Market-Specific Trade Costs and Firm Dynamics: Evaluation of the Integrated Cargo Containers Control Program between Pakistan and the United States

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Abstract
Using novel firm-level microdata that tracks the location of firms' export processing stations over time, this study examines the trade effect of the Integrated Cargo Container Control (IC3) program and explores the mechanism and the speed of adjustment. IC3 program, launched between Pakistan and the US in the wake of 9/11 aimed to thwart the potential vulnerability of cargo containers to terrorist exploitations. Although primarily a security measure, it affected beyond-the-border and behind-the-border costs of exporting to the US market. We exploit the exogenous nature of this shock and its specificity to one export market in the identification strategy. Using the EU as a counterfactual, difference-in-difference estimates show that after this intervention, Pakistan's exports to the US relative to the EU dropped by 15%, on average. Firms that switched from other export-processing stations to one specific seaport equipped with intrusive scanning and live monitoring technologies experienced the largest decline in their trade. The subsequent policy interventions aimed at facilitating the process moderated this effect. This security policy appears to have caused a loss of US market access amounting to $8 billion between 2007 and 2014, which is economically significant for a small developing economy. These findings have policy implications for the adoption of similar technologies in the wake of emerging security scenarios in various parts of the world. It shows how adding another layer of security to the existing supply chain can influence the behaviour of exporting firms and disrupt existing trade flows.

Keywords: Trade Costs, Supply Chain Security, Scanning, Integrated Cargo Container Control, 9/11 and Trade, Trade Diversion

JEL Codes: F1, F13, F14

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1 Introduction

In a world of increased global security threats, the transportation networks are viewed as a weak link that can be exploited to ship technology of terrorism internationally. Understanding the effect of policy responses to this perceived threat on international trade in goods is therefore of increasing importance. The difficulty is that countries do not alter or adopt new security policies randomly, but rather do so because of a range of other factors that might also be correlated with trade. Even where adoption is random, finding a suitable counterfactual is challenging. Because of these complications, the estimation of precise effect of additional layer of security on the supply chain remain a mystery. Exploring this effect has assumed importance in the wake of emerging security situation in different parts of the world, which pose a threat to the progress achieved so far in liberalising trade flow and reducing cost of doing international business.

A similar situation emerged after the event of 9/11, which heightened fears that containerized cargo could be used as a conduit for smuggling radioactive or nuclear materials into the US. To alleviate these concerns, the US Congress passed a 100% scanning law applicable from July 2012 to all incoming containerized cargo. IC3, a pilot program under this scheme, was launched at Port Qasim (PQ), Karachi, Pakistan, in 2006. It required screening of US-bound cargo containers originating from Pakistan jointly by the Customs administrations of both the countries via a live video link.

This study investigates the net effect on firm-level exports of changes in trade costs due to imposition of an additional layer of security on the supply chain in the shape of 100% scanning of United States (US)-bound cargo containers before their shipment from the port of origin (GAO, 2008). It uses the Integrated Cargo Container Control (IC3) program between Pakistan and the US as a quasi-natural experiment and applies a difference-in-difference (DID) approach, using the European Union (EU) as a counterfactual group. It also explores the mechanisms and the speed of adjustment along various margins of firms and products.

This empirical setting is quite unique in two important aspects. First, the requirement of 100% intrusive scanning was unilaterally imposed on Pakistan as a result of its internal security situation in the US after the events of 9/11. Moreover, the technology primarily aimed at improving security; therefore, the trade effect of the United States' security policy is completely exogenous for Pakistan's exporting firms. Second, IC3 had a differential effect on trade costs that is specific to one export market only. Exports to the US (treatment group) were influenced by IC3, whereas those to the EU (control group) were not, as these are still processed through standard channels from all exporting stations in Pakistan. These distinguishing features allow us to use a DID estimation approach. Application of a DID estimation approach allows us to wash out the effect of other factors such as improvement in technology, infrastructure and institutional changes that could have affected trade flows in this period.

We initially document the factors imposing additional trade costs at- and behind-the-borders that appear to offset any reduction in beyond-the-border trade costs of IC3 program and then generate econometric evidence about the drop in Pakistan's exports to the US market relative to the EU. Following that we explore the heterogeneity of the effect for various cohorts of the firms, and examine its implications for extensive margins of firms and products, prices and quantities, as well as over time. This decomposition along multiple dimensions inform us about the mechanism, drivers and speed of adjustment to the initial shock. The identification strategy exploits a novel variation directly affecting the cost of international trade between Pakistan and the US. The exogenous nature of the shock unilaterally imposed on Pakistan's and its specificity to one export market allows us to perform estimations by finding a suitable counterfactual group – that is, the EU – that did not impose such trade restrictions.

This study finds IC3 has, in general, imposed an additional burden on Pakistan's firms rather than facilitating their exports to the US. The reduction in trade costs, if any, brought about by the

installation of scanning facilities at the port of origin is offset by the increase in costs associated with internal trade diversion resulting from the concentration of the intrusive scanning operations at one exporting station. The estimates show that, in these new arrangements, Pakistan's exports to the US drop by 15% compared with those to the EU. The effect is relatively higher for the firms that had to switch from other exporting stations to QP in order to meet scanning obligations. This adjustment appears to have occurred through the channels of extensive margins of firms and product as well as through prices and quantities. The drop is severe for the period of initial four years, from 2007 to 2011. The subsequent policy interventions in 2011 facilitated this process, which reversed this decline in trade. These results are robust to a battery of sensitivity checks comprising product-level estimations, first-differencing the data and adding time-varying fixed effects for firms and products.

This work extends the narrow stream of literature focusing on trade and security issues (Mirza and Verdier, 2008); EC, 2009; WCO, 2008; GAO, 2008). Mirza and Verdier (2008) setup a general analytical framework that describes the existing relations between terrorism, counter-terrorism actions and trade, and argue that terrorism affects trade primarily through two channels: reducing willingness to do business with un-secure country and trade-restrictive effect of counter-terrorism policies. Our paper, however, provide empirical evidence to the effect of these channels. Similarly, EC (2009), WCO (2008) and GAO (2008) alluded to the unfeasibility of 100% scanning of US-bound cargo owing to the high costs associated with the internal movement of cargo, congestions at ports and associated infrastructure constraints. Although these studies found the potential 100% scanning operations to be highly cost-intensive and trade-restrictive, they did not perform quantitative assessment of the magnitude of the impact on trade flows. We bridge this gap by generating methodologically robust empirical evidence to this effect and examine its implications for various margins of firms and products.

We add to the four distinct stands of literature pertaining to technology and trade, economic sanctions, trade costs and trade diversion. The recent literature on effect of technology on trade examines the effect of containerisation (Bernhofen et al., 2015) and maritime transport (Pascali, 2014; Hummels, 2007), whereas this paper explores the effect of intrusive scanning technology, which is increasingly being adopted for the security and trade facilitation purposes. This literature on economic sanction, for example, Afesorgbor and Mahadevan (2016); Yang et al. (2009); Caruso (2003); Cooper (1989); Khan (1988), find a negative trade effect of these sanctions. We add to this stream by generating the evidence of an unusual trade restriction. Similarly, the trade diversion studies examine the changes in importing countries' trade patterns in the context of PTA and FTAs (Carrere, 2006) but we explore the effect on exporting country' trade pattern due cost-raising effect of this policy change. This trade diversion effect of behind-the-border costs speaks to the literature on trade costs (Arkolakis, 2010; Feyrer, 2009; Anderson and Van Wincoop, 2003, 2004; Baier and Bergstrand, 2001; Donaldson, 2014). In contrast to these studies, we estimate the trade-restricting effect by finding a suitable counterfactual group, which is a superior estimation approach to isolate the effect of this shock from other potential omitted variables impacting exports during this period.

