

**Ali, Salamat (2017) Trade Costs in International Trade.  
PhD Thesis, School of Economics, University of Nottingham**

# **Trade Costs in International Trade**

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## Acknowledgments

I am indebted to several individuals for contributing to the completion of my Doctorate Thesis at the School of Economics, University of Nottingham. First and foremost, I thank God for providing me with the drive, patience and sustenance needed to complete this work at the middle stage of my professional career. Second, I would like to pay special gratitude to my supervisors, Professor Chris Milner and Professor Richard Kneller, for their kind guidance and encouragement in this process. They inspired, encouraged and supported me in this journey, and I have greatly benefitted from their appraisal of my work, contributions of ideas to circumvent the challenges and suggestions for improvement.

I would like to express my sincerest thanks to my family for having great confidence in me. I must especially mention my wife, Rabia, for agreeing to move to the UK, out of her comfort zone in Pakistan and taking care of growing kids and other household responsibilities. Additionally, thanks to my daughter Maryam and son Usama for sacrificing their company of friends and family in Pakistan and moving to UK for my PhD. The support of my parents and immediate and extended family members has also been invaluable. They never doubted my ability to successfully complete this challenge.

I would also like to thank all my Nottingham and other UK-based friends. They have been a major source of support and provided me with a much-needed work and life balance. Finally, I appreciate my employer, the Federal Board of Revenue (FBR), Government of Pakistan, for granting me the extended leave to pursue higher studies. The financial support from various sources including the School, International Growth Centre and the Commonwealth Secretariat is gratefully acknowledged.

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## **Abstract**

This thesis explores the effects of trade costs on international trade at macro and micro levels. It focuses on traditional and non-traditional sources of trade costs that impeded trade flows at various phases of a typical export shipment: behind the borders, at the borders and beyond the borders.

It initially examines the connection between trade costs and the composition of developing countries' exports and then explores the responses of firms to additional costs associated with the security of supply chain imposed on Pakistan's firms in the wake of events of 9/11. Following this, it investigates the differential effects of domestic and international transportation distance on the reactions of firm-level trade flows and multiple margins of trade. Finally, it considers the effects of exchange rate movement on agricultural exports. The thesis primarily uses micro-level information from administrative datasets of exports and intra-country trade (VAT dataset) from Pakistan. It also benefits from international data sources, such as the WB-UNESCAP trade costs dataset, WITS, WTO tariff profiles and the World Development Indicators (WDI).

This thesis comprises four core chapters (2 to 5), excluding the introduction and conclusion. The analysis at a macro level (Chapter 2) finds the trade costs negatively affect the composition of developing countries exports in that the industries located in higher trade cost countries gain a relative smaller share of manufactured exports in the country's overall exports. The effect is relatively greater for high trade cost sensitive industries (such as automobiles, electronics) and for high trade cost regions, especially Sub-Saharan Africa. The evaluation of trade effect of US security policy on Pakistan's exports (Chapter 3) shows that following the implementation of Integrated Cargo Containers Control (IC3) programme, Pakistan's exports to the US relative to the EU dropped by 15%, on average. Pakistan's firms that were forced to switch from various export-processing stations to the one specific sea port equipped with the intrusive scanning and live monitoring technologies of the export cargos, experienced the largest decline. The subsequent policy interventions aimed at facilitating the process moderated this effect to some extent.

The examination of differential effects of domestic and international distances on trade flows (Chapter 4) reveals that the marginal effect of inland distance to sea

ports is much larger than that of international distance from sea ports to export markets. Moreover, both distances have heterogeneous effects along trade margins. Domestic distance impedes exports primarily through extensive margins (EM) of firms and product, whereas international distance restricts these mainly through quantity margins, in addition to constricting the EM. Although the trade-impeding effects of both components of distance have reduced over time, the drop has been relatively greater for the international leg.

Finally, the investigation of response of agricultural exports to the exchange rate movement (Chapter 5) indicates that the domestic currency depreciation positively affects both intensive and extensive margins (IM and EM). The increase in the IM operates mainly through the channel of prices (75%), whereas the response of quantities is relatively smaller (25%). Similarly, the increase in extensive margins operates through widening of export basket and expansion of firms' client base within existing markets. These responses however vary widely across products, markets, firms' exporting experience, exchange rate regimes type and invoicing currency use.

Four key policy implications emerge from the thesis. First, reducing trade costs could increase manufacturing exports from high trade cost regions, and the response would be larger in high trade cost sensitive industries. Second, improving access to trade-processing infrastructure could incentivise entry of more firms into exporting and encourage widening of export basket. Third, the unintended effects of response to potential threats to supply chain could offset the trade facilitating aspect of these scanning technologies and further restrict trade flows across national borders. Finally, the policy makers need to be cautious in using domestic currency depreciation as a policy tool to promote the growth of agricultural exports as the trade response might not be commensurate with the level of depreciation.

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## Acronyms and Abbreviations

| Acronym | Definition                                                  |
|---------|-------------------------------------------------------------|
| CSI     | Container Security Initiative                               |
| DHS     | Department of Homeland Security                             |
| EC      | European Commission                                         |
| EM      | Extensive Margins                                           |
| ER      | Exchange Rate                                               |
| FTA     | Free Trade Agreements                                       |
| HS      | Harmonised System                                           |
| IC3     | Integrated Cargo Containers Control Programme               |
| IM      | Intensive Margins                                           |
| IRS     | Inland Revenue Service                                      |
| MPI     | Mega Port Initiative                                        |
| NTN     | National Tax Number                                         |
| OECD    | Organization for Economic Cooperation and Development       |
| PTA     | Preferential Trade Agreement                                |
| RCEP    | Regional Comprehensive Economic Partnership                 |
| SFI     | Secure Freight Initiative                                   |
| TPP     | Trans-Pacific Partnership                                   |
| TTIP    | Trans-Atlantic Trade and Investment Partnership             |
| UNESCAP | United Nations Economic Commission for Asia and the Pacific |
| VAT     | Value-added Tax                                             |
| WCO     | World Customs Organization                                  |
| WDI     | World Development Indicators                                |
| WITS    | World Integrated Trade Solutions                            |
| WTO     | World Trade Organization                                    |

# **1 Thesis Introduction**

## **1.1 Background and Context**

Trade costs have always been of interest to researchers and economic policy makers as they impact on the volume of international trade, the composition of exports, foreign direct investment, exchange rates and price stability. Their importance is highlighted in the mystery of missing trade (Trefler, 1995; McCallum, 1995), and puzzles in international economics (Obstfeld and Rogoff, 2001). The notion that trade costs limit the range of commodities that are traded is well established in the international trade theory. Dornbusch, Fischer, and Samuelson (1977) illustrate that countries trade only those commodities for which domestic unit labour requirements are short of foreign unit labour requirements adjusted for transportation costs. Similarly, in Krugman (1980), trade costs influence the relative consumption of goods and patterns of specialisation between trading partners. In recent theoretical models (for instance, Melitz (2003), Chaney (2008) and others) trade costs influence the entry into exporting and reallocation of market share across firms.

Trade costs are generated by multiple policy and non-policy barriers and they impede trade flows at various stages of the supply chain: at the borders, behind the borders and beyond the borders (for a survey see Anderson and Van Wincoop, 2004). Traditionally, the academic literature has focused on trade costs at the borders such as those imposed by tariffs, quotas and other policy interventions. Since tariffs have gradually been curtailed<sup>1</sup> under various multilateral, regional and national initiatives, and quotas declared illegal except in a few sensitive sectors, more recent exploration has focused on non-traditional sources of trade costs that impede trade flows at border and behind the border.

A vast literature has considered the effects of trade costs on trade flows (Limao and Venables, 2001; Helpman et al., 2008), and explored their influence on firms' behaviour (Melitz, 2003; Bernard et al., 2007; Chaney, 2008). Amongst this, the existing literature using micro data largely focuses on firms in advanced economies.

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<sup>1</sup> In 2015, applied average tariff in was 3.5% in the US, 4.0% in Japan, 5.1% in the EU and 9.9% in China (<http://www.economist.com/news/briefing/21721935-idea-reciprocity-animates-white-houses-view-trade-what-donald-trump-means-fair>)

For example, Mayer and Ottaviano (2008) study European firms, Bernard et al. (2007) examine US data and Eaton et al. (2004) explore French firms. However, recently with the increased availability of firm-level datasets from developing countries, the examination of micro-level effects of these costs is gaining momentum. Some recent studies exploit firm-level data from China, Indonesia, Tunisia, Iran and others, although it remains the case that knowledge of constraints faced by exporters in low and middle-income countries is relatively limited.

It is widely acknowledged that trade costs are relatively higher in developing countries<sup>2</sup>; moreover, these countries face peculiar type of constraints to exporting. These includes those of being landlocked, as well as security issues and poor connectivity of manufacturing regions with trade-processing infrastructure at ports of entry and exit. These policy and non-policy sources of trade costs reduce firms' competitiveness and affect their integration in international markets. Furthermore, firms' behaviour has been shown to vary with level of development (Fernandes et al., 2016). This heterogeneity in firms' behaviour along the development path provides an important motivation to analyse in depth the trade effect of various non-traditional sources of these costs in a developing economy.

## **1.2 Aims and Objectives**

This thesis investigates the impact of trade costs on the composition of developing countries exports in general and explores the trade-impeding effects of costs associated with security policy, remoteness from trade-processing facilities, and exchange rate movement in Pakistan.

Four inter-related research questions explored in this work: (i) the impact of trade costs on the composition of developing countries' exports, (ii) responses of firms to security screening of containerised cargos, (iii) differential effects of inland and international distances on trade flows and (iv) responses of agricultural exports to exchange rate movement. These four areas are at the core of current debate in the international trade literature because of their direct policy relevance. Export diversification is a policy priority area in most developing countries, especially after

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<sup>2</sup> For details see Arvis et al. (2016).

the collapse of the recent commodity boom, and the security of containerised cargo has assumed a rising importance in the wake of growing threats of terrorism in various parts of the world. Similarly, increasing market access by improving connectivity and infrastructure is a flagship programme of most donor agencies, especially Annex D+ organisations. Finally, the exchange rate, especially currency manipulation, features widely in debate on the multilateral system and reflects in the negotiation of many emerging trade agreements such as the TTIP, TPP and RCEP.

Although the existing literature has examined numerous effects of trade costs, these four areas have received relatively less attention especially in a developing country context. For instance, the empirical literature on trade costs at the macro level has considered mainly trade volume effect of trade costs, whereas this thesis aims to explore whether these costs have a systematic influence on the composition of developing country's exports. This part of analysis (Chapter 2) <sup>3</sup> is performed by using a comprehensive trade cost indicator developed in Arvis et al. (2016), which is based on a micro-founded and theory consistent inverse gravity approach developed in Novy (2013).

A second empirical contribution is made in Chapter 3 which quantifies the effect on Pakistan's exports of changes in the US security policy<sup>4</sup> after the events of 9/11. Security of supply chains is an emerging issue in the international trade. In a world where the threats to national security are globalised, transportation networks have been recognised as a weak link that could be exploited to ship the technologies of terrorism internationally (Meade and Molander, 2006; OECD, 2005). The reliance of international trade on these same networks highlights the importance of understanding and quantifying the effects of any policy responses to counter this terrorist threat. The major difficulty to reliably providing such estimates is that countries do not alter or adopt new security policies randomly but rather do so in response to the actual or perceived threat of terrorism by and in its trading partners; confounding variables that can additionally affect trade flows directly or indirectly through numerous channels (Mirza and Verdier, 2008). To confront this issue, the thesis exploits part of the counter-terrorism policy response to the events of 9/11 that

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<sup>3</sup> This Chapter has been published jointly with Professor Chris Milner as a GEP Working Paper No. 15/13 (Ali and Milner, 2015).

<sup>4</sup> This Chapter has been published jointly with Professor Richard Kneller and Professor Chris Milner as a GEP Working Paper No. 17/02 (Ali, Kneller and Milner, 2017).

affected the costs of trade with Pakistan and uses detailed transaction-level trade data.

Third, this thesis aims to disentangle the trade-resisting effects of internal transportation distance (from factories to sea ports) from that of its external elements (to export markets). The trade-inhibiting effect of beyond-the-border distance is well established in the gravity literature (for a survey see Head and Mayer, 2014). Some studies examine the role of inland transportation and show that the trade-resisting effect of domestic spatial frictions is much higher in developing countries (Atkin and Donaldson, 2015; Coşar and Demir, 2016; Donaldson, 2015; Van Leemput, 2016). So far, these two streams of research proceed in isolation. Chapter 4 examines the trade effects of internal and external components of distance together and thus juxtaposes the above two strands of the literature<sup>5</sup>.

Finally, this thesis seeks to inform on the response of agricultural exports to domestic currency depreciation, a widely used policy tool to stimulate exports and to improve other macroeconomic imbalances. The response of exports to exchange rate movement has been highly debated in the existing literature and the current evidence is mixed. For example, Bernard and Jensen (2004) find no association between the exchange rate and firms' exports and Bugamelli and Infante (2003), Campa (2004), Das, Roberts and Tybout (2007), Greenaway and Kneller (2008) and Greenaway, Kneller and Zhang (2010) find negative and significant effects of exchange rate appreciation (for a survey see Auboin and Ruta, 2013). Estimation of the precise effect of exchange rate movement on exports is complex as it affects trade simultaneously through two channels: it reduces the costs of exports but at the same time it offsets this effect by raising the costs of imported intermediary inputs. To circumvent this challenge, this thesis focuses on the trade response of commodity exporting firms, where the effect of the offsetting channel is relatively low. Moreover, it conducts an integrated analysis of prices and quantities, together with firm-level trade flows, by using the exchange rates of the actual currencies of invoicing at the transaction level. The existing micro literature in this stream focuses mainly on the manufacturing sector and the responses of firms in the agriculture

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<sup>5</sup> The study has been published as Forum for Empirical Research in International Trade (FREIT) Working Paper No. 1169 (Ali, 2017).

sector remain largely unexplored. Chapter 5 therefore bridges an important gap in the literature by using a novel dataset on firm-level agricultural exports<sup>6</sup>.

### 1.3 Data

This thesis benefits from various international and national data sources. Chapter 2 uses the bilateral trade costs indicator developed in Arvis et al. (2016) and retrieves trade flows from Comtrade. Chapters 3 to 5 however use micro-level datasets of exports and intra-country trade from Pakistan. As trade costs are induced at distinct phases of the supply chain (at the borders, behind the borders and beyond the borders) and affect trade patterns through multiple channels (such as intensive and extensive margins, prices, quantities, market access and competitiveness), the response of these margins are investigated with this highly-disaggregated data for Pakistan.

Pakistan is the 26th largest economy globally and is characterised as being among the emerging and growth-leading countries of the developing world. The country maintains a highly-disaggregated, rich dataset of exports, imports and VAT but these datasets have never been used for research purposes<sup>7</sup>. The export dataset contains information about product code, prices and quantities at an 8-digit level of Harmonised System (HS), in addition to the identities of export-processing stations and modes of shipment. It includes all product categories, from Chapters 1 to 99 of the Harmonised System (HS) and covers the universe of firms shipping from all exporting stations (dry ports, airports and sea ports) to markets of Pakistan's 215 trading partners.

Details on the firms' spatial locations come from the VAT records of Pakistan Inland Revenue Services (IRS). Both datasets (Customs and VAT) identify firms by the same unique identification code, their National Tax Number (NTN), which facilitates merger of the datasets. These combined datasets of exports, imports and VAT inform on, inter alia, internal dimensions of exporting (distribution of manufacturing and export-processing activities in the hinterland), modes of

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<sup>6</sup> This Chapter has been published as a GEP Working Paper No. 17/09 (Ali, 2017).

<sup>7</sup> These datasets are subjected to a confidentiality agreement with the author. Some of the information is, however, available from the Export Dynamics Database of the World Bank.

shipment (such as sea, air or land), ports of entry and exit and currencies of invoicing at the transaction level. The datasets also contain gross weight, net weight and price of each shipment, which makes it possible to explore the relative responses of these variables in tandem with the behaviour of firm-level exports.

These data are unique in many other aspects. First, they identify products at an 8-digit level of the HS classification and contain information on actual description of products, which permits exploration of the relatively subtle response of extensive margins (EM). Second, they cover the universe of firms in all sectors, agricultural as well as manufacturing, whereas most firm-level datasets of other countries contain information on manufacturing firms only. Since agriculture is a key component of exports from many developing countries in Asia, Africa and South America (Hanson, 2012), the analysis based on the data of firms in all sectors helps in generalising the results to other economies. In addition, the micro focus on firms in a developing country informs on many additional constraints faced by firms of such economies.

Third, the data records the exchange rates and invoicing currencies for each shipment, which allows estimating the export response by using exchange rates of actual invoicing currencies, rather than bilateral exchange rate between trading partners, a standard practice in this literature. Fourth, the relatively long-time span of the data (2000-2014) allows me to observe export responses to various element of trade costs over time and permits to control for unobserved heterogeneity across firms, products and markets by incorporating time-varying fixed effects for these variables. Moreover, it allows observing exchange rate effects on trade flows in two different regime types: fixed and floating.

This administrative dataset has been constructed after scrutiny at different levels. Exporting firms file this information to customs authorities to seek border clearance for their products; the agency verifies these declarations and reports the same data to various national and international statistical bodies. The data are also scrutinised at the central bank as these firms realise export proceeds through the banking channels. The intense scrutiny at these institutions means the data can be considered substantially purged of measurement error. Furthermore, my personal experience of the collection and compilation of the data from 2000 to 2011 while being part of the

customs administration in Pakistan, as well as the consistency, integrity and accuracy checks performed by comparing aggregation results with the same information retrieved from the UN Comtrade dataset, suggests the data are of high quality.

## **1.4 Main Findings and Organisation of Thesis**

This thesis comprises four core chapters (2 to 5), excluding the introduction and conclusion.

Following the introduction, Chapter 2 examines the response of developing countries' industrial exports to trade costs and extends Milner and McGowan (2013). Milner and McGowan (2013) show that trade costs negatively influence the export mix of 37 OECD countries, whereas this chapter conducts a similar investigation for 103 trading partners of the US. Besides focusing on developing countries, this Chapter fundamentally differs from Milner and McGowan (2013) in terms of coverage of industries as well as in terms of estimation methodology and time span of the data. The identification strategy exploits the variation in trade costs across countries and the differences in trade cost sensitivity across industries. This Chapter finds that trade costs fashion export composition of developing economies, with higher trade costs (other things constant) lowering the share of an industry's exports in the country's total exports, and importantly with the share of exports declining more for more trade cost sensitive industries. These results support the findings of Milner and McGowan (2013) but reveal a great deal of heterogeneity on the effect of trade cost across various developing regions and industrial sectors.

Chapter 3 examines the trade effect of the Integrated Cargo Container Control (IC3) program — a supply chain security initiative launched between Pakistan and the US in the wake of 9/11— and explores the drivers and the speed of adjustment. Although primarily a security measure, IC3 affected beyond-the-border and behind-the-border costs of exporting to the US. This Chapter exploits the information on firms' export-processing stations and modes of shipments over time, and uses the exogenous nature of IC3 shock and its specificity to one export market in the identification strategy. The analysis finds that the centralisation of scanning operations of US-

bound exports at one port (that was equipped with intrusive scanning and live monitoring technologies) led to diversion of this trade at the domestic level, increasing behind the border trade costs. The DID estimates show that after this intervention, Pakistan's exports to the US relative to the EU (a counterfactual) dropped by 15%, on average. The process of adjustment to the shock took around five years. In this period, 2007-2013, this security policy caused a cumulative loss of US market access of around \$8 billion. The Chapter shows how the addition of another layer of security at the already very thick national borders could influence the behaviour of exporting firms, and that the measures put in place at borders can influence trade flows behind the borders.

Chapter 4 disentangles the trade-impeding effects domestic and international transportation distances. It capitalises on the information about the location of manufacturing facilities within the country, ports of entry and exit and modes of shipment over time (land, air and sea). This Chapter finds that the marginal effect of domestic distance to port of exit is almost three times than that of international distance to export markets. Both distances have heterogeneous effects along trade margins. Domestic distance impedes exports primarily through extensive margins (EM) of firms and product, whereas international distance restricts these mainly through quantity margins, in addition to constricting the EM. Although the trade-impeding effects of both components of distance have reduced over time, the drop has been relatively greater for the international leg.

Chapter 5 examines the effects of domestic currency depreciation on agricultural exports and investigates various channels of influence. This Chapter finds that exchange rate movement positively affects both the intensive and extensive margins (IM and EM). The increase in the IM operates mainly through the channel of prices, whereas the response of quantities is relatively smaller. The EM also improve on three accounts: firms, products and the client base within existing markets. These responses vary widely across products, markets, exporting experience, exchange rate regimes and invoicing currencies. Chapter 6 reflects on the main findings of the thesis, their policy implications and concludes with suggestions for further research.

## **2 Trade Costs and the Composition of Developing Countries' Exports**

## 2.1 Introduction

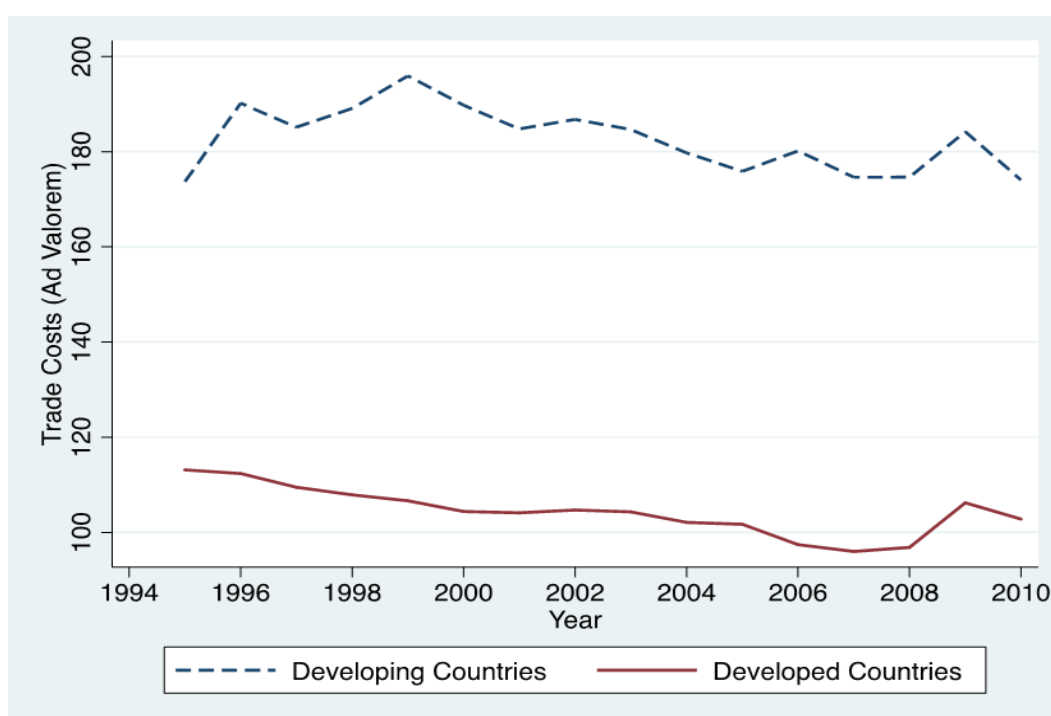
'What you export matters' and 'the large trade-impeding effect of various trade barriers' have recently received much attention in trade and development literature. Hummels and Klenow (2005) show that rich countries export a wider set of goods and this larger set of products accounts for two-thirds of their exports and one-third of their imports. Hausmann et al. (2007) argue that export product mix is one of the determinants of income level and subsequent economic development, with the countries specialising in high-income country products tending to grow more rapidly. These two key papers, among others, emphasise the importance of trade composition in economic growth.

Among several factors that shape trade composition, trade costs are considered to have a vital role. Obstfeld and Rogoff (2001) argue that trade frictions in international goods market offer a unified basis for understanding six major puzzles in international macroeconomics. Earlier, Trefler (1995) and McCallum (1995) highlight the role of trade costs. To-date, the empirical literature in this stream has mainly focused on trade volume effects of various barriers to international business. The trade-detering effect of bilateral distance between trading partners (proxying for trade costs) is extensively identified in the gravity model literature (for a survey see Head and Mayer, 2014). This literature has also explored the trade effects of specific types of trade costs, such as tariffs, national borders, differences in languages and currencies. The theoretical literature also captures a range of aspects of the possible role or influence of trade costs (Melitz 2003; Chaney, 2008).

One area which has received relatively less attention is the influence of trade costs on the composition of developing economies' exports. Recently, Milner and McGowan (2013) find that trade costs influence the manufacturing export mix of a set of industrial countries; industries located in lower trade cost countries capturing relatively higher shares in the multilateral exports of manufactured goods, the production of which is more sensitive to trade costs. The above work focuses on developed economies with relatively smaller trade costs. Arvis et al. (2016) finds that trade costs are much higher in developing countries and they are falling more slowly than in developed economies. De Sousa et al. (2012) show that difficulties faced by developing countries' exporters in accessing developed markets are 50%

higher than those faced by Northern exporters. Waugh (2010) also argues that poor countries face higher trade costs to export relative to rich countries and these relatively higher trade frictions are quantitatively important to our understanding of the differences in the standards of living and productivity across countries because these costs prevent specialisation in line with standard endowments-driven comparative advantage. Given that trade costs are considerably higher in general in developing countries (see Figure 2.1) and variable across and within developing regions (Figure 2.4) and that the composition of exports have important implications for the growth and development prospects, it is important to understand if and how trade costs differences affect the export composition of developing countries.

**Figure 2.1: Trade Costs in Developed and Developing Countries (Ad Valorem)**



Source: Bilateral trade cost dataset (The World Bank)

This Chapter therefore examines the connection between trade costs and trade composition in developing world. Using a comprehensive trade cost indicator and trade flows of a large set of developing economies, it shows that trade costs fashion export composition of these economies, with higher trade costs lowering the share of an industry's exports in the country's total exports, and this effect is asymmetric across countries and industries in that the export share declines disproportionately for high trade cost countries and for more trade cost sensitive industries.

Besides focusing on the effect of trade costs in developing countries' context, it fundamentally departs from Milner and McGowan (2013) in terms of coverage of industries, time-span of the data and empirical estimation approach. Milner and McGowan (2013) analyse a sample of 15 (of 22 as per ISIC Rev. 3) manufacturing industries of 37 OECD countries for the period 1995 to 2004, whereas this Chapter examines the data of all industries for 113 developing countries from 1995 to 2010. This comprehensive coverage of all industrial sectors of most developing countries in various parts of the globe<sup>8</sup> generalises the results to developing world and permits examination of heterogeneity of the effect across developing regions.

In terms of methodology, this Chapter differs from Milner and McGowan (2013) in three fundamental ways. First, it uses a common trading partner approach (US, with replacement by Germany for robustness checking), allowing the more precise measurement of the effect of trade costs and easier control for unobserved effects. Second, it deals systematically with the zero trade flows - a problem that was not evident for the multilateral trade of the industrial countries - but the concentration on a specific bilateral trade flow in developing economies makes it necessary to account for it in an appropriate manner. This Chapter therefore uses the Pseudo Poisson Maximum Likelihood (PPML) estimator which account for zero trade flows, rather than the OLS which truncates them. Third, it confronts the potential problem of the endogeneity of trade costs by using a set of cost shifters as instruments. Finally, it explores the heterogeneity of impact of trade costs across countries and industries, which was not explored in the earlier work, but is very pertinent for this analysis as trade costs vary widely in developing countries (Table 2.1).

The core hypothesis of this Chapter is that higher trade costs reduce the industry share of developing countries' exports (other things constant), and do so more the more trade cost-intensive or sensitive is the production of goods in that industry. To test this proposition, this Chapter construct a panel dataset of trade costs and the export share for 113 trading partners of the United States for the period 1995 to 2010, and investigate the relationship between these variables in a regression framework. Trade costs differ across countries and overtime, and trade cost

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<sup>8</sup> The estimation sample contains 113 developing countries covering all developing regions (Table 2.1).

intensity (the proportion of imported inputs used in manufactured goods) also varies across industries as well as overtime. The identification strategy exploits the variations in trade costs and trade cost sensitivity. In the robustness checks, the analysis is restricted to the variation in trade costs only. Moreover, the robustness checks use different estimation approaches and empirical settings, include controls for factor endowments and institutional quality variables and incorporate origin and destination specific elements of trade costs in the estimations. This empirical analysis shows that the costs of conducting international trade are relatively high in developing economies and that these costs vary enormously across developing countries. Relatively high (low) costs are a source of comparative disadvantage (advantage), which reduces (increases) the manufacturing export shares of high (low) trade cost developing countries and reduces (increases) export shares most for industries that are more trade cost sensitive. The trade-restricting effect is relatively larger for high trade cost regions, especially Sub-Saharan Africa.

#### *Theoretical Literature on Trade Costs*

The theoretical literature captures a range of aspects of the possible role or influence of trade costs. Dornbusch, Fisher and Samuelson (1977) explore the influence of trade costs on the tradability of goods. Similarly, Markusen and Venables (2005) incorporate trade costs into an endowments model of trade, but allow trade costs only to vary across countries (trade costs being the same for goods to/from a particular country, and a particular country having the same trade costs with all its trading partners). This specification allows for a clearly defined ‘world price’ for each good ( $X_i$ ). They develop a model of three goods (produced under constant returns and competitive conditions), using two factors (capital,  $K$ , and labour,  $L$ ). With zero (country) trade costs the pattern of production across countries would be indeterminate, though with full employment one can make predictions about the overall or average factor content of trade. The addition of trade costs (here country-specific trade costs,  $t$ ) makes the commodity structure of production determinate. A key message from their modelling is that lower trade cost countries are characterised by partial or complete specialisation in production, while higher trade cost countries tend to become less specialised in production. Low trade cost countries trade all goods, while the incidence of autarky or non-tradability increases with higher trade costs. Indeed, reduced tradability starts to

be a feature of increasing trade costs for countries close to the world average endowments. Further, at higher trade costs, more extreme endowments are required to maintain a country as an exporter of the good intensively using the country's abundant factor.

In the above formulation, national trade costs are a modifier of comparative advantage and the pattern of trade, through their influence on the tradability of goods. To capture national trade costs role as a source of comparative advantage, this Chapter represent national trade costs as analogous to a traditional endowment. In a strand of the literature this has been done in effect by representing national trade costs as the country-specific, fixed cost or additional investment associated with the trade impediments that agents in that country need to overcome to transact internationally. This is an extension of Levchenko's representation (Levchenko, 2007) of national institutional differences which induce differences in international transaction impediments across countries.<sup>9</sup> In a world of trade cost frictions, a fraction ( $f$ ) of the investment of factor resources (capital and/or labour) required to produce certain units of a tradable good become specific to the activity. In a frictionless world ( $f=0$ ) agents do not need to invest specific resources (ex ante) to acquire information about how the infrastructure and institutional characteristics of the economy affect their ability to recoup their investment. Where  $f>0$  it is harder to induce resources to enter sectors in general (harder relative to countries where trade costs are lower), and the more so in sectors that are more transactions-intensive; the ex post returns to factors being driven down relative to the frictionless case.

Analogous to Levchenko (2007), trade in a two country or bloc (L – low trade cost country and H – high trade cost country) can be viewed as involving differences in national trade costs such that  $f^H > f^L$ ; a lower fraction of factors being specific to transactions-sensitive activities in L than H.<sup>10</sup> In this set-up national trade cost differences act much like a normal endowment difference source of comparative advantage in an H-O framework; the low trade cost country being able to produce

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<sup>9</sup> Nunn (2007) also develops an analytical framework in which inter-country differences in institutional quality are a source of comparative advantage.

<sup>10</sup> Other possible sources of difference across countries, such as technological differences, are ruled out.

transaction-intensive goods, *ceteris paribus*, at relatively lower cost than the high trade costs country.

The remainder of the Chapter is organised as follows. Section 2.2 surveys various approaches for measuring trade costs and section 2.3 introduces the dataset. It also describes the trade cost indicator and summarises the pattern of trade costs across developing countries. It then explains the identification strategy and the estimation methodology. Section 2.4 contains the baseline estimation results. Section 2.5 reports on the robustness analysis, in particular endogeneity and specification issues. Section 2.6 concludes.

## **2.2 Measuring Trade Costs**

Trade costs include all the factors that drive a wedge between the producers' price in the country of origin and the consumers' price in the country of destination. It would be very useful to have direct 'input' measures of aggregate trade costs (covering all trade policy instruments, border procedures, international transport and other trade impeding factors) for a large set of countries and for a significant time period. Such data is not available and would be very difficult to construct. In the absence of directly observed data on various elements of trade costs, most studies compute them indirectly. This section provides a brief overview of these approaches.

### **2.2.1 CIF/FOB Ratios**

Hummels (2007) argues that the gap between the value of goods at the port of origin (FOB) and port of discharge (CIF) is a best aggregate measure of trade costs. The CIF figures include the cost (value of merchandise), insurance and freight at the port of discharge, whereas the FOB (free on board) contains the value of merchandise only at the port of origin. Therefore, the gap between the CIF and the FOB value implies transportation costs. To compute the CIF to FOB ratios, researchers apply the matched partners' techniques, mainly on the Direction of Trade Statistics that the IMF reports. Sourdin and Pomfret (2012) apply this approach to compute bilateral trade costs for the trading partners of the United States, Australia, and Brazil. Baier and Bergstrand (2001) use the CIF to FOB ratios

to disentangle the effect of transportation costs from other policy barriers and Limao and Venables (2001) use it as a viable measure of transportation costs.

Critics, however, argues that this approach is error-ridden owing to the imputation methodology applied by international statistical agencies for generating the data of missing trade flows, and also because of the variations in the classification and valuation systems in exporting and importing countries (Hummels and Lugovskyy, 2006). They suggest that estimates generated using this technique may be considered informative only if used in combination with other estimation approaches. The second criticism of the CIF to FOB ratios is that they do not inform on other costs such as border delays, non-tariff measures, language barriers and variation in the currencies of transactions, etc.

