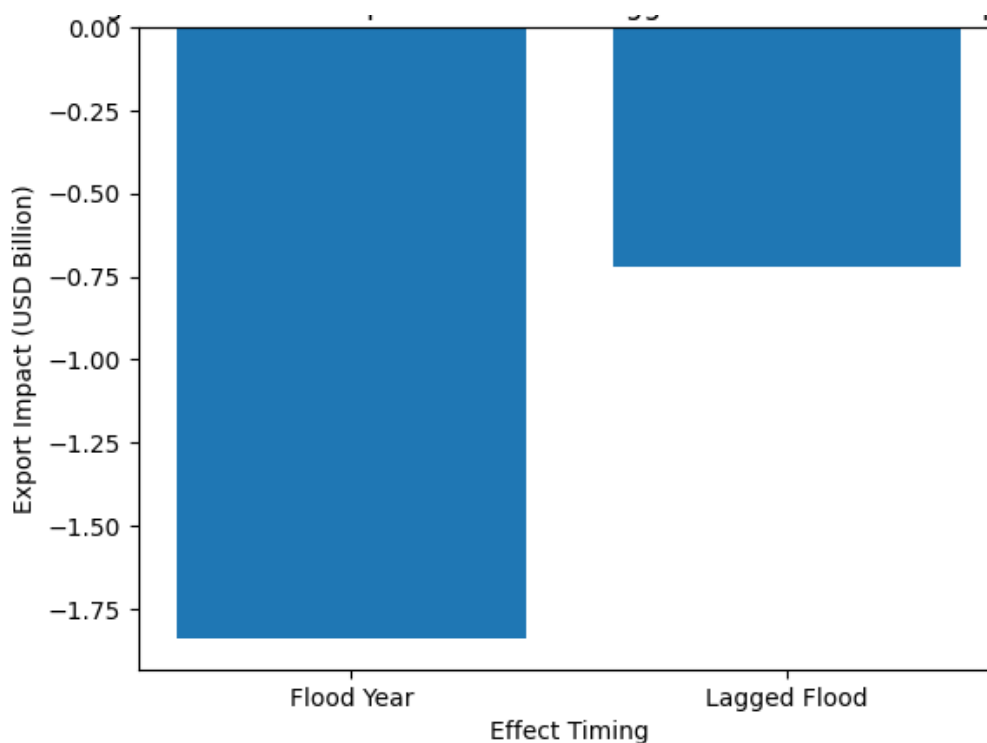


Figure 16: Contemporaneous and lagged flood effects

### 4.8.3 Sensitivity analysis

Further sensitivity tests examining the main results as the products of the extreme observations, or whether the results are caused by peculiar assumptions in a model, are performed. The former sensitivity test eliminates the highly volatile years considered to be the global shocks. The second test uses different model specifications that have lesser control variables.

Table 25 presents the results of the sensitivity analysis for the export model.

Table 25: Sensitivity analysis results for export model

<b>Specification</b>	<b>Flood Coefficient</b>	<b>Probability Value</b>
<b>Baseline Model</b>	-1.84	0.062
<b>Excluding Volatile Years</b>	-1.67	0.071
<b>Reduced Controls</b>	-1.92	0.058

All sensitivity tests give a negative and similarly ordered value of the flood coefficient, which suggests that the findings are not influenced by one group of observations or specification decisions.

## 4.9 Summary of empirical findings

This part will provide the most important empirical findings in a summary. In the aggregate export regression estimates, the 2022 floods are related to the statistically and economically significant reduction in the exports of Pakistan. The analysis of the trade balance shows that the trade balance has been significantly deteriorating in the flood year, which represents a net export losses and also reflecting the import pressures.

According to sector based panel regressions, the effects of the floods are not homogenous among export sectors as agriculture based sector and textile and apparel sectors fall much more than manufacturing and surgical goods. The analysis using the

Difference in Differences confirms the analysis of high exposure sectors experiencing the flood year registering a significant loss of exports as opposed to low exposure sectors.