To the best of our knowledge, this is the first *ex-post* quantitative assessment of the trade costs associated with the launch of IC3 and the resulting diversion of trade at the domestic and international fronts. Moreover, our focus on a developing country informs us about the additional constraints faced by exporting firms of such economies.

The next section introduces the data, describes empirical setting and presents estimation methodology. Section 3 discusses main estimation results and robustness checks. Section 4 examines mechanism, drivers and speed of adjustment. Section 5 concludes by highlighting the policy implication of the study. A short note on the IC3 program is contained in the appendix.

2 Data, Empirical Setting and Estimation Strategy

2.1 Data and Empirical Setting

We conduct this research by using primary transaction-level datasets of Pakistan's exports. Pakistan is a fast-growing developing economy and ranks sixth in the world in terms of population size. It has been a frontline state in the war against terrorism; because of this security situation its US-bound exports undergo 100% scanning at the port of origin before their shipment since the launch of IC3 program in April 2007. The micro-level information on various margins of trade is retrieved from the administrative dataset of Pakistan Customs. This dataset contains information about product code, unit values, and quantities at an eight-digit level of Harmonized System (HS), in addition to the identities of export processing stations and those of exporters and importers in the markets of origin and destination, respectively. It covers universe of firms shipping from all exporting stations (dry ports, airports and seaports) to 215 trading partners of Pakistan. We, however, restrict the analysis to the comparison of US and EU markets.

The cleaned dataset of exports to the EU and US contain 6.1 million transactions (3.8 million for the EU and 2.3 million for the US) for 24,174 firms, of which 20,297 exported to the EU and 11,737 to the US during 2002-2014. This long time span covers the period of five years prior to and six years after the launch of IC3. Moreover, it includes all product categories in manufacturing as well as in agriculture sectors. For ease of estimations, we collapse the data at firm-product-market-year level. This transformation yields 472, 258 observations, of which 322, 523 pertain to the EU and 149, 735 to the US. We test the integrity and accuracy by performing aggregation tests and comparing the results with the same information retrieved from the UN Comtrade dataset.

Details on the spatial location of firms across Pakistan and locations of their export operations comes from monthly sales tax returns filed with the Inland Revenue Services (IRS) of the government of Pakistan. The merging process of these datasets was made possible through the use of a single tax identification code called the national tax number (NTN), which is allocated to each firm. The remaining information about other economic variables is retrieved from open data sources at the World Trade Organization (WTO) and the World Bank.

2.2 Defining Treatment Effects: Effect of IC3 on US-bound Exports

IC3 program had a differential effect on trade costs that is specific to one export market only. It targeted US-bound exports only but did not affect exports to other markets, which continued to be processed through standard channels from all exporting stations in Pakistan. Therefore, the trade effect of IC3 is quite different from most trade related infrastructure projects whose scope is generally quite broad. For example, construction of a new port or improvement in the existing infrastructure could influence trade flows to all export destinations served by that port. By contrast, the changes in trade costs owing to implementation of IC3 are destination specific. This distinguishing feature allows us to find a suitable counterfactual group. This sub-section discusses the effect of IC3 on treatment group and then explains the selection of control group (EU).

IC3 affected the cost of exporting to the US market in two distinct legs of the supply chain – beyond-the-border, and at-and behind-the- borders; it reduced the former but increased the latter. A systematic analysis of its influence on these two distinct domains indicates that the increase in behind-the-border trade costs offsets the effect of reduction in those beyond-the-borders.

2.2.1 Reduction in Beyond-the-Border Trade Costs due to Direct Shipments to the US Market

In order to ensure buy-in from program stakeholders, Pakistan's administration advocated IC3 as a trade facilitation initiative. Documents of the national Customs authorities as well as the Pakistan Trade Policy Review (2007) describe it as a step towards facilitating trade through curtailing vessel sailing time to the US, eliminating transhipment requirements at intermediary ports for scanning, and simplifying procedural formalities at the port of origin and destinations, in addition to ensuring the security of the supply chain. In these new arrangements, Pakistan's cargo containers are scanned at

the port of origin and shipped directly to the US, which has reduced the lead-time to reach the US market by two to six days. In the pre-IC3 period, a container shipped from PMBQ could take up to 35 days to reach US market depending on the route of ship and port of transhipment (Table 1). This sailing time has now dropped to 24-32 days.

Table 1: Maritime Distances and Vessel Sailing Time to the US Market in the Post-IC3 Period

A: Maritime Distances (Km)

Direct Shipments		Via Transhipment Ports					
		Sri Lanka		Hong Kong		Salalah (Oman)	
Destination	KM	KM	Diff. (%)	KM	Diff. (%)	KM	Diff. (%)
New York	14,812	18,424	-19.60	28,591	-	14,852	-0.27
Los Angles	19,564	19,756	-0.97	19,828	-1.33	21,754	-10.07

B: Vessel Sailing Time (days)

Direct Shipments		Via transhipment port					
		Sri Lanka		Hong Kong		Salalah (Oman)	
Destination	Days	Days	Diff. (%)	Days	Diff. (%)	Days	Diff. (%)
New York	24	30	-6	45	-	25	-1
Los Angles	31	32	-1	32	-1	35	-4

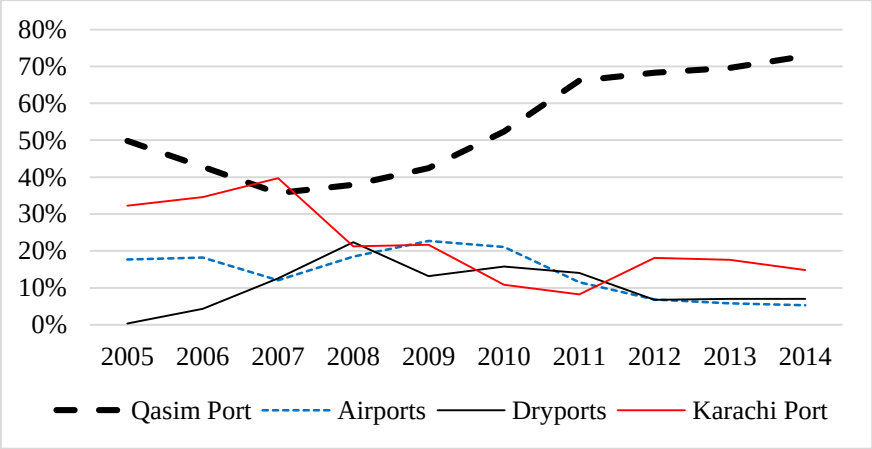
Source: http://www.searates.com/reference/portdistance/

2.2.2 Increase in Behind-the-Border Trade Costs due to Centralisation of the Scanning Operations

This beyond-the-border reduction in trade costs is offset by the rise in trade costs at- and behind-the border mainly because of two reasons. First, the scanning is an additional layer to standard border clearance procedures[1], and is applicable to all cargo irrespective of its potential risk. It affects all the cargo originating from Karachi and that from hinterland dry ports, and entails duplication of some procedures especially for upcountry cargo.

Second, the concentration of scanning operations at one port has led to a massive diversion of trade at the internal level. The share of QP in US-bound cargo has increased from 36% in 2007 to around 80% in 2013 (Figure 1). This increase occurred because the export containers processed at other stations have to be transported to PQ for scanning. This internal trade diversion has increased inernal transportation costs and created processing delays.