#### **2.2.2 Gravity Model**

The trade policy community, by and large, employs a gravity model for estimating the effect of these elements. According to the gravity model, international trade between countries follows Newton's law of gravity, in that the volume of trade varies directly with the economic mass (measured in terms of GDP), and inversely with the distance between trading partners. This approach can isolate the effect of various elements of trade costs such as those associated with language, culture, geography, and colonial heritage, etc. Gravity modelling incorporates dummies to isolate the effect of common language, culture, geography, and colonial heritage (Rose, 2002). It is a bottom up approach and is thus criticised for not being completely purgative of omitted variables, and also for not providing aggregate figures for cross country comparisons. Baldwin and Taglioni (2007) argue that these proxies measure the impact of trade costs on the level of trade rather than trade cost itself.

#### **2.2.3 Liner Shipping Connectivity Index (LSCI)**

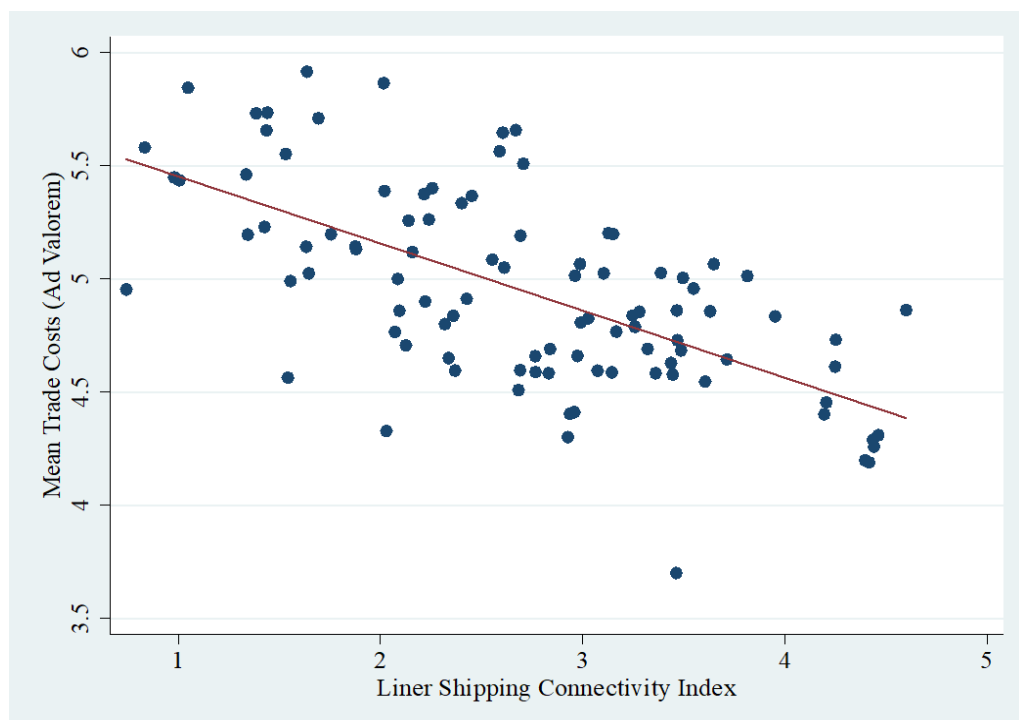
The literature on maritime transport uses the Liner Shipping Connectivity Index (LSCI) developed by the United Nations Conference on Trade and Development (UNCTAD) as an indicator of transportation costs (Fugazza et. al, 2013; Wilmsmeier and Hoffmann, 2008; Wilmsmeier and Notteboom, 2009). UNCTAD computes this index from five components of the maritime connectivity: number of

ships, their container-carrying capacity, maximum vessel size, number of services, and the number of companies that deploy container ships in a country's ports. These elements capture access to the transportation facilities, and the level of competition on shipping routes; therefore, this index directly reflects transportation cost through the connectivity of a country to the global shipping networks. The LSCI values range from 0 to 100, with higher values indicating better connectivity, which also mean lower trade costs. Figure 2.2 graphs the relationship between average trade costs and LSCI for the year 2009. As the chart shows the LSCI has strong negative correlation with trade costs indicator of the World Bank.

This index, however, does not capture the influence of policy and non-policy factors impacting trade (such as tariff, non-tariffs, behind the border barriers, etc.). Secondly, it varies across countries and overtime but does not have bilateral dimensions because UNCTAD publishes its average figures only.

**Figure 2.2: Connection between Shipping Connectivity and Trade Costs (2009)**

On a Logarithmic Scale



#### 2.2.4 Logistic Performance Index (LPI)

The World Bank has also developed a similar index, namely Logistic Performance Index (LPI). This index measures trade costs along various phases of supply chain:

from factory to port, the efficiency of port operations and the connectivity between trading partners. It has much broader coverage of various elements of trade costs compared with LSCI developed by UNCTAD. Since this indicator captures multiple aspects of trade costs (behind the borders, at the borders and beyond the borders), it is widely used as an indicator of trade facilitation. However, it suffers from the same limitations as LSCI; it is not bilateral in nature. But it does provide aggregate figures for cross country comparison.

Because of the limitations of various techniques, this Chapter uses the trade cost indicator of the World Bank in main estimations, which is described in detail in section 2.3.1. These alternative indicators are employed in robustness checks.

## **2.3 Data and Descriptive Statistics**

To investigate the relationship between trade costs and trade composition this Chapter constructs a panel dataset of the low and middle-income trading partners of US by extracting information from multiple sources. This section describes the data on key variables that are trade flows, trade costs and trade cost sensitivity. The description of other covariates such as country, industry and policy variables is relegated to the appendix (Annex 2.1 and 2.2).

### **2.3.1 Trade Cost Indicator**

This Chapter uses a comprehensive indicator of trade costs from the World Bank trade costs dataset. This trade cost indicator is based on the theoretical foundation using an inverse gravity approach developed in Novy (2013) and subsequently formalised in Arvis et al. (2016). The indicator is explained in detail in the appendix (Annex-2.3). Furthermore, in robustness checks, this chapter also uses distance between trading partners, a standard measure of trade costs employed in the gravity literature, which too generates comparable results.

### **2.3.1 Export Composition**

The share of each industries' exports in a countries' total manufacturing exports with the common trade partner (US) is used to measure export composition. Industry-level trade flows of 22 industries (ISIC codes 15-36) of 113 countries at

two-digit level of ISIC Rev 3 classification are retrieved from the UN Comtrade database for the period 1995 to 2010. The dataset contains 22,253 (68%) actual trade flows and 10,615 (32%) zeroes. Since the trade flows are observed at a relatively high level of aggregation (two-digit level of ISIC Rev 3 classification), it cannot be assumed that these observations are missing at random. Literature suggests that these missing observations may be structural zeroes because firms may not export to high trade cost destinations (Bacchetta et al., 2012, p-112). Given that the proportion of zeros is quite large, and their distribution is not random, the econometric analysis recognises this pattern of data in estimations. The estimation sample has wide geographical and temporal coverage. The lists of developing countries and industries included in the analysis are contained in the appendix (Table A 2.1 and Table A 2.2).

### 2.3.2 Trade Cost Intensity

Trade cost intensity data is taken from the OECD structural database for the US. The US is taken as the reference or frontier technology for this purpose, because it is a relatively open and undistorted economy and because it is exogenous to the set of developing countries whose export structure is being investigated<sup>11</sup>. Figure 2.5 presents the variation in trade cost intensity across industries for the year 2008. As this diagram illustrates, relatively high-tech industries such as the motor vehicles, office equipment, and the telecommunication sectors are relatively high trade cost intense, whereas the relatively low-tech industries such as food and mineral sectors, wood and furniture manufacturing are low trade cost intense.

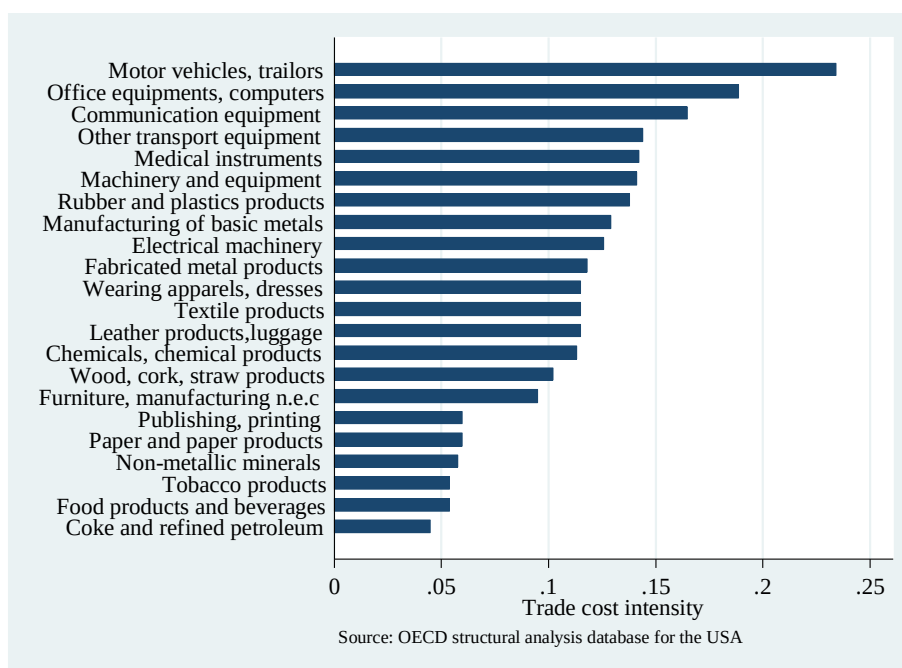
Figure 2.6 shows the cross-sectional relation between industry export share and the country trade cost indicator for these two variables (with colour coding for each industry). The chart illustrates this for two specific industries – coke and refined petroleum (the least trade cost sensitive industry) and motor vehicles (the most trade cost sensitive industry). It supports the idea that export share falls more with an increase in trade costs as an industry's trade cost intensity increases. There is of course some heterogeneity in the uncontrolled relationships, but it is evident that

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<sup>11</sup> The choice of US reduces the concerns of endogeneity, but it might raise the concerns of representativeness. Therefore, in robustness checks we show that using trade cost intensity of a representative developing country, South Africa, also generates similar results.

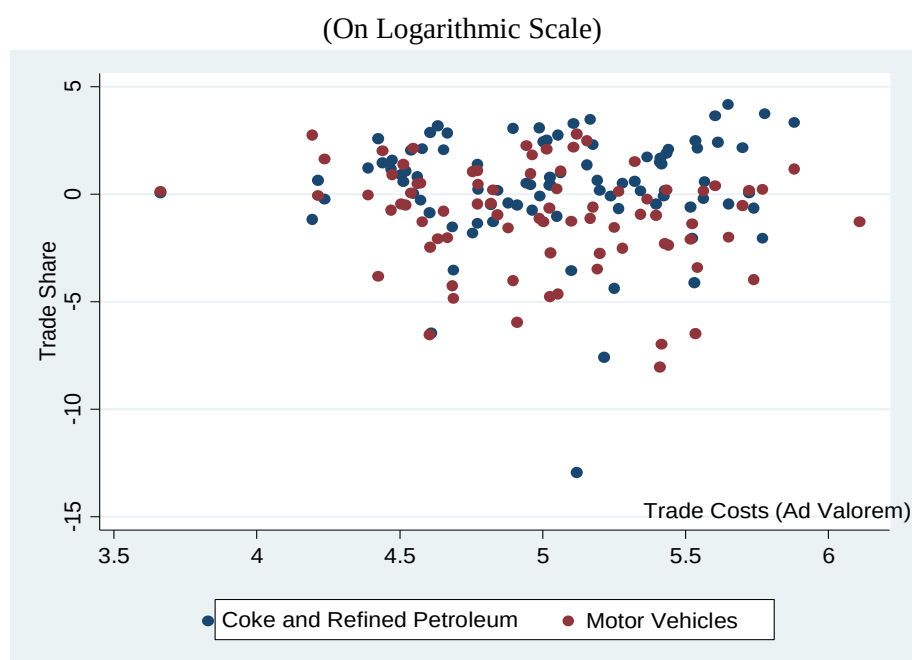
an increase in trade cost reduces export share more in motor vehicles (which is more trade cost intense) than in coke and petroleum (which less trade cost intense).

**Figure 2.3: Variation in Trade Cost Sensitivity across Industries (2008)**



Note: The figure presents the variation in trade cost intensity across industries. As the chart shows, the more technologically advanced industries such as machinery and equipment, computers, motor vehicles, are high trade cost intensive, whereas low tech industries such as coke and refined petroleum, food products and others are low trade cost intense.

**Figure 2.4: Variation in Trade Share of Selected Industries to the US (2008)**



Intuitively, if an industry needs to import a lot of imported inputs to produce a unit of exports, then that industry is more exposed to trade costs than an industry which

uses a smaller share of imported inputs to product a unit of exports, as trade costs are assumed to be symmetric in both directions (from  $i$  to  $j$  and from  $j$  to  $i$  (Arvis et al. 2016)).

The remaining information on policy-related variables and factor endowments (used in the robustness tests) has been collected from multiple sources described in Annex 2.1 and 2.2). The summary statistics of all the variables are contained in Table A 2.3.

### **2.3.3 Identification Strategy**

This Chapter exploits the variation in trade costs of developing countries (with a common trading partner, the US) and the variation in trade cost sensitivity across industries in the identification strategy. To make estimation results comparable across countries and keep the sample size large, the United States (US) is chosen as a common trading partner of all developing countries. Romer (1994) illustrates that large economies import a wider variety of goods from many foreign suppliers, and this dataset further confirms that the US is most sought-after export market: 113 developing countries from various geographical regions exported to the US in this period (Table 2.1). The wide geographical and temporal coverage generates a relatively large estimation sample (32,868 observations<sup>12</sup>). The second pillar of the identification strategy, sensitivity to trade costs, varies across industries as well as over time. The proportion of imported inputs used in manufactured goods for each industrial category is used to proxy this variable. The data on this variable is retrieved from the OECD structural database.

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<sup>12</sup> Ideally the data should have 39,776 observations (22 industries x 113 countries x 16 years). But complete information on trade costs for some countries is not available for a few years, which reduces the sample size to 32,868 observations. A robustness tests show that the replacement of missing trade costs with the average for the adjacent years does not affect the results.

#### 2.3.4 Regression Framework

To investigate our hypothesis - that higher trade costs reduce the industry share of a developing country's exports more, the more trade cost-intensive or sensitive is the industry - in a regression framework, the following baseline specification is adopted:

$$(ES)_{ict} = \beta_0 + \beta_1(\ln TC)_{ct} + \beta_2(\ln CI)_{it} + \beta_3(\ln TC_{ct} \times \ln CI_{it})_{ict} + \epsilon_{ict} \dots \dots \dots (2)$$

The subscripts  $i$ ,  $c$  and  $t$  denote industry, country and time, respectively.

The dependent variable is export share (ES) as defined below (equation 3). It is exports of an industry 'i' of a country 'c' to the common trade partner (US) at time 't' relative to the country's average manufactured exports to the US over the period 1995 to 2010 defined as below.

$$(ES)_{ict} = \frac{X_{cit}}{\frac{1}{T} \sum_t (\sum_i X_{cit})} \dots \dots \dots (3)$$

The period average rather than annual export value is used to measure export share or composition for several reasons. First, it reduces the correlation between the numerator (scale or volume of trade) and share measure as much as possible, so as to clearly distinguish the compositional effect of trade costs from any volume effect. Second, it also helps to smooth the dependent variable (especially for countries with relatively concentrated export structures), and avoids any non-independence of the industry relationships if the sum of the annual shares were strictly constrained to unity.

The key explanatory variable is the interaction term, trade costs and trade cost intensity (TC x CI), but the specification also includes trade costs (TC) and trade cost intensity (CI) as separate regressors in the estimations. The description of the trade cost indicator, cost intensity and their data sources is provided in Section 2.3.1. above. Initially equation (2) is estimated using the ESCAP-World Bank trade cost indicator as it provides an index of comprehensive trade costs. However, in the robustness checks origin or destination specific measures of trade costs (tariffs, non-tariffs, cost of exporting/importing, etc.) are also incorporated.  $\epsilon_{ict}$  is the i.i.d component.

To account for unobservables a set of fixed effects for countries and industries is added. Year fixed effects absorb cost or demand shocks common to all suppliers, such as changes in energy prices, shipping and logistics technologies, or global crises. Similarly, the country fixed effects control for time-invariant country characteristics that might affect export outcomes in all industries, such as local infrastructure or regulatory obstacles to production and trade, while industry fixed effects capture industry features that shape trade composition across developing countries, such as the factor and technological intensity of production. Taking advantage of the panel nature of the data, country-year fixed effects are added to account for time-varying unobservable such as GDP growth of trading partners and industry-year fixed effects to control for any technology and other time-varying changes at the industry level.

In this framework, the effect of trade costs on trade composition is determined by the variation in trade costs across countries and time, and the variation in trade cost sensitivity across industries as well as across time. This is a sort of difference-in-difference estimation approach. Although both trade costs and trade cost intensity are continuous variables, Angrist and Pischke (2008, p-201) argue that the idea of difference-in-difference is more general, and it implicitly assumes treatment and control groups. The coefficient on the interaction terms (trade costs x trade cost intensity) is the focus of this investigation. A negative and statistically significant value of the coefficient would mean that the share of an industry's exports in a country's total manufacturing exports to the US will be lower (greater) the higher (lower) are a country's trade costs and the more (less) trade cost intense or sensitive is production in the industry. This functional form is quite standard in international trade literature. Many earlier studies, for instance, Rajan and Zingales (1998), Nunn (2007) and Levchenko (2007), use the interaction of country and industry characteristics as in equation (2) above.

To mitigate any problem of serial correlation, robust standard errors are clustered at the country level since trade flows between countries tend to be highly persistent due to the presence of sunk costs. Moreover, to obviate the possibility of a unit root due to the time series nature of the panel data, the augmented Dickey-Fuller (ADF) test as well as Maddala and Wu unit root tests have been conducted. Both of which

confirm the stationarity of the data series at the 1% significance level. Note that the scope of work is restricted to industrial sectors only and the agriculture sector excluded deliberately because trade in this sector is subject to a plethora of market access barriers, such as tariff-rate quotas, sanitary and phyto-sanitary and quality control measures.<sup>13</sup>

Given zero trade flows and corresponding zero export share measures, the OLS estimator truncates the sample by dropping missing trade flows. This could be problematic as the descriptive analysis of data in the previous section suggests the presence of a substantial fraction of zeroes (32%). Therefore, the model is estimated with the Pseudo Poisson Maximum Likelihood (PPML) estimator that explicitly accounts for the zeroes and can circumvent this problem. Moreover, the PPML estimator accounts for any heteroskedasticity that is prevalent in the trade flow data, and is also robust to arbitrary patterns of serial correlation (Silva and Tenreyro, 2006).

## 2.4 Estimation Results

This section presents main results and decomposes them across various developing regions and industrial sectors.

Table 2.2 reports base estimations. Columns (1) and (2) contains results for the OLS estimator and columns (3) to (5) for the PPML estimator. Row (1) shows that the coefficient on the critical interaction term, trade costs x trade cost intensity (TC x CI), is negative and statistically significant in all specifications. The magnitude of the coefficient however varies with the estimations approach. As expected, the estimated coefficients are smaller in PPML regressions compared with those in the OLS (Silva and Tenreyro, 2006). The number of observations are smaller in columns (1) and (2) than in columns (3) to (5) as zero trade flows are dropped in the OLS estimations but accounted for in the PPML regressions.

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<sup>13</sup>Moreover, the measure of trade cost intensity is also not available, and in any case less appropriate, for the agriculture sector.

**Table 2.1: Base Estimates**

Dependent Variable: Export Share

|                                              | OLS Estimator        |                      | PPML Estimator     |                     |                    |                     |
|----------------------------------------------|----------------------|----------------------|--------------------|---------------------|--------------------|---------------------|
|                                              | (1)                  | (2)                  | (3)                | (4)                 | (5)                | (6)                 |
| Trade costs x cost intensity                 | -1.385***<br>(0.104) | -0.883***<br>(0.089) | -0.137*<br>(0.085) | -0.285**<br>(0.146) | -0.234*<br>(0.145) | -0.474**<br>(0.134) |
| Trade costs (TC)                             | -3.780***<br>(0.235) |                      | -0.459<br>(0.352)  |                     |                    |                     |
| Cost intensity (CI)                          | 0.679***<br>(0.059)  |                      | -0.0604<br>(0.076) |                     |                    |                     |
| Industry-year                                |                      | Y                    |                    | Y                   | Y                  | Y                   |
| Country-year                                 |                      | Y                    |                    | Y                   | Y                  | Y                   |
| R <sup>2</sup> / R <sup>2</sup> <sub>p</sub> | 0.0171               | 0.396                | 0.001              | 0.369               | 0.361              | 0.391               |
| N                                            | 22,253               | 22,253               | 32,868             | 32,868              | 32,868             | 32,516              |

Notes: Robust standard errors are in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Y indicates the inclusion of fixed effects. The coefficients on the fixed effects are not reported. The estimation method is the OLS in columns (1) and (2) and the PPML in columns (3) to (5). These coefficients were obtained using Stata IC 13.0. The estimates in column (4) are used as baseline. Columns (1) to (4) allow trade costs intensity to vary over time, whereas column (5) uses the values of the initial period.

Columns (1) and (3) show pure variation in the data. However, all other regressions (columns 2, 4 and 5) add industry-year and country year fixed effects to account for potentially omitted time-invariant and time-varying factors. These dummies pick up the effect of other factors such as GDP growth that might affect trade share. They also absorb the effect of the other regressors, trade costs and trade costs intensity, which vary along these dimensions. However, the coefficient on the key interaction term is retrieved in all the estimations. Column (4) is our preferred specification and it is used in all subsequent estimations.

The base results in column (4) allow both trade costs and trade cost sensitivity to vary over time. Column (5) considers therefore the effect of making the ‘technology’ (i.e. industry level, intermediate import-intensity) invariant over time, by taking the start of sample value (1995) and interacting this revised measure with trade costs (which continues to vary across country and time). This transformation overcomes any potential endogeneity concerns as higher trade costs in particular industry may lead to lower imports and lower observed trade cost intensity as a result. Moreover, this allows me to check that the key finding in column (4) is not being driven only by the change over time in trade cost intensity. Encouragingly,

the interaction term in column (5) remains negative and highly significant, supporting the core hypothesis.

**Table 2.2: Heterogeneity across Developing Country Regions**

| Dependent Variable: Export Share         |                      |
|------------------------------------------|----------------------|
|                                          | (1)                  |
| Trade costs x cost intensity (TC x CI) x |                      |
| East Asia & Pacific                      | -0.182***<br>(0.057) |
| Europe & Central Asia                    | -0.226***<br>(0.079) |
| Latin America & Caribbean                | -0.155***<br>(0.060) |
| Middle East & North Africa               | -0.225***<br>(0.076) |
| South Asia                               | -0.207***<br>(0.077) |
| Sub-Saharan Africa                       | -0.293***<br>(0.090) |
| R <sup>2</sup> _p                        | 0.205                |
| N                                        | 32,868               |

Notes. This table decomposes the baseline results from column (4) of Table 2.2 across various geographical regions. Robust standard errors are in parentheses \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01. The estimations contain industry-year fixed effects but the coefficients on the fixed effects are not reported. The estimation method is the PPML using Stata IC 13.0.

The use of data of trade costs intensity for the US might raise the concern for the representativeness, given the heterogeneity of countries in the sample. In column (6) we use trade cost intensity for a representative developing country, South Africa. Moreover, we drop South Africa from the estimation sample. This substitution does not affect the sign and statistical significance of results, the magnitude of the effect however increases.

Table 2.3 and Table 2.4 explore the heterogeneity of the impact of trade costs for various sub-samples. Note the marked variation in trade costs between regions, with Africa having experienced some decline in trade costs over the period but being the highest cost region throughout (Figure 2.4). Trade cost intensity also varies markedly across industries as depicted in Figure 2.5, and it might be argued that the above results are being driven by some specific regions or industrial sectors. Table 2.3 presents the estimation results decomposed along the regional sub-

samples used. The results in column (1) indicate that effect of trade costs is negative and significant for each developing region. The magnitude of the effect, however, varies, with larger negative coefficients being found for the Sub-Saharan Africa, which is very high trade cost region as shown in Figure 2.4.

To explore the heterogeneity of response across manufacturing sectors, Table 2.4 presents the results for industries grouped according to whether they are relatively low or high trade cost sensitive. It finds a negatively significant effect on the key interaction term for both groups; the magnitude of the negative coefficient found for each grouping being in line with expectations, and with the export share of high trade cost intense industries being most responsive to trade costs<sup>14</sup>. These high trade cost sensitive industries such as machinery and equipment, computers, motor vehicles, are relatively more technologically-intensive (Figure 2.5).

**Table 2.3: Heterogeneity across Industries**

| Dependent Variable: Export Share         |                     |
|------------------------------------------|---------------------|
|                                          | (1)                 |
| Trade costs x cost intensity (TC x CI) x |                     |
| Low cost intensive                       | -0.146**<br>(0.071) |
| High cost intensive                      | -0.329**<br>(0.141) |
| R2_p                                     | 0.173               |
| N                                        | 32,868              |

Notes: This table decomposes the baseline results from column (4) of Table 2.2 above across high and low trade cost intensive industries. Robust standard errors are in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . The estimations contain country-year fixed effects but the coefficients on the fixed effects are not reported. The estimation method is the PPML using Stata IC 13.0. The industries having above average trade costs intensity are categorised as high cost intensive industries and the others as low-cost intensive.

<sup>14</sup> The magnitude of estimated coefficient for high trade cost industries (-0.329) is almost double to that of low trade cost group (-0.146) (Table 4).

## 2.5 Robustness Analysis

This section tests robustness of base line results by incorporating additional controls and using alternative estimation approaches.

### 2.5.1 Alternative Estimators

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), for example, argue for employing it to overcome the problem of serial correlation. These authors recommend including fixed effects for countries and time in addition to first-differencing the data, or applying this technique at least to test the robustness of results. Magee (2008) adopts a similar approach. The results for the first-differenced estimator are contained in column (1) of Table 2.5. Again, the coefficient on the interaction term remains negative as in the earlier estimations.

**Table 2.4: Robustness Checks**

| Dependent Variable: Export Share |                                 |                            |                                             |                                     |                                             |                               |
|----------------------------------|---------------------------------|----------------------------|---------------------------------------------|-------------------------------------|---------------------------------------------|-------------------------------|
| Estimation approach              | First-differenced OLS estimator | Fractional logit estimator | Distance to market as trade costs indicator | Germany as a common trading partner | Distance to market as an IV for trade costs | LSCI as an IV for trade costs |
|                                  | (1)                             | (2)                        | (3)                                         | (4)                                 | (5)                                         | (6)                           |
| Trade cost x cost intensity      | -0.078***<br>(0.021)            | -0.530***<br>(0.017)       | -0.261***<br>(0.070)                        | -0.268***<br>(0.034)                | -0.682***<br>(0.0453)                       | -0.689***<br>(0.0855)         |
| R <sup>2</sup>                   | -                               | -                          | 0.161                                       | 0.201                               | 0.186                                       | 0.177                         |
| N                                | 18,468                          | 28,261                     | 30,052                                      | 43,274                              | 21,096                                      | 7,355                         |

Notes: Robust standard errors are in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . The estimations use specification (4) of Table 2.2 and the set of fixed effects accordingly, except in column (1). The coefficients on the fixed effects are not reported. The estimates in column (1), were obtained using the OLS estimator because the PPML estimator does not work on first-differenced-data due to some negative values of dependent variable. The coefficients in columns (3) and (4) were, however, obtained with the PPML estimator. The sample size in the column (4) is larger as the common trading partner is not the same; moreover, the PPML estimations account for the presence of zeros also. Columns (5) and (6) contain IV estimates. The magnitude of coefficient is slightly larger in columns (5) and (6) as these are OLS estimates.

As this Chapter uses the share of exports as a dependent variable, the fractional dependent variables pose specific econometric problems as marginal effects cannot be constant. Therefore, the robustness of results with factional logit estimator as suggested in Papke and Wooldridge (1996) and Santos Silva et al. (2014) is

investigated. The alternative estimator yields similar results in column (2). As the results in columns (1) and (2) suggest, this variation in the estimation technique also does not influence the sign or significance level on the coefficient of interest.

#### **2.5.2 Alternative Trade Cost Indicator**

Column (3) uses distance to market as an alternative indicator of trade costs<sup>15</sup>, which generates results identical to those of baseline specification. This further address potential concern about the endogeneity of trade costs indicator, which is inferred from domestic and international trade flows, although it has been shown earlier in section 2.3.1 that the correlation between our dependent variable and trade flow is very low (0.05) and also further alleviate this concern through an IV strategy in columns (5) and (6).

#### **2.5.3 Alternative Common Trading Partner**

In column (4), the same analysis is replicated by selecting Germany as the common trading partner, rather than the US. This alternative setting obviates the possibility that preferential access of some developing countries to the US market may influence the estimations. As the results show, this change in the empirical setting does not affect the sign and significance level of the coefficient of interest.

These robustness tests - by employing an alternative estimation approaches and by using a different common trading partner - further validate the initial findings that trade costs are an important determinant of export composition.

#### **2.5.4 Instrumental Variable Estimations**

In columns (5) and (6) of Table 5, trade costs are instrumented on geographical distance to the market of the common trading partner (US) and on the Liner Shipping Connectivity Index (LSCI), respectively. Using distance as an instrument offers an advantage as it is considered exogenous to trade flows. This distance has a positive correlation of 0.50 with bilateral trade costs, indicating high trade costs for remote countries. Column (5) presents the estimation results by instrumenting

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<sup>15</sup>A vast literature uses geographical distance between trading partners as a proxy for trade costs. For a survey see Head and Mayer (2014).

trade costs on distance. As the results illustrate, the coefficient of the interaction variable has the expected sign and is statistically significant.

In column (6), the Liner Shipping Connectivity Index (LSCI) developed by the United Nations Conference on Trade and Development (UNCTAD) is used as an instrumental variable for trade costs (Fugazza et al., 2013). This instrument is a ‘relevant’ because it is strongly correlated with the trade cost indicator, with the correlation coefficient being ‘-0.625’. Moreover, it is largely exogenous to trade flows, for shipping line connectivity (frequency, time, competition) impacts on trade flows only through the channel of transportation costs: the improvement in shipping line connectivity of a given country may affect transportation charges, which in turn might influence its trade share. Further, the market structure of shipping lines is oligopolistic in nature because a few shipping lines handle the major quantum of world trade. The three biggest shipping lines – the CMA of France, Maersk of Denmark and Mediterranean Shipping line (MSC) of Switzerland – transport more than half of the containerised trade between Asia and Europe. This group, namely P3, is a large international monopoly, with these companies having entered into a space sharing arrangement (The Economist, 21<sup>st</sup> June 2014, p-74). Due to this unique market structure and high correlation of the LSCI with the trade costs indicator, this instrument satisfies both the conditions of exogeneity and relevance.

Given that the index is negatively correlated with trade costs, it would be expected to yield a positive coefficient for the interaction variable because higher values of the LSCI mean lower trade costs. However, for the sake of clarity and consistency, the inverse of this index is used in the estimations. This transformation generates negative and statistically significant results (Column 6, Table 2.5). Overall, these estimations further substantiate the earlier findings reported in Table 2.2.

#### **2.5.5 Controls for Institutional Variables and Factor Endowments**

This sub-section investigates whether the trade costs indicator is picking up the effect of some other policy variables. To test this, policy-related variables are added in to the base model and the equation is re-estimated using the PPML method. A brief description of the policy variables and their data sources is contained in the Annex 2.1 in the appendix.

**Table 2.5: Additional Control for Policy Variables**

| Dependent Variable: Export Share |                      |                      |                      |                      |                      |                      |
|----------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                                  | (1)                  | (2)                  | (3)                  | (4)                  | (5)                  | (6)                  |
| Trade costs x cost intensity     | -0.420***<br>(0.073) | -0.495***<br>(0.088) | -0.495***<br>(0.088) | -0.423***<br>(0.073) | -0.484***<br>(0.064) | -0.241***<br>(0.069) |
| Legal institutions               | 0.392**<br>(0.171)   |                      |                      |                      |                      |                      |
| Cost to import                   |                      | -1.046**<br>(0.437)  |                      |                      |                      |                      |
| Cost to export                   |                      |                      | -0.791**<br>(0.397)  |                      |                      |                      |
| Freedom to trade                 |                      |                      |                      | 0.160<br>(0.190)     |                      |                      |
| Tariffs                          |                      |                      |                      |                      | -0.803<br>(1.351)    |                      |
| Non-tariff measures              |                      |                      |                      |                      |                      | -0.027***<br>(0.002) |
| R2_p                             | 0.230                | 0.243                | 0.243                | 0.266                | 0.232                | 0.232                |
| N                                | 20,636               | 12,210               | 12,210               | 20,592               | 27,764               | 27,764               |

Notes: Standard errors in parentheses  $p < 0.10$ ,  $** p < 0.05$ ,  $*** p < 0.01$ ; The estimations use specification (4) of Table 2.2 above. All regressions contain industry-year and country fixed effects. Country fixed effects rather than country-year are used as the latter are collinear with additional covariates (which vary along country-year dimensions) and thus soak up their effects. The number of observations vary across columns as per availability of data of these covariates. These coefficients were obtained using the PPML estimator using Stata IC 13.0.