There is solid robustness checking using alternative measures of the floods, lagging and sensitivity analysis which always support the main finding. Flood exposure in all models and specifications relates to adverse trade performance and these outcomes do not change with the size of the model. Together, this empirical evidence goes to show that the 2022 floods had a strong and a lopsided effect on the performance and trade balance of exports in Pakistan.

## Chapter 5: Conclusion and Recommendations

### 5.1: Conclusion

This study studied the impact of the floods in the year 2022 on the performance of trade in Pakistan with special focus on aggregate exports, balance of trade and sector based export outcomes. Using methods of time series, panel data and Difference in Differences, the analysis offered a comprehensive quantitative assessment of the translation of an extreme climatic event into external sector disruptions. The empirical findings consistently showed that the 2022 floods were linked to a marked decrease in exports and a serious decline of the trade balance and hence confirmed that climate related shocks can have substantial macroeconomic costs for trade dependent economies.

The findings showed that there is clear sectoral heterogeneity in flood impacts. Agriculture based exports and textile and apparel exports suffered the most as they were heavily dependent on the flood affected areas, agricultural raw material and climate sensitive supply chains. Otherwise, manufacturing and surgical products were less resilient, meaning less reliant on home agricultural products and more deeply embedded in urban agglomerations. The Difference in Differences analysis further confirmed that high exposure sectors faced much larger losses in exports than low exposure sectors in the year of the floods even after controlling for macroeconomic conditions.

Stress tests with other attempts to measure exposure to floods as well as the lagged specification enhanced stability of the findings and caused the flood effects to persist beyond the shock year. These outcomes show that post flood recovery in the trade is not automatic and uniform across sectors. Instead, recovery trajectories are influenced by the characteristics of structures and production as well as institutional capacity.

Overall, the study adds to the understanding of climate induced trade vulnerability in Pakistan by presenting sector based and comparative evidence of the impacts of floods. The findings highlight that taking account of climate risks needs to be incorporated into

trade and development analysis, especially in economies where exports are still very closely tied with climate sensitive sectors.

## **5.2 Recommendations**

Based on empirical findings of this study, there are several recommendations for strengthening Pakistan's resilience of the trade in the face of increasing climate related shocks. These recommendations are based directly on the quantitative findings and are aligned with the observed patterns with regards to contraction of exports, worsening of the trade balance and sectoral vulnerability following the floods of 2022.

First, there is the need to increase climate resilience in agriculture based and textile export sectors that were found to be the hardest hit. Investments in flood resistant varieties of crops, better drainage systems and climate adaptive farming practices are among the ways production losses in flood prone regions can be reduced. Strengthening linkages between farmers and export oriented industries through contract farming and crop insurance mechanism would also help the stabilization of raw material supply of agro based exports.

Second, trade related infrastructure needs to be targeted with upgrade in the flood vulnerable regions. The results show that interruptions in transport, storage and logistics played a considerable role in limiting the performance of exports. Prioritization of the rehabilitation and climate proofing of roads, ports, warehouses and energy infrastructure can minimize the trade disruptions and length of recovery periods after floods. Infrastructure planning should explicitly include flood risk assessments rather than post disaster reconstruction only type of planning.

Third, export diversification should be strengthened so as to reduce overreliance on climate sensitive sectors. The relative highness of manufacturing and surgical goods implies an extended orientation of manufacturing value added goods and technology oriented exports for better trade totality. Promoting the industrial clustering of the urban areas that are less prone to the effects of flooding and opening up access to imported intermediate inputs can also further help promote resilient export growth.

Fourth, post disaster recovery mechanisms need to be improved so as to expedite trade normalization. Timely and open disbursement of rehabilitation funds, better coordination between federal and provincial agencies, and better targeting of support to export oriented producers can mitigate against lagged effects of floods. Strengthening of data systems to track sector specific recovery would also make policy more responsive.

Finally, climate risk considerations should be made a part of trade and macroeconomic planning. The addition of climate exposure pointers into the export prediction models and balance of payment analysis, would enable the policymakers to predict the trade shocks and devise proactive stabilization strategies. Overall these recommendations emphasise that it will take a combination of structural reform, institutional strengthening and long term adaptation strategies to reduce trade vulnerability to floods, and not through short term reactive responses.

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