Figure 1: Internal Diversion of US-bound Export Cargo to Qasim Port due to Centralisation of the Scanning Operations, 2005-2014



Note. The values on y-axis are trade share of various processing stations in the total US-bound exports
Source: Pakistan Customs

[1] Such as random physical inspections by Customs and drug checks by anti-narcotics force.

In addition to the cost of diversion, relatively under-developed port infrastructure and poor connectivity with hinterland exacerbated the cost of shipping to the US through QP. Port infrastructure and support services vary widely at both seaports. Karachi is the main port of Pakistan with better and well-developed port infrastructure, such as shipping agents, freight forwarders, and handling facilities. Because of these allied services, most firms preferred to despatch their US-bound shipments from KP in the pre-IC3 period. But in post-IC3 period, they were constrained to operate from QP, a relatively new port with fewer berths and support facilities. Moreover, QP is located in a relatively unsecure area at a remote location from the main city of Karachi.

Since QP is not directly connected with the main road network, cargo vehicles have to wait in daytime to ply through the city. This heavy traffic is allowed to cross the city after 11pm in order to avoid huge traffic congestion in this mega city of 22 million populations. Moreover, the IC3 scanning yard at QP is located outside the main port terminal. This means there is a need for unloading, handling and internal transportation, which further increases the costs, in addition to causing delays.

2.2.3 Heterogeneity of the Behind-the-Border Effect across Firms

Concentration of the scanning operations at one exporting station had a differential effect on firms' depending upon the location of their previous exporting operations. It is expected to be less severe for firm already shipping through QP prior to the launch of IC3 (called incumbents hereinafter) because they continued their exporting operations at the same port, although their consignments were also subjected to scanning prior to shipment. This cohort may benefit initially from their established position at the exporting station. However, they may be hurt due to the switching of other firms who may compete for storage space and other operational facilities.

The effect on other cohort, which was forced switch from KP and dry ports (DP) to QP in order to meet the scanning requirements, is expected to be relatively stronger. The switching firms, although hurt initially, are expected to improve over time. Table 2 presents summary statistics of these cohorts and their overtime evolution is contained in the appendix (Table A2).

Table 2: Decomposition of Treatment Group to Incumbents and Switchers

Group	Statistics	
Incumbents		
	Firms	1,381
	Products	2,440
	Observations	16,583
Switchers		
	Firms	10,355
	Products	5,218
	Observations	133, 240

Note: Switchers exported from Karachi Port and dry ports before the launch of IC and had to shift to PQ after IC3, whereas incumbent export from PQ before and after IC3.

2.2.4 Policy Adjustment in 2011

These arrangements continued until 2011 and Pakistan's exports to the US in this period stagnated. In order to stem this drop, two new initiatives were taken in 2011. First, the existing scanning yard at IC3 was expanded to double of its existing capacity, and second, the Qasim Port launched an off-dock terminal near Karachi Port to collect US-bound export cargo and arrange its further transportation and processing at QP themselves. These measured seem to affect the US-bound export positively.

2.3 Selection of a Control Group

IC3 program influenced the processing of Pakistan's exports to the US (treatment group) only, whereas those to the all other markets remained unaffected, and these are handled from all exporting stations across Pakistan as per previous practice. This distinguishing feature allows us to find a suitable counterfactual group. Some potential control-group candidate countries are China, Afghanistan, and the United Arab Emirates (Table 3), all of which are major export markets of Pakistan. Although the volume of exports to these markets is comparable to that destined to the US, the nature of trade policy regime and the structure of exports to some of these markets varies.

For example, exports to China mainly comprise raw materials and those to Afghanistan are food and textile items, whereas those shipped to the US are higher value finished goods. Because of these compositional differences, China and Afghanistan less suitable control groups. Similarly, the United Arab Emirates (UAE) is also ruled out as a suitable counterfactual because exports to the UAE are not necessarily absorbed in that market but are transited through its ports to other destinations.

Table 3: Value and Share of Pakistan's Exports to Potential Control Group Countries, 2013

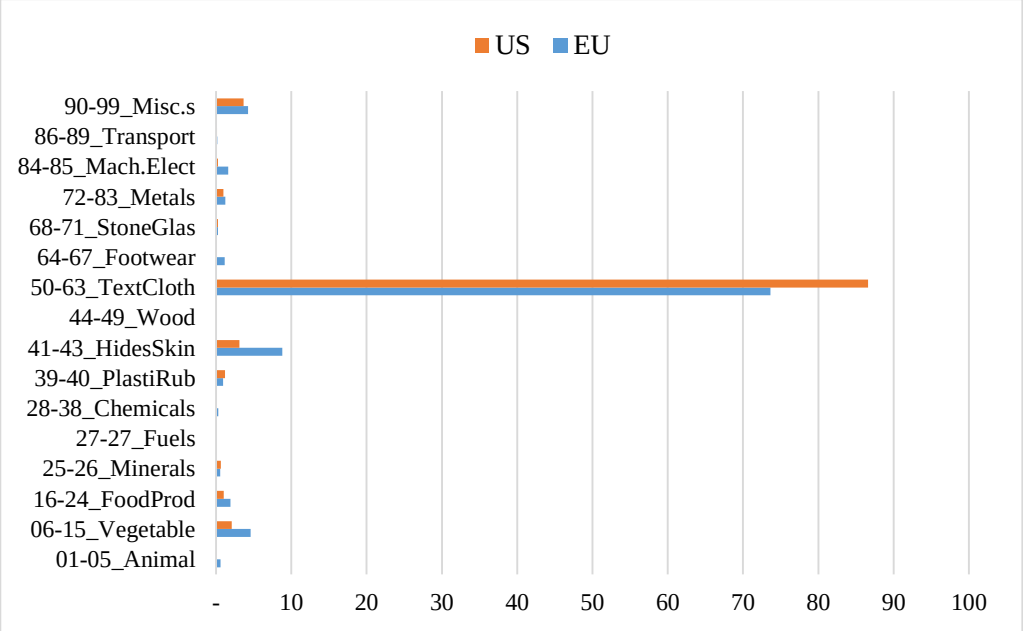
Trading Partner	Exports (US$ M)	Share (%)
United States	3,746	14.91
China	2,652	10.56
Afghanistan	1,998	7.95
United Arab Emirates	1,775	7.07
European Union (28)	5,932	23.01

Note: Share indicates the fraction of Pakistan's total exports.

Source: Pakistan Customs.

Figure 2: Composition of Exports to the Control (EU) and Treatment (US) Groups

Share of various products groups in the exports baskets (%), 2013



Source: Pakistan Customs

In terms of nature of export products, EU is closer to the US as these economies are key destination of Pakistan's textile and other finished goods. Textiles constitute around 75% and 85% of Pakistan export basket to the EU and US, respectively (Figure 2). The production process of these goods uses the same raw material, machinery and equipment. Moreover, demand structure these countries are almost the same because of similar level of economic development.

A further decomposition of data of EU and US indicates that a large number of firms serving both markets, and these markets absorb a wide overlapping set of products. Table 4 presents the detail of firms and their export-product set shipped to both markets over time. It shows that some firms ship to single market, either EU or US, but a large set of firms export to both markets. Similarly, some products are market specific, whereas a large overlapping set of products are absorbed in both markets. Therefore, in terms of composition of exports as well in terms of level of demand structure, the EU constitutes a most suitable control group. We, however, control for the differences in product quality across markets in our estimations.