Table 2.6 contains the results of the extended specifications. As the estimates show, the coefficient on the regressor of interest is negative and significant in all the estimations. The effect of the additional covariates is generally as expected, without confounding the effect of trade costs. For instance, the coefficient on legal institutions and freedom to trade is positive, whereas that for cost of exporting or importing is negative, suggesting that the increase in these indicators (strong legal institutions and freedom to trade) raises export shares, whereas increase in the cost of exporting or importing reducing that. The impact of tariff and non-tariff barriers is negative as expected but the coefficient on tariffs is statistically insignificant. This could be a result of substantially lower tariffs in the manufacturing sector. Similarly, the effect of non-tariff measures is of less economic significance on the developing country's manufacturing export composition.

Romalis (2004), and many other studies, argue that factor endowments are a major source of comparative advantage and an important driver of trade composition. Therefore, the base model is augmented with traditional factor endowments i.e. physical capital, human capital, rule of law, and financial development to examine their effect on the baseline results.

Table 2.7 reports the estimated coefficients adjusted for the separate effect of each factor endowment. The inclusion of controls for these additional covariates further validates the base results. Although the magnitude of the coefficient on the trade costs interaction term varies slightly once the policy variables and factor endowments are accounted for, it still has the expected sign and remains statistically significant at a 1% significance level.

**Table 2.6: Interaction between Country and Industry Characteristics**

| Dependent Variable: Trade Share                       |                      |                      |                      |                     |                     |
|-------------------------------------------------------|----------------------|----------------------|----------------------|---------------------|---------------------|
|                                                       | (1)                  | (2)                  | (3)                  | (4)                 | (5)                 |
| Trade costs x cost intensity                          | -0.521***<br>(0.089) | -0.468***<br>(0.078) | -0.379***<br>(0.069) | -0.120**<br>(0.076) | -0.105*<br>(0.097)  |
| Physical capital x physical intensity                 | 0.001<br>(0.004)     |                      |                      |                     | 0.097<br>(0.201)    |
| Human capital x human capital intensity               |                      | 0.005<br>(0.006)     |                      |                     | 0.560<br>(2.176)    |
| Rule of law x contract intensity                      |                      |                      | 0.039***<br>(0.006)  |                     | 0.228***<br>(0.067) |
| Financial development x external financial dependency |                      |                      |                      | 0.019*<br>(0.06)    | 0.171***<br>(0.064) |
| R2_p                                                  | 0.238                | 0.244                | 0.258                | 0.274               | 0.47                |
| N                                                     | 29,876               | 22,792               | 20,636               | 15,040              | 8,948               |

Notes: Standard errors in parentheses\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ; The estimations use specification (4) of Table 2.2 above. All regressions contain country-year and industry-year and country fixed effects. The number of observations vary across columns as per availability of data of these covariates. These coefficients were obtained using the PPML estimator using Stata IC 13.0. The number of observations in column (5) is very small as data of a lot of countries is missing.

## 2.6 Conclusions

This Chapter investigates the influence of trade costs on the export composition of developing countries. It finds that despite substantial reduction, trade costs in developing countries are relatively high and vary widely between developing countries (from 30% ad valorem for Hong Kong to 600% ad valorem for Mongolia). Most importantly, the analysis finds that these high trade costs influence the comparative advantage of these economies. Other things controlled for, an industry located in a higher trade cost country gains a relatively smaller share of that country's exports of manufactured goods compared to that of the same industry in lower trade cost countries, and that this effect is greater the more trade

cost- intense is the production of the export. This statistically significant negative relationship holds for sub-samples of countries and industries, different estimation techniques (OLS, PPML, IV and first-difference estimators), alternative common trading partners, and even to the inclusion of other sources of comparative advantage, such as factor endowments and institutional quality variables. The Chapter therefore generates robust econometric evidence about how international trade costs systematically fashion the composition, as well as volume, of exports of the developing countries.

In checking even further on the robustness of our finding, it would have been attractive to have been able to generate a measure of aggregate trade costs which was not inferred from information on aggregate (international and domestic) trade flows. Identifying, measuring and aggregating all at, within and beyond the border trade costs is, however, not feasible. Anderson and van Wincoop (2004) apply such an ‘input’ or components approach to measuring total trade costs, but only multilaterally and only for one (high income country, the US) and for one year. The summary measure of bilateral trade costs adopted in this Chapter may give rise to a concern that the identified relationship between trade costs and export composition is a product of the method used to infer trade costs. The analysis therefore checks formally against the possibility of the volume and share of industry exports being highly correlated, and for the possibility of endogeneity due to reverse causation. Besides which the hypothesised relationship is between the interaction of trade costs with trade cost intensity and industry export share. It is far less plausible that changes in export composition systematically drive changes in this interaction term, than that changes in trade costs differentially affect export shares depending on the trade cost intensity of the industry.

The evidence that trade costs fashion the composition of developing countries’ exports in a systematic manner has important development policy implications. The design and implementation of trade policies, including export promotion measures, in developing countries needs to recognise relative national trade costs and differences in trade cost intensity across industries. Selective export promotion measures are less (more) likely to be effective in promoting exports of trade sensitive industries in higher (lower) trade cost countries.

The estimated trade-inhibiting effect is relatively higher for exports of high trade-costs-intense industries (such as autos, telecommunication). This is because these industries are more dependent on imported intermediate inputs, and higher trade costs push up the costs of these inputs as well as increasing the direct costs of exporting. In terms of policy implications this means that reducing trade costs will generate a higher export response in these industries compared to less trade cost sensitive ones.

## 2.7 Appendix

**Table A 2.1: Developing Countries Included in the Empirical Analysis**

|                    |                    |                  |                 |
|--------------------|--------------------|------------------|-----------------|
| Afghanistan        | Dominica           | Lesotho          | Senegal         |
| Albania            | Dominican Republic | Macedonia, FYR   | Seychelles      |
| Algeria            | Ecuador            | Madagascar       | Sierra Leone    |
| Andorra            | Egypt, Arab Rep.   | Malawi           | South Africa    |
| Argentina          | El Salvador        | Malaysia         | Sri Lanka       |
| Armenia            | Eritrea            | Maldives         | St. Lucia       |
| Azerbaijan         | Ethiopia           | Mali             | Suriname        |
| Bangladesh         | Fiji               | Mauritania       | Swaziland       |
| Belarus            | FM Sudan           | Mauritius        | Syrian Republic |
| Belize             | Gabon              | Mexico           | Tanzania        |
| Benin              | Gambia, The        | Moldova          | Thailand        |
| Bhutan             | Georgia            | Mongolia         | Togo            |
| Bolivia            | Ghana              | Montenegro       | Tonga           |
| Bosnia Herzegovina | Grenada            | Morocco          | Tunisia         |
| Botswana           | Guatemala          | Mozambique       | Turkey          |
| Brazil             | Guinea             | Namibia          | Turkmenistan    |
| Bulgaria           | Honduras           | Nepal            | Tuvalu          |
| Burkina Faso       | Hungary            | Nicaragua        | Uganda          |
| Burundi            | India              | Niger            | Ukraine         |
| Cambodia           | Indonesia          | Nigeria          | Vanuatu         |
| Cameroon           | Iran, Islamic Rep. | Pakistan         | Venezuela       |
| Cape Verde         | Israel             | Panama           | Vietnam         |
| C.African Republic | Jamaica            | Papua New Guinea | Yemen           |
| China              | Jordan             | Paraguay         | Zambia          |
| Colombia           | Kazakhstan         | Peru             | Zimbabwe        |
| Congo, Rep.        | Kenya              | Philippines      |                 |
| Costa Rica         | Kiribati           | Romania          |                 |
| Cote d'Ivoire      | Kyrgyz Republic    | Rwanda           |                 |
| Cuba               | Lebanon            | Samoa            |                 |

**Table A 2.2: ISIC Rev.3 Industry Classification**

| Code | Industry                                            |
|------|-----------------------------------------------------|
| 15   | Coke, refined petroleum products and nuclear fuel   |
| 16   | Food products and beverages                         |
| 17   | Tobacco products                                    |
| 18   | Other non-metallic mineral products                 |
| 19   | Chapter and Chapter products                        |
| 20   | Publishing, printing and recorded media             |
| 21   | Furniture; manufacturing n.e.c.                     |
| 22   | Wood and of products of wood                        |
| 23   | Chemicals and chemical products                     |
| 24   | Textiles                                            |
| 25   | Wearing apparel; dressing and dyeing of fur         |
| 26   | Tanning and dressing of leather                     |
| 27   | Fabricated metal products, except machinery         |
| 28   | Electrical machinery and apparatus n.e.c.           |
| 29   | Basic metals                                        |
| 30   | Rubber and plastics products                        |
| 31   | Machinery and equipment n.e.c.                      |
| 32   | Medical, precision and optical instruments, watches |
| 33   | Other transport equipment                           |
| 34   | Radio, television and communication equipment       |
| 35   | Office, accounting and computing machinery          |
| 36   | Motor vehicles, trailers and semi-trailers          |

Source: UN, ISIC Rev.3

**Table A 2.3: Summary Statistics**

| Variable                         | Min   | Mean   | SD    | Max    | Obs    |
|----------------------------------|-------|--------|-------|--------|--------|
| Trade costs (Ad valorem)         | 32.49 | 191.09 | 95.17 | 821.39 | 32,868 |
| Trade cost intensity             | 0.03  | 0.11   | 0.05  | 0.24   | 32,868 |
| Cost of importing                | 317   | 1616   | 946   | 7709   | 12,210 |
| Cost of exporting                | 295   | 1349   | 766   | 5491   | 12,210 |
| Legal institutions index         | 0.00  | 5.13   | 2.32  | 10.00  | 20,636 |
| Economic Freedom Index (EFI)     | 21.40 | 55.48  | 8.07  | 76.30  | 24,288 |
| Protection of property rights    | 5.00  | 40.48  | 15.43 | 75.00  | 24,288 |
| Freedom from corruption index    | 7.00  | 30.33  | 13.59 | 80.00  | 24,288 |
| Freedom of business index        | 10.00 | 59.62  | 12.01 | 87.90  | 24,288 |
| Freedom to trade index           | 0.00  | 60.90  | 15.49 | 89.10  | 20,592 |
| Applied tariffs (simple average) | 0.00  | 3.03   | 17.25 | 350.00 | 26,615 |
| Linear shipping connectivity     | 0.00  | 14.98  | 13.09 | 88.14  | 10,934 |
| Gross domestic product (PPP)     | 319   | 5370   | 4485  | 28589  | 36,476 |
| Financial development index      | 0.03  | 32.33  | 42.60 | 433.10 | 17,864 |
| External financial development   | -0.15 | 0.32   | 0.30  | 0.96   | 15,040 |
| Physical capital intensity       | 0.04  | 0.13   | 0.16  | 1.04   | 29,876 |
| Human capital index              | 1.13  | 2.20   | 0.50  | 3.27   | 26,752 |
| Human capital intensity          | 0.90  | 0.98   | 0.02  | 1.00   | 22,792 |
| Legal institutions index         | 0.00  | 5.13   | 2.32  | 10.00  | 15,752 |
| Contract intensity               | 0.68  | 0.93   | 0.09  | 1.00   | 20,636 |

## **Annex 2.1: Data Sources for Country, Industry and Policy Variables**

The description of country, industry, and policy variables (used in Table 2.6) is as follows:

*Cost of importing:* Taken from the World Bank (ranging from 317 to 7709 USD). It includes all official costs measured in US dollars (except tariffs or trade taxes) incurred for importing a 20-foot container. It indicates administrative burden on new business for imports. The higher values indicate higher burden.

*Cost of exporting:* Taken from the World Bank (ranging from 295 to 5491 USD). It includes all official costs measured in US dollars (except tariffs or trade taxes) incurred for exporting a 20-foot container. It is another indicator of administrative burden.

*Freedom to trade:* Taken from the Heritage Foundation. It is an economic freedom index (EFI), which reflects an economy's openness to the flow of goods and services from around the world and the citizen's ability to interact freely as buyer or seller in the international marketplace. The index ranges from 0 to 100 and the higher values indicate higher level of freedom to trade.

*Legal rights index:* Taken from the World Bank. It measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending. The index ranges from 0 to 10, with higher scores indicating that these laws are better designed to expand access to credit.

*Tariffs:* Taken from the World Integrated Trade Solutions (WITS) dataset. It is ad valorem tariff levied by the United States on the imports from its trading partners.

*Non-tariff measures:* Taken from the World Bank trade cost dataset. It is ad-valorem equivalent of all additional costs other than tariff costs involved in trading goods bilaterally rather than domestically. Its values range from 20% to 800%.

*GDP per capita:* Taken from the World Bank. It measures income level of trading partners based on purchasing power parity (PPP) at current prices in the US dollars.

## **Annex 2.2: Data Sources for Country and Industry Characteristics**

The description of country and industry characteristics (used in Table 2.7) is as follows:

*Physical capital stock*: Taken from the Penn World Tables (PWT 08) generated by Feenstra et al. (2013) which constructed it using the data of initial assets, investment, and depreciation.

*Physical capital intensity*: Taken from EU Klems database. It is a ratio of gross fixed capital to the number of employees in the industry.

*Human resources index*: Taken from the Penn World Tables (PWT 08). It is based on the average years of schooling of population aged fifteen and above and assumed returns from education as in Psacharopoulos (1994).

*Human capital intensity*: Taken from EU Klems database. It is the number of hours worked by the high-skilled workers in each industry in the United States relative to the number of hours of worked by medium and low skilled workers.

*Rule of Law*: Taken from Heritage Foundation (<http://www.heritage.org>). It is an economic freedom index for the protection of property rights.

*Contract intensity*: Taken from Nunn (2007). It is a measure of relationship specific investment across industries and is computed as a fraction of inputs neither traded on organised exchanges nor having a reference price.

*Financial development*: Taken from the World Bank dataset. It is measured as a ratio of stock market capitalization to GDP.

### Annex-2.3: Trade Cost Indicator

This Chapter primarily uses a trade costs from the World Bank trade costs dataset. The indicator is based on the theoretical foundation using an inverse gravity approach developed in Novy (2013) and subsequently formalised in Arvis et al. (2016). It measures international trade costs relative to the cost of domestic trade and computes them from the gap between observed trade and actual trade potential. The trade potential is estimated from the patterns of production, consumption, and trade in origin and destination countries and trade costs are computed using the following formula:

$$\tau_{ijkt} = \left( \frac{t_{ijkt} t_{jikt}}{t_{iikt} t_{jjkt}} \right)^{\frac{1}{2}} - 1 = \left( \frac{x_{iikt} x_{jjkt}}{x_{ijkt} x_{jikt}} \right)^{\frac{1}{2(\sigma_k - 1)}} - 1$$

where ‘ $\tau_{ijkt}$ ’ is trade cost between country ‘i’ and country ‘j’ at time ‘t’, in sector ‘k’ (agriculture or manufacturing); ‘x’ is exports, ‘ $\sigma$ ’ is elasticity of substitution, subscripts ‘ii’/‘jj’ indicate intra-country trade and subscripts ‘ij’/‘ji’ designate inter-country trade. Bilateral trade costs computed using this procedure are ad valorem (tariff) equivalents, and are symmetric in nature.

A few unique features of this trade costs indicator make it attractive for the use in empirical modelling. First, compared with other measures of trade costs, such as distance between trading partners or the CIF to FOB ratios or other partial measures of specific sources of trade costs (tariffs or NTB coverage), this indicator is very comprehensive in nature. This methodology for inferring trade costs has micro-theoretical foundations and is devoid of omitted variables bias. Moreover, it is theoretically consistent as it includes most components of trade costs discussed in Anderson and van Wincoop (2004). In absence of any direct measure of various elements of trade costs, this is probably the second-best alternative.

Second, the comprehensive nature of this measure and its availability cross countries and over time<sup>16</sup> allows the estimation of empirical models in a panel setting. Tombe (2015) employs this trade cost indicator to examine the relationship between the international food trade and differences in aggregate labour

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<sup>16</sup> This dataset provides bilateral trade costs for 178 countries for the period 1995 to 2013.

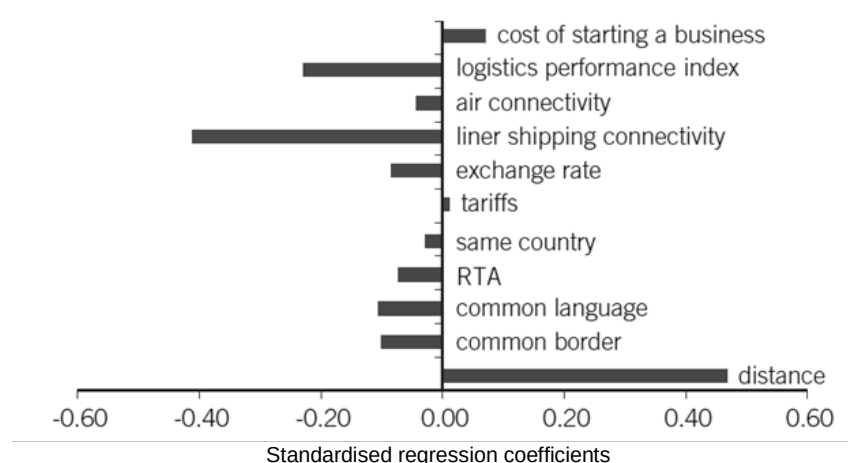
productivity across countries, and Chan and Manova (2015) use it to examine the effect of financial frictions on the choice of trading partners.

**Table 2.7: Variation in Trade Costs across Trading Partners of the US**

| Geographical Region          | Trading Partners (#) | Trade costs (ad valorem) |      |     |     |        |
|------------------------------|----------------------|--------------------------|------|-----|-----|--------|
|                              |                      | Min                      | Mean | Max | SD  | Obs    |
| East Asia and Pacific        | 24                   | 32                       | 148  | 425 | 92  | 3,696  |
| Europe and Central Asia      | 17                   | 61                       | 192  | 356 | 51  | 4,642  |
| Latin America and Caribbean  | 25                   | 34                       | 123  | 384 | 46  | 7,546  |
| Middle East and North Africa | 12                   | 98                       | 182  | 625 | 72  | 2,640  |
| South Asia                   | 7                    | 92                       | 190  | 358 | 83  | 1,892  |
| Sub-Saharan Africa           | 44                   | 94                       | 253  | 821 | 102 | 10,450 |

Source: Authors' working using Comtrade and trade costs dataset.

**Figure 2.5: Sensitivity of Trade Cost Measure to its Components**



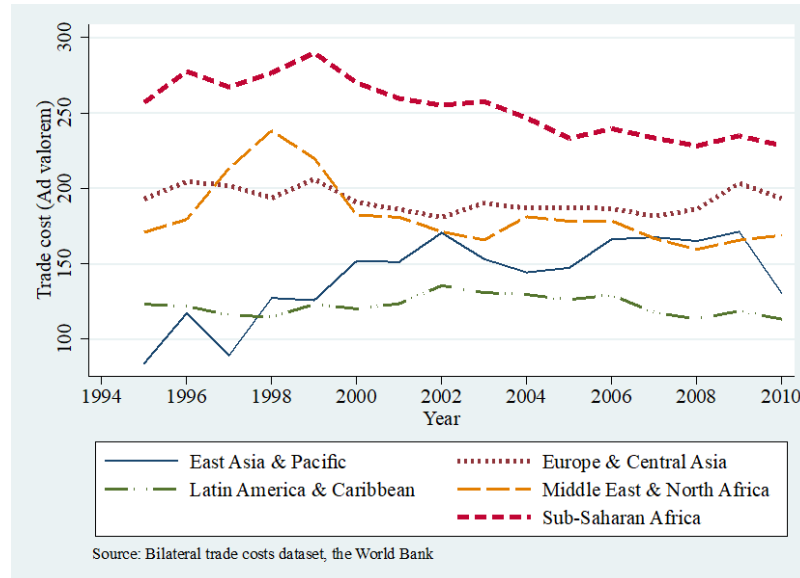
Source: Economic Premise 104 (World Bank)

Note: The chart plots standardised regression coefficients depicting the correlation of the aggregate indicator with various components of trade costs.

The third re-assuring feature of this indicator is its strong correlation with key components of trade costs: policy barriers, and non-policy or natural barriers (Figure 2.3). The former includes tariffs and non-tariff measures, shipping line connectivity, and infrastructure performance, whereas the latter comprises geographical or natural factors, such as distance and the lack of common language, etc. Finally, the substantial variation of this indicator across countries and over time provides a good setting for the econometric analysis in a panel structure (Table 2.1 and Figure 2.4). Note the marked variation in trade costs across regions, with

Sub-Saharan Africa having experienced some decline in trade costs over the period but being the highest cost region throughout (Figure 2.4).

**Figure 2.6: Trade Costs by Geographical Region and over Time**



In contrast to other indicators of trade costs discussed in the previous section (LSCI and LPI), this indicator is bilateral in nature and does not require aggregation across countries. Since trade flows are also measured on bilateral dimensions, the estimations at a disaggregated level reduce measurement errors and aggregation bias. Moreover, its data availability for many countries overtime allows estimations in panel settings, which permits incorporating controls for unobserved heterogeneity overtime.

These above features of this trade cost indicator make it interesting to use it in empirical work, however, on the downside, these trade costs are inferred from relative volumes of intra- and inter- country trade. But the analysis ensures that the trade cost effect captured in the empirical strategy is a distinct compositional, as opposed to hidden volume effect. This measure of the industry composition of exports is not correlated with the volume of trade at the industry level as the correlation coefficient between a share and volume measure of bilateral trade at the industry level in the data is almost insignificant (0.05).

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

### **3.1 Introduction**

In a world of increased global security threats, transportation networks are viewed as a weak link that can be exploited to ship technologies of terrorism internationally. Understanding the effect of policy responses to this perceived threat on international trade 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 an additional layer of security on already very thick national borders remains a difficulty. Exploring this effect has assumed importance in the wake of the emerging security situation in different parts of the world, which seems to pose a threat to the progress achieved so far in liberalising trade flows and reducing the cost of conducting international business.

In this background, this Chapter examines the trade effect of a policy response to the security situation that emerged after the events of 9/11, which heightened fears that containerised cargos could be used as a conduit for smuggling radioactive or nuclear materials into the US. To alleviate these apprehensions, the US Congress passed a 100% scanning law applicable from July 2012 to the US-bound containerised export cargo of all trading partners. Implementation of the laws halted owing to stiff resistance from the EU and Asian economies. However, a pilot project under this scheme had been launched at Qasim Port (QP), Karachi, Pakistan, in April 2006. The project titled, Integrated Cargo Container Control (IC3) program, required intrusive screening of US-bound cargo containers before their shipment from the port of origin (GAO, 2008) and live monitoring of the scanning operations by the National Targeting Centre (NTC) in Washington DC via a video link (for details see section 3.2).

This security policy affected the cost of exporting to the US market in two distinct legs of the supply chain\_ behind-the-border as well as beyond-the-border. It reduced the latter by allowing direct shipments of the export cargo containers to the US market, which were previously diverted randomly to Sri Lanka, Hong Kong or Oman for the scanning. However, it increased the former by centralising the

screening process at Qasim Port, leading to massive diversion of the trade internally, from inland dry ports and Karachi port to this particular exporting station. This second component of IC3 effect (behind-the-border effect) is expected to be heterogeneous across firms depending upon the pre-IC3 port of exit. For firms that were already shipping from Qasim port (incumbents) the effect is considered to be smaller relative to the other cohort that had to switch from Karachi port and inland dry ports (switchers) to Qasim to meet these scanning requirements.

This Chapter investigates the net effect on firm-level exports of the changes in trade costs because of these new arrangements by exploiting the IC3 program as a quasi-natural experiment. The exogenous nature of this shock and its specificity to one export market (US) allows performing the estimations by finding a suitable counterfactual group – that is, the EU – that did not impose such security measures. This Chapter initially estimates the effect of IC3 using the EU as a control group but in robustness checks it employs China as an alternative counterfactual.

This empirical setting is quite unique in two important aspects. First, the requirement of 100% intrusive scanning was unilaterally imposed on Pakistan because of the prevailing security situation in the US after the events of 9/11. Moreover, this scanning technology installed by the US primarily aimed at improving its internal security; therefore, its trade effect is largely exogenous for Pakistan's exporting firms. Second, IC3 had a differential effect on trade costs across markets: it targeted exports destined to the US only (treatment group), whereas those to other markets including the EU or China (control group) remained unaffected. These distinguishing features allow applying a difference-in-difference (DID) estimation approach. Application of a DID framework helps to wash out other factors such as improvement in shipping technology, infrastructure and institutional changes that could have affected trade flows to both destinations in this period.

This Chapter initially documents IC3-related factors imposing additional trade costs at- and behind-the-borders that appear to offset the reduction in beyond-the-border trade costs of the program, and then generate econometric evidence about the net effect on Pakistan's exports to the US market relative to the EU. Following this, it explores the heterogeneity of the effect on various cohorts of the firms, and

examine its implications for extensive margins (EM) of firms and products, margins of prices and quantities, as well as adjustments along intensive margins (IM) over time. This decomposition of the trade effect along multiple dimensions informs us about the mechanisms, drivers and speed of adjustment to this additional layer of security on the existing supply chain.

This Chapter finds that IC3 has, in general, imposed an additional burden on Pakistan's firms rather than facilitating their exports to the US. The reduction in beyond-the border trade costs brought about by the installation of scanning facilities at the port of origin and thus allowing direct shipments to the US market is offset by the increase in behind-the-border costs associated with internal trade diversion resulting from the concentration of the intrusive scanning operations at one exporting station only. The DID estimates show that, in these new arrangements, Pakistan's exports to the US dropped by 15% compared with those to the EU. The effect, however, varies widely across firms and products as well as over time. It is relatively higher for the firms that had to switch from other exporting stations to Qasim Port (QP) to meet the scanning requirement, and particularly higher for single markets firms and those exporting non-textile products. The drop is severe for the period of initial four years, from 2007 to 2011. The subsequent policy refinement in 2011 facilitated this process, which stemmed the declining trend to some extent. Adjustment to this shock appears to have occurred through the EM of firms and product as well as through the channels of prices and quantities. These results are robust to a battery of sensitivity checks comprising estimations at higher-levels of aggregation, first-differencing the data, controlling for potential time-varying omitted variables, using alternative control group and to a falsification test comparing the US-bound exports of India and Pakistan.

This research extends the narrow stream of literature on trade and security issues (Mirza and Verdier, 2008; EC, 2009; WCO, 2008; GAO, 2008). Mirza and Verdier (2008) in a general analytical framework, describe the existing relations between terrorism, counter-terrorism actions and trade, and argue that terrorism affects trade flows primarily through two channels: reducing the willingness to do business with un-secure countries and the trade-restrictive effect of counter-terrorism policies. This Chapter, however, provides empirical evidence on the adjustment of firm-

level exports along these channels. Many other studies in this stream, for instance, EC (2009), WCO (2008) and GAO (2008), argue against the feasibility of 100% scanning of US-bound exports owing to the high costs associated with the internal movement of cargo, congestion at ports and infrastructure constraints. Although these studies found the scanning operations to be highly cost-intensive and trade-restrictive, they did not perform quantitative assessment of the magnitude of the trade-restricting impact due to data limitations. This Chapter bridge this gap in the literature by using an administrative dataset to estimate the trade effect of IC3 and examine its heterogeneity along multiple dimensions at a micro level.

These findings also add to four distinct strands of literature on (i) technology and trade, (ii) economic sanctions, (iii) trade costs and (iv) trade diversion. First, the recent literature on technology and trade examines the effect of containerisation (Bernhofen et al., 2016) and maritime transport (Pascali, 2014; Hummels, 2007), whereas this Chapter explores the effect of intrusive scanning technology, which is increasingly being adopted for security and trade facilitation purposes. Second, it adds to the literature on economic sanctions by generating the evidence about the trade-restricting effect of these disguised sanctions. The existing studies in this stream mainly focus on income effect, however, a few studies find a negative trade effect also; for example, Afesorgbor and Mahadevan (2016), Yang et al. (2009), Caruso (2003), Cooper (1989) and Khan (1988).

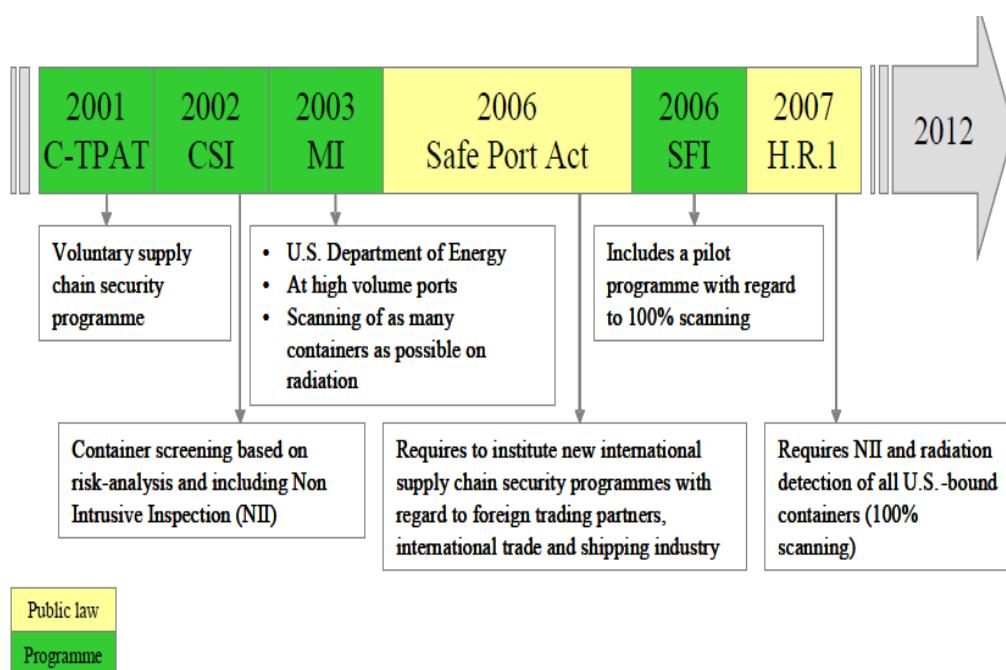
Third, the existing trade diversion literature mainly examines the changes in importing countries' trade patterns in the context of PTA and FTAs (for example Carrere, 2006), whereas this Chapter explores the effect on the exporting country's trade flows due to cost-raising effect of the security policy. This trade diversion effect of security-related costs speaks to the vast literature on trade costs (Arkolakis, 2010; Feyrer, 2009; Anderson and Van Wincoop, 2003, 2004; Baier and Bergstrand, 2007; Donaldson, 2015). In contrast to these studies, this chapter isolates the effect of this trade cost shock from other potentially omitted variables influencing exports during this period by finding a suitable counterfactual group. To the best of my knowledge, this is the first *ex-post* quantitative assessment of the trade effect associated with the IC3 programme and the resulting diversion of trade within and beyond international borders.

The next section provides an overview of IC3 program and section 3.3 introduces the data. Section 3.4 describes the empirical setting and section 3.5 the estimation methodology. Section 3.6 presents the main estimation results and section 3.7 the robustness checks. Section 3.8 concludes by highlighting the policy implications of the study.

### 3.2 IC3 Program in Brief

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 the MPI aimed at scanning as many containers as possible at high-volume ports. The SFI kicked off in April 2007 with the launch of International Container Security pilot at Qasim Port (QP) in Karachi, Pakistan (Marine Log, 2008). 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. Figure 3.1 illustrates the evolution of this scheme.

**Figure 3.1: Evolution of Integrated Cargo Container Controls (IC3) Program**



Source: European Commission (2009)

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). The WCO

commissioned a study to the University of Le Havre in 2007 to examine the economic impacts of the 100% scanning law. This ex-anti work illustrates the magnitudes of challenges to be faced by the containerised transport and port authorities including potential blocking of port installations, uncertainties in the handling of these cargos, in addition to financial burden of up-gradation, operation and maintenance, which will ultimately be passed on to users. The report concludes that the 100% scanning law is a disguised protectionist measure that might impose considerable impact, including slowing down trade dynamics and consequently the world growth (Carluer, 2008).

The EU fiercely objected to the unilateral nature of the legislative requirement and argued that the law 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 potentially divert resources away from strengthening EU's own security. The EU further alluded to retaliatory measures comprising similar scanning of EU bound cargo originating from the US before being shipped to the EU market.

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 the SFI. As a result, the process reverted to CSI protocols. The CBP also approached the port of Singapore for similar scanning measures 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 buyers in the US market. In these circumstances, the IC3 project was perceived as a trade facilitation initiative as it allowed direct shipments to the US markets by completing the scanning formalities at the port of origin.

### 3.3 Data and Descriptive Evidence

This section describes data and presents preliminary evidence on the trade effect of IC3 program.

#### 3.3.1 Data

This Chapter exploits two features of the firm-level data described in detail in Chapter ‘1’: the information on the use export-processing stations and modes of shipment over time. It restricts the main analysis to the comparison of Pakistan’s exports to the US and EU markets. The cleaned dataset of Pakistan’s exports to the EU and US contains 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 seven years prior to and seven years after the launch of IC3. For ease of estimations, data is collapsed at firm-product-market-year level. These transformations yield 463,932 observations, of which 316,520 pertain to the EU and 147,413 to the US. Table 3.1 presents summary statistics.

**Table 3.1: Summary Statistics: Firm-Level Data, 2002-2014**

| Variable      | Observations | Mean  | Std. Dev. |
|---------------|--------------|-------|-----------|
| Exports       | 463,931      | 13.2  | 131.63    |
| Treat x After | 463,931      | 0.268 | 0.443     |
| Treat         | 463,931      | 0.317 | 0.465     |
| After         | 463,931      | 0.878 | 0.327     |

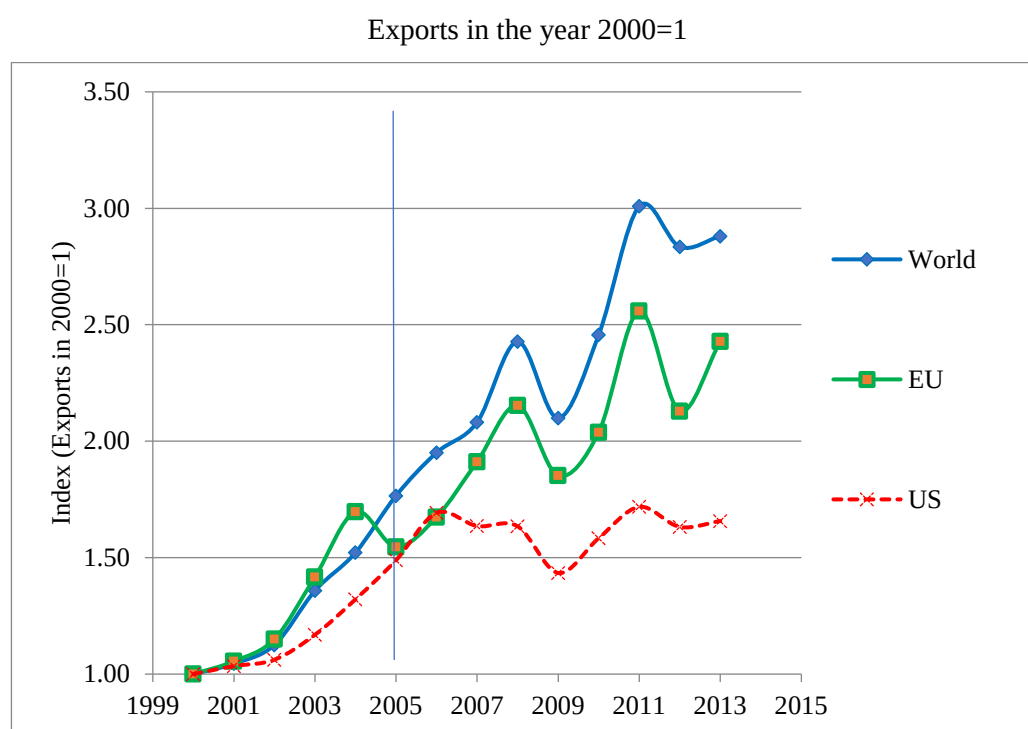
Notes: Exports are defined at firm-product-market-year level and measured in PKR million.

#### 3.3.2 Descriptive Evidence

The data suggests that immediately after the launch of IC3 program, Pakistan’s US-bound exports experienced a significant drop (Figure 3.1). This drop is specific to the US market only as Pakistan’s overall exports to the world continued a rising trajectory even after the launch of IC3.

Table 3.2 presents the detail of firms and products shipped to both markets (EU and US) over time. It shows that some exporters ship to single market, either EU or US, but a large set of firms export to both markets. Similarly, some products are market specific, while a large overlapping set of products is absorbed in both markets.

**Figure 3.2: Pakistan's Exports to the EU, US and the World, 2000-2014**



Note: Export values are normalized to '1' in the year 2000 to clearly depict the changes in the trend.  
Source: Authors working using Pakistan Customs dataset.

**Table 3.2: Firms and Products in the Control and Treatment Groups**

| Year | Firms     |       |               |       |              | Products     |       |               |     |              |
|------|-----------|-------|---------------|-------|--------------|--------------|-------|---------------|-----|--------------|
|      | All Firms |       | Single Market |       | Both Markets | All Products |       | Single Market |     | Both Markets |
|      | 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 the HS8 level.  
Source: Pakistan Customs

The effect of IC3 is evident along extensive margins (EM) of firms and products (Table 3.2). 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 then experienced a modest increase in the subsequent period. Single-market firms (serving the US market only) are affected the most: size of this cohort drops in three consecutive years, from 2007 to 2009. In contrast, the size of the multi-market cohort (firms shipping to the both markets, EU as well as US) continues to expand over time except for a drop in 2009, which appears to coincide with the global financial crisis. This decomposition suggests that the adjustment to this shock occurred through extensive margins of firms and products and the effect appears to have attenuated over time.

### **3.4 Defining Treatment: IC3 Effect on US-bound Exports**

IC3 influenced US-bound exports from Pakistan in three distinct legs of the supply chain: behind the border and at-and-beyond the border. This section initially discusses the effect of IC3 on different components of trade costs for the treatment group and then sets out the selection of a suitable control group.

#### **3.4.1 Reduction in Beyond-the-Border Trade Costs**

To ensure buy-in from program stakeholders, IC3 was presented as a trade facilitation initiative. Documents of the national Customs authorities as well as the Pakistan Trade Policy Review (WTO, 2007) describe it as a step towards facilitating trade through curtailing vessel sailing time to the US, eliminating transshipment requirements at intermediary ports for the scanning, and simplifying procedural formalities at the port of origin and destinations, in addition to ensuring the security of the supply chain. Since in the new arrangements Pakistan's cargo containers are scanned at the port of origin, they are shipped directly to the US. These direct shipments have reduced the lead-time to reach the US market by about two to six days.

According to Dubai Ports World (the port operator), this facility has reduced the lead-time to reach the US market by 2-6 days. Currently a container shipped from Qasim Port (where this facility is located) can reach main ports in the US in 24-32 days, whereas previously this travel time could be up to 35 days. It largely depended upon the route of ship and intermediary port of scanning because prior to the IC3 project these containers were diverted to three different ports— Hong Kong,

Colombo (Sri Lanka) or Salalah (Oman) — for scanning before they were allowed shipment to the US (European Commission, 2009, p-20).

**Table 3.3: IC3 Effect on Maritime Distances and Vessel Sailing Time**

| A: Maritime Distances (Km) |        |                         |           |           |           |                |           |
|----------------------------|--------|-------------------------|-----------|-----------|-----------|----------------|-----------|
| Direct Shipments           |        | Via Transshipment 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 Transshipment 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        |

Note: The table presents the IC3 effect on the maritime distance and vessel sailing time to the US Market in the Pre- and Post-IC3 Periods

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

This reported reduction in sailing time finds some support from the maritime distances and lead times data presented below (Table 3.3). The data indicates that maritime distance for direct shipments to US from Qasim Port is lower by 10% to 20% on some routes. This reduced maritime distance (due to availability of scanning facility at the port of origin) can save up to six days in travel time for delivery at the port of New York (Atlantic Ocean) and up to 1-2 days for delivery at the port of Los Angles (Pacific Ocean). The delivery time at other US ports located on Atlantic and Pacific coasts however varies by a few hours only.

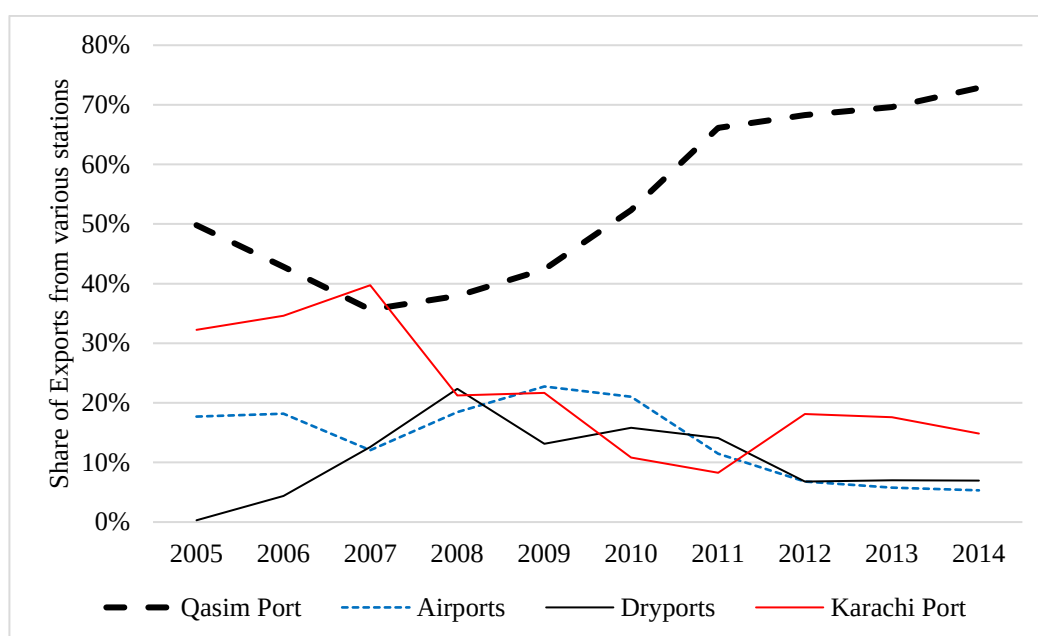
A representative of shipping line pointed toward the reduction in transshipments costs also. He informed that *“Due to scanning facility at IC3, this has no doubt reduced carrier’s equipment turn-around times and additional cost because with this we can avoid handling of containers at t/s ports which were earlier nominated to scan US bound containers. Since US bound containers can be routed directly from PK, we find ourselves more competitive in terms of price, transit times and service cycles.”* Saving on this account could be substantial as transshipment is quite

an expensive operation. UNCTAD's data indicate that transshipment charges vary from \$50 to \$400 per container.

### 3.4.2 Increase in Behind-the-Border Trade Costs

Although IC3 reduced beyond-the-border trade costs, it increased those at- and behind-the border mainly because of two reasons. First, the scanning is an additional layer to standard border clearance procedures<sup>17</sup>, and is applicable to all US-bound cargo irrespective of its potential risk. Since it affects all the containers originating from Karachi and those from hinterland dry ports, it entails duplication of some procedures especially for upcountry cargo.

Figure 3.3: Internal Diversion of US-bound Export Cargo to Qasim Port



Note: This chart shows the diversion of US-bound export to Qasim Port due to centralisation of the scanning operations, 2005-2014. The figures on the y-axis are percentage of exports handled at each trade-processing station.

Second and most important, the concentration of scanning operations at one port has led to a massive diversion of trade at the domestic level. The share of QP in US-bound cargo has increased from 36% in 2007 to around 80% in 2014 (Figure 3.3). This increase occurred because of the switching of the export containers that were previously processed at other stations to QP to fulfil the mandatory requirement of screening before their shipment. This centralisation of processing has thus increased internal transportation costs and created processing delays.

<sup>17</sup> Such as random physical inspections by Customs and drug checks by anti-narcotics force.

Table 2 summarises the increase in internal road distances for exports diverted from Port Karachi to Qasim Port for firms located in different cities in Pakistan.

**Table 3.4: Increases in Internal Distance to Port for Diverted Exports**

| Export Origin       | Distance to ports (in Km) |            | % Increase | Export wt.<br>2009 |
|---------------------|---------------------------|------------|------------|--------------------|
|                     | Karachi                   | Qasim      |            |                    |
| (1)                 | (2)                       | (3)        | (4)        | (5)                |
| Faisalabad          | 1,188                     | 1,243      | 4.6        | 0.123              |
| Gujranwala          | 1,345                     | 1,400      | 4.9        | 0.010              |
| Hyderabad           | 147                       | 202        | 37.4       | 0.001              |
| Islamabad           | 1,506                     | 1,561      | 3.7        | 0.001              |
| Karachi             | 55                        | 110        | 100.0      | 0.532              |
| Lahore              | 1,265                     | 1,320      | 4.3        | 0.149              |
| Multan              | 943                       | 998        | 5.8        | 0.004              |
| Peshawar            | 1,601                     | 1,656      | 3.4        | 0.000              |
| Quetta              | 670                       | 725        | 8.2        | 0.019              |
| Rawalpindi          | 1,501                     | 1,556      | 3.7        | 0.001              |
| Sargodha            | 1,396                     | 1,451      | 3.9        | 0.000              |
| Sialkot             | 1,219                     | 1,274      | 4.5        | 0.161              |
|                     |                           | % Increase |            |                    |
| Simple Average      | 1,070                     | 1,125      | 5.1        | 15.3               |
| Weighted<br>Average | 593                       | 648        | 9.3        | 55.4               |

Source: Authors' calculations.

Notes: Columns (2) and (3) contain shortest road distances from centres of towns to seaports measured with the Google Maps. Column (4) contains export weights for 2009.

The average internal distance that exports were transported rose by about 5% (in unweighted terms) and by 9.3% when weighted by export values from the various locations. The effect however varies widely. In percentage terms, the distance-raising effect was greater for firms situated nearer to Karachi (where most exporters were located); doubling the distance for firms in Karachi, but increasing it by only 3.4% for firms in Peshawar (inland distance here on average being over 1600 km from both ports). For those firms that switched to exporting through Qasim, behind-the-border trade costs rose due to the longer domestic journey times.

These higher costs were ameliorated to some extent by scanning and port-infrastructure expansions in 2011. For those that continued to use ports other than Qasim shipping times rose owing to the longer distances involved on average with transshipment via and scanning at a foreign port. Behind and at-the-border costs were however unchanged in this case. An open empirical question is whether the change in beyond-the-border trade costs caused by the IC3 program were larger or smaller

than the changes in at- and behind-the-border costs and how these differed across firms and over time depending on their pre-IC3 use of ports.

In addition to the cost of diversion, relatively under-developed port infrastructure and poor connectivity of QP with hinterland exacerbated cost of shipping. The reason is that port infrastructure and support services vary widely at Karachi and Qasim. Karachi is the main sea port of Pakistan with well-developed port infrastructure and handling facilities. Moreover, the major support services, such as shipping agents and freight forwarders, are located near Karachi port. 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 only, a relatively new port with fewer berths and limited handling facilities. Furthermore, 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. Moreover, QP is connected with the main road network through Karachi. The cargo vehicles must wait in daytime outside the city to ply through the mega city of 22 million people. Finally, a relatively unsecure location<sup>18</sup> of QP, further discourages shipments from this station.

Overall, IC3 increased the behind-the-border cost of exporting to the US market through these multiple channels, especially for those firms who were previously exporting via Karachi Port. An earlier study by the European commission also identifies the increase in domestic trade costs due to these kind of internal factors (EC, 2009).

### **3.4.3 Policy Refinement to Facilitate Shipments from Qasim Port**

Pakistan's US-bound exports in the post-IC3 period initially stagnated and then dropped (Figure 3.2). To stem this decline, two initiatives were launched in 2011. First, the existing scanning yard at IC3 was expanded to double of its existing capacity, and the second, the Qasim Port launched an off-dock terminal near Karachi Port to collect US-bound export cargo containers and arrange their further transportation to and processing at QP themselves. These measures seem to affect

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<sup>18</sup> Karachi is known for violence and ethnic clashes, which caused more than 8,000 deaths during the last decade.

the US-bound export positively. But these also have heterogeneous effect across firms: the switching cohort might benefit from these arrangements.

#### **3.4.4 Differential 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: incumbents and switchers. In 2006, around 3,575 firms exported to the US market from Pakistan. Of these 490 firms made all their shipments from QP (hereinafter called 'incumbents') and others used Karachi seaport or dry ports (herein after called 'switchers'). In the post-IC3 period, all these firms export from Qasim Port.

The trade restricting effect of IC3 is expected to be less severe for incumbents because they continue their exporting operations at the same port, although their consignments were also subjected to scanning from 2007 onwards. This cohort may benefit initially from their established position at the exporting station. However, they may be hurt due to the shifting of firms from other stations who may compete for storage space and other operational facilities. By contrast, the initial effect on switchers, which were forced to shift from KP and DP to QP to meet the scanning requirements, is expected to be relatively stronger. The switching firms, although hurt initially, are expected to adjust over time.

#### **3.4.5 Selection of a Control Group**

The trade cost effect of IC3 is quite different from typical trade-related projects, which are generally quite broad in scope. For example, construction of a new port or improvement in the existing trade-processing infrastructure could influence trade flows to many export destinations. By contrast, the changes in trade costs owing to implementation of IC3 are destination specific. It influenced the processing of Pakistan's exports to the US (treatment group) only, whereas those to all other markets remained unaffected with their exports being handled from all exporting stations across Pakistan as per previous practice. The processing of US-bound exports, however, was centralised for the intrusive scanning and live monitoring purpose by the National Targeting Centre in Washington DC. This distinguishing feature of the IC3 set up allows finding a suitable counterfactual group. Some potential control-group candidate countries are China, European Union (EU) and the United Arab Emirates (UAE), all of which are major export markets of Pakistan

(Table 3.5). Although the volume of exports to these markets is comparable to that destined to the US, the structure of exports varies.

Table 3.5: **Potential Control Group Countries, 2013**

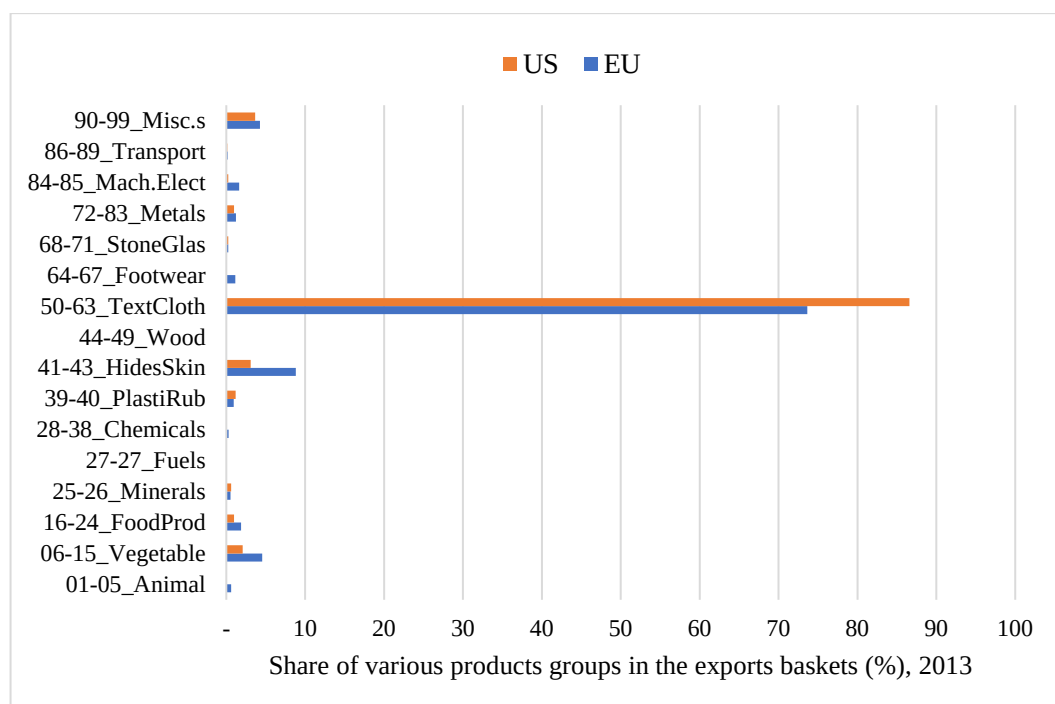
| Trading Partner      | Exports (US\$ M) | Share (%) |
|----------------------|------------------|-----------|
| United States        | 3,746            | 14.91     |
| China                | 2,652            | 10.56     |
| United Arab Emirates | 1,775            | 7.07      |
| European Union (28)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

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

For example, exports to China mainly comprise raw materials and semi-processed goods, whereas those to the US are finished products. Similarly, exports to the UAE are not necessarily absorbed in that market but are transited through its ports to other destinations. In terms of nature of products, EU is closer to the US as these economies source comparable products from Pakistan; Textiles constitute around 75% of Pakistan export basket to these markets (Figure 3.4).

**Figure 3.4: Composition of Exports to the EU and US**

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



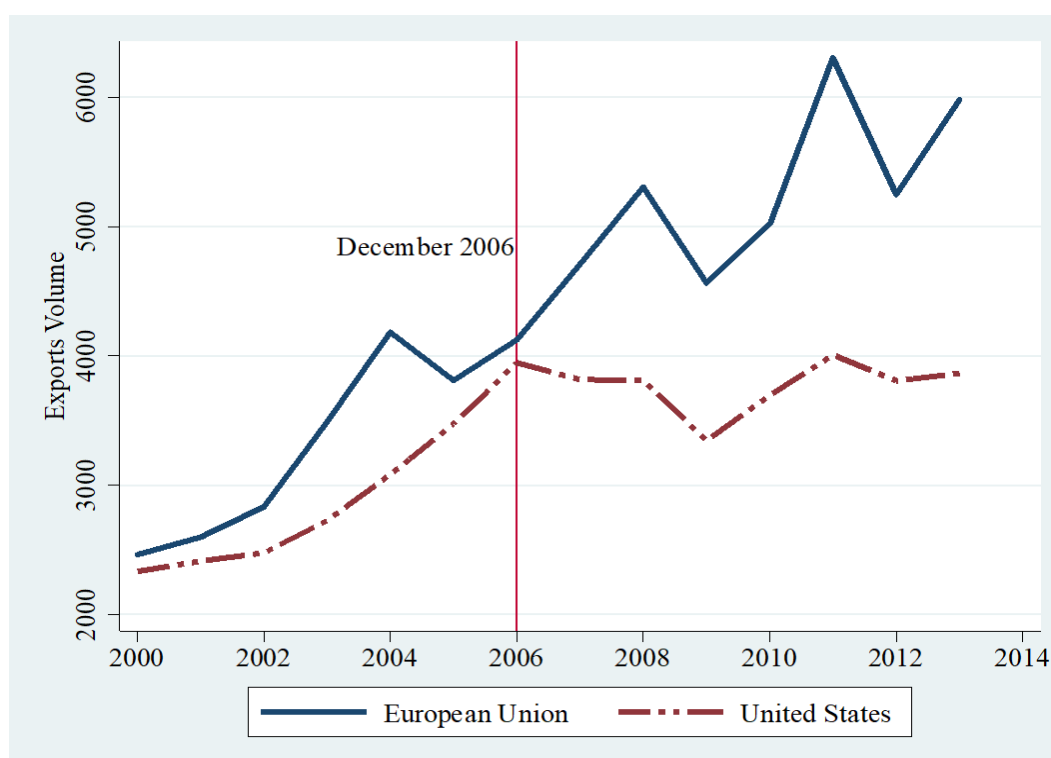
Source: Pakistan Customs

Both markets are key destination of Pakistan's textile and other finished goods. The production process of these goods uses the same raw materials, machinery and equipment. Moreover, the demand structure in these countries are almost similar. Therefore, in terms of composition of exports as well in terms of demand structure, the EU constitutes a most suitable control group. The trade flow to EU was not directly affected, though it may be indirectly affected if there is destination substitution. This potential concern is addressed in detail in the robustness analysis by decomposing the trade effect across single and multiple markets firms as well as by using China as an alternative control because the possibility of export diversion to China is quite limited.

### 3.5 Estimation Framework

To isolate the effect of IC3 on trade flows from other variables impacting exports during this period, this chapter compares 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 from all exporting stations in Pakistan. The application of a DID estimation approach helps to control for other confounding factors such as improvement in technology, infrastructure, institutional changes and economic growth that could influence exports to the both groups. Before proceeding to developing a formal estimation strategy, the key identifying assumption of parallel trends in the evolution of control and treatment groups in the pre-treatment period is tested. The following graphical and statistical analysis shows that this assumption holds.

**Figure 3.5: Exports to the Control (US) and Treatment (EU) Groups**



Note: Exports in millions of US dollars.  
Source: Pakistan Customs.

Figure 3.5 plots Pakistan's total exports to the EU and US, the control and treatment groups, respectively. The chart suggests that the evolution of exports to both markets was similar before the launch of IC3 but differed afterwards. Exports to the both groups were on a rising trajectory until 2004; however, those to the EU declined

slightly 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 resumed a parallel path again. A major divergence in the export trends to the both economies occurred from 2006 onwards, after the launch of IC3: exports to the US dropped and stagnated, whereas those to the EU continued the same trajectory, with some fluctuations. 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. 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. Further test on the equality of export growth rates to these markets across sectors during the pre-IC3 period are also conducted.

Table 3.6 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 the pre-IC3 period. In none of the years do it finds a statistically significant difference in the means, indicating that the parallel trends assumption is satisfied, and the EU represent a valid counterfactual group.

**Table 3.6: Parallel Trend Tests, 2002-06**

| Δ Growth<br>(1) | Control<br>(2)   | Treatment<br>(3) | Difference<br>(4)  | t-statistics<br>(5) |
|-----------------|------------------|------------------|--------------------|---------------------|
| 2003            | 0.381<br>(0.031) | 0.315<br>(0.311) | 0.070<br>(0.052)   | 1.327               |
| 2004            | 0.390<br>(0.031) | 0.316<br>(0.041) | 0.073<br>(0.052)   | 1.388               |
| 2005            | 0.203<br>(0.029) | 0.242<br>(0.039) | -0.0389<br>(0.048) | -0.782              |
| 2006            | 0.277<br>(0.277) | 0.269<br>(0.269) | 0.007<br>(0.054)   | 0.147               |

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.

To quantify the magnitude of the trade effect of the first intervention at a firm level, the following regression framework is used:

$$\ln(X_{ijkt}) = \beta_0 + \beta_1(Treat)_j + \beta_2(After)_t + \beta_3(Treat \times After)_{jt} + \alpha_{ij} + \gamma_k + \lambda_t + \varepsilon_{ijkt} \dots \dots \dots (1)$$

The subscript  $i$  denotes exporting firm,  $j$  trading partner,  $k$  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 margin). 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.  $\alpha$ ,  $\gamma$  and  $\lambda$  are a set of fixed effects for firms, products and time. Product fixed effects are included at HS8 level, and  $\varepsilon_{ijkt}$  is an idiosyncratic error term.

Our regressor of interest is interaction term (treat x after). The estimated coefficient on this regressor is expected to be negative as the effect of the 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,  $\beta_3$ , would suggest that, exports to the treatment group (US) relative to the control group (EU) have dropped.

To examine the effect of policy adjustment in 2011 (see section 3.4.3), the baseline regression specification is modified as follows.

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

All the variables in equations (2) are the same as in equation (1) except that it has an additional interaction terms (treat x after<sub>2</sub>), which isolates the effect of second treatment in 2011. ‘After<sub>1</sub>’ is a dummy variable equal to ‘1’ for the period 2007-2014 and ‘0’ otherwise and ‘After<sub>2</sub>’ is also a dummy variable equal to ‘1’ for the period 2011-2014 and ‘0’ otherwise.  $\beta_5$  is the coefficients of interest 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 QP without transporting the cargo to that port.

The above equation is estimated by using disaggregated data at an 8-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 the firm-market-year

level. The model with high dimensional fixed effects is estimated with stata command ‘reghdfe’, as suggested in Guimaraes and Portugal (2010).

The DID econometric approach accounts for much of the potential omitted variables. However, fixed effects for firms and products are added to account for time-invariant and time-varying factors pertaining to these variables and add time effects to soak up any factors affecting the whole economy at some time. Following the baseline estimations, the robustness of the main results is checked by examining various threats to the identification. In these checks, besides changes in specification and to the transformation of data, China is used as an alternative counterfactual and a falsification test is conducted by comparing the US-bound exports from India and Pakistan.

The IC3 project was established in Pakistan because of 9/11 attacks in the US, which is an exogenous event for the exporting country. Since it was unilaterally imposed by the US in the wake of its prevailing security environment, the ‘treatment’ is therefore devoid of any domestic influence creating endogeneity challenge. Second, this program focused primarily 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 reform initiatives in trade policy or the improvement in infrastructure.

### **3.6 Main Results**

Table 3.7 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) indicates, the coefficient on the 1st interaction term is negative and statistically significant at the 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 specifications, 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 size of the IC3 effect 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 and its significance level.

**Table 3.7: Main Estimates: IC3 Effect on US-bound Exports**

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

|                               | (1)                  | (2)                  | (3)                  | (4)                  |
|-------------------------------|----------------------|----------------------|----------------------|----------------------|
| Interaction (treat x after) x |                      |                      |                      |                      |
| 1st Treatment <sub>2007</sub> | -0.200***<br>(0.022) | -0.134***<br>(0.019) | -0.157***<br>(0.018) | -0.151***<br>(0.018) |
| 2nd Treatment <sub>2011</sub> | -0.218***<br>(0.018) | -0.014<br>(0.016)    | 0.036**<br>(0.015)   | 0.030**<br>(0.015)   |
| Firm FE                       |                      | Y                    | Y                    | Y                    |
| Product FE                    |                      |                      | Y                    | Y                    |
| Time FE                       |                      |                      |                      | Y                    |
| R <sup>2</sup>                | 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 shows the effect of subsequent remedial measures. Y indicates the inclusion of fixed effects.

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

Row (2) contains estimation results for the second intervention of (policy modification) in 2011. Column (1) presents results for the pooled sample and columns (2) through (4) contain the same estimates by incorporating fixed effects for firms, products and time. The coefficients on the second interaction term, although negative initially, switches sign once omitted variables are controlled for. The estimates indicate that the effect of the second intervention is positive and statistically significant at a 5% level (column 4), suggesting that the subsequent policy changes mitigated the trade-impeding effect of IC3 to some extent.

### 3.6.1 Heterogeneity of IC3 Effect across Firms

Table 3.8 examines the differential effect of IC3 on two cohorts of the treated firms: incumbents and switchers.

**Table 3.8: Heterogeneity of IC3 Effect across Firms**

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

|                             | (1)                  |
|-----------------------------|----------------------|
| <b>1st Treatment_2007 x</b> |                      |
| Incumbents                  | -0.089***<br>(0.029) |
| Switchers                   | -0.164***<br>(0.018) |
| <b>2nd Treatment_2011 x</b> |                      |
| Incumbents                  | -0.018<br>(0.026)    |
| Switchers                   | 0.041**<br>(0.017)   |
| FE (firms, products, time)  | Y                    |
| R <sup>2</sup>              | 0.50                 |
| Observations                | 463,931              |

Notes: 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. Y indicates the inclusion of fixed effect.

Incumbents were shipping from QP prior to 2007 and continue to use the same port in the later period. Switchers were previously shipping from other stations, KP and DPs, but had to shift to QP to meet the IC3 requirements. It seems that the effect of the first treatment on the both cohorts (incumbents and switchers) is negative and statistically significant at the 1% significance level. But magnitude of the effect is around 50% smaller for incumbents. The effect of the second treatment, however, is positive for switchers and statistically insignificant for incumbents.

These results suggest that the incumbents are affected differently than the switchers. They experience a relatively smaller initial drop in exports as they might benefit from their established position at PQ. By contrast, the switchers experience relatively larger effect as they incur additional costs owing to the shifting of their export-processing activities to the other station. The subsequent policy refinements in 2011, therefor, mitigate the initial adverse effect for switchers to some extent but do not affect incumbents.

### 3.6.2 Adjustments along Trade Margins

The analysis, so far, identifies overall 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, the developments within firms and products as well as changes in the prices and quantities are examined.

One potential channel of adjustment could be changes in prices or quantities. To explore IC3 effect on them the same estimations (equation 2) are replicated by substituting the dependent variable to price (export value per product per firm) and quantity (weight of shipment per product per firm). The results in Table 3.9 show that the quantity of US-bound shipments relative to the EU dropped by 15% (column 1), whereas the corresponding effect on price is statistically insignificant (column 2).

**Table 3.9: Adjustments Along Margins of Trade**

| Dependent Variables           | Quantity Margin<br>(1) | Price Margin<br>(2) | Firm EM<br>(3)       | Product EM<br>(4)    |
|-------------------------------|------------------------|---------------------|----------------------|----------------------|
| Interaction (treat x after) x |                        |                     |                      |                      |
| 1st Treatment_2007            | -0.146***<br>(0.017)   | -0.007<br>(0.013)   | -0.378***<br>(0.081) | -0.271***<br>(0.009) |
| 2nd Treatment_2011            | 0.059***<br>(0.015)    | -0.026**<br>(0.011) | 0.008<br>(0.070)     | 0.020**<br>(0.008)   |
| FE (firms, products, time)    | Y                      | Y                   |                      |                      |
| FE (products, time)           |                        |                     | Y                    |                      |
| FE (firms, time)              |                        |                     |                      | Y                    |
| R <sup>2</sup>                | 0.57                   | 0.55                | 0.47                 | 0.51                 |
| Observations                  | 463,931                | 463,931             | 42,323               | 96, 308              |

Notes: Robust standard errors are in parentheses. These coefficients in columns (1) and (2) were obtained using OLS and those in columns (3) and (4) using the PPML estimator using stata 13SE, \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . EM denotes extensive margins. Y indicates the inclusion of fixed effects.

Columns (3) and (4) examine the adjustment along EMs of firms (the number of firms per product by market) and products (the number of products per firm by market). Since these variables are non-negative integers, this analysis uses a count data model, Poisson Maximum Likelihood Estimator (PPML), as in Berthou and Fontagné (2008), Dennis and Shepherd (2007) and Persson (2013). The results can be interpreted as semi-elasticities. Column (3) indicates that relative to the EU, these firms are 33% less likely to export to the US market<sup>19</sup> in the post-IC3 period.

<sup>19</sup> Exp  $(-0.378) - 1 = -0.31$  (33%)

Similarly, these products are 23% less likely to be shipped to the US relative to the EU (column 4). These results support the pattern reflected in the descriptive analysis of the data in Table 3.2, which too reveals the exit of firms and shrinkage of products for the US market. These estimations suggest that adjustment in exports for the US market occurred along all the four dimensions: extensive margins of firms and products, and the margins of prices and quantities but the effect is relatively larger along extensive margins.

### 3.6.3 Heterogeneity of the IC3 Effect over Time

Table 3.10 decomposes the average trade effect along time to examine the heterogeneity of IC3 effect over the period and explore the speed of adjustment to the shock.

**Table 3.10: Speed of Adjustment**

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

|                               | Coeff.<br>(1) | SE<br>(2) |
|-------------------------------|---------------|-----------|
| Interaction (treat x after) x |               |           |
| 2007                          | -0.478***     | (0.022)   |
| 2008                          | -0.495***     | (0.024)   |
| 2009                          | -0.497***     | (0.024)   |
| 2010                          | -0.349***     | (0.024)   |
| 2011                          | -0.083***     | (0.024)   |
| 2012                          | 0.245***      | (0.024)   |
| 2013                          | 0.367***      | (0.024)   |
| 2014                          | 0.398***      | (0.025)   |
| R <sup>2</sup>                | 0.50          |           |
| Observations                  | 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 are not reported as they are not of direct interest. The regressions include fixed effects for firms, products and time.