The effect of IC3 is evident on firms and products. Prior to the launch of IC3 in 2007, the number of firms shipping to both markets —the control (EU) and treatment group (US)— were rising gradually. In the post IC3 period, the control-group cohort continued its expansion, whereas the treatment group stagnated from 2007 to 2011 and experienced a modest increase in the subsequent years. Single-market firms (serving the US market only) appear to drive this trend: the size of this cohort drops in three consecutive years, from 2007 to 2009. In contrast to the above, the size of multi-market cohort (firms shipping to the both markets, EU as well as US) continued expansion over time except for a drop in 2009, which appears to coincide with the period of global financial crisis.

Table 4: Exporting Firms and Products in the Control (EU) and Treatment (US) Groups

	Firms					Products				
	All Firms		Single Market		Both Markets	All Products		Single Market		Both Markets
Year	EU	US	EU	US	EU & US	EU	US	EU	US	EU & US
2002	191	80	176	65	15	160	67	126	33	34
2003	1,041	724	777	460	264	568	354	345	132	223
2004	2,287	1,463	1,648	824	639	1,346	834	1,000	357	673
2005	4,064	2,513	2,764	1,213	1,300	2,401	1,640	1,131	372	1,284
2006	5,921	3,575	3,941	1,595	1,980	2,210	1,520	1,004	314	1,206
2007	6,415	3,586	4,357	1,528	2,058	2,273	1,469	1,093	430	1,168
2008	6,673	3,485	4,612	1,424	2,061	2,062	1,280	1,034	244	1,040
2009	6,791	3,428	4,835	1,472	1,956	2,239	1,344	1,143	241	1,108
2010	6,977	3,563	4,953	1,539	2,024	2,268	1,411	1,128	262	1,154
2011	7,341	3,789	5,174	1,622	2,167	2,270	1,412	1,130	265	1,152
2012	7,605	3,931	5,296	1,622	2,309	2,348	1,469	1,173	286	1,187
2013	7,631	3,981	5,248	1,598	2,383	2,202	1,420	1,063	272	1,155
2014	7,404	3,833	5,068	1,497	2,336	2,101	1,363	990	247	1,120

Note: Products are identified at HS8 level.

2.4 Estimation Framework

In order to isolate the effect of IC3 on trade flows from other variables impacting exports during this period, we compare Pakistan's exports to the US market with those to the EU. Exports to the US (treatment group) were influenced by IC3, whereas those to the EU (control group) were not, as these are still processed through standard channels from all exporting stations in Pakistan. The application of a DID estimation approach takes out the effect of other confounding factors such as improvement in technology, infrastructure, institutional changes and economic growth that could influence exports to both groups.

Before proceeding to developing a formal estimation strategy, we test the key identifying assumption of parallel trends in the evolution of control and treatment groups prior to the treatment. The following graphical and statistical analysis shows that this assumption holds.

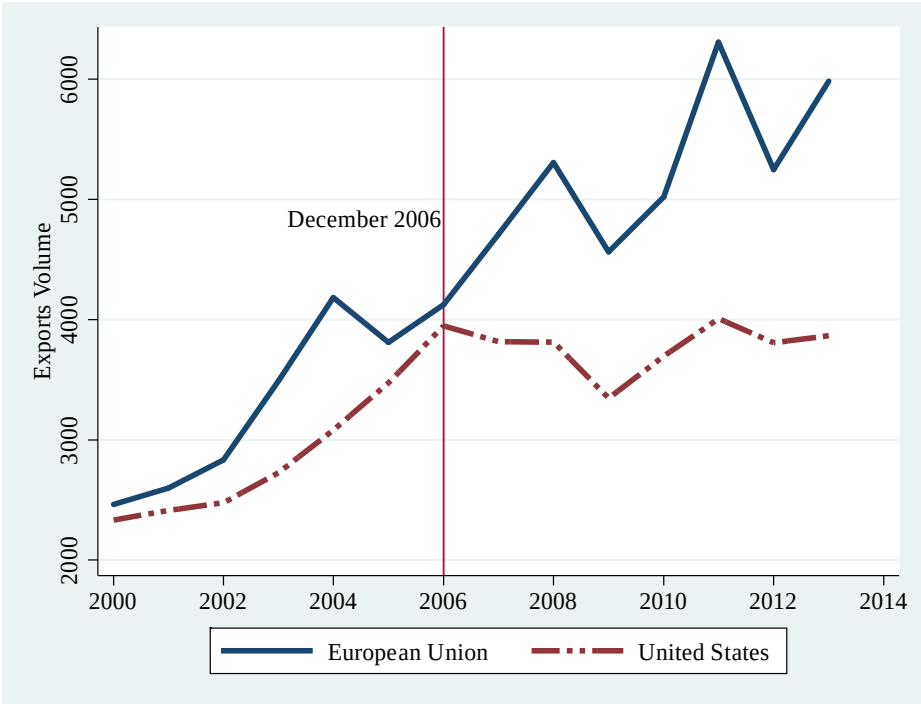
2.4.1 Parallel Trends

Figure 3 plots Pakistan's total exports to the EU and US, the control and treatment groups respectively. The chart suggests that evolution of exports to both markets was similar before the launch of IC3 but differed afterwards. Exports to both the groups were on a rising trajectory until 2004; however, those to the EU declined in 2005 while the earlier trend continued for the US market.

This shift seems to coincide with the elimination of quotas for the export of textiles and clothing. In the subsequent year, 2005-2006 however, these exports are return to a parallel path again.

Another major variation in the export trend to both the economies occurred in 2007, after the launch of IC3. Following this intervention, exports to the US dropped and stagnated, whereas those to the EU continued, more or less, on the same trajectory, with some blips. As the chart shows, the timing of the divergence in the trend of US-bound exports from the earlier path coincides with the launch of IC3 program. This drop is specific to the US market only and Pakistan's overall exports to the world continued a rising trajectory even after the launch of IC3 (Figure A 3).

Figure 3: Pre- and Post-Treatment Trends for the Control (US) and Treatment (EU) Groups, 2000-2014



Note: Export volume is in millions US dollars.
Source: Pakistan Customs

Overall, the chart indicates that exports to the EU and US were almost on a parallel path before the launch of IC3 but these paths diverged afterwards. We further test the equality of export growth rates to these markets across sectors during the pre-IC3 period.

Table 5: Parallel Trend Tests for Control and Treatment Groups, 2002-06

Δ Growth	Treatment	Control	Difference	t-statistics
(1)	(2)	(3)	(4)	(5)
2002	0.759	0.455	0.304	0.638
	(0.874)	(1.252)	(-0.377)	
2003	0.875	1.253	-0.378	-0.428
	(0.473)	(0.702)	(0.882)	
2004	1.196	187.6	-186.4	-0.925
	(0.571)	(185.0)	(100.3)	
2005	0.682	0.553	0.129	0.184
	(0.599)	(0.395)	(0.348)	
2006	1.334	2.238	-0.904	-0.733
	(0.702)	(0.976)	(1.234)	

Note: Δ Growth indicates annual growth rate of exports. Standard errors are in parenthesis. The t-statistics pertain to column (4) for the difference in the mean of treatment and control groups.