These estimates suggest that the exports drop in the initial four years. This effect, however, fades out in later years, albeit gradually, and adjustment to this new environment takes almost five years. The results are similar to the pattern revealed in Figure 3.5 that depicts the rise in the US-bound exports from 2012 onwards. These improvements reflect the effect of subsequent policy refinement in 2011.

### 3.7 Robustness Checks

This section tests the robustness of baseline results. It controls for time-varying omitted variables, replicate the same estimations on sub-samples, on the first-differenced data as well as at higher levels of aggregation of trade flows. The baseline results hold to these changes in specification and to the transformation of data as well to the use of China as an alternative counterfactual and to a falsification test comparing the US-bound exports of India and Pakistan.

#### 3.7.1 Threats to Identification

To control for potentially omitted factors affecting firms and products, the baseline specification is augmented with time-varying fixed effects for these categories (equation 2). Firm-year fixed effects soak any changes in the firms' productivity or technological improvements overtime that can influence their exports to these markets. Similarly, product-year fixed effects account for fluctuation in product specific factors, such as supply shocks and firm-product fixed effects absorb any heterogeneity in the quality of products across firms.

**Table 3.11: Controlling for Time-Varying Omitted Variables**

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

|                                | (1)                  | (2)                  | (3)                  |
|--------------------------------|----------------------|----------------------|----------------------|
| Interaction (treat x after) x  |                      |                      |                      |
| 1 <sup>st</sup> Treatment_2007 | -0.157***<br>(0.026) | -0.220***<br>(0.025) | -0.269***<br>(0.022) |
| 2 <sup>nd</sup> Treatment_2011 | 0.257***<br>(0.021)  | 0.233***<br>(0.020)  | 0.093***<br>(0.019)  |
| Firm-year FE                   | Y                    | Y                    |                      |
| Product-year FE                |                      | Y                    |                      |
| Firm-product FE                |                      |                      | Y                    |
| R <sup>2</sup>                 | 0.50                 | 0.53                 | 0.75                 |
| Observations                   | 463,931              | 432,463              | 295,506              |

Notes: 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. Y indicates the inclusion of fixed effects.

Table 3.11 presents the estimation results. As the estimates indicate, the effect of the first intervention is negative, whereas that of the second is positive. These effects are statistically significant at 1% in all the specifications, which support the baseline findings. The size of the coefficients is slightly larger compared with those of baseline estimates.

**Table 3.12: Accounting for Potential Trade Diversion to the EU Market**

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

|                      | (1)                  |
|----------------------|----------------------|
| 1st Treatment_2007 x |                      |
| Single-market firms  | -0.235***<br>(0.031) |
| Multi-market firms   | -0.164***<br>(0.028) |
| 2nd Treatment_2011 x |                      |
| Single-market firms  | 0.000<br>(0.029)     |
| Multi-market firms   | 0.074***<br>(0.026)  |
| R2                   | 0.471                |
| Observations         | 280,881              |

Notes: Single-market firms export either to the EU or US and multiple-market firms ship to both the EU and US. Robust standard errors are in parentheses. The 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 sample size is relatively smaller as it is restricted to continuing firms only, which ship every year from 2006 to 2014.

There may be concerns about the potential of trade diversion from the US to the EU owing to similar nature of demand in these markets. Although, this concern is addressed specifically in section 3.7.7 by using China as an alternative control group, the above estimates suggest that that IC3's effect still exists even if we account for the possibility of diversion. The baseline results are split for two different cohorts of exporters: single-market firms that export to the EU or US and multiple-market firms that ship to the EU as well as the US. Multi-markets firms might have some incentive to divert trade to the EU, whereas the single market firms do not because of the presence of sunk cost of exporting to a new market.

As these estimates in Table 3.12 show, IC3 had a negative and statistically significant effect on the exports of the both cohorts, and the effect is particularly higher for single market firms. These results are as expected because the single market firms are less likely to divert their trade to other market. The policy refinement in 2011 had a positive effect on multi-market firms and no effect on the other cohort.

Since many firms enter into or exit from exporting over time, there might be a concern that this churning may affect baseline results. To obviate this possibility, the above estimates are restricted to the sample of continuing firms only, which shipped ever year from 2006 to 2014. The relatively large size of estimated

coefficients in the above regression compared to the baseline estimates indicate that churning moderate this effect to some extent.

Also, critics may argue that exporting firms to both the markets might be different and this heterogeneity may influence the results. Since the above results for multi-market firms show pure within-firms variation as they pertain to the same firms in control and treatment groups, they circumvent the many of endogeneity problems that arise when making comparisons between heterogeneous groups (Meyer, 1995).

### 3.7.2 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 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 to account for any difference in pre-shock trends.

**Table 3.13: First-Differenced Estimates**

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

|                                | (1)                  | (2)                  | (3)                  |
|--------------------------------|----------------------|----------------------|----------------------|
| <hr/>                          |                      |                      |                      |
| Interaction (treat x after) x  |                      |                      |                      |
| 1 <sup>st</sup> Treatment_2007 | -0.153***<br>(0.015) | -0.143***<br>(0.014) | -0.201***<br>(0.018) |
| 2 <sup>nd</sup> Treatment_2011 | 0.191***<br>(0.017)  | 0.100***<br>(0.018)  | 0.071***<br>(0.020)  |
| Prod. FE                       |                      | Y                    | Y                    |
| Firm FE                        |                      |                      | Y                    |
| R <sup>2</sup>                 | 0.001                | 0.002                | 0.065                |
| Observations                   | 152,717              | 152,704              | 147,077              |

Notes: 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 stata drops singleton observations in column (2) and (3). Y indicates the inclusion of fixed effects.

Moreover, the first-differencing of data takes into account the time-invariant factors specific to firm-product-year, such as firms' experience of exporting a product to a given destination and addresses any concerns about non-stationarity of the series. In line with these studies, the following equation is estimated on the first-differenced data.

$$\Delta \ln(X_{ijkt}) = \beta_0 + \beta_1(\text{Treat} \times \text{After}_1)_{jt} + \beta_2(\text{Treat} \times \text{After}_2)_{jt} + \lambda_i + \gamma_k + \varepsilon_{ijkt} \dots \dots \dots (3)$$

The dependent variable is firm-level exports in terms of a first-difference. The explanatory variables are defined as before. The subscript  $i$  denotes firm,  $k$  product, and  $t$  time (year).

The results provide support to baseline findings as the coefficients of interest bear expected signs and are statistically significant at the 1% level (Table 3.13). The magnitude of the drop is larger (20%), compared with that observed in the baseline estimations (15%). Similarly, the estimated effect of improvement in trade flows owing to the policy refinement is also higher than the baseline estimates.

### 3.7.3 Estimations at Higher Levels of Aggregation

As suggested in Bertrand et al. (2004), to account for the problem of serial correlation, the estimations are replicated by collapsing the time series data to a single pre- and post-treatment period. The removal of time series dimension does not affect the main results (first treatment), although the magnitude of the effect is slightly higher (Table 3.14). The effect of second intervention is negative but not statistically significant.

**Table 3.14: Collapsing Data to Single Pre- and Post-IC3 Period**

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

|                                | (1)                  | (2)               |
|--------------------------------|----------------------|-------------------|
| Interaction (treat x after)    |                      |                   |
| 1 <sup>st</sup> Treatment_2007 | -0.173***<br>(0.021) |                   |
| 2 <sup>nd</sup> Treatment_2011 |                      | -0.030<br>(0.018) |
| FE (firms, products)           | Y                    | Y                 |
| R <sup>2</sup>                 | 0.49                 | 0.50              |
| Observations                   | 295, 668             | 295,668           |

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. Y indicates the inclusion of fixed effects.

Table 3.15 replicates the same estimations by collapsing the data at product-destination-year level, which is a slightly higher level of aggregation. These product-level estimation results are consistent with those of firm level, confirming baseline results. Although the magnitude of the effect is slightly larger, the sign and statistical significance remains the same.

**Table 3.15: Collapsing Data at Product-Level**

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

|                                | (1)                  |
|--------------------------------|----------------------|
| Interaction (treat x after)    |                      |
| 1 <sup>st</sup> Treatment_2007 | -0.317***<br>(0.041) |
| 2 <sup>nd</sup> Treatment_2011 | 0.071<br>(0.043)     |
| Prod FE                        | Y                    |
| Time FE                        | Y                    |
| R <sup>2</sup>                 | 0.71                 |
| Observations                   | 39,353               |

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

#### 3.7.4 Heterogeneity of IC3 Effect across Textiles and Non-Textiles

Since more than 70% of Pakistan's exports to these markets comprise textiles and the remainder are miscellaneous goods, there may be a concern that the changes in market access owing to the elimination of the agreement on textiles and clothing (ATC) might drive the results.

**Table 3.16: Heterogeneity of the IC3 Effect for Textiles and Other Products**

Dependent variable is log of exports by firm by market

|                      | (1)                  |
|----------------------|----------------------|
| 1st Treatment_2007 x |                      |
| Textiles             | -0.139***<br>(0.022) |
| Others               | -0.175***<br>(0.026) |
| 2nd Treatment_2011 x |                      |
| Textiles             | 0.101***<br>(0.020)  |
| Others               | -0.096***<br>(0.024) |
| R <sup>2</sup>       | 0.50                 |
| Observations         | 463,931              |

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

A decomposition of the trade effect of IC3 across textiles and non-textiles suggests that it adversely influenced exports of all products but the textile exports rebound,

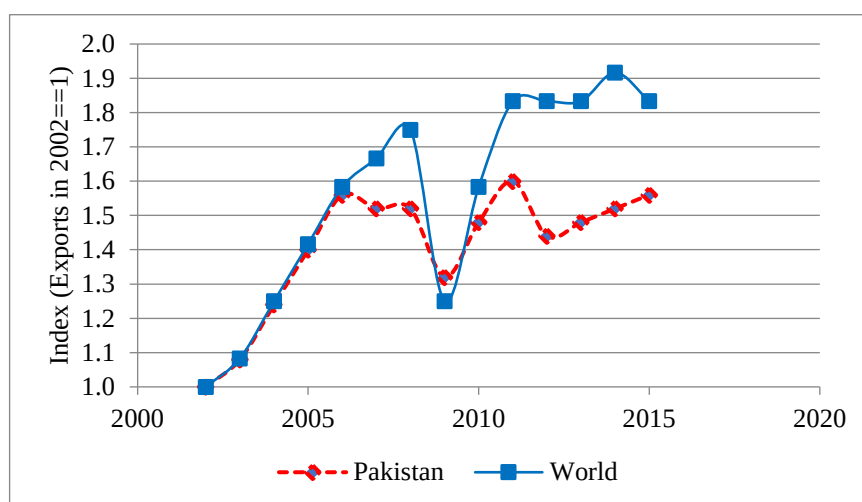
to some extent, due to subsequent policy refinement, whereas those of non-traditional items do not (Table 3.16). The effect of first intervention is relatively smaller for textiles compared with that for other products. This is quite intuitive as textiles are less time sensitive compared with other products. The lack of response of non-textiles to the second intervention indicates that searching for alternative markets for these items might be challenging as most of the small firms operate in these non-textile sectors.

This heterogeneity of the effects across textiles and non-textiles further suggests that in addition to reducing the volume of exports, IC3 constricted the export product set also, and thus, impeded the diversification of exports to the US market.

### 3.7.5 Differential Effect of Global Financial Crisis

One potential concern could be the heterogeneous effect of global financial crisis on import demand in the US and EU markets. Figure 3.6 show that IC3 influenced the US-bound exports of Pakistan prior to the onset of the global financial crisis. In that period, the US imports from the rest of the world were rising but those from Pakistan experienced a drop. Since the decline predates the great trade collapse, it cannot be attributed to the global financial crisis.

**Figure 3.6: Effect of Global Financial Crisis on US Imports**



Source: Authors' calculations using Comtrade dataset

Another potential concern could be the heterogeneity in the timing of the financial crisis and differential pace of recovery in the EU and US. To address this concern, the analysis includes controls for the import demand in these markets. As the

estimations in Table 3.17 show, the coefficient of interest on first treatment is negative and statistically significant at the 1% significance level and on the second treatment is positive and significant at 10% significance level. These estimates further support baseline findings and the import variable bears a positive coefficient as expected.

**Table 3.17: Controlling for Import Demand in Destination Markets**

Dependent variable is log of exports by firm by destination

|                                      | (1)                  |
|--------------------------------------|----------------------|
| Interaction (treat x after) x        |                      |
| 1 <sup>st</sup> Treatment_2007       | -0.148***<br>(0.019) |
| 2 <sup>nd</sup> Treatment_2011       | 0.029*<br>(0.015)    |
| ln(Imports)                          | 0.038***<br>(0.005)  |
| Fixed Effects (firms, product, time) | Y                    |
| R <sup>2</sup>                       | 0.50                 |
| Observations                         | 452,724              |

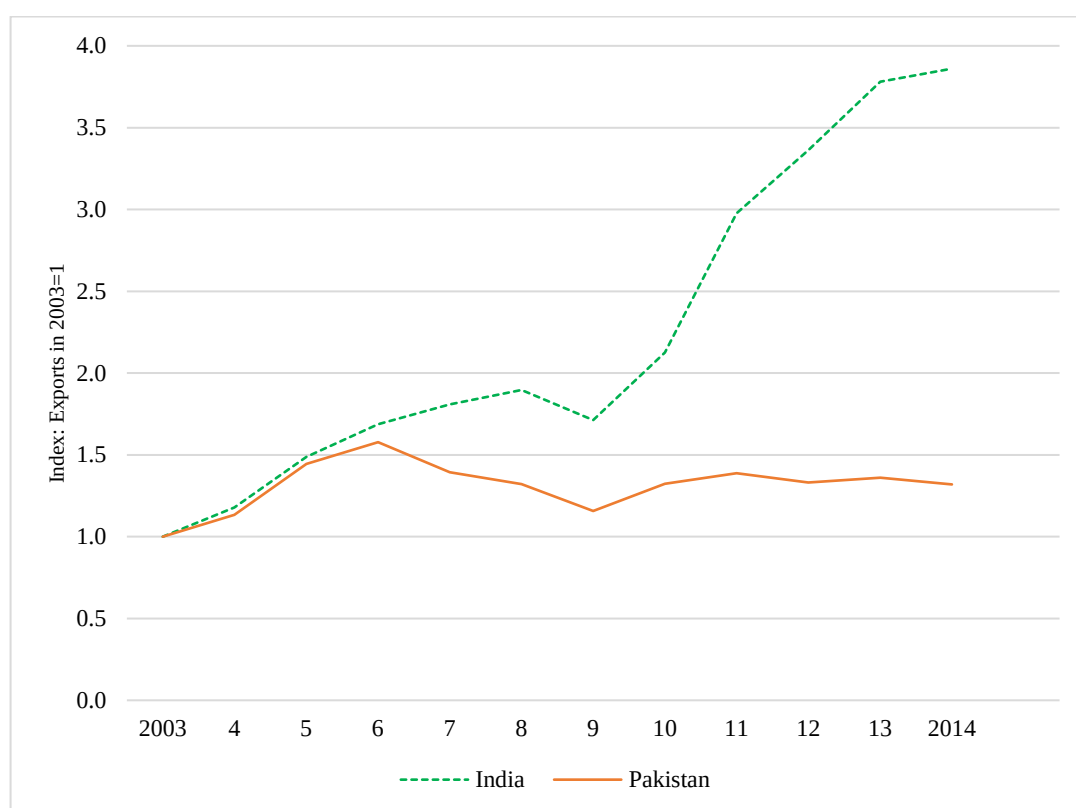
Notes: Robust standard errors are in parentheses. These coefficients were obtained using stata 13SE\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . These estimations control for the import demand in both market in order to account for the differential effect of financial crisis on the EU and US markets. The import variable captures total importations of the EU and US from the world less their imports from Pakistan.

### 3.7.6 Comparison of US-bound Exports from Pakistan and India

IC3 exclusively targeted the US-bound exports from Pakistan but the exports from India, the closest regional economy were not subjected to this screening process. Figure 3.7 plots the evolution of US-bound exports from India and Pakistan. This data is normalised to '1' in 2002 for the both economies for the ease of comparison as US-bound export of Pakistan are much smaller than India's. As this chart suggests, the decline in export from 2006 onwards is specific to Pakistan, whereas India's exports continue on a rising trajectory. DID estimates in Table 3.18 show that relative to India's, Pakistan's export dropped by 60%, on average, and that this difference is statistically significant at the 1% level. Even the policy refinement in 2011 does not increase the US-bound exports relative to India.

**Figure 3.7: US-bound Exports of India and Pakistan**

(Exports in 2003=1)



Source: Comtrade

**Table 3.18: Falsification Tests**

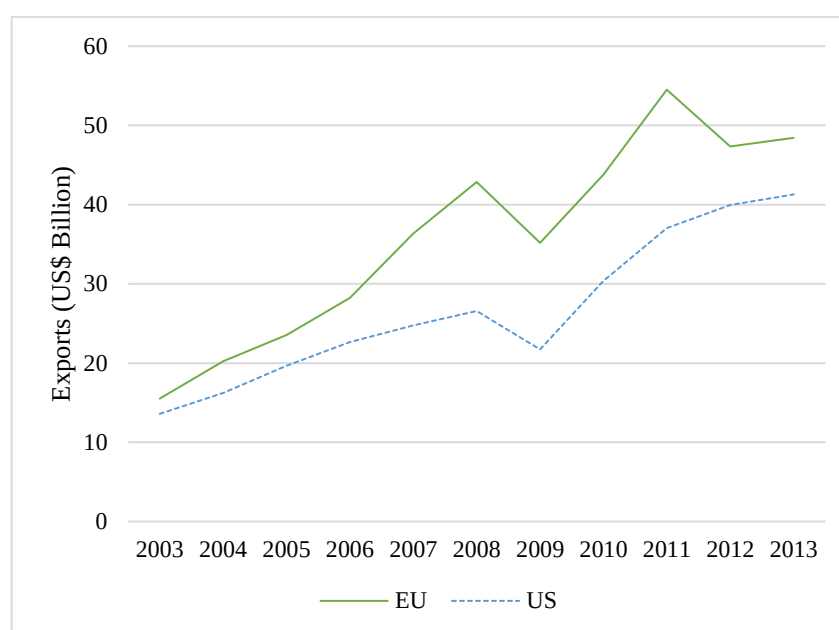
Comparison of US-bound Exports from India and Pakistan and Comparison of India's Exports to the US and EU.

Dependent variable is log of exports by market

|                                | (1)                  | (2)                  | (3)               |
|--------------------------------|----------------------|----------------------|-------------------|
| Interaction (treat x after)    |                      |                      |                   |
| 1 <sup>st</sup> Treatment_2007 | -0.275***<br>(0.106) | -0.594**<br>(0.237)  | 0.030<br>(0.041)  |
| 2 <sup>nd</sup> Treatment_2011 | -0.193*<br>(0.102)   | -1.007***<br>(0.254) | -0.054<br>(0.041) |
| Prod-year                      |                      | Y                    | Y                 |
| Exporter-year                  |                      | Y                    | Y                 |
| R2                             | 0.030                | 0.863                | 0.731             |
| Observations                   | 57,359               | 57,359               | 87,197            |

Note: Robust standard errors are in parenthesis. Model (2) and (3) contains fixed effects for product-year and exporter-year. These estimations use product-level data from Comtrade at HS6 level. Model (3) compares India's US-bound exports relative to the EU.

**Figure 3.8: India's Exports to the US and EU**



Source: Comtrade

Moreover, India's export to the EU and US in this whole period show a rising patterns in the both markets (Figure 3.8). DID estimates indicate that India's US-bound exports relative to the EU did not suffer any decline (column 3). This falsification test further corroborates that the trade impeding effect of IC3 program is only Pakistan specific.

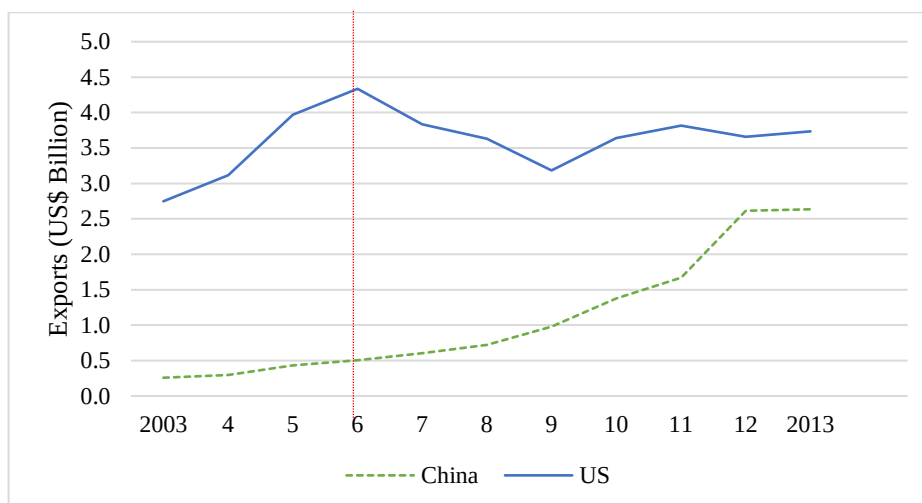
### 3.7.7 Alternative Control Group: China

Since IC3 exclusively targeted Pakistan's US-bound exports only, and those to other markets, including China, were not subjected to screening. The same estimations are replicated using China as an alternative control group. This alternative counterfactual offers two additional advantages. First, the exports to China were not affected by the conclusion of ATC in 2005, which might have influenced textiles exports to the EU market due to the removal of the quota under ATC. Second, as illustrated in Section 3.4.5 above the nature of demand in the US and China is different, therefore, the scope of switching markets by exporting firms is quite limited.

Figure 3.9 suggests that Pakistan's exports to the US and China were increasing in the pre-IC3 period, whereas in the post-IC3 period the former declines while the latter continues on the same trajectory. The difference in the growth rate of exports

to these markets in the pre-treatment period is statistically insignificant (Table 3.19).

**Figure 3.9: Pakistan's Exports to the US and China, 2003-2013**



Source: Comtrade

However, in the post-treatment period, Pakistan's US-bound exports relative to China drop by 50%, on average (Table 3.20). The second intervention facilitates exports to the US relative to China too. These results hold even after controlling for the differences in product quality across these markets by incorporation product-market fixed effects. These estimates show that the previous estimation set up, using the EU as a counterfactual, might underestimate the trade-restricting effect of IC3.

**Table 3.19: Parallel Trend Tests, 2002-06**

| $\Delta$ Growth | Control            | Treatment          | Difference         | t-statistics |
|-----------------|--------------------|--------------------|--------------------|--------------|
| (1)             | (2)                | (3)                | (4)                | (5)          |
| 2003            | -0.315<br>(0.335)  | 0.1539<br>(0.379)  | -0.469<br>(0.851)  | -0.551       |
| 2004            | 0.51615<br>(0.416) | 0.34353<br>(0.112) | 0.17261<br>(0.172) | 0.424        |
| 2005            | 0.416<br>(0.146)   | 0.399<br>(0.088)   | 0.016<br>(0.182)   | 0.091        |
| 2006            | 0.027<br>(0.027)   | 0.157<br>(0.154)   | -0.131<br>(0.038)  | -1.251       |

Notes:  $\Delta$  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 3.20: Comparing Pakistan's Exports to China and the US**

| Dependent variable is log of exports by firm by destination |                      |                      |
|-------------------------------------------------------------|----------------------|----------------------|
|                                                             | (1)                  | (2)                  |
| Interaction (treat x after)                                 |                      |                      |
| 1 <sup>st</sup> Treatment_2007                              | -0.447***<br>(0.022) | -0.511***<br>(0.023) |
| 2 <sup>nd</sup> Treatment_2011                              | 0.129***<br>(0.021)  | 0.106***<br>(0.022)  |
| FE (firms, products, time)                                  | Y                    |                      |
| FE (firms, prod-market, time)                               |                      | Y                    |
| R <sup>2</sup>                                              | 0.545                | 0.556                |
| Observations                                                | 161,100              | 160,014              |

Notes: The table presents DID estimates. Robust standard errors are in parentheses. These coefficients were obtained using stata 13SE. \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01. The number of observations are smaller in in column (2) and (3) as singleton observations are dropped once fixed effects are included in estimations. Y indicates the inclusion of fixed effects.

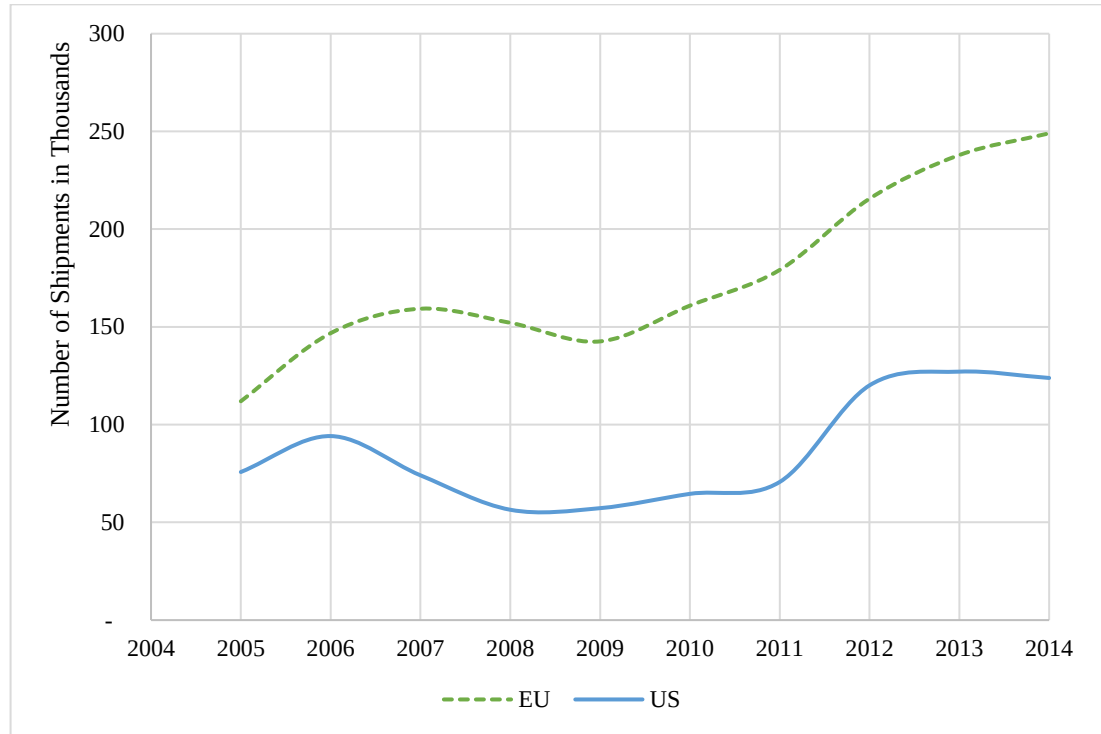
Finally, it can be argued that firms might dump extra inventory in the EU market once the access to the US market reduces due to the increase in trade costs. If the proposition of dumping holds, then prices of goods in the EU market should be lower than those in the US market. But the decomposition of IC3's effect along relative contribution of prices and quantities shows that the drop in the US-bound exports seems to have operated mainly through quantity channels (Table 3.9). Since the IC3 effect on prices in the US market relative to those in the EU is statistically insignificant, the proposition of dumping can be ruled out.

### 3.7.8 Alternative Dependent Variable: Frequency of Shipments

The above estimates indicate that the effect of reduction in beyond-the-border trade costs is offset by the increase in the domestic trade costs at-and-beyond the border. This subsection examines the IC3 effect on frequency of shipment. The data shows that in the post-IC3 period, the frequency of shipment to the US dropped, whereas that to the EU continuously increased, except during the financial crisis (Figure 3.6). DID estimates in Table 3.21 show that the drop for the US market relative to the EU is statistically significant at 1% significance level. The reduction in the frequency of shipment despite a fall in the international component of trade costs suggests that the increase in domestic components of trade costs, at-and behind-the

border, offsets the effect of the reduction in international costs and deters firms from exporting to the US market.

**Figure 3.10: Effect on the Frequency of Shipment to the EU and US Markets**



Source: Pakistan Customs

**Table 3.21: Effect of IC3 on Frequency of Shipment**

Dependent variable is number of shipments per product per firm by market in log

|                                       | (1)                  |
|---------------------------------------|----------------------|
| Interaction (treat x after)           |                      |
| 1 <sup>st</sup> Treatment_2007        | -0.051***<br>(0.009) |
| 2 <sup>nd</sup> Treatment_2011        | 0.044***<br>(0.011)  |
| Fixed Effects (firms, products, time) | Y                    |
| R2                                    | 0.305                |
| Observations                          | 463,342              |

Note: Robust standard errors are in parentheses. These coefficients were obtained using stata 13SE. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Table presents DID estimates for the IC3 effect on the frequency of shipments between the control and treatment groups.

### 3.8 Conclusions

This Chapter finds that the integrated cargo containers control (IC3) program has restricted trade flows rather than facilitating those. Although it reduced beyond-the-border trade costs by allowing direct shipments of the cargo containers to the US market and eliminating transshipment requirements at various transiting countries, the un-intended increase in behind-the-border costs offset these trade facilitation effects. These beyond-the-border costs increased from the concentration of the intrusive scanning and live monitoring operations of all US-bound containers at one specific port, leading to a massive diversion of the exports at the domestic level. Moreover, the duplication of some procedures, and the relatively under developed port infrastructure and the allied services compounded this effect.

Since the changes in the security policy, Pakistan's exports to the US market relative to the EU have suffered a decline to the tune of 15%, on average. The drop registered soon after the launch of the IC3 program and operated through the extensive margins of firm and products and the margins of quantities. Back-of-the-envelope calculation show a loss of the US market access to the tune of \$8 billion. This is quantitatively meaningful for a developing economy struggling to grow its exports. Some partial adjustment to the shock has taken place in the spell after around five years owing to another intervention designed to facilitate the US-bound shipments without transporting the cargo at the scanning facility.

The trade-impeding effect is heterogeneous across firms and products. The firms that were forced to switch their export-processing operations to the port that is equipped with the screening and live monitoring facilities experienced the largest decline in exports. Similarly, the firms exporting to the US market only experienced larger effect compared with those shipping to the both destinations, the EU and US. Also, IC3 effect is heterogeneous across textiles and non-textiles with the larger effect on the latter. It seems that, in addition to reducing the volume of exports, IC3 constricted the export basket also, and thus impeded the diversification of products in the US market.

## **4 Differential Effects of Internal and External Distances on Trade Flows**

## 4.1 Introduction

During the last two decades, the fall in tariffs, improvement in maritime transport and increased access to communication technologies have reduced the cost of transacting business internationally. Despite the reduction in the international elements of trade costs, the integration of most developing countries in the world trading system is very low. This has drawn attention to trade barriers within countries, especially prohibitive costs of transporting goods from factories and farms to gateway ports and airports. These domestic trade costs are quite high: for example, Anderson and van Wincoop (2004) argue that domestic costs in the US are more than twice as high as the cost of international transportation. Limao and Venables (2001) show that the per unit cost of overland transport in the US is higher than that of the sea leg. Rousslang and To (1993) find that domestic freight costs for US imports are of the same order as their international component.

This domestic component of trade cost is particularly high in developing countries: Atkin and Donaldson (2014) find that intra-national costs in Ethiopia and Nigeria are 4 to 5 times larger than that for the US. In the developing world, these costs – *inter-alia* – are usually induced by the remoteness of trade-processing infrastructure from firms' production facilities and are further compounded by poor transport networks (ODI, 2015). Theoretically, all firms are within the same country, but in practice firms may be located thousands of miles away from export-processing stations<sup>20</sup>. These within country haulages, in some cases, could be longer than international maritime voyages to the markets of trading partners.

Since a typical trade consignment involves both domestic and international transportation, from firms manufacturing facilities to trade-processing facilities and from gateway ports to export markets, this chapter investigates the differential effects of both segments of distance on firm-level trade flows. It exploits the rich information on the locations of firms' in Pakistan's hinterland, ports of entry and exit and modes of shipments to compute the inland distances from manufacturing locations to sea ports. This domestic component of transportation distance is used as an additional regressor in gravity estimations together with the international

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<sup>20</sup>The inland transportation distances from manufacturing locations to main sea ports for some economies vary from 500 Kilometres (km) to more than 1,000 km (see Table A 4.1 in the appendix). The average inland distances in Pakistan to gateway sea ports is 555 km; it however varies from 50 km to more than 2500 km for different industrial regions (Table 4.4).

component of distance (to markets of trading partners). Following estimation of the overall trade-impeding effects of both components of distances, the chapter deconstructs the estimated coefficients along the relative responses of extensive margins (EM) of firms and products as well as margins of prices and quantities. Finally, it explores the heterogeneity in the responses of trade margins along firms' trade orientation, sectoral distribution and over time.

The chapter finds that, on average, the marginal effect of internal distance (from factory location to sea ports) is almost three-folds than that of international distance (to export markets). Both elements of distance have heterogeneous effects along trade margins: internal distance shrinks mainly the EM of firms and products, whereas external distance, besides restricting trade flows along the EM, has a relatively large effect through quantity margins. The relatively large trade-impeding effect of inland distance is robust to various specifications, but its magnitude is sensitive to firms' trade orientation; the effect is larger for exports than for imports and much larger for intra-country trade. Although the distance effect has dropped over time, the drop is smaller for the domestic segment than for the international element.

A main challenge in this kind of analysis is to overcome the issue of endogeneity arising from firms' potential choice of manufacturing locations. Exporting firms may decide to build a plant at a particular location to serve the domestic market (in addition to exporting) or use local inputs or benefit from externalities of industrial clusters. Although these issues have no definitive solution, this chapter attempts to circumvent them by using the rich datasets on domestic sales and purchases, along with information on the historical pattern of firms' entry into exporting. Till late, Pakistan has been a relatively protectionist economy<sup>21</sup>. Most firms were established near major population centres in the hinterland to serve the domestic market in the restrictive trade policy regime. However, many of them started exporting following the economic reforms of military regime, which came to power by toppling the elected government in 1999. This chapter exploits this change in trade policy regime together with the information on cultural and ethnic factors to show that potential endogeneity arising from the manufacturing location choice is unlikely to bias these

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<sup>21</sup> Although the country has gradually opened to trade, its import tariffs are still highest in the region.

findings. It is shown that ethnic and historical factors drive the locations of firms in the hinterland rather than participation into exporting or efficiency concerns.

The key contribution of this chapter lies in its comparison of the trade-restricting effects of internal and external distances together, which remains under-researched in the micro-literature on firms. Quantitative models of international trade use mainly distance between countries in gravity estimations and find robust evidence of its trade-impeding effect (for a survey see Head and Mayer, 2014). Existing micro literature in this stream (e.g. Bernard et al., 2007; Eaton et al., 2004; Mayer and Ottaviano, 2008) also focuses mainly on the responses of trade margins to the international component of distance. Some studies examine the role of the domestic component of transportation and show that the inland distance effect is larger and is particularly large in developing countries (Coşar and Demir, 2016; Donaldson, 2015; Van Leemput, 2016)<sup>22</sup>. In this line of literature, Coşar and Demir (2016) explore the effect of improvements in transportation infrastructure on regional access to international markets in Turkey and show that the effect is transmitted through extensive margins. In a related work, Hillberry and Hummels (2008)<sup>23</sup> focus on the effects of domestic spatial frictions on trade margins for intra-national shipments in the US, and Limão and Venables (2001) examine the effect of geography on transportation costs and trade volume across countries. These two streams of literature focus on international and domestic components of distance in isolation, whereas this chapter examines the differential effects of both elements in tandem. Moreover, it informs on the differential effect of each element of distance on trade margins and explores the heterogeneity of the distance effect along multiple dimensions of firm and product characteristics, which the above studies do not examine.

Since distance is commonly used proxy for trade costs, the examination of responses of trade margins to domestic and international components of distance improves our understanding of the mechanisms of influence of domestic and international trade costs. Existing literature shows that these costs inhibit the entry of firms into export markets (ADBI, 2009; Albarran et al., 2013), affect the pattern of regional

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22 In another related paper, Crozet and Koenig (2010) use domestic transportation distances for French firms' exports to adjacent countries to compute the structural parameters of Chaney's (2008) model.

23 In contrast to Hillberry and Hummels (2008), this chapter examines the implications of internal and external distance for international shipments originating from a developing economy and reveals the precise channels of their influence.

specialisation (Coşar and Fajhelbaum, 2016) and impede firms from moving up the value chain ladder (OECD/WTO, 2015). In extension of these studies, this chapter shows that the internal and external components of trade costs have heterogeneous effects on trade margins. The internal element operates primarily through the extensive margins of firms and products and thus impedes the entry of firms and diversification of exports, whereas the external element restricts mainly the quantities of shipment.

The second main contribution of this chapter is to extend the literature on (i) market access and (ii) transportation infrastructure. In the first stream, Atack and Margo (2011) and Banerjee, Duflo and Qian (2012) estimate the relative impact of improvement in transportation infrastructure in the US and China, respectively. These studies compare the effect of market access for the counties that received railroad access with those that did not. In the same vein, Donaldson and Hornbeck (2015) estimates the aggregate effect of railroads on the price of land in the US while Emran and Hou (2013) explore the effect of access to markets on household consumption in China. In contrast to these studies, this chapter investigates the effect on firm-level trade flows of distance to trade-processing infrastructure, and measures these distances at a more micro level, i.e. at the level of town.

In the transportation literature, Hummels (2007) provides detailed accounting of the time-series pattern of shipping costs and shows that the ad-valorem impact of ocean shipping costs is not much lower today than in the 1950s. In the earlier work, Limão and Venables (2001) show that per unit cost of overland transport in the US is higher than that of the sea leg. In extension of these studies, this chapter shows that the marginal effect of road distances is larger than that of sea distance and both segments have heterogenous effects on trade margins. These findings not only corroborate the results of above studies but also inform on the transmission mechanisms.

Finally, the findings regarding variation in the distance effect over time add to the literature on “Distance Puzzle”, a well-known challenge in international trade<sup>24</sup>. This phenomenon is also referred to as the “missing globalisation puzzle” (Coe, Subramanian, and Tamirisa, 2007; Coe, Subramanian, Tamirisa, and Bhavnani, 2002), or “the conservation of distance in international trade” (Berthelon and

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<sup>24</sup> Levinsohn (1995, 1387–1388) stated that the effect of distance on trade patterns is not diminishing over time.

Freund, 2008). The debate is still unsettled: for instance, Brun et al. (2005) argue that “distance has died”, while Carrere and Schiff (2005), state that “it is alive and well” and Anderson and Van Wincoop (2004) state that “the report of death was an exaggeration.” This chapter adds another dimension to this debate. It generates some evidence on the decline in trade-impeding effect of international element of distance over time while showing that the domestic distance effect has changed little during the last 15 years.

In terms of methodology, Atkin and Donaldson (2014), Donaldson (2015) and Van Leemput (2016) examine the effect of domestic transportation through price channels, whereas Coşar and Demir (2016) use gravity type estimations. This Chapter follows a similar estimation approach to Coşar and Demir (2016), but it conducts estimations at the firm-level, rather than at the district level. Moreover, compared with the US, France and Turkey (explored in the above studies), Pakistan is a relatively under-developed country with poor infrastructure and long inland haulages, varying from 50 km to 2,500 km. This empirical setting is typical of a developing economy and the results have wider application for countries with similar geography and levels of infrastructure and stage of development<sup>25</sup>.

This chapter thus contributes to the literature as the first study (to the best of my knowledge) that explicitly investigates the differential effect of trade flows to domestic and international elements of distance with unique datasets from a developing country. The results are however to be interpreted with caution as the international distance coefficient is mixed up with correlated multilateral resistance effects, which cannot be controlled in a single country setting. Second, the estimates do not inform anything about the per kilometre costs but only about how quickly trade declines with distance.

The structure of this Chapter is as follows. Section 4.2 introduces the data and section 4.3 presents preliminary evidence. Section 4.4 discusses the empirical strategy and contains the main estimation results. Section 4.5 presents detailed robustness checks. Section 4.6 deconstructs the responses of trade flows along trade margins while section 4.7 examines the heterogeneity of the distance effect across

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<sup>25</sup> Fernandes et al. (2016) show that the behaviour of exporters varies with the level of development.

sectors and over time. Section 4.8 concludes and highlights the policy implications of this work.

## **4.2 Data Description and Preliminary Analysis**

The section provides an overview of Pakistan's geography, discusses measurement approaches of domestic and international distances and illustrates the spatial dispersion of manufacturing and exporting activities. It then shows the heterogeneous effects of internal distance on trade flows originating from various parts of the economy to generate empirical motivation for the Chapter.

### **4.2.1 Background**

Pakistan is the 36<sup>th</sup> largest country in terms of geographical size (with an area 340,509 square miles), 6<sup>th</sup> largest in terms of population (200 million) and 25<sup>th</sup> largest in terms of purchasing power parity (PPP)<sup>26</sup>. It is a semi-landlocked country and is bordered by India to the east, Afghanistan to the west, Iran to the southwest and China to the far northeast.

Manufacturing and exporting activities are unevenly distributed in the economy with a clear division between the coastal belt and hinterland. These regions house population of around 20 million (m) and 180m, respectively. The detailed description of population distribution is shown in the appendix (Figure A4. 1). The coastal belt includes Karachi and other neighbouring towns, most of which are within 50 miles of sea ports. The hinterland comprises several large cities, namely, Lahore, Faisalabad, and Multan, and other provincial, district and Tehsil headquarters. Most of the hinterland towns are more than 1,000 km far from the sea ports.

Pakistan's coastline along the Arabian Sea in the south has two sea ports, Karachi and Qasim, which handle 90% of export cargo. Exporting firms based in hinterland regions either directly transport goods to sea ports or use inland export-processing stations that are linked to sea ports through the road network ((Figure 4.1). A large fraction of firms uses sea ports, both for exports and imports and the use of dry ports

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<sup>26</sup> [https://en.wikipedia.org/wiki/Economy\\_of\\_Pakistan](https://en.wikipedia.org/wiki/Economy_of_Pakistan).

is quite limited. In 2014, dry ports catered for less than 5% of exports and 10% of imports. Since road transport is the primary mode of inland transportation and road distances from industrial areas in the hinterland to the sea ports range from 50 km to more than 2,000 km (Table 4.4), domestic transportations constitute an essential element of trade costs<sup>27</sup>.

The large fraction of manufacturing is concentrated around big cities in the hinterland for historical and cultural reasons. These towns flourished along the Grand Trunk (GT) road which connected parts of Pakistan, India and Bangladesh in the pre-partition period. The GT road served as a main trade route that was disrupted following the partition of sub-continent into several countries.

**Table 4.1: Snapshot of Pakistan's Exporting Sectors in 2014**

| Category                                          |                | Exports |    | Firms  |    | Products |    | Markets |    |
|---------------------------------------------------|----------------|---------|----|--------|----|----------|----|---------|----|
|                                                   |                | Value   | %  | #      | %  | #        | %  | #       | %  |
| Spatial distribution of manufacturing for exports | Hinterland     | 1,235   | 50 | 7,362  | 44 | 3,496    | 83 | 182     | 96 |
|                                                   | Coastal region | 1,228   | 50 | 9,283  | 56 | 3,194    | 76 | 186     | 98 |
| Modes of shipment                                 | Sea            | 2,204   | 89 | 12,335 | 74 | 3,690    | 88 | 179     | 95 |
|                                                   | Air            | 246     | 10 | 9,701  | 58 | 2,650    | 63 | 183     | 97 |
|                                                   | Land           | 13      | 1  | 429    | 3  | 108      | 3  | 11      | 6  |
|                                                   | All            | 2,463   |    | 16,645 |    | 4,200    |    | 189     |    |

Notes: The data presents the distribution of exports, firms and products along spatial dimensions, as well as along modes of shipment for the most recent year (2014). Export values are in PKR billions. Products are identified at an eight-digit level of the Harmonised System (HS). Coastal region indicates manufacturing areas near the sea ports including industrial zones in five districts of Karachi, and hinterland represents all up-country regions of Pakistan. The nearest hinterland industrial region (Hyderabad) is 150 KM from the sea port of Karachi.

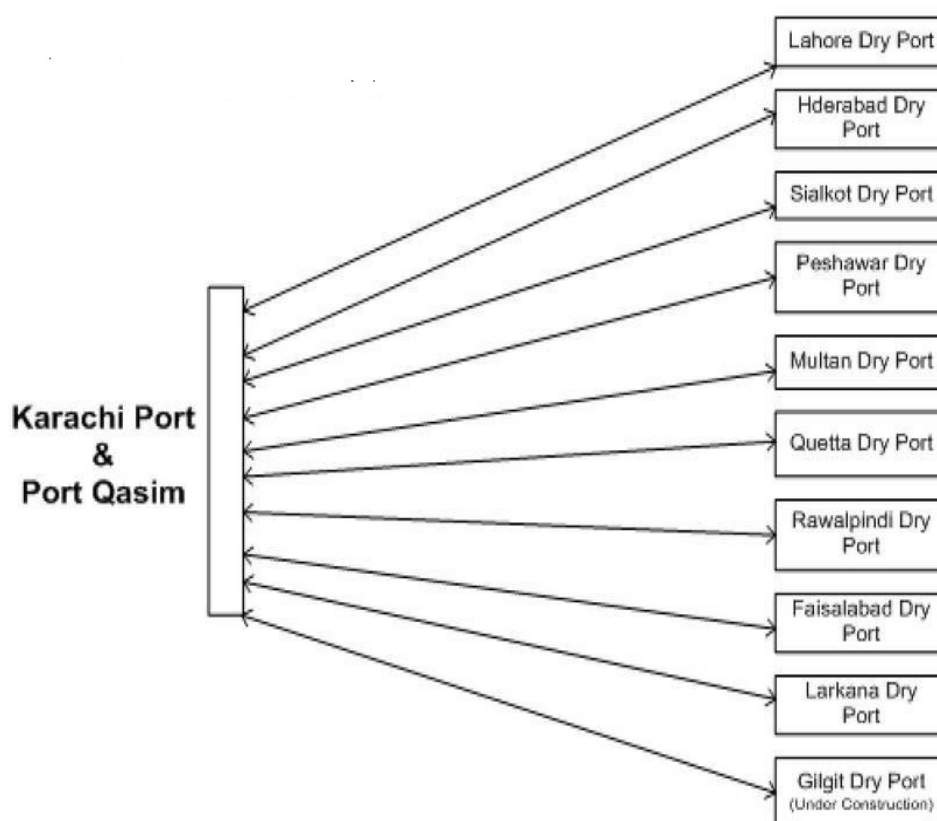
After independence in 1947, Pakistan pursued a highly protectionist trade policy aimed at import substitution and the growth of infant industries. In this period, the firms established in the remote areas mainly served the domestic market. As explained in detail in the following paragraphs, historical, cultural and ethnic factors mainly determined their location choice, rather than access to export markets.

As of 2014, around 50% of exports originate from the coastal belt and the remainder 50% from the hinterland (Table 4.1). However, as recently as 2000, the hinterland accounted for 20% of exports and coastal belt for 80% (Figure 4.2). Having primarily focused on domestic demand many hinterland firms started exporting

<sup>27</sup> The country has North-South rail network, which is in dilapidated condition and caters for 4% freight only: <http://trtapakistan.org/wp-content/uploads/2015/12/Export-Potential-in-Transport-Services-3.pdf>

gradually after the policy change in 1999. In this year, military staged a successful coup, toppled the elected government and initiated a range of trade and economic policy reforms to garner legitimacy on the basis of economic performance, which incentivised many already established firms to export<sup>28</sup>.

**Figure 4.1: Export-Processing Infrastructure in Pakistan**

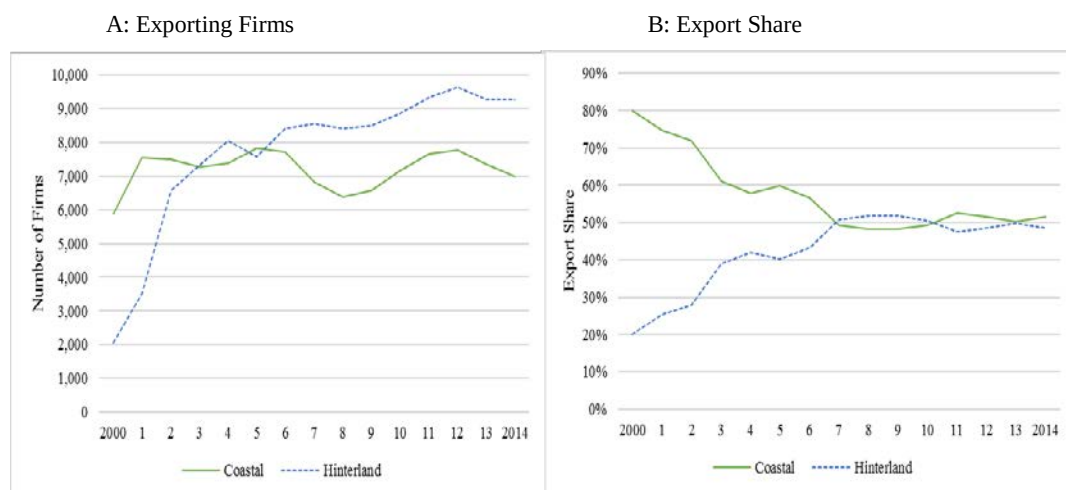


Following the economic reform by the military establishment, many established firms entered exporting and some new firms were born. As a result, the proportion of exports originating from the hinterland increased gradually. Figure 4.3 presents the age-wise distribution of exports for two cohorts of exporters: those born prior to policy change in 1999 (old firms), and born in the latter period (new firms). The former cohort (old firms) comprises relatively large firms that handled around 70% of export originating from hinterland in 2014. It seems that even after the policy change, this cohort remained largely focused on domestic demand for a couple of years and gradually entered exporting. The other cohort (new firms) born after the

<sup>28</sup> Among other measures to promote trade, such as generous duty drawback scheme on imported inputs, the government cut import tariffs from 47.4% (in simple average terms) in 1999 to 17.3% in 2003 (Sara, 2015). Amjad (2007) notes that growth and confidence of the private sector improved by more liberal trade regime for imports of machinery and other inputs. Some of these policy changes were highlighted on international media: <http://news.bbc.co.uk/1/hi/business/1944567.stm>

policy change, is relatively smaller and their contribution to aggregate exports remained relatively limited for several years (Figure 4.3).

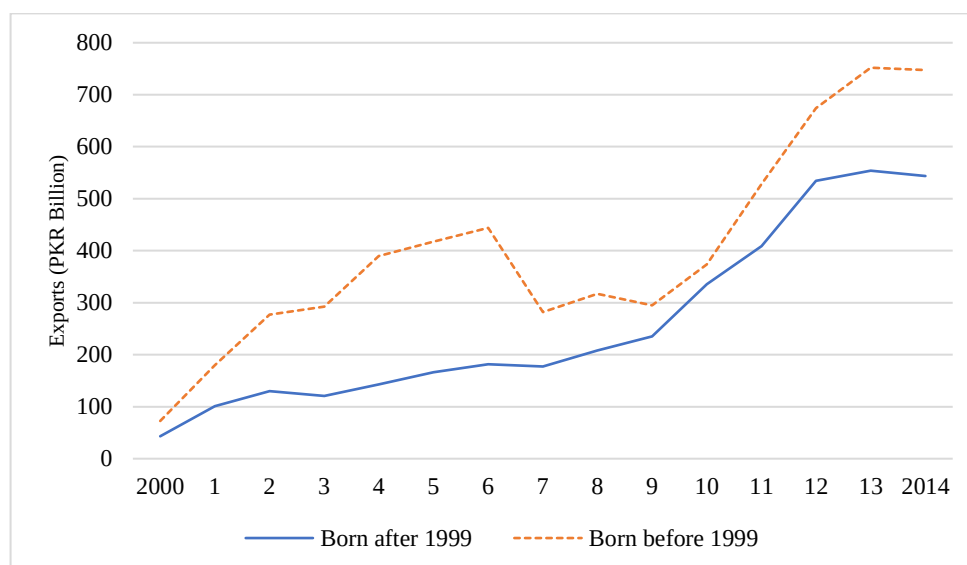
**Figure 4.2: Evolution of Exports from the Hinterland and Coastal Regions**



Notes: Coastal region indicates the areas near the sea ports of Karachi and the hinterland represent all up-country parts of Pakistan. Panel B indicates that, prior to 2000, Pakistan's exports were dominated by firms based near the sea ports. However, the export share of hinterland firms increased gradually as a result of trade policy reforms post 2000.

Source: Constructed using administrative datasets

**Figure 4.3: Evolution of Exports by Firm Age**



Source: Author's construction using VAT and Customs datasets.

Pakistan has eight export processing zones (EPZ) in various regions but their export contribution is limited. EPZs established in the hinterland in the 1980s did not flourish and have become dysfunctional. Currently, the largest operational EPZ is located in in the coastal belt near Karachi. In 2014, the combined exports from all EPZs valued US \$516.389 million, which is around 2% of country's total exports.

The hinterland's topography is relatively flat, with a moderate gradient starting from coastal region up to the distance of around 2,000 km. The areas further north are mountainous but they do not have much manufacturing and exporting activities, either. Therefore, the variability of terrain is not a relevant factor in driving inland transport costs (as considered in some earlier studies, for instance Giuliano et al., 2014).

#### **4.2.2 Firm-Level Trade Data of Exports, Imports and Domestic Trade**

This Chapter uses the same primary data sources of Pakistan described in detail in Chapter 1. Micro-level information on various margins of firms and products is retrieved from Pakistan Customs' export dataset. This dataset contains export values, product codes, prices and quantities, port of exit and mode of shipment for the universe of exporting firms for 190 export markets. Together with export data, this chapter also uses firm-level imports and intra-country trade data in robustness checks. The import data has similar variables as that in the export data and has similar spatial and temporal coverage and is sourced from Pakistan Customs. Most of the variables in the import and export datasets are relatively standard, but those in the intra-country trade (VAT) data are quite unique and novel. The VAT dataset records firm ID (National Tax Number), date of incorporation, address of manufacturing location, and ID of firm's suppliers and buyers along with the value of trade at monthly frequency. It is sourced from Pakistan Inland Revenue Services (IRS). The IRS has territorial jurisdiction and firms are required to register with regional VAT offices and file VAT returns on a monthly basis. This is the first study, to the best of my knowledge, that uses firm-level information of inland trade of a developing country.

Details on the firms' spatial locations come from the VAT records of the IRS. Both datasets (Customs and IRS) identify firms by the same unique identification code, their National Tax Number (NTN), which facilitates their merger. The merged dataset informs on the location of firms' production facilities, port of exit and modes of shipments (sea, air and land). The three unique features allow examining the effect of internal distance on exporting arising from the dispersion of production and exporting activities within the country.

Since exports through sea ports are a major component of the overall exports of the country (Table 4.1), this chapter restricts the analysis to shipments through sea only<sup>29</sup>. The export data of shipment through sea contains 15.4 million transactions for the period 2000–2014. For ease of estimation, the data is collapsed at a firm-product-market-year level, with products defined at the HS2 level<sup>30</sup>. This transformation generates 809,242 observations. The analysis is restricted to the manufacturing sector. The exports of agricultural products are dropped as a large fraction of these is shipped by air due to their perishable nature. However, in the robustness checks, it is shown that the differential effects of inland and international distances hold for agricultural products shipped through sea also.

#### 4.2.3 Measurement of Inland and International Distances

This chapter computes the distances from the manufacturing locations of firms to sea ports in two ways: straight-line distance with geographical coordinates and road distance from Google Maps. These measurements are precise up to the town level, the smallest unit of administration<sup>31</sup>.

**Table 4.2: Variation in Straight-line and Road Distances (KM)**

| for Selected Towns |                             |                             |                             |                            |
|--------------------|-----------------------------|-----------------------------|-----------------------------|----------------------------|
| Town Name          | Straight-line distance (km) | Shortest road distance (km) | Difference (km)<br>(2) -(3) | Difference (%)<br>(2) -(3) |
| (1)                | (2)                         | (3)                         | (4)                         | (5)                        |
| Hyderabad          | 148                         | 178                         | -30                         | -20                        |
| Multan             | 737                         | 936                         | -199                        | -27                        |
| Lahore             | 1,034                       | 1,245                       | -211                        | -20                        |
| Rawalpindi         | 1,131                       | 1,488                       | -357                        | -32                        |
| Peshawar           | 1,106                       | 1,365                       | -259                        | -23                        |

Source: Authors Construction

The VAT dataset identifies the location of exporting firms in 1,323 towns across Pakistan. The latitudes and longitudes for these towns are retrieved from Google Maps and straight-line distances to sea ports computed using Stata command ‘geodist’. This command provides the length of the shortest curve between two points along the surface of a mathematical model of the earth. The same approach

<sup>29</sup> Sea ports handle around 90% of Pakistan’s exports and remainder 9% transacts through air and 1% through land routes.

<sup>30</sup> This large size of data (15.4 million transactions and 4GB size) is difficult to handle in Stata, especially with a demanding set of time-varying fixed effects. The aggregation at the HS2 level generates 809,242 observations, which are still large but manageable. This aggregation might be an issue for a diversified economy, but Pakistan’s export basket is quite narrow, with textiles having a dominant share.

<sup>31</sup> Pakistan consists of four provinces, one federal capital territory and one autonomous region (Kashmir). These administrative units are divided into 34 divisions, 149 districts, 588 sub-districts or tehsils (roughly equivalent to counties) and several thousand towns.

is applied to compute intra-town distances within the country to run a domestic gravity model, used as a robustness check for baseline estimates. In another variant of this approach, the shortest road distance from the centre of towns to sea ports are computed from Google Maps. A comparison of these two approaches indicate that the straight-line distances (computed from coordinates) are smaller, on average, than road distances to the tune of 20-32%, suggesting that the former might bias the effect of inland distances( Table 4.2).

Changes in road distances or transportation time from the up-grade of inland road infrastructure is not a key factor in this context as the country has been in political and economic turmoil during the last two decades and has not made significant public investment to improve North-South road or rail network, other than improvement of intra-province roads mainly in the Punjab province. There are few alternative routes to access the sea ports<sup>32</sup>. This use of a constant measure of inland distance over time is consistent with the measurement of other key explanatory variable, international distance, which is also assumed to be time-invariant.

As discussed above, a small fraction of trade is processed at inland dry ports. Usually small firms use dry ports to complete export documentation and customs procedures and then despatch the shipments to sea ports. This inland transportation, from dry ports to sea ports, occurs through the same road network. Since dry ports are situated in major industrial towns and deal with very limited export volume, this analysis uses the road distances from manufacturing locations to sea ports, rather than through dry ports. This approach might underestimate the effect of inland distance for some firms; therefore, these estimates might be considered as lower bound.

**Table 4.3: Summary Statistics of International Distance (KM)**

| Distance          | Obs | Mean      | Std. Dev. | Min      | Max       |
|-------------------|-----|-----------|-----------|----------|-----------|
| Between capitals  | 197 | 7,372.90  | 4,124.57  | 805.97   | 16,334.90 |
| Between sea ports | 197 | 10,394.07 | 4,834.30  | 1,075.52 | 20,731.02 |

Source: Distance between capitals is retrieved from CEPII and distance between ports is collected from UNCTAD.

This chapter uses two measures of international distance, straight-line distances between capitals of countries, which is quite standards in the gravity literature, and

<sup>32</sup> Pakistan has recently launched a large infrastructure development programme with the cooperation of Asia Infrastructure Development Bank (AIIB). This \$65 billion-dollar Chinese investment (the largest Chinese investment in any country) aims to overhaul road and rail network and thus improve connectivity with sea ports.

sea distance between ports. Sea distance is a measure of the shortest maritime distance between two countries. These distances have been extracted from the Vesseltracker.com (2014) for the largest port of each country (two ports when the country is flanked by two different oceans). For each country-pair, the shortest maritime distance between any of the ports of both countries is reported. For landlocked countries, the closest foreign port is used. Table 4.3 reports a comparison of international distance measured with both approaches.

### 4.3 Preliminary Analysis and Empirical Motivation

#### 4.3.1 Descriptive Evidence

Table 4.4 shows the spatial distribution of exports across geographical regions of Pakistan (sorted by order of distance from sea ports) and decomposes this into the number of firms, products and markets.

**Table 4.4: Spatial Distribution of Pakistan's Exports in 2014**

| Inland<br>Dist.<br>≤km | Exports (Bn) |      | Firms  |      | Products |      | Markets |      | Region     |
|------------------------|--------------|------|--------|------|----------|------|---------|------|------------|
|                        | Value        | %    | #      | %    | #        | %    | #       | %    |            |
| (1)                    | (2)          | (3)  | (4)    | (5)  | (6)      | (7)  | (8)     | (9)  | (10)       |
| 50                     | 1,235.5      | 50.1 | 7,273  | 42.8 | 3,497    | 82.6 | 182     | 96.3 | Karachi    |
| 162                    | 23.9         | 0.9  | 63     | 0.4  | 122      | 2.9  | 83      | 43.9 | Hyderabad  |
| 490                    | 3.8          | 0.2  | 34     | 0.2  | 13       | 0.3  | 15      | 7.9  | Sukkur     |
| 715                    | 39.4         | 1.4  | 153    | 0.9  | 296      | 7    | 72      | 38.1 | Quetta     |
| 876                    | 0.3          | 0    | 8      | 0    | 14       | 0.3  | 16      | 8.5  | Bahawalpur |
| 958                    | 64.2         | 2.5  | 174    | 1    | 406      | 9.6  | 84      | 44.4 | Multan     |
| 1,203                  | 272.9        | 11   | 691    | 4.1  | 782      | 18.5 | 141     | 74.6 | Faisalabad |
| 1,280                  | 465.0        | 19.2 | 3,405  | 20   | 2,362    | 55.8 | 163     | 86.2 | Lahore     |
| 1,360                  | 34.0         | 1.3  | 341    | 2    | 629      | 14.9 | 99      | 52.4 | Gujranwala |
| 1,390                  | 146.0        | 5.9  | 3,940  | 23.2 | 1,096    | 25.9 | 178     | 94.2 | Sialkot    |
| 1,411                  | 6.9          | 0.3  | 45     | 0.3  | 129      | 3    | 45      | 23.8 | Sargodha   |
| 1,516                  | 17.6         | 0.7  | 277    | 1.6  | 552      | 13   | 82      | 43.4 | Rawalpindi |
| 1,521                  | 21.7         | 1.4  | 124    | 0.7  | 371      | 8.8  | 86      | 45.5 | Islamabad  |
| 1,605                  | 2.7          | 0.1  | 26     | 0.2  | 47       | 1.1  | 23      | 12.2 | Abbottabad |
| 1,616                  | 129.0        | 5.1  | 442    | 2.6  | 845      | 20   | 103     | 54.5 | Peshawar   |
| 2,500                  | 0.1          | 0    | 6      | 0    | 60       | 1.4  | 16      | 8.5  | Sust       |
| All                    | 2,463        |      | 16,645 |      | 4,200    |      | 189     |      |            |

Notes: The data shows the spatial distribution of exports across geographical regions of Pakistan and decomposes exports by firms, products and markets. Distance is measured in km from the sea ports of Karachi. Export values are in PKR billions. Products are identified at the eight-digit level of the Harmonised System (HS).

Source: Constructed using administrative dataset of Pakistan Customs.

This dispersion presents some preliminary evidence on how the export performance of firms based in the hinterland is different from that of those located near sea ports. It indicates that although major exporting activity tends to agglomerate in Karachi,

there is considerable spatial variation within the country. Following Karachi, the three main export manufacturing regions are Lahore, Sialkot and Rawalpindi, all of which are more than 1,000 km from sea ports.

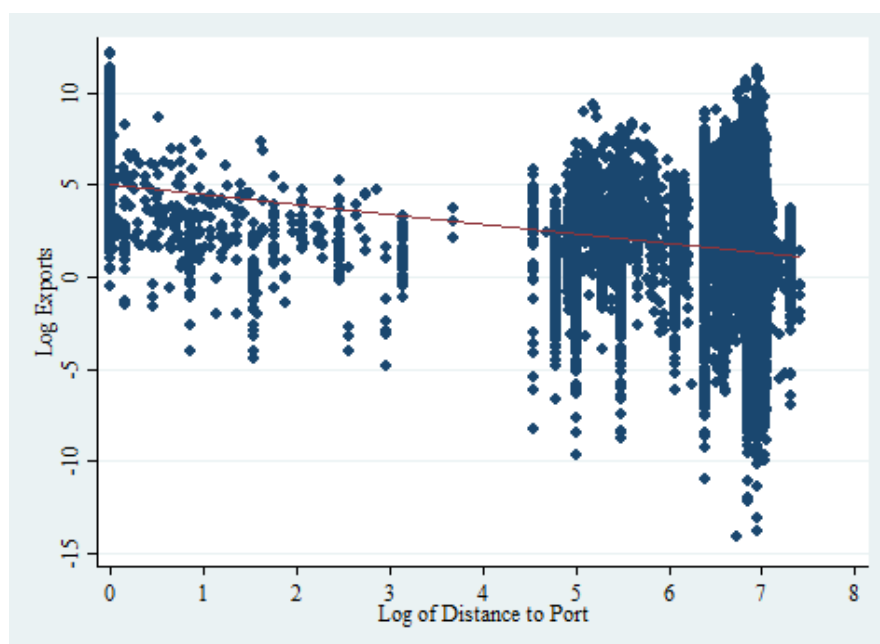
Second, firms located in Karachi (near the sea ports) export a large set of products to a large number of markets (columns 7 and 9). By contrast, the set of exported products is quite narrow for firms located in distant regions and they appear to ship to fewer destinations. This heterogeneity in trade margins across the spatial distribution highlights, *inter alia*, the potential trade-impeding effect of internal transportation distance to trade-processing facilities.

Figure 4.4 presents the distribution of exports according to distance from sea ports and Figure 4.5 decomposes this into four trade margins: extensive margins (EM) of firms and products, and margins of price and quantity. These charts suggest that the value of exports fall with distance from sea ports, and the main action appears to come from the EM of firms and products. This pattern is quite intuitive as firms located in the hinterland face more transport costs compared with those located in coastal areas. For example, shipping a standard 20-feet container from the port of Karachi to the US involves a freight charge of \$700, but the internal transportation of the same container from the industrial area of Rawalpindi (1,500 km from sea ports) to Karachi incurs almost the same charges<sup>33</sup>. The charts also show a large clustering of data points at the upper end, which reflect exports originating from two large hinterland cities, Lahore and Faisalabad, and their adjoining regions. These areas, although relatively far from sea ports, are major centres of textile production.