Table 4 presents the results of two sample t-tests on an annual basis. As the columns (4) and (5) indicate the difference between the mean growth rate of exports to the control and treatment groups is statistically insignificant. In none of the years do we find a statistically difference in the means, indicating that the parallel trends assumption is satisfied, and the EU represent a valid counterfactual group. In order to quantify the magnitude of the trade effect at a firm level, we use the following regression framework:

$$ln(X_{ijkt}) = \beta_0 + \beta_1(Treat)_j + \beta_2(After)_t + \beta_3(Treat\ x\ After)_{jt} + \alpha_i + \gamma_k + \lambda_t + \varepsilon_{ijkt} \quad \ldots\ldots(1)$$

The subscript 'i' denotes exporting firm, 'j' trading partners, 'k' product, and 't' time (year). The description of various variables is as follows:

$\ln(X_{ijkt})$, the dependent variable, is the value of exports (in logs) of a firm 'i' to market 'j' in product 'k' at a time 't' (intensive margins). The exports volume is measured in PKR millions.

'Treat' is a dummy variable equal to '1' if an observation pertains to the US and '0' for the EU. 'After' is also a dummy variable equal to '1' for the period 2007-2014 and '0' otherwise. α, γ and λ are a set of fixed effects for firms, products and time. Product fixed effects are included at HS8 level, and ε_{ijkt} is an idiosyncratic error term.

Our regressor of interest is interaction term (treat x after). It is expected to be negative as the effect of increase in the behind-the-border costs appears to be higher compared with that of the reduction in beyond-the-border costs. A negatively significant coefficient on this regressor, β_3, would suggest that, exports to the treatment group (US) relative to the control group (EU) have dropped.

In order to examine the effect of policy adjustment in 2011 (see section 2.2.4), the baseline regression specification is modified as follows.

$$ln(X_{ijkt}) = \beta_0 + \beta_1(Treat)_j + \beta_2(After_1)_t + \beta_3(Treat\ x\ After_1)_{jt} + \beta_4(After_2)_t + \beta_5(Treat\ x\ After_2)_{jt} + \alpha_i + \gamma_k + \lambda_t + \varepsilon_{ijkt} \quad \ldots\ldots(2)$$

All the variables in equations (2) are the same as in equation (1) except that it has an additional interaction terms (treat x $after_2$) to isolate the effect of second treatment in 2011. '$After_1$' is a dummy variable equal to '1' for the period 2007-2014 and '0' otherwise and '$After_2$' is also a dummy variable equal to '1' for the period 2011-2014 and '0' otherwise. β_5 is coefficients of interests and is expected to be positive as these interventions in 2011 aimed to facilitate trade flows by easing congestion at the IC3 yard and facilitating shipments from PQ without actually transporting the cargo to that port.

In order to estimate the above equation, we use disaggregated data at an eight-digit level of Customs tariff for the period 2002-2014. This reasonably long timespan allows precise estimations and enables the examining of adjustments to the shock over time. The estimation method is OLS. Standard errors are clustered at firm-market-year level, as trade flows between markets tend to be highly persistent over time. We estimate the model with high dimensional fixed effects using the stata command 'reghdfe', as suggested in Guimaraes and Portugal (2010).

The DID econometric approach accounts for most of the potential omitted variables. However, we include fixed effects for firms and products in order to account for time-invariant and time-varying factors pertaining to these variables and also add fixed effects for time to soak up any factors affecting the whole economy at some particular time. Following the baseline estimations, we test the robustness of main results by examining various threats to identification.

Exogeneity: This project was established in Pakistan as a result of 9/11 attacks in the US, which is definitely an exogenous event for the exporting country. It was not a home grown initiative but unilaterally imposed by the US in the wake of its prevailing security environment, therefore, the 'treatment' is devoid of any domestic influence creating endogeneity challenge. Second, this additional layer of security primarily focused at enhancing international maritime security as well as the internal security environment in the US. Therefore, its influence on firm-level trade flows can be treated an exogenous event. These peculiar features of IC3 scheme make these estimations, to a large extent, devoid of endogeneity issues arising due to home grown initiatives in trade policy or the improvement in infrastructure.

3 Main Estimation Results and Discussion

3.1 Baseline Estimates

Table **6** presents the main estimation results of equation (2). The estimates in column (1) explain the pure variation in the data, as they do not account for any other co-variates, while columns (2) through (4) add fixed effects for firms, products and time. As Row (1) of the estimates indicates, the coefficient on the 1st interaction term is negative and statistically significant at a 1% significance level. It shows that, in comparison with those to the EU, Pakistan's exports to the US have dropped by 20% since the launch of this program (Column 1). Magnitudes of the coefficients vary across columns but their sign and significance level are quite stable. Adding fixed effects for firms in column (2) and for products in column (3) reduces the magnitude of the coefficients and improves the R-squared, indicating that some omitted variables relate to these categories. Column (4) includes time fixed effects, which does not alter the magnitude of the coefficient but its significance level.

Table 6**: Effect of IC3 on US-bound Exports, Main Estimation Results**

The dependent variable is a log of exports per firm by destination

	(1)	(2)	(3)	(4)
Interaction (treat x after)				
1st Treatment_2007	-0.200***	-0.134***	-0.157***	-0.151***
	(0.022)	(0.019)	(0.018)	(0.018)
2nd Treatment_2011	-0.218***	-0.014	0.036**	0.030**
	(0.018)	(0.016)	(0.015)	(0.015)
Firm FE		y	y	y
Product FE			y	y
Time FE				y
R^2	0.02	0.40	0.51	0.51
Observations	463,931	463,931	463,931	463,931

Note: Robust standard errors are in parentheses. These coefficients were obtained using Stata 13 SE; * p < 0.10, ** p < 0.05, *** p < 0.01. The coefficients on other regressors and fixed effects are not reported as they are not of direct interest. 1st treatment indicates the effect of initial shock and the 2nd treatment show the effect of subsequent remedial measures.

These estimates suggest the difference between exports to the US and EU before and after the installation of IC3 is negative. Thus, instead of facilitating exports, this policy appears to have impeded them. In terms of magnitude, Pakistan's exports to the US relative to the EU appear to have dropped by 15%, on average, in the post-IC3 implementation period up to 2014.

Row (2) contains estimation results of the second intervention in 2011. Column (1) presents results for the pooled sample and models (2) through (4) contain the same by incorporating fixed effects for firms, products and time. The estimates indicate that the effect of second intervention is positive and statistically significant at a 5% level (column 4). It shows the subsequent policy interventions aimed at facilitating the process reversed the declining trend.

3.2 Heterogeneity of the Effect across Firms (Incumbents and Switchers)

Table 7 examines the differential effect of IC3 on two cohorts of the treated firms: incumbents and switchers. Incumbents are the firms that were shipping from QP prior to 2007 and continue to use the same port in the later period. Switchers are the other cohort that were previously exporting from other stations, KP and DPs, but had to shift to QP in order to meet the IC3 requirements. In order to examine the heterogeneity of the both treatment effects, we replicate the same estimations (equation 2) for these cohorts.

Column (1) contains estimates of our preferred specification from the above estimates and columns (2) and (3) decompose the same across these two groups. It seems that the effect of first treatment on the incumbents is positive but that of second is negative. None of these effects is statistically

significant (column 2). By contrast, the effect of first treatment for switchers is negative and significant at 1% significance level, whereas the effect of second treatment on them is positive and statistically insignificant.

Table 7: Heterogeneity the Effects across Firms (Incumbents and Switchers)

The dependent variable is a log of exports per firm by destination

	(1)	(2)	(3)
Interaction (treat x after)			
All _2007	-0.15***		
	(0.021)		
All _2011	0.03**		
	(0.014)		
Incumbents_2007		0.042	
		(0.052)	
Incumbents_2011		-0.022	
		(0.038)	
Switchers_2007			-0.127***
			(0.022)
Switchers_2011			0.004
			(0.015)
R^2	0.515	0.530	0.517
Observations	472,258	339,025	455,740

Robust standard errors are in parentheses. These coefficients were obtained using stata 13SE. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Incumbents exported from Qasim Port before and after IC3 while the switchers exported from Karachi Port and dry ports in the pre-IC3 period and from Qasim port in the post_IC3 period.