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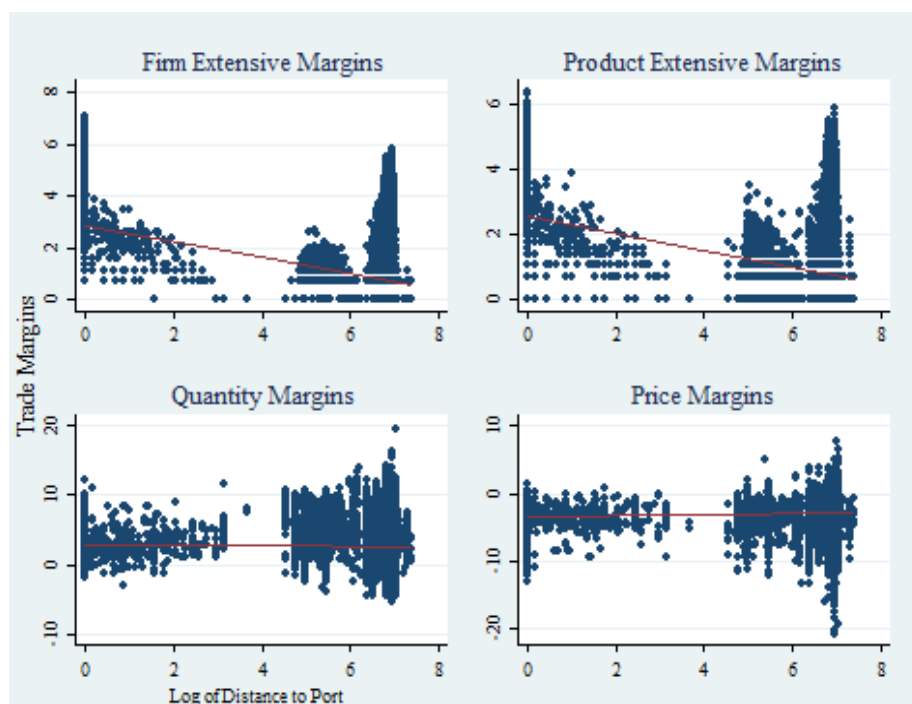
<sup>33</sup> Figures on domestic freight collected from transporters' associations and those on international freight are retrieved from the Customs' dataset.

**Figure 4.4: International Sales with Distance from Sea Ports**



Notes: The figure presents the variation in firm-level export in internal remoteness from sea ports. The clustering of data points at the upper end reflects exports originating from two large cities, Lahore and Faisalabad, and other adjoining regions. These regions, although relatively far from sea ports, are major centres of production of textiles.

**Figure 4.5: Responses of Trade Margins to Distance from Sea Ports**



Notes: The figure presents the variation in four elementary margins against internal remoteness from sea ports. Following Mayer and Ottaviano (2008), the overall trade flow is decomposed to firm EM (number of exporting firms), product EM (number of products per firm) and quantity margins (quantity exported per product per firm), and price margins (price per product per firm).

#### 4.3.2 Empirical Motivation

To examine the heterogeneity of the international distance effect for firms based in various regions a typical gravity model following the estimation approach of Bernard et al. (2007) and Mayer and Ottaviano (2008) is estimated (equation 1).

$$\ln(X)_{jkt} = \alpha_0 + \beta_1 \ln(dist)_j + \beta_2 \ln(GDP)_{jt} + \beta_3(contig)_j + \beta_4(lang)_j + \beta_5(PTA)_{jt} + \varepsilon_{jkt} \dots \dots \dots (1)$$

In this equation, the dependent variable is log of exports at region-market-year level. The gravity variables are retrieved from CEPII and bear the definitions contained therein. The regression results in Table 4.5, show that distance negatively affects trade flows, while GDP of trading partner, contiguity, common language and FTA affect it positively. All gravity controls have the expected sign and the magnitude of their coefficients is in the range of those found in earlier studies (Head and Mayer, 2014).

**Table 4.5: Gravity Estimates at Aggregate Level**

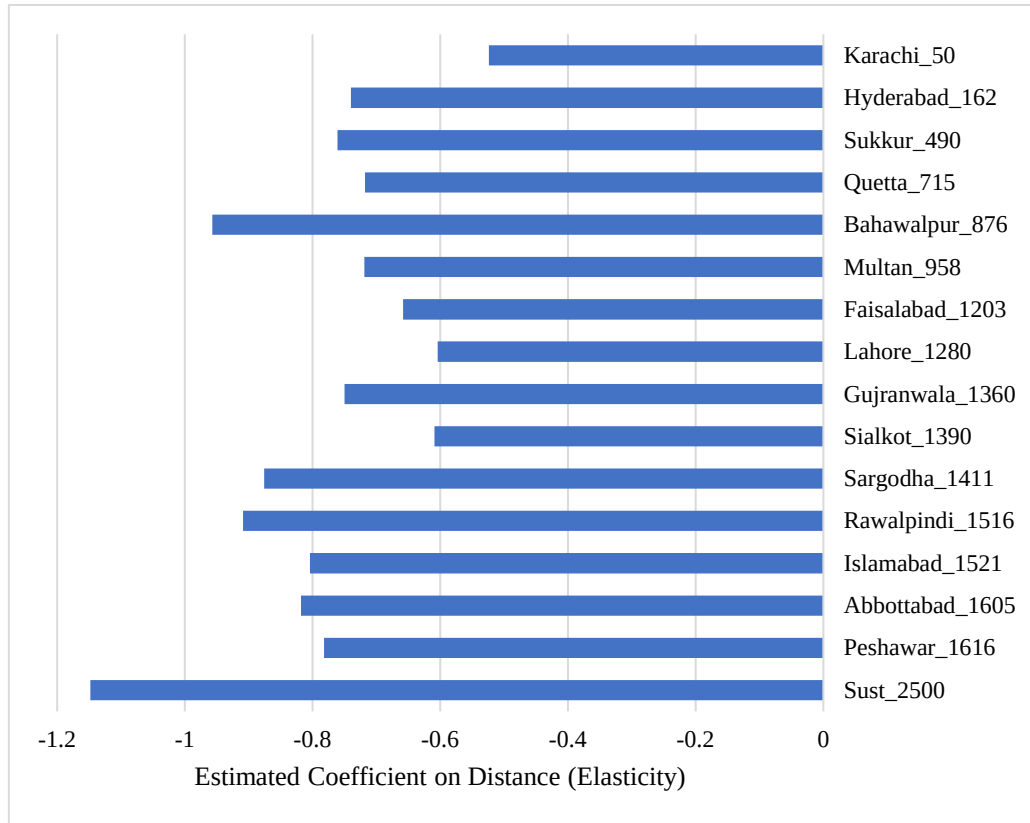
Dependent variable is log of export at region-market-year level

|                        | (1)                  |
|------------------------|----------------------|
| International Distance | -0.831***<br>(0.036) |
| Destination GDP        | 0.742***<br>(0.008)  |
| Contiguity (0,1)       | 0.361***<br>(0.137)  |
| Language (0,1)         | 0.714***<br>(0.039)  |
| PTA (0,1)              | 1.188***<br>(0.141)  |
| R <sup>2</sup>         | 0.43                 |
| Observations           | 21,808               |

Notes: Standard errors clustered at market level are in parentheses \* p<0.10, \*\* p<0.05, \*\*\* p<0.01. The estimation method is OLS using Stata 13 SE.

Using the same estimation equation (1) the distance effect is decomposed across various industrial regions. Figure 4.6 presents heterogeneity of the distance effect for various regions in the order of their distance from sea ports. The chart shows that the trade-impeding effect of distance is relatively larger for firms located in the hinterland compared with for those located in coastal belt (Karachi). Within the hinterland, the effect is quite heterogenous: it is particularly large for regions having poor connectivity with trade-processing infrastructure (Bahawalpur and Sust).

**Figure 4.6: Decomposition of International Distance Effect along Spatial Distribution**



Notes. The figure decomposes the distance effect on trade flows for various regions in Pakistan. It shows that the trade-impeding effect of distance is relatively larger for hinterland firms compared with those located in coastal region of Karachi. The estimation method is OLS using regression equation (1) above.

The above estimates indicate the relatively large distance effect for exports originating from hinterland regions. There might be some other factors affecting exports of the hinterland firms, but a part of this difference could be attributed to internal transportation costs.

To investigate this effect further, Table 4.6 compares three dimensions of export performance of firms located in hinterland and coastal regions by using the following equation.

$$\ln(X)_{ijt} = \alpha_0 + \beta_1 (D) + \gamma_{jt} + \varepsilon_{ijt} \dots \dots \dots (2)$$

where  $i$  denotes firm and  $j$  export market. The dependent variables are intensive margins (IM) defined as the value of exports per firm by market and extensive margins defined as the number of HS8 products per firm by market, and number of markets by firm. The explanatory variable,  $D$ , is a dummy that takes the values of '1' for hinterland firms and '0' for costal.  $\gamma_{jt}$  are market-year fixed effects. The estimations include control for firm size.

The negative and statistically significant coefficient on the dummy variable indicate that, on average, exports of firms located in hinterland (further from shipping facilities) are lower to the tune of 15% (column 1). Moreover, these firms ship a narrower set of products and serve a smaller number of markets. Distance from sea ports, therefore, seems to negatively affect both IM (column 1) and EM (columns 2 and 3).

**Table 4.6: Differential Export Response from Coastal and Hinterland Firms**

| Dependent variables      | Exports per firm<br>by market<br>(1) | Products per firm<br>by market<br>(2) | Markets<br>per firm<br>(3) |
|--------------------------|--------------------------------------|---------------------------------------|----------------------------|
| Hinterland region (1, 0) | -0.152***<br>(0.006)                 | -0.039***<br>(0.004)                  | -0.048***<br>(0.003)       |
| Market-year FE           | Y                                    | Y                                     | Y                          |
| Firm Size $t-1$          | Y                                    | Y                                     | Y                          |
| R-squared                | 0.281                                | 0.265                                 | 0.326                      |
| Observations             | 742,029                              | 742,029                               | 239,359                    |

Notes: The table shows the regressions of a few firm performance measures on a dummy variable that takes the value of ‘1’ if a firm is located in the hinterland regions of Pakistan and ‘0’ if it is located in the coastal regions. Coastal region indicates manufacturing areas near the sea ports that comprise industrial zones in five districts of Karachi, and hinterland represents all up-country regions of Pakistan. The nearest hinterland industrial region (Hyderabad) is 150 KM from Karachi. The dependent variable is described at the head of each column. All estimations are in log. Standard errors clustered at market level are in parentheses \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Y indicates the inclusion of fixed effects. Firm fixed effects are not included as they absorb the effect of the location dummy.

#### 4.4 Empirical Strategy and Estimations

The descriptive analysis in the previous section shows that manufacturing activities in Pakistan are quite dispersed in the hinterland, and many firms are located at thousands of miles far from the gateway sea ports. Moreover, various margins of firms and products appear to drop in internal distance to trade-processing stations. The availability of information on the locations of exporting firms in the hinterland makes it possible to separately identify the effect of domestic and international components of distance. To investigate formally the differential effects of internal and external distances on trade flows the following equation (3) is estimated:

$$\ln(X^f)_{ijkt} = \beta_0 + \beta_1 \ln(dist.)_i + \beta_2 \ln(dist.)_j + \beta Z'_{ijt} + \gamma_{kt} + \alpha_{it} + \varepsilon_{ijkt} \dots \dots \dots (3)$$

The subscript  $f$  denotes firm,  $i$  town,  $j$  export market,  $k$  product and  $t$  time (year). The dependent variable,  $X^f_{ijkt}$ , is the value of exports per firm at a product-market-year level.

The main explanatory variable,  $dist_{i,j}$ , is the distance from the locations of firms in Pakistan to the sea port. The construction of this variable is explained above in Section 4.2.3. The inland distance varies across and within firms depending upon the port of shipment, which is determined mainly by export destination as these ports specialise in handling cargo for different markets (for details see section 4.6) The second explanatory variable,  $dist_{i,j}$ , measures the international distance to export market. It measures the sailing distance from the ports of exit in Pakistan to port of entry in exports markets. The coefficients  $\beta_1$  and  $\beta_2$  are expected to be negative.

$\gamma_{kt}$  are time-varying fixed effects for products, which account for heterogeneity across different product groups and absorb and product-specific shocks over time.  $\alpha_{it}$  is a set of region-year fixed effects, which control for differences in physical and human infrastructure and the nature of economic activities across various administrative regions, like growth in GDP, population or income. The country is divided into five regions following the administrative set-up discussed in Section 4.2.1. These products- and region-specific fixed effects account for time-invariant and time-varying unobservable that could potentially affect trade flows from various parts of Pakistan.

$Z'$  is a set of controls. The specification incorporates the usual standard gravity controls, such as GDP of trading partners, and a dummy variable identifying whether the trading partners have a common border, share a common official language and are a member of a preferential trade agreement. The common language and adjacency dummies are used to capture information costs. Search costs are probably lower for countries whose business climate, language and institutional structures are similar. These gravity variables are taken from CEPII and follow the definitions therein. In addition, all regressions include controls for firm size. In the absence of information on firms' turnover, employment or capital for the universe of Pakistan's exporters, the study relies on export-based measures of firm characteristics. Namely, it uses the total value of exports (across firm's destinations) as a proxy for firm size. Melitz and Redding (2014) argue that the total amount of export is a plausible proxy for firm size and productivity. Its lagged values are used to avoid a simultaneity problem.

In an alternative specification (equation 4), both internal and external components of distance are added (as in Crozet and Koenig (2010)) and their combined effect is estimated. The modified regression equation is as follows.

$$\ln(X^f)_{ijkt} = \beta_0 + \beta_1 \ln(dist.)_{ij} + \gamma_{kt} + \lambda_{jt} + \alpha_{it} + \varepsilon_{ijkt} \dots \dots \dots (4)$$

In this revised form, the variable of interest,  $dist.ij$ , becomes the total distance from the location of firm  $i$  in Pakistan to export market  $j$ .  $\lambda_{jt}$  are market-year fixed effects. These dummies allow for a better control for destination market's multilateral resistance. The coefficient  $\beta_1$  represents the combined effect of domestic and international elements of distance<sup>34</sup>. This alternative estimation approach is used to verify the robustness of the baseline results obtained from equation (2).

The estimation method is Ordinary Least Squares (OLS)<sup>35</sup>. The model with high dimensional fixed effects is estimated with the Stata command, 'reghdfe', suggested in Guimaraes and Portugal (2010). Standard errors are clustered at town-destination level. Following the baseline estimations, and robustness checks, the heterogeneity of the effect across sectors and over time is investigated and, finally the estimated distance coefficient is decomposed to the responses of different trade margins.

#### 4.4.1 Main Results

Table 4.7 presents the baseline estimation results for equation (3). Row (1) contains the coefficients for inland distance to sea ports and row (2) for international distance to export markets.

Column (1) contains the estimated coefficient on inland distance, which is negative and statistically significant at a 1% significance level, showing that remoteness from trade-processing facilities negatively affects trade, as transportation costs are higher for exports originating from distant towns. Column (2) incorporates both distances (internal and external) in the estimation. The effect of external distance is also negative as expected but the magnitude of both segments of distance varies. The

34 Addition of the internal and international elements of distances allows the bilateral distance to trading partners to vary depending on the location of firm in Pakistan. This modified specification therefore permits incorporating market-year fixed effects, which could otherwise soak up the effect of international distance.

35 Since the OLS is a linear estimator, the coefficients have additive property, which allows estimation of relative responses of various trade margins. As shown in section 4.7 firm level trade flows can be decomposed to firm EM, product EM, quantity margin and price margin.

coefficient on inland distance (in row 1) is larger than that for external distance (in row 2). In terms of relative effect, the marginal effect of inland distance is almost double than that of international distance. Columns (1) and (2) show pure variation in the data, but the subsequent regressions incorporate additional controls for potentially omitted variables.

Column (3) adds product-year effects, which absorb product specific factors affecting trade flows, for instance, any supply shocks that might vary over time. This leads to adjustment in the magnitude of coefficients; the effect of the external component increases (becomes more negative) while that of internal segment drops slightly. Column (4) adds region-year effects that control for potentially omitted factors that vary across administrative regions and over time. Pakistan comprises five administrative regions and these regions vary widely in terms of physical infrastructure, human resources and the level of development. Punjab is the most developed province with a high quality intra-province road network followed by Sindh and KPK. The region-year dummies control for this heterogeneity. As the results in column (4) indicate, the estimated effect of both components of distance remain negative and statistically significant. The magnitude of the coefficient on internal distance variable increases: the coefficient on inland distance is now almost three times than that for international distance. This increase in the coefficient on inland distance reflects the importance of controlling for heterogeneity in factor endowments across various geographical region of Pakistan.

These results show that the marginal effect of domestic distance is almost three folds than that of international distance. Since these estimations are in logs, the coefficients correspond to an elasticity measure. The coefficient in column (4), for example, suggests that, on average, an increase of 10% in the inland distance is associated with a decline in exports by 4.6%. The corresponding effect of international distance is 1.05% only. Among other factors, the variation in mode of shipment for inland and international transportations could explain large marginal effect of domestic distance. Inland transportation occurs mainly through the land route which is particularly cost intensive given the poor infrastructure. By contrast international transportation cost have fallen drastically with the improvement in international shipping and communication technologies. This change in distance effect over time is further explored in section 4.6.

**Table 4.7: Trade-Impeding Effect of Remoteness – Main Results**

Dependent variable is log of exports at firm-product-market-year level

|                                      | Road and Sea Distances (Columns 1 to 5) |                      |                      |                      |                      | Straight-line Distances | Total Distance.      |
|--------------------------------------|-----------------------------------------|----------------------|----------------------|----------------------|----------------------|-------------------------|----------------------|
|                                      | (1)                                     | (2)                  | (3)                  | (4)                  | (5)                  | (6)                     | (7)                  |
| $\ln(\text{Distance})_i$             | -0.177***<br>(0.002)                    | -0.182***<br>(0.002) | -0.161***<br>(0.002) | -0.460***<br>(0.023) | -0.447***<br>(0.025) | -0.486***<br>(0.070)    |                      |
| $\ln(\text{Distance})_j$             |                                         | -0.081***<br>(0.003) | -0.107***<br>(0.003) | -0.102***<br>(0.003) | -0.154***<br>(0.006) | -0.170***<br>(0.008)    |                      |
| $\ln(\text{Dist}_i + \text{Dist}_j)$ |                                         |                      |                      |                      |                      |                         | -0.575***<br>(0.054) |
| Additional controls                  |                                         |                      |                      |                      |                      |                         |                      |
| Firm Size $t-1$                      | Y                                       | Y                    | Y                    | Y                    | Y                    | Y                       | Y                    |
| Product-year effects                 |                                         |                      | Y                    | Y                    | Y                    | Y                       | Y                    |
| Region-year effects                  |                                         |                      |                      | Y                    | Y                    | Y                       | Y                    |
| Gravity variables                    |                                         |                      |                      |                      | Y                    | Y                       |                      |
| Market-year                          |                                         |                      |                      |                      |                      |                         | Y                    |
| R2                                   | 0.236                                   | 0.237                | 0.323                | 0.326                | 0.336                | 0.347                   | 0.351                |
| N                                    | 809,242                                 | 809,242              | 809,242              | 809,242              | 809,242              | 809,242                 | 809,242              |

Notes: Robust standard errors clustered at town-market level are in parentheses, \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Columns (1) to (6) contain the results of specification (3), and column (7) contains those for specification (4). The estimates in column (5) are used as a baseline. Y indicates the inclusion of fixed effects. The coefficients on fixed effects and other gravity variables are not reported since they are not of direct interest.

Column (5) adds gravity variables. These covariates affect the magnitude of the coefficient on the external component while the coefficient on inland distance remain unaffected, which is quite intuitive as the gravity variables differ across export markets only. The estimates in column (5) are used as a baseline.

Columns (6) and (7) present initial robustness checks. Column (6) uses an alternative measure of inland distance. Rather than using road distances, it replaces them with straight-line distance computed using geographical coordinates. This transformation generates, more or less, similar results. The slight variation in the magnitude of coefficient reflects the problem of measurement error in computing inland distances as shown in Table 4.2 above. As the straight-line routes may well not exist, the measurement error could bias the estimates. One could expect higher elasticity of exports to straight-line distance, as trade flows remain the same, only distance variable are smaller in magnitude. The similar results with both measurement approaches appear could be Pakistan specific as the country is like a narrow strip with population and industrial activity concentrated along the main road.

Column (7) estimates the combined effect of both internal and external distances (equation 4 above). This estimation includes market-year fixed effect as well, which absorb other factors that vary across markets and over time. The estimated coefficient represents the combined effect of inland and external elements of distance. The effect of combined distance is negative as expected and is statistically significant. The magnitude of combined effect is similar to the sum of individual coefficients estimated in the baseline regression (column 5).

These estimates imply that the trade-impeding effect of domestic transportation is much larger than that of their international component. These results are in line with the findings of earlier studies. The magnitude of the effect is sensitive to inclusion of product, region and market-year fixed effects. In our preferred specification that controls for both product and region year fixed effects the estimated effect of inland distance is almost three times that of international distance.

## 4.5 Robustness Checks

One of the major empirical challenge in this kind of analysis is to circumvent the potential endogeneity of firms' manufacturing location choice. This section first shows that historical, cultural and ethnic factors drive the choice of manufacturing locations, rather than decision to exporting. It then shows that these firms were established primarily to serve domestic market during the period of restrictive trade policy but started exporting subsequently following the trade policy reforms of military establishment. A predominantly influential role of these two factors means that their location choice and hence internal distance to ports is potentially exogenous to their exporting decisions. It also shows that exploiting the exogenous variation in inland distance that occurred because of launch of Integrated Cargo Containers Control Programme (IC3) at Qasim Port in 2007, yields comparable results.

### 4.5.1 Effect of Changes in Trade Policy Regime on Decision to Export

As explained earlier the agglomeration of manufacturing in hinterland occurred in the era of restrictive trade policies<sup>36</sup>. This sub-section decomposes the effect of inland distance for two sets of firms: those born before the policy change and those born after the policy change in 1999. For the set of firms that served the domestic market in the earlier period but entered exporting in the later years, the location choice is potentially exogenous to their exporting decision, as engagement in export markets was not their primary concern at the time of establishment. However, for the other cohort (born after 1999), the inland distance effect could be biased because they might have chosen an optimal location to benefit from the policy reforms.

The decomposition of inland distance effect for these groups in column (1) of Table 4.8 shows that the estimated coefficient on inland distance is negative and statistically significant for both groups. The magnitude of the effect is smaller however for older firms (those born before the trade policy reforms). It suggests that the estimated coefficient on inland distance in the base results reported above may be somewhat upward biased. For these old firms, although the magnitude of inland distance effect is relatively smaller, the coefficient is still higher than that of

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<sup>36</sup> Similar argument regarding the effect of restrictive trade policies has been many earlier studies ((for instance, see Karayalcin and Yilmazkuday, 2015)

international distance. This also indicates ignoring the pattern of entry of firms in to exporting might overestimate this effect.

**Table 4.8: Robustness Checks**

| Effects of Ethnicity and Policy Change |                                            |                                       |
|----------------------------------------|--------------------------------------------|---------------------------------------|
|                                        | Effect of Policy Change in 1999 on Exports | Effect of Ethnicity on Domestic Trade |
|                                        | (1)                                        | (2)                                   |
| Intra-town distance                    |                                            | -0.848***<br>(0.043)                  |
| Domestic distance x                    |                                            |                                       |
| Born after 1999                        | -0.420***<br>(0.025)                       |                                       |
| Born before 1999                       | -0.314***<br>(0.025)                       |                                       |
| International distance                 | -0.139***<br>(0.004)                       |                                       |
| R2                                     | 0.222                                      | 0.566                                 |
| N                                      | 809,242                                    | 103,494                               |

Notes: The table shows the heterogeneity of inland distance effect along firm age, and also examines the effect of intra-town distance on for domestic trade. Dependent variable in column (1) is log of exports at firm-product-market-year level and in column (2) is log of domestic trade at firm-product-town level. Regression (1) contain product-year and region-year fixed effects and regression (2) contains product fixed effects. The coefficients on fixed effects and other covariates are not reported since they are not of direct interest. Robust standard errors clustered at market level are in parentheses. \* p<0.10, \*\* p<0.05, \*\*\* p<0.01.

#### 4.5.2 The Role of Ethnic Factors in Location Choice

To demonstrate the effect of cultural and ethnic factors on location choice, we explore the pattern of firms' domestic sales in various administrative regions. Pakistan is very diverse country internally. Its four main provinces (KP, Punjab, Sindh and Baluchistan) are geographically contiguous but differ in terms of language and culture. Three provinces, KP, Sindh and Baluchistan have their own official languages, which are medium of instructions in schools as well as medium of government businesses, in addition to a national language (Urdu). These regional languages are based on dissimilar scripts<sup>37</sup> and are hard to understand for residents of other regions. An attempt by federal government to merge these regions into one administrative unit failed mainly due to stiff resistance by regional ethnic groups and had to be undone after a few years

37 <http://www.omniglot.com/writing/pashto.htm> and <http://www.omniglot.com/writing/sindhi.htm>

Table 4.9 shows that for comparable inland distances domestic sales are highly skewed towards trading partners located in the same ethnic region. For instance, firms based in Kohat (an administrative district of KP<sup>38</sup> province but very close to the border of Punjab) conduct relatively more trade with firms based in Peshawar and Haripur, towns in the same province, rather than with firms located in Nowshera and Islamabad that are at comparable inland distances but in the other province.

**Table 4.9: Orientation of Domestic Sales of Firms Located in Kohat**

| Location of Trade Partners | Trade (PKR M) | Ethnic Region of Trade Partner | Distance from Kohat (km) |
|----------------------------|---------------|--------------------------------|--------------------------|
| Banda Daud Shah            | 10.90         | Different                      | 42                       |
| Peshawar                   | 440.68        | Same                           | 50                       |
| Nowshera                   | 0.43          | Different                      | 69                       |
| Chota Lahore               | 4.86          | Different                      | 101                      |
| Bannu                      | 10.90         | Different                      | 102                      |
| Haripur                    | 210.63        | Same                           | 147                      |
| Islamabad                  | 19.72         | Different                      | 155                      |
| Sheikhupura                | 0.35          | Different                      | 316                      |
| Lahore                     | 103.15        | Different                      | 355                      |
| Lahore City                | 0.04          | Different                      | 340                      |
| Lahore Cantt.              | 2.31          | Different                      | 365                      |
| Malir                      | 7.32          | Different                      | 1,046                    |
| Karachi South              | 66.52         | Different                      | 1,058                    |

Note: Data sorted in the order of distance between towns. Kohat is a town in KPK province near the border of Punjab province.

This pattern of internal trade appears to hold for other parts of the country (see Table A 4.7 in the appendix). The firms located in Rahim Yar Khan (a town in Punjab near the border of Sind province) trade largely with those based in Lahore (a town in the same province) compared with those located in Malir or Peshawar (towns in other provinces, Sindh and KP, respectively), although they are at similar distances. The same pattern holds for firms located in Sukkur (a town in Sindh near the border of Punjab province), which conduct relatively large trade with Karachi-based firms, rather than with those based in Hub, a town at the same distance but located in Baluchistan province.

These ethnic differences are reflected in large trade-impeding effects of domestic distance. Column (2) of Table 4.8 empirically examines the effect of inland distances on domestic trade flows. As the estimates indicate, the effect is negative

<sup>38</sup> KP stand for Khyber Pakhtunkhwa province.

and statistically significant, but the magnitude of the coefficient is much larger compared with the estimates for exports (reported above in Table 4.7). A main reason for this relatively trade-resisting effect of inland distance seems to be the concentration of internal trade within the specific geographical regions for the ethnic and cultural factors discussed above.

These estimates provide support to large trade-impeding effect of domestic distance and also inform on the dominant role of ethnicity in manufacturing location choice. They suggest that exporting firms are located in various hinterland regions for historical, cultural and ethnic reasons, rather than for efficiency concerns or access to export markets. The likely endogeneity of firms' location choice is diminished in the current setting.

#### 4.5.3 Exploiting Exogenous Variation in Domestic Distance

In 2007, a trade security initiative namely Integrated Cargo Containers Control Programme (IC3), led to diversion of US-bound exports at the domestic level (within Pakistan) for intrusive scanning before being shipped to the US. The scanning technology was provided at Qasim Port only and the scanning was mandatory to access the US market. This shift in the US security policy forced most firms to switch their US-bound exports from Karachi Port and inland dry ports to Qasim Port, which increased inland transportation distances ranging from 10 km to 86 km (55 km on average), depending upon firms' geographical location and previous port use. IC3 was primarily a security initiative and imposed on Pakistan following the events of 9/11 to thwart potential exploitation of cargo containers for the smuggling of weapons of mass destruction. Therefore, the resulting changes in inland transportation distance to ship through Qasim Port are potentially exogenous for exporting firms. A detailed description of IC3 programme and its effect on trade flows are explored in Chapter 3. The trade effect of this increased component of inland distance on US-bound exports is estimated using the regression equation (4).

$$\ln(\Delta X)_{ikt} = \beta_0 + \beta_1 \ln(\Delta dist._i) + \varepsilon_{ikt} \dots \dots \dots (4)$$

where  $i$  denotes firm,  $k$  product and  $t$  time (year) and  $\Delta dist._i$  is change in inland distance caused by switching of port in the post-IC3 period. The model is estimated on the first-differenced data to soak up any time-invariant factors affecting trade

flows. As the results in Table 4.10 indicate, the distance effect is negative and statistically significant; the magnitude of effect is relatively smaller than that estimated earlier but it might not be directly comparable with earlier estimates as the sample is restricted to US-bound exports in the post-IC3 period only.

**Table 4.10: Effect of Change in Inland Distance on US-bound Exports, 2007-14**

| Dependent variable change in exports at firm-product-year level |                      |
|-----------------------------------------------------------------|----------------------|
|                                                                 | (1)                  |
| $\ln(\Delta \text{ Distance})_{\text{inland}}$                  | -0.152***<br>(0.011) |
| R2                                                              | 0.144                |
| N                                                               | 37,149               |

Notes: Standard errors in parentheses, \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01. The estimation sample contain US-bound exports through Qasim Port from 2007 to 2014.

Further robustness checking involved aggregating the information at the region-sector-market-year level yields identical results (column 1 of Table 4.13). Moreover, collapsing the data to a single period to overcome any potential problem of serial correlation in error terms generates estimates that are comparable to the baseline specification.

#### 4.5.4 Robustness to Other Factors Affecting Location Choice

Literature suggests that several other factors, such as engagement in sales at home (demand effect), access to domestic inputs (linkage effect) or benefit from externalities (agglomeration effect), could influence the choice of manufacturing location. This section empirically examines the effect of these factors on the baseline estimates.

Access to the domestic market may affect the location choice for firms that simultaneously engage in domestic and international sales. In column (1) the home-market effect is controlled for by incorporating domestic sales of these firms by year as an additional regressor, which leaves results unaffected<sup>39</sup>. Column (2) controls for domestic inputs by incorporating domestic purchases in the estimations. As the results in column (1) and (2) indicate, the sign and statistical significance of the coefficient on the regressors of interest remain almost unaffected in these estimations. Both domestic sales and purchases positively affect trade flows. The

<sup>39</sup> This approach inherently assumes that domestic sales are a proxy for local population size.

positive effect of domestic sales may reflect the benefit of scale economies in production when serving domestic and international markets simultaneously. Similarly, the positive effect of domestic purchases (in column 2) suggests a linkage effect. These additional controls do not affect relative trade resisting effects of domestic and international distances.

**Table 4.11: Robustness to Other Factors Affecting Location Choice**

Dependent variable is log of exports at firm-product-market-year level

| Additional controls    | Domestic Sales<br>(1) | Domestic Inputs<br>(2) | Agglomeration Effect<br>(3) |
|------------------------|-----------------------|------------------------|-----------------------------|
| Domestic distance      | -0.568***<br>(0.030)  | -0.657***<br>(0.011)   | -0.530***<br>(0.010)        |
| International distance | -0.170***<br>(0.005)  | -0.190***<br>(0.006)   | -0.125***<br>(0.008)        |
| Domestic sales         | 0.074***<br>(0.002)   |                        |                             |
| Domestic purchases     |                       | 0.106***<br>(0.007)    |                             |
| R <sup>2</sup>         | 0.199                 | 0.110                  | 0.210                       |
| N                      | 538,718               | 538,924                | 483,772                     |

Notes: Robust standard errors clustered at market level are in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . These estimations follow specification 5 of Table 4.7 above. The estimations contain product-year and region year fixed effects. The sample size in these estimations is smaller as the information for domestic sales and purchases is not available for all firms.

Column (3) explores the effect of agglomeration by using an instrumental variable (IV) strategy. It uses the output of all existing firms as an IV for the location choice of new entrants. Pakistan has various industrial clusters in different regions. For instance, Faisalabad is a hub for textiles, Sialkot is a centre for sports goods and Wazirabad is a manufacturing base for surgical equipment. This spatial distribution alludes to the role of the agglomeration effect, which is exploited in the IV strategy. The output of all existing firms before the entry of a new firm in each region by sector and year is used as an instrument for the potentially endogenous variable, inland distance to port.

The detailed results of first and second stage regressions are reported in the appendix (Table A 4.8). The first-stage regression has reasonable explanatory power and F statistics are much larger than the required threshold. Moreover, the correlation between endogenous regressor and IV is statistically significant at a 1% significance level. The negative coefficient on the instrumental variable (total\_output) indicates

that the increase in distance to port is associated with fall in total output per firm. The second-stage regression shows that the effect of inland distance is almost four times than that of external distance. The IV estimations corroborate the earlier results, although the actual effect of inland distance varies with the estimation approach.

## **4.6 Heterogeneity Analysis and Further Robustness Checks**

This section examines the heterogeneity of the inland distance effect across ports, along firms' trade orientation, sectoral distribution and over time.

### **4.6.1 Heterogeneity across Sea Ports**

The inland distance effect is expected to be heterogeneous across ports (Karachi and Qasim) as they differ in terms connectivity with the hinterland. Karachi is the largest port of Pakistan and has relatively better connectivity, whereas the Qasim Port is relatively new and situated in a more remote part of the country with poorer access. Moreover, these ports handle export cargos for different destinations. Although cargo destined to the Western markets is processed at both ports, Karachi Port specialises in handling east-bound maritime traffic. The effect of inland distance for Qasim Port is expected to be larger because of poor connectivity as well as congestion caused by diversion of US-bound exports to this port following the implementation of IC3 programme in 2007 as discussed above.