The effect of first treatment on the switchers is negative as expected and that of second treatment is positive. These results suggest that the overall negative effect of the first treatment (in 2007) on US-bound exports is born by switchers as they incur additional costs owing to the shifting of their export processing activities to other port. The positive effect of the second treatment for this cohort means that the subsequent policy adjustments in 2011, largely, mitigate the initial adverse effect.

The incumbents are affected differently than the switchers. They seem to benefit initially from their established setup at QP but face competition for the space and port facilities from the switchers, which might attenuate the advantage accruing from their previous position.

3.3 Adjustment Mechanisms

The analysis, so far, alludes to a negative effect of the IC3 program on US-bound exports relative to the EU. An important question is how these firms adjust to this exogenous shock. To investigate various channels of adjustment, we initially focus on developments within firms and products and then examine changes in the prices and quantities.

In order to examine the effect on the set of exporting firms and that of exported products, we estimate the baseline regression equation (1) for extensive margins of firms (the number of unique firms per product per market) and products (the number of unique products per firm by market). Since these variables are non-negative integers, we use a count data model, Poisson Maximum Likelihood Estimator (PPML), as in Berthou and Fontagné (2008), Dennis and Shepherd (2007) and Persson (2013).

The results reported in Table 8 can be interpreted as semi-elasticities. Column (1) indicates that relative to the EU, these firms are 33% less likely to export to the US market[2] in the post-IC3 period. Similarly, these products are 20% less likely to be shipped to the US relative to the EU. These phenomena do appear in the descriptive analysis of the data in Table 4, which reveals the exit of firms and shrinkage of products for the US market.

[2] Exp (-0.404)-1=0.33 (33%)

Table 8: Adjustment along Extensive Margins of Firms and Products

The dependent variables are a count of firms and products by destination

	Firm EM	Product EM
	(1)	(2)
Interaction (treat x after)	-0.404***	-0.236***
	(0.092)	(0.031)
Product FE	y	
Firm FE		y
Time FE	y	y
Observations	42,323	96, 308

Robust standard errors are in parentheses. These coefficients were obtained using the PPML estimator using stata 13SE, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. EM denotes extensive margins.

Another potential channel of adjustment could be along prices and quantities. To examine effect along these dimensions, we replicate the same estimations (equation 1) by switching the dependent variables with prices (average value per product per firm) and quantity (average weight of shipment per product per firm). The results in Table 8 show that the weight of US-bond exports relative to the EU dropped by 12%. The corresponding drop in the prices in the post-IC3 period is 2% and this effect is relatively weak as it is statistically significant at a 10% level. These estimations suggest that adjustment in exports for the US market occurs along all the four dimensions: extensive margins of firms and products, and margins of prices and quantities.

Table 9: Adjustment along Prices and Quantities

The dependent variables are log of prices and quantities

	Quantity Margin	Price Margin
	(1)	(2)
Interaction (treat x after)	-0.120***	-0.019*
	(0.092)	(0.023)
FE (firms, products and time)	y	y
R^2	0.57	0.55
Observations	472,258	472,258

Robust standard errors are in parentheses. These coefficients were obtained using OLS estimator using stata 13SE, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 10: Speed of Adjustment: Heterogeneity of the Effect over Time

The dependent variable is the log of exports per firm by destination

	Coeff.	SE
	(1)	(2)
Interaction (treat x after) x		
int_2007	-0.478***	(0.022)
int_2008	-0.495***	(0.024)
int_2009	-0.497***	(0.024)
int_2010	-0.349***	(0.024)
int_2011	-0.083***	(0.024)
int_2012	0.245***	(0.024)
int_2013	0.367***	(0.024)
int_2014	0.398***	(0.025)
R^2	0.50	
N	464, 361	

Note: Robust standard errors are in parentheses. These coefficients were obtained using Stata 13 SE; * p < 0.10, ** p < 0.05, *** p < 0.01. The coefficients on other regressors are not reported as they are not of direct interest. The regressions include fixed effects for firms, products and time.

In order to examine the heterogeneity of the effect over time, Table 10 decomposes the trade effect along time dimension. These estimates suggest that the major drop in exports occurred in the initial three years. This effect, however, fades out in subsequent years, albeit gradually, and adjustment to this new environment takes almost five years. The results are similar to the pattern revealed in Figure 3 that depicts the rise in the US-bound exports from 2012 onwards.

4 Robustness Checks

This sub-section tests the robustness of baseline results by adding time-varying fixed effects, and by replicating the same estimations on the first-differenced data and on product-level aggregates of trade flows. Our baseline results hold to these changes in specification and to the transformation of data.

4.1.1 Including time-varying fixed effects

To control for potential time-varying factors affecting firms, products and market, we augment the baseline specification by adding time-varying fixed effects for these categories (equation 3). Firm-year fixed effects (λ_{it}) soak any changes in the firms' productivity or technological improvements overtime that can affect their exports to these markets. Similarly, product-year fixed effects (γ_{kt}) account for fluctuation in product specific factors and firm-product-market fixed effects soak any heterogeneity in the quality of products across markets. The alternative regression equation is as follows.

$$ln(X_{ijkt}) = \beta_0 + \beta_1(Treat)_j + \beta_2(After)_t + \beta_3(Treat\ x\ After)_{jt} + \lambda_{it} + \gamma_{kt} + \alpha_{ik} + \varepsilon_{ijkt} \quad \ldots\ldots(3)$$

The subscript 'i' denotes exporting firm, 'j' trading partners, 'k' product, and 't' time (year).

We estimate different variant of equation (3) by using various combinations of these fixed effects (Table 11). As the Row (1) indicates, the estimate of interest is negative and statistically significant at a 1% level in all the specifications, further support our baseline findings.

Table 11: Controls for Time-varying Omitted Variables

The dependent variable is the log of exports per firm by destination

	(1)	(2)	(3)
Interaction (treat x after)	-0.144***	-0.191***	-0.101***
	(0.030)	(0.029)	(0.018)
Firm-year FE	y	y	
Product-year FE		y	
Firm-product-market			y
R^2	0.50	0.53	0.15
Observations	472,258	432,463	270,740

Robust standard errors are in parentheses. These coefficients on fixed effects and other covariates are not reported. These estimates were obtained using stata 13SE * p < 0.10, ** p < 0.05, *** p < 0.01. The number of observations varies across columns as the estimates in columns (2) and (3) drop singleton observations.

Critics may argue that exporting firms to both the markets are different and this heterogeneity may be driving the results. In order to address this concern, I estimate the equations (1) for two different cohorts: single-market firms (exporting to the EU or US) and multiple-market firms (exporting to the EU and US). Column (1) and (2) contains estimation results for these cohorts, respectively (Table 12).

Table 12: Heterogeneity across Single and Multiple Market Firms

The dependent variable is the log of exports per firm by destination

	EU &US	EU/US
	(1)	(2)
Treat x After	-0.176***	-0.099***
	(0.021)	(0.031)
R^2	0.486	0.551
Observations	235, 830	225, 416

Robust standard errors are in parentheses. These coefficients on fixed effects and other covariates are not reported. These estimates were obtained using stata 13SE * p < 0.10, ** p < 0.05, *** p < 0.01.

These estimates show that exports of both the cohorts drop in the post-IC3 period. The effect, however, is relatively higher for the firms serving both markets (column 1) compared with those shipping to single market only (column 2). Another advantage of this decomposition is that results in

column (1) show pure within variation firm as they pertain to same firms in the control and treatment groups.

Since a lot of new firms enter into and exit from exporting over time, there may be a concern that these entrants may affect exports to these markets. To ensure that the selection does not drive the results, we estimate the equation (1) for the continuing cohort only. Column (1) contains the estimates for all firms that exported from 2006 to 2014 and column (2) and (3) split those for single-market and multi-market firms from the same cohort (Table 13). As these estimates show, the effect on US-bound exports is negative and statistically significant for this cohort. The magnitude of coefficients is relatively higher than that of baseline estimates. These estimates show that the effect of IC3 is strong for this continuing firms and entrants tend to moderate this effect.

Table 13: Estimates for the Continuing Cohort of Firms

	All Firms	EU and US	EU/US
	(1)	(2)	(3)
Treat x After	-0.172***	-0.155***	-0.206***
	(0.026)	(0.031)	(0.041)
R^2	0.471	0.444	0.506
Observations	280,881	148, 494	130, 936

Robust standard errors are in parentheses. These coefficients were obtained using stata 13SE
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The continuing cohort is exporting to these market since 2006 (prior to the launch of IC3).

4.1.2 First-differenced estimations

The first-difference estimator has been suggested in many studies as it relies on weaker exogeneity assumptions and is more efficient when the error term is serially correlated (Baier and Bergstrand 2007). These authors further recommend including fixed effects in addition to first-differencing the data or applying this technique at least to test the robustness of results. Demir et al. (2014) adopt a similar approach in firm-level estimations in order to account for any difference in pre-shock trends. Moreover, focusing on first-difference takes into account the time-invariant factors specific to firm-product-year, such as firms' experience of exporting a product to a given destination. In line with these studies, we estimate the following equation on the first-differenced data.

$$\Delta ln(X_{ijkt}) = \beta_0 + \beta_1(Treat\ x\ After)_{jt} + \lambda_i + \gamma_k + \varepsilon_{ijkt} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The dependent variable is firm-level exports in terms of a first-difference. The other variables are defined as before. The results in Table 14 provide support to baseline findings as the coefficient of interest is negative and statistically significant at 1% level. Column (3) suggest that in the post-IC3 period, Pakistan's exports to the US dropped by 16.4%, which is similar to magnitude of drop in trade (15%) observed in baseline estimations.

Table 14: Robustness Test: First-differenced Estimates

The dependent variable is firm-level exports by destination in first difference

	(1)	(2)	(3)
Interaction (treat x after)	-0.044***	-0.050***	-0.164***
	(0.009)	(0.010)	(0.014)
Prod. FE		y	y
Firm FE			y
R^2	0.001	0.002	0.065
Observations	152,717	152,704	147,077

Robust standard errors are in parentheses. These coefficients on fixed effects and other covariates are not reported. These estimates were obtained using stata 13SE * p < 0.10, ** p < 0.05, *** p < 0.01. The number of observations vary across columns as singleton observations are dropped in column (2) and (3).

4.1.3 Product-level Estimations

Table 15 replicates the same estimations by collapsing the data at product-destination-year level, which is a slightly higher level of aggregation. The regression equation in this slightly varied form is as follows.

$$ln(X_{kjt}) = \beta_0 + \beta_1 (Treat \times After)_{jt} + \gamma_k + \lambda_t + \varepsilon_{jkt} \quad \ldots\ldots(5)$$

These product level results are consistent with those of firm-level estimates, confirming that the shock led to a reduction of exports to the US market. Although the magnitude of the effect is slightly higher, the sign and statistical significance remains the same.

Table 15: Robustness Tests: Product-level Analysis

The dependent variable is the log of exports per product by destination

	Product-level data
	(1)
Interaction (treat x after)	-0.274***
	(0.059)
Prod FE	y
Time FE	y
R^2	0.323
Observations	39,353

Robust standard errors are in parentheses. These coefficients were obtained using stata 13SE, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.1.4 Dumping of Extra Inventory in the EU Market.

Critics may argue that firms may dump extra inventory in the EU market once the access to the US market is reduced. To investigate this proposition, we examine changes in prices and quantities of shipments across market (Table 9). If the dumping logic is accepted then prices of goods in the EU market should be lower than that in the US market. Since the prices in the EU market are not lower compared those in the US, the consideration of dumping is ruled out.

5 Findings and Policy Implications

This study finds that the IC3 arrangements have restricted trade flows rather than facilitated those. The concentration of scanning operations at one specific port, irrespective of their potential risk, led to a massive diversion of the US-bound exports at the domestic level. The resulting increase in behind-the-border costs seems to offset the trade facilitation aspect of the program, which resulted from the reduction in beyond-the-border trade cost owing to direct shipments of the cargo to the US market and elimination of transhipment requirements at various transiting countries.

Since the launch of this project, Pakistan's exports to the US market relative to the EU have experienced a decline to the tune of 15%, on average. The drop registered soon after the launch of the program and appears to operate through the reduction in the number of exporting firms, shrinkage of their export-product set as well as a fall in prices and quantities. Some partial adjustment to the shock appears to take place in the spell of around five years. Back-of-the-envelope calculation show a loss of the US market access to the tune of $8 billion owing to these changes in the security policy. This is economically meaningful for a developing economy struggling to grow its exports.

The drop in exports because of this additional layer of security has policy implications for the ongoing drive to deploy similar technologies for facilitating trade as well as ensuring security of the supply chain. These findings suggest that policy-makers need to focus on domestic constraints, such as infrastructure issues, and look into the potential unintended effect of internal trade diversion, which can offset the effect of improvements at- and beyond-the-borders. IC3 is in its pilot phase but its trade-restricting effect has become quite evident, as exports to the US have dropped. Similar arrangements if implemented in other ports in developing countries due to worsening security situation in different parts of the world might present a serious blow to the market access of those economies.

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7 Appendix

Annex A: IC3 Program in Brief

In the broader perspective, the integrated cargo containers control(IC3) program is a part of the Secure Freight Initiative (SFI), a Department of Homeland Security (DHS) program. It builds on two similar arrangements launched after 9/11 in 2001: the Container Security Initiative (CSI) and the Mega Ports Initiative (MPI). CSI required the stationing of US Customs and Border Protection (CBP) officials at foreign ports to scan containers based on risk assessment, whereas MPI aimed at scanning as many containers as possible at high-volume ports. SFI kicked off in April 2007 (MarineLog, 2008) with the launch of International Container Security pilot at Qasim Port (QP) in Karachi, Pakistan. The '100% scanning' law, or House Resolution 1 (H.R. 1), however, required extension of the scanning operations to all US-bound cargo of all trading partners by July 2012.

The practicability of the 100% scanning of US-bound cargo originating from other trading partners and its potential trade-inhibiting effect have been a subject of intense debate in economies that are heavily reliant on exports to the US. And implementation has faced significant resistance from EU port operators, Asian governments and the World Customs Organization (WCO). These institutions objected to the unilateral nature of the legislative requirement and argued that it inherently ignores the international character of global maritime trade. The European Commission (EC) expressed concerns regarding implementing a measure designed to protect the US that could divert resources away from strengthening EU's security. The EU further alluded to retaliatory measures aimed at forcing US export cargo containers to undergo similar scanning before being shipped from seaports in the US to their markets.

A similar pilot program launched at Southampton port in 2006 faced a great many technical and operational issues (EC 2009). After the conclusion of pilot phase in 2008, Her Majesty's Revenue and Customs (HMRC) decided to cease its participation in SFI. As a result, the process reverted to CSI protocols. CBP also approached the port of Singapore but delays and complications in starting the trials meant the port operator decided not to participate in the program. However, Pakistan being a frontline state in the war against terrorism had to accept these arrangements because prior to the launch of IC3 at PQ, its US-bound commercial cargo containers were diverted to Sri Lanka, Hong Kong or Oman for the scanning purposes (EC, 2009). This random diversion caused uncertainty in the timing of delivery of shipments to the final buyers. In these circumstances, this project was perceived as a trade facilitation initiative as it allowed direct shipments to the US markets by completing the scanning requirements at the port of origin.

Annex-B

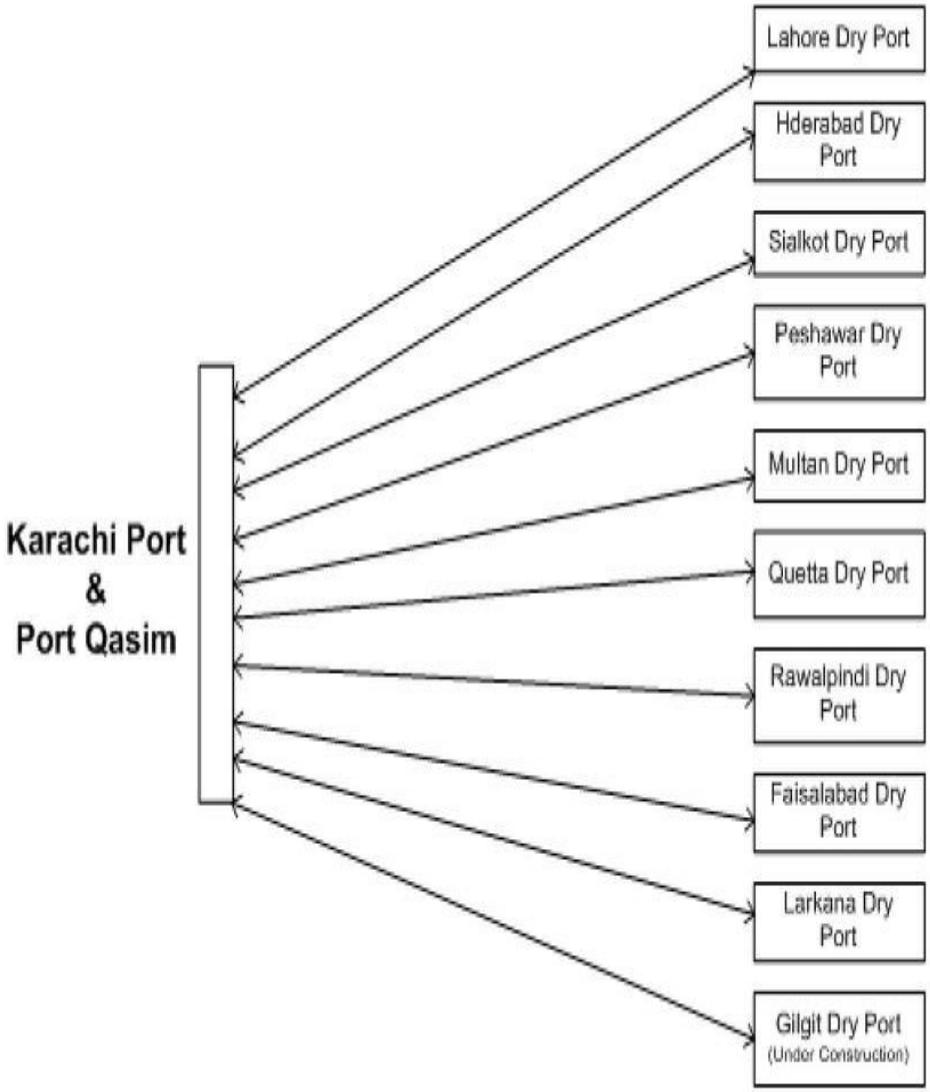
Table A 1: Summary Statistics: Firm-level data, 2002-2014

Variable	Num. of Obs.	Mean	Std. Dev.	Min	Max
Log (Exports)	472,258	-0.430	2.594	-18.93	10.361
Treat x After	472,258	0.268	0.443	0	1
Treat	472,258	0.317	0.465	0	1
After	472,258	0.878	0.327	0	1

Figure A 1: Geographical Map of Pakistan

Source: maps.google.co.uk

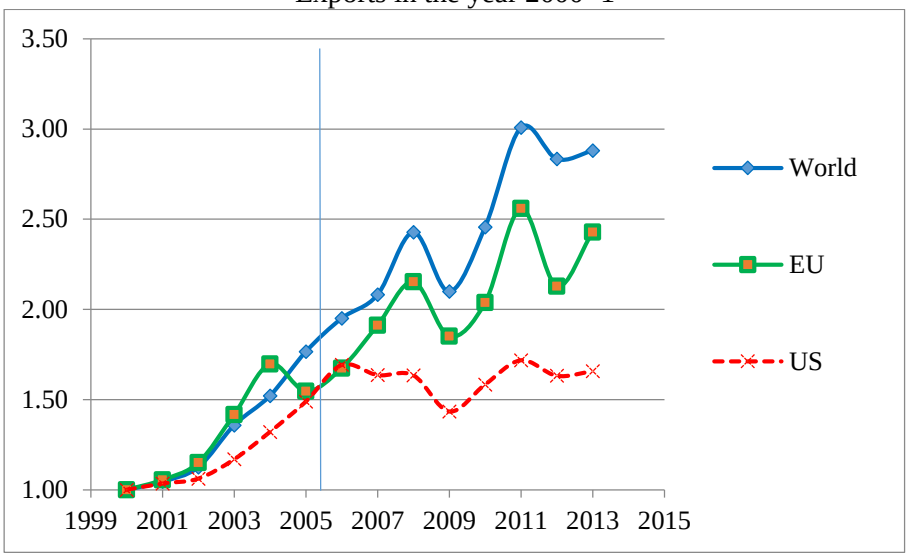
Figure A 2: Network of Dry Ports in Pakistan



Source: Pakistan Customs

Figure A 3: Pakistan's Overall Export Volume, 2000-2013

Exports in the year 2000=1



Note: Export values are normalized to '1' in the year 2000.

Source: Authors working using Pakistan Customs dataset.

Table A2: Evolution of Incumbent and Switching Cohorts over Time

	Firms		Exports		Observations	
Year	Incumbents	Switchers	Incumbents	Switchers	Incumbents	Switchers
2003	86	638	372	6,208	152	1,366
2004	242	1,221	2,547	55,342	666	5,499
2005	773	1,740	9,837	278,735	2,148	13,192
2006	870	2,705	9,334	333,030	2,336	12,683
2007	467	3,119	11,491	187,033	2,330	16,262
2008	380	3,105	7,029	77,013	1,508	11,158
2009	323	3,105	7,240	77,191	1,275	10,570
2010	311	3,252	8,878	93,535	1,200	11,324
2011	313	3,476	10,443	143,590	1,337	11,884
2012	299	3,632	17,721	337,683	1,321	13,391
2013	300	3,681	19,916	388,869	1,171	13,296
2014	265	3,568	22,092	373,979	1,064	12,531

Note: Incumbents export from Qasim port before and after IC3 while switchers export from Karachi port and dry ports before IC3 and from Qasim port after IC3; Export volume is in PKR million.