Table 4.12 splits the effect of domestic distance effect across ports (Karachi and Qasim). The estimated coefficient is negative and statistically significant for shipments through both ports. As expected the magnitude of inland distance coefficient is larger for shipments through Qasim Port than through Karachi (column 1). This decomposition not only informs on the heterogeneity of inland distance effect across trade-processing facilities but also provides additional evidence on the rise in behind-the-border costs for the US-bound exports for the shipments through Qasim port as discussed in Chapter 3.

**Table 4.12: Distance Effect across Ports and along Trade Orientation**

Dependent variable is log of exports at firm-product-market-year level

|                                               | Exports              |                      | Imports              |
|-----------------------------------------------|----------------------|----------------------|----------------------|
|                                               | (1)                  | (2)                  | (3)                  |
| Domestic distance x                           |                      |                      | -0.125***<br>(0.012) |
| Qasim Port                                    | -0.321***<br>(0.025) |                      |                      |
| Karachi Port                                  | -0.221***<br>(0.025) |                      |                      |
| # Firms that exports<br>and sell domestically |                      | -0.225***<br>(0.025) |                      |
| #Exporting-only firms                         |                      | -0.349***<br>(0.025) |                      |
| International distance                        | -0.128***<br>(0.004) | -0.126***<br>(0.004) | -0.182***<br>(0.009) |
| R2                                            | 0.224                | 0.214                | 0.224                |
| N                                             | 809,271              | 809,271              | 363,300              |

Notes: Robust standard errors clustered at market level are in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . These estimations follow specification 5 of Table 4.7 above. The estimations contain product-year and region year fixed effects but the coefficients on fixed effects and other gravity variables are not reported since they are not of direct interest.

#### 4.6.2 Heterogeneity along Firms' Trade Orientation

Within the exporting cohort, the trade-impeding effect of inland distance is expected to differ between exporting-only firms and exporters-cum-domestic sellers. The firms serving both domestic and international markets are relatively large; they constitute 35% of exporters but handle more than 85% of exports. The other cohort, exporting-only firms, are relatively small and account for 15% of exports. The location choice of exporting-only firms might depend on their decision to export but for other firms, which engage in exports and domestic sales simultaneously, it might be influenced by other factors. As these exporting-only firms might choose optimal location, the effect of inland distance for this cohort could be biased.

The decomposition of distance effect for exporting only and exporter-cum-domestic seller in column (2) of Table 4.12 shows that the effect is negative and statistically significant for both cohorts, but the magnitude is somewhat higher for exporting-only firms. It suggests that the endogeneity of location choice could be even more important for exporting-only firms and might explain the increase in the coefficient on inland distance. But for other firms it is less likely to be the case.

Similarly, the inland distance effect is expected to be heterogenous along firms' trade orientation: exports or imports. Export shipments originate from various parts of the country, but imports shipments are initially discharged at sea ports and then transported upcountry for further processing at the inland dry ports. Karachi is the largest importing station and hub of the transport sector. It is therefore much easier to arrange lorries for upcountry shipments than for transporting goods from hinterland to sea ports. Second, imports also occur under a multi-modal scheme, wherein foreign shippers take responsibility of international and domestic transportation. Third, a few large freight forwarders<sup>40</sup> handle the transshipment of import cargo to dry ports in bulk. Therefore, the scale economies in transportation of imports is expected to reduce the effect of inland distance.

Column (3) examines inland distance effect on imports processed at dry ports. The estimated effect of domestic distance is negative and statistically significant, but the magnitude of the effect is relatively smaller compared with that for exports, which could reflect the effect of competition in transport sector in Karachi and other factors discussed above.

#### **4.6.3 Heterogeneity over Time and across Sectors**

Figure 4.7 deconstructs the effects of internal and external remoteness on trade flows over time. The detailed estimates are contained in Table A 4.5 in the appendix. As the chart shows, the magnitudes of the effect of international component of distance are smaller than those for domestic component for all years. Moreover, the trade-impeding effect of both components of distance tended to fall over time, and the drop being relatively larger for the international component. From 2000 to 2014, the trade-resisting effect of international distance dropped by 34%, whereas that for domestic distance dropped by 9% only, on average. The former may be a result of improvements in international shipping and communication technologies, leading to a reduction in international freight and other associated costs, and the latter may be a result of somewhat improvement in domestic infrastructure. Similarly, the heterogeneous reactions of quantity margins observed at aggregate level are not

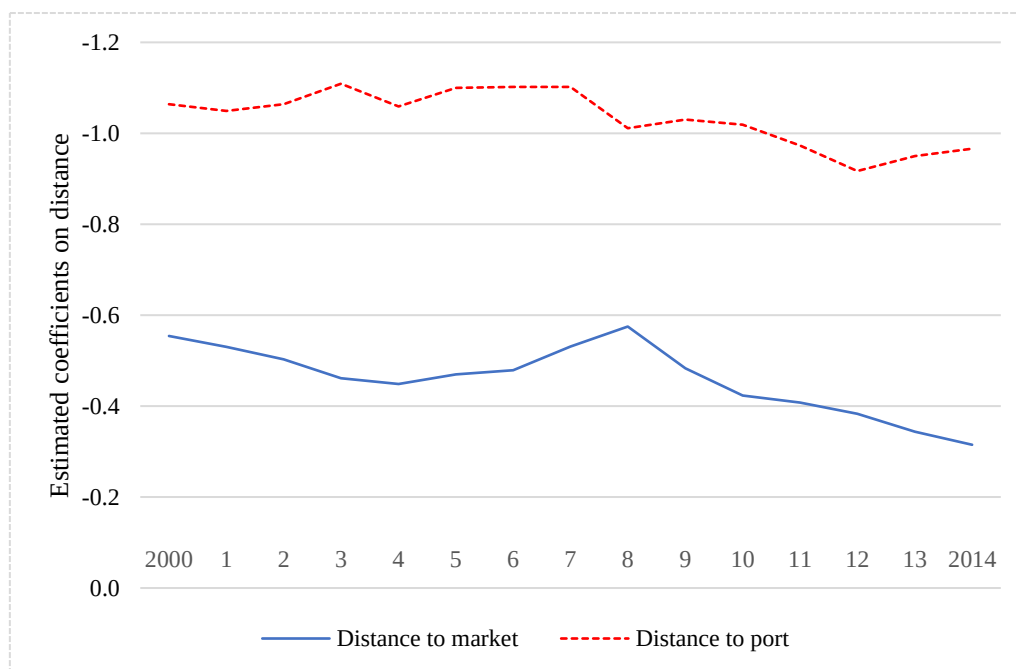
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<sup>40</sup> Importing firms are not authorised to transport their cargo directly from sea ports to inland stations without payment of duty and taxes. However, they tranship it through bonded carriers (freight forwarding companies), which are licenced by Customs.

specific to any particular year; the quantity margins respond positively to inland distance but negatively to international distance.

**Figure 4.7: Distance Effects over Time**

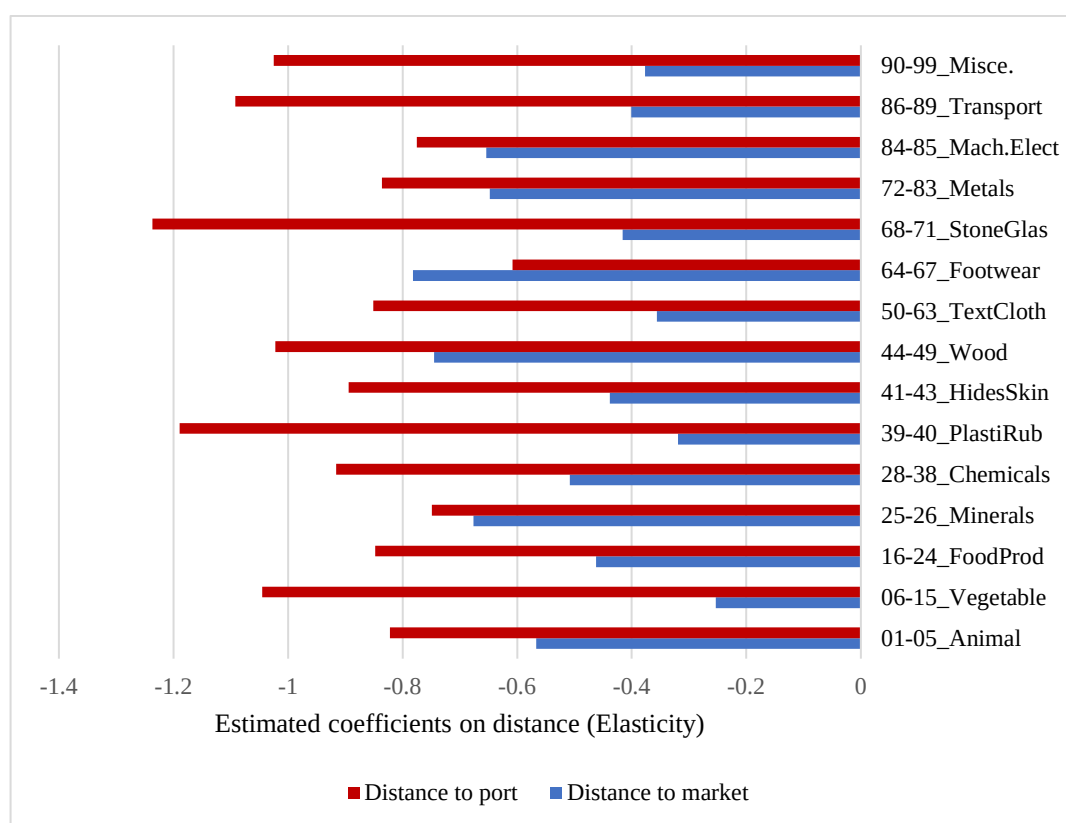
(Values on the y-axis are in reverse order)



Notes: The figure plots the regression coefficients on internal and external distances estimated using equation (3). As the chart indicates, the effect of remoteness from port is larger than the effect of remoteness from export markets for all years in the study period. The detailed estimates are contained in Table A 4.5 in the appendix.

Moreover, the deconstruction of the baseline results across sectors in Figure 4.8 shows that the trade-restricting effect of internal distance is larger in all sectors. Similarly, the heterogeneity of the effect along the EM of firms and products (columns 2 and 3) and quantity margins (column 4) is evident across panels A and B (Table A 4.6 in the appendix). This decomposition confirms baseline estimates and also yields further information on the asymmetric nature of trade costs across sectors.

**Figure 4.8: Heterogeneity of the Distance Effects across Sectors**



Notes: The figure plots the regression coefficients on internal and external distances deconstructed at a sector level using equation (3). The detailed estimates are contained in Table A 4.6 in the appendix. It indicates that the effect of remoteness from ports is larger than the effect of remoteness from export markets for all sectors. The estimates vary widely, reflecting heterogeneity in the trade costs' sensitivity across sectors.

#### 4.7 Extension: Transmission Mechanisms of Inland and International Distances

The above estimates reveal the overall effect of domestic and international distances but for policy purposes the relative responses of trade margins are also likely to be informative. This section therefore deconstructs the overall effect of both distances into the responses of four constituent trade margins: the EM of firms and products, as well as price and quantity margins

Following Bernard et al. (2007), Mayer and Ottaviano (2008) and Hillberry and Hummels (2008), the overall trade flow is decomposed to firm EM (number of exporting firms), product EM (number of products per firm) and quantity margins (quantity exported per product per firm), and price margins (price per product per

firm)<sup>41</sup>. Trade flows and trade margins are constructed at the region-sector-market-year level, following the administrative structure of country and Comtrade's broader classification of products in 16 sectors<sup>42</sup>. The combined reaction of these four elementary margins adds to the total trade-impeding effect of distance on exports at the aggregate level, which helps in understanding the relative contribution of each margin.<sup>43</sup>

Table 4.13 contains the estimation results of equation (3). Panel A contains the results for inland distance and panel B for international distance. Figure 4.9 plots these coefficients for ease of interpretation. Since the OLS is a liner estimator, the coefficients in columns (2) and (5) add up to that in column (1).

**Table 4.13: Decomposition of Distance Effect along Trade Margins**

| Dependent variables | X <sub>ijkt</sub><br>(1) | Firm EM<br>(2)              | Prod. EM<br>(3)      | Qty. M<br>(4)               | Price. M<br>(5)  |
|---------------------|--------------------------|-----------------------------|----------------------|-----------------------------|------------------|
| Panel A:            |                          |                             |                      |                             |                  |
| Distance to port    | -0.943***<br>(0.034)     | <b>-0.607***</b><br>(0.017) | -0.505***<br>(0.016) | <b>0.155***</b><br>(0.031)  | 0.013<br>(0.028) |
| Panel B:            |                          |                             |                      |                             |                  |
| Distance to market  | -0.476***<br>(0.024)     | <b>-0.146***</b><br>(0.009) | -0.120***<br>(0.009) | <b>-0.226***</b><br>(0.019) | 0.016<br>(0.016) |
| R <sup>2</sup>      | 0.343                    | 0.393                       | 0.401                | 0.362                       | 0.314            |
| Observations        | 34,117                   | 34,117                      | 34,117               | 34,105                      | 34,105           |

Note: Robust standard errors are in parentheses, \*p<0.10, \*\*p<0.05, \*\*\*p<0.01. The coefficients on fixed effects and other gravity variables are not reported since they are not of direct interest. EM denotes extensive margins and IM indicates intensive margins. Column (1) contains the overall effect of distance and columns (2) through (5) decompose the coefficient in column (1) into various trade margins. All estimations are in logs.

A comparison of the estimates in panels A and B shows that the EM of both firms and products fall with distances but the relative effect is much larger for internal distance (column 2 panel A). As the chart shows, 64% of domestic distance effect is transmitted through EM of firms and 54% through EM of products. The corresponding figures for international distance are 31% and 25%, respectively (panel B of Figure 5).

Columns (4) and (5) contain the responses of quantity and price margins. The results show that the response of quantities to domestic distance is positive (panel A) but

<sup>41</sup>  $X_{ijkt} = N_{ijkt}^f \times N_{ijkt}^p \times p^{-fp_{ijkt}} \times q^{-fp_{ijkt}}$ , where  $X_{ijkt}$  is value of exports from region  $i$  in sector  $k$  at time  $t$ .  $N_{ijkt}^f$  and  $N_{ijkt}^p$  are the number of firms and products per market by sector and  $p^{-fp_{ijkt}}$  and  $q^{-fp_{ijkt}}$  are average quantity and average price per product by firm. Quantity is measured in metric tons and price in PKR millions.

<sup>42</sup> The details of various sectors are contained in Table A 4.4 in the appendix.

<sup>43</sup> The reactions of intensive margins (IM) of firms and products, which are a sort of 'mixed' margin (Gil-Pareja et al., 2015) and represent price and quantity margins at a higher level of aggregation, are not considered separately in the analysis.

the same to international distance is negative (panel B), indicating that quantity margins defy domestic distance but drop with international distance. The relative effects on quantity margins are -47% for international remoteness and +16% for internal remoteness.

Panel A of Figure 4.9 shows that the net effect of domestic distance is almost double that of international distance (panel A). The deconstruction in panel B suggests that the response of firms to inland distance is different from that to international distance. The former operates mainly through the EM of firms and products, whereas the latter operates primarily through quantity margins besides restricting trade along EM. It seems that the extensive margin declines relatively more sharply with internal distance simply because firms have an extra margin of adjustment through their location choices.

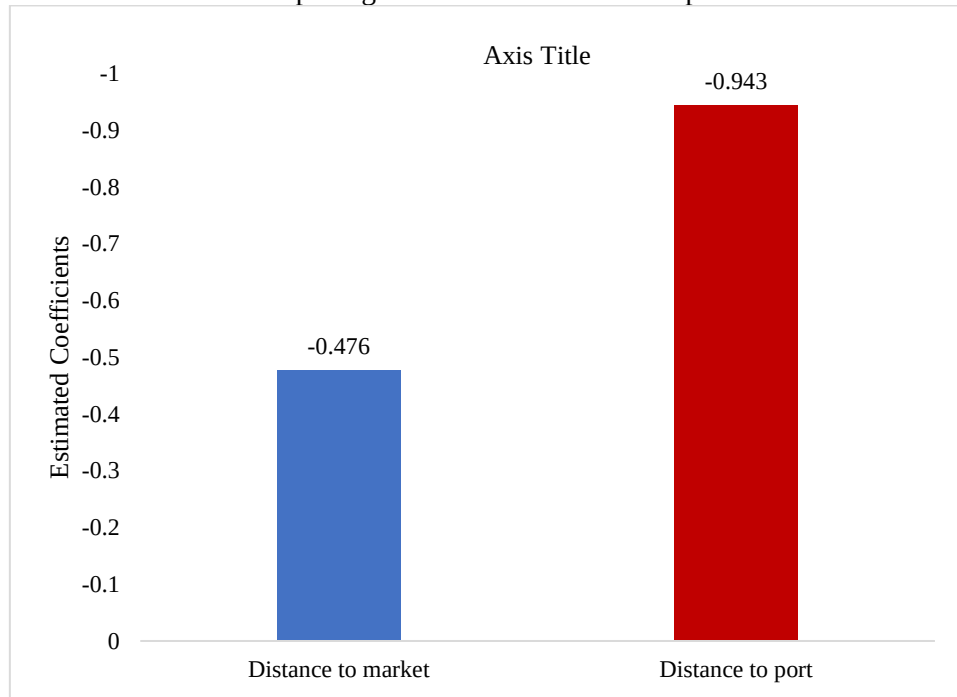
In the case of distance (a proxy for trade costs), the usual assumption in gravity modelling has been that it reflects transportation costs, which vary with the quantity exported. The positive response of quantities, however, suggests that there may be a fixed cost element associated with the domestic distance component. For instance, loading, unloading, handling and documentation charges do not vary with distance.

These estimations suggest that the fixed cost component of domestic distance operates through average sales and the variable cost component through the EM by restricting the entry of firms. It seems that domestic distance may be capturing the other elements; for example, information networks may decline with distance from port and absence of information may increase the cost of entry (Krauthaim, 2009). This analysis also shows that internal distance to sea ports has some sort of selection effect on firms and products. It restricts the entry of firms into exporting, but the entrants export a higher volume on average.

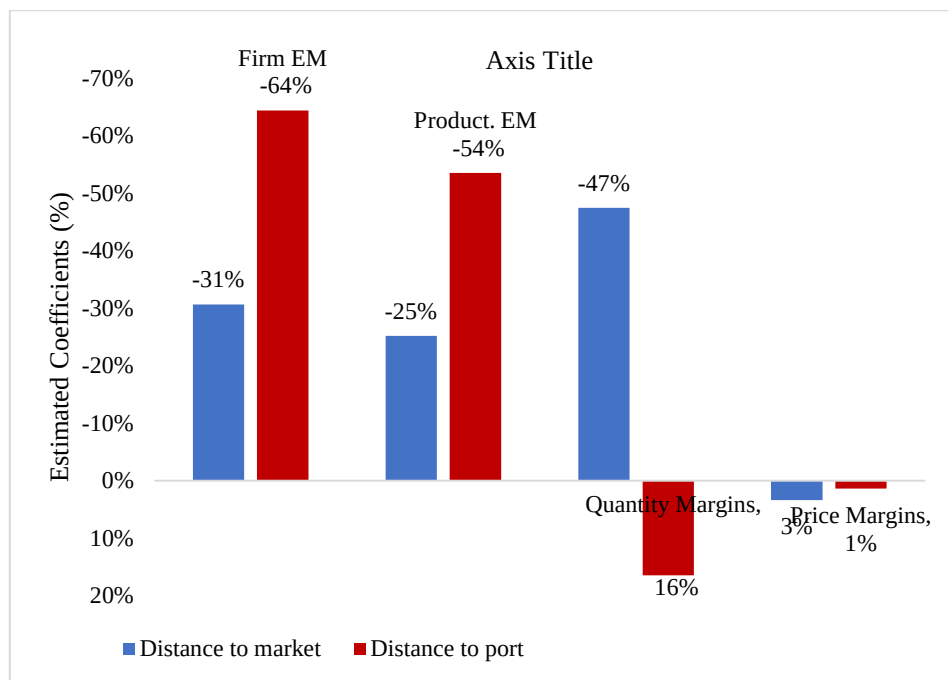
**Figure 4.9: Distance Effect on Trade Flows and Trade Margins**

(Values on y-axis are in reverse order)

**Panel A: Trade-impeding Effects of Distance on Exports**



**Panel B: Relative Responses of Trade Margins**



Notes: These figures plot the estimated coefficients in Table 4.13. Panel A indicates the net effect of distances on trade flows and panel B provides the relative contribution of each trade margin. EM denotes extensive margins. Panel A shows that the net effect of domestic distance is almost double that of international distance. The deconstruction in panel B suggests that the trade-inhibiting effect of domestic distance operates mainly through the EM of firms and products, whereas international distance operates primarily through quantity margins besides restricting trade along EM.

## 4.8 Conclusions

This chapter examines the differential effects of domestic and international segments of distance by using novel datasets from a developing country. These datasets identify the locations of manufacturing firms, ports of entry and exit, and modes of shipment (air, land and sea) over time.

It finds that, on average, the marginal export-restricting effect of internal distance (from manufacturing location to port of shipment) is almost three times than that of international distance (to the markets of trading partners). While the negative effects of internal and external distances have been documented separately in some earlier studies, this chapter examines relative contribution of each component. It further shows that both segments of distance have heterogeneous effects on different trade margins: the external distance negatively affect trade along all margins, with a relatively large effect through quantity margins, but the inland distance operates mainly through the extensive margins (EM) of firms and products, suggesting a larger role for domestic distance in restricting the entry of firms and constricting the diversification of products. Moreover, quantity margins defy internal remoteness, although they drop with its international component.

The inland distance effect varies with firms' trade orientation. It is relatively larger for export shipments than for imports and much larger for domestic trade. The measurement approach of inland distances also matters: the straight-line distance, rather than road distances, might generate some bias in the estimates. The analysis further finds that the trade-impeding effects of distance, both international and domestic, have reduced over time but the drop is relatively higher for the international component. These results are robust to alternative specifications, data sources and the measurement approach of internal distances as well as to the decomposition of the distance effects across sectors and over time.

Since distance is commonly used proxy for trade costs, this chapter shows that the relatively higher element of domestic transportation cost is a key impediment to accessing international markets. In the developing world, these costs – *inter alia* – are usually induced by the remoteness of trade-processing infrastructure from firms' production facilities and are further compounded by poor transport networks (ODI,

2015). Inland distance therefore represents an implicit tax: it inhibits firms' participation in exporting and constricts their export product sets. This finding for Pakistan suggests that, from a trade facilitation perspective, a focus on improving within-country transportation and connectivity matters more than improving the same at the international level for generating an appropriate trade response. Second, since the overall trade-restricting effect of domestic trade costs is much higher along the EM, the policies aimed at strengthening these margins assume more importance in promoting exports. Export promotion strategy and policy should focus on facilitating the market entry of firms and products, rather than on quantity subsidies, as reducing inland transportation costs can boost exports through the channels of 1) entry of more firms into exporting and 2) widening of the export product set.

## 4.9 Appendix

**Table A 4.1: Three Legs of Distance for Selected Economies**

| Country         | Elements of Distance (km) |               |             |
|-----------------|---------------------------|---------------|-------------|
|                 | Origin                    | International | Destination |
|                 | (1)                       | (2)           | (3)         |
| Pakistan        | 555                       | 7,373         | 246         |
| Malaysia        | 556                       | 9,992         | 256         |
| C. African Rep. | 557                       | 7,495         | 269         |
| Vietnam         | 560                       | 9,908         | 252         |
| South Africa    | 585                       | 8,392         | 285         |
| Saudi Arabia    | 606                       | 6,469         | 270         |
| FM Sudan        | 620                       | 11,942        | 266         |
| Mozambique      | 696                       | 7,879         | 261         |
| Mexico          | 706                       | 10,063        | 282         |
| Indonesia       | 716                       | 10,471        | 286         |
| Congo, Rep.     | 803                       | 6,995         | 267         |
| Kenya           | 865                       | 8,343         | 255         |
| India           | 869                       | 8,128         | 244         |
| Kazakhstan      | 877                       | 7,233         | 250         |
| China           | 1,018                     | 9,378         | 284         |
| Australia       | 1,121                     | 12,813        | 275         |
| Brazil          | 1,157                     | 9,232         | 265         |

Source: CEPII

Notes: This table presents domestic and international transportation distances for selected developing countries. Column (1) contains average inland transportation distance to port of exit, column (2) contains the distances between countries and column (3) contains the average transportation distance within the export market.

**Table A 4.2: Summary Statistics for Trade Margins**

| Variable                               | Observations | Mean  | Std. Dev. |
|----------------------------------------|--------------|-------|-----------|
| Exports ( $X_{ijkt}$ ) in PKR billions | 34,117       | 0.335 | 2.67      |
| Firm extensive margins                 | 34,117       | 0.83  | 1.11      |
| Product extensive margins              | 34,117       | 0.81  | 1.05      |
| Quantity margins                       | 34,105       | 2.59  | 2.10      |
| Price margins                          | 34,105       | 0.26  | 8.29      |

Notes: The table contains summary statistics of the data used for decomposing distance effect along trade margins. Following Bernard et al. (2007), Mayer and Ottaviano (2008) and Hillberry and Hummels (2008), the overall trade flow is decomposed to firm EM (number of exporting firms), product EM (number of products per firm) and quantity margins (quantity exported per product per firm, and price margins (price per product per firm).

**Table A 4.3: List of Trading Partners of Pakistan Included in the Analysis**

|                 |                   |                     |                |
|-----------------|-------------------|---------------------|----------------|
| Afghanistan     | El Salvador       | Mauritania          | Tanzania       |
| Albania         | Equatorial Guinea | Mauritius           | Thailand       |
| Algeria         | Estonia           | Mexico              | The Gambia     |
| Angola          | Ethiopia          | Moldova             | Togo           |
| Argentina       | Fiji              | Mongolia            | Tonga          |
| Armenia         | Finland           | Morocco             | Trinidad and   |
| Australia       | France            | Mozambique          | Tobago         |
| Austria         | Gabon             | Nepal               | Tunisia        |
| Azerbaijan      | Georgia           | Netherlands         | Turkey         |
| Bangladesh      | Germany           | New Zealand         | Turkmenistan   |
| Belarus         | Ghana             | Nicaragua           | Uganda         |
| Belgium         | Greece            | Niger               | Ukraine        |
| Belize          | Grenada           | Nigeria             | United Kingdom |
| Benin           | Guatemala         | Norway              | United States  |
| Bolivia         | Guinea            | Panama              | Uruguay        |
| Bosnia and      | Guinea-Bissau     | Papua New           | Uzbekistan     |
| Herzegovina     | Guyana            | Guinea              | Vanuatu        |
| Brazil          | Haiti             | Paraguay            | Venezuela      |
| Bulgaria        | Honduras          | Peru                | Vietnam        |
| Burkina Faso    | Hong Kong         | Philippines         | Yemen          |
| Burundi         | Hungary           | Poland              | Zambia         |
| Cabo Verde      | Iceland           | Portugal            | Zimbabwe       |
| Cambodia        | India             | Romania             |                |
| Cameroon        | Indonesia         | Russia              |                |
| Canada          | Iran              | Rwanda              |                |
| Central African | Ireland           | Samoa               |                |
| Republic        | Italy             | Senegal             |                |
| Chad            | Jamaica           | Seychelles          |                |
| Chile           | Japan             | Sierra Leone        |                |
| China           | Jordan            | Singapore           |                |
| Colombia        | Kenya             | Slovak Republic     |                |
| Comoros         | Korea             | Slovenia            |                |
| Congo, Republic | Kyrgyz Republic   | South Africa        |                |
| of              | Lao PDR           | Spain               |                |
| Costa Rica      | Latvia            | Sri Lanka           |                |
| Croatia         | Lebanon           | St. Kitts and Nevis |                |
| Czech Republic  | Liberia           | St. Lucia           |                |
| Cote d'Ivoire   | Libya             | Sudan               |                |
| Dem. Rep. Congo | Lithuania         | Suriname            |                |
| Denmark         | Luxembourg        | Sweden              |                |
| Djibouti        | Macao             | Switzerland         |                |
| Dominica        | Madagascar        | Syrian Arab         |                |
| Dominican       | Malawi            | Republic            |                |
| Republic        | Malaysia          | Sao Tome and        |                |
| Ecuador         | Maldives          | Principe            |                |
| Egypt           | Mali              | Tajikistan          |                |

**Table A 4.4: Sector Definitions and Labels**

| Abbreviation    | Sector                                                                                                                                                                                                      |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 01-05_Animal    | Live animals; animal products                                                                                                                                                                               |
| 06-15_Vegetable | Vegetable products                                                                                                                                                                                          |
| 16-24_FoodProd  | Prepared foodstuffs; beverages, spirits and vinegar; tobacco and manufactured tobacco substitutes                                                                                                           |
| 25-26_Minerals  | Mineral products                                                                                                                                                                                            |
| 27-27_Fuels     | Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes.                                                                                                       |
| 28-38_Chemicals | Products of the chemical or allied industries                                                                                                                                                               |
| 39-40_PlastiRub | Plastics and articles thereof; rubber and articles thereof                                                                                                                                                  |
| 41-43_HidesSkin | Raw hides and skins, leather, fur, skins and articles thereof; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silk-worm gut)                       |
| 44-49_Wood      | Wood and articles of wood; wood charcoal; cork and articles of cork; manufactures of straw, of esparto or of other plaiting materials; basket ware and wickerwork                                           |
| 50-63_TextCloth | Textiles and textile articles                                                                                                                                                                               |
| 64-67_Footwear  | Footwear, headgear, umbrellas, sun umbrellas, walking-sticks, seat-sticks, whips, riding-crops and parts thereof; prepared feathers and articles made therewith; artificial flowers; articles of human hair |
| 68-71_StoneGlas | Articles of stone, plaster, cement, asbestos, mica or similar materials; ceramic products; glass and glassware                                                                                              |
| 72-83_Metals    | Base metals and articles of base metal                                                                                                                                                                      |
| 84-85_MachElec  | Machinery and mechanical appliances; electrical equipment; parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles |
| 86-89_Transport | Vehicles, aircraft, vessels and associated transport equipment                                                                                                                                              |
| 90-99_Miscellan | Miscellaneous manufactured articles                                                                                                                                                                         |

Source: WTO, HS Nomenclature 2012 Edition

**Table A 4.5: Deconstruction of Distance Effect over Time**

| Dep. variables                 | $X_{ijkt}$<br>(1)    | Firm EM<br>(2)       | Prod. EM<br>(3)      | Qty. M<br>(4)        | Price. M<br>(5)      |
|--------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| <b>A: Distance to port x</b>   |                      |                      |                      |                      |                      |
| 2000                           | -1.064***<br>(0.038) | -0.671***<br>(0.020) | -0.512***<br>(0.018) | 0.173***<br>(0.035)  | -0.054*<br>(0.030)   |
| 2001                           | -1.049***<br>(0.038) | -0.663***<br>(0.019) | -0.499***<br>(0.017) | 0.163***<br>(0.035)  | -0.051*<br>(0.030)   |
| 2002                           | -1.064***<br>(0.038) | -0.674***<br>(0.020) | -0.554***<br>(0.020) | 0.162***<br>(0.039)  | 0.001<br>(0.033)     |
| 2003                           | -1.109***<br>(0.041) | -0.682***<br>(0.021) | -0.594***<br>(0.019) | 0.080*<br>(0.047)    | 0.087**<br>(0.044)   |
| 2004                           | -1.059***<br>(0.040) | -0.649***<br>(0.020) | -0.563***<br>(0.020) | 0.134***<br>(0.040)  | 0.016<br>(0.038)     |
| 2005                           | -1.100***<br>(0.040) | -0.667***<br>(0.020) | -0.589***<br>(0.019) | 0.173***<br>(0.035)  | -0.018<br>(0.031)    |
| 2006                           | -1.102***<br>(0.038) | -0.660***<br>(0.018) | -0.581***<br>(0.017) | 0.161***<br>(0.035)  | -0.021<br>(0.031)    |
| 2007                           | -1.102***<br>(0.041) | -0.660***<br>(0.020) | -0.579***<br>(0.019) | 0.109***<br>(0.042)  | 0.030<br>(0.036)     |
| 2008                           | -1.011***<br>(0.045) | -0.639***<br>(0.022) | -0.555***<br>(0.020) | 0.104**<br>(0.044)   | 0.078**<br>(0.038)   |
| 2009                           | -1.030***<br>(0.049) | -0.623***<br>(0.023) | -0.536***<br>(0.023) | 0.123***<br>(0.043)  | 0.006<br>(0.035)     |
| 2010                           | -1.019***<br>(0.051) | -0.626***<br>(0.024) | -0.523***<br>(0.020) | 0.123***<br>(0.042)  | 0.007<br>(0.036)     |
| 2011                           | -0.973***<br>(0.048) | -0.617***<br>(0.022) | -0.518***<br>(0.020) | 0.158***<br>(0.041)  | 0.002<br>(0.035)     |
| 2012                           | -0.917***<br>(0.041) | -0.578***<br>(0.019) | -0.495***<br>(0.018) | 0.101***<br>(0.038)  | 0.055<br>(0.034)     |
| 2013                           | -0.950***<br>(0.041) | -0.584***<br>(0.019) | -0.496***<br>(0.019) | 0.077**<br>(0.039)   | 0.053<br>(0.034)     |
| 2014                           | -0.966***<br>(0.042) | -0.591***<br>(0.019) | -0.495***<br>(0.018) | 0.108***<br>(0.036)  | 0.012<br>(0.031)     |
| <b>B: Distance to market x</b> |                      |                      |                      |                      |                      |
| 2000                           | -0.554***<br>(0.028) | -0.179***<br>(0.013) | -0.211***<br>(0.011) | -0.266***<br>(0.023) | 0.103***<br>(0.018)  |
| 2001                           | -0.530***<br>(0.027) | -0.171***<br>(0.012) | -0.211***<br>(0.010) | -0.263***<br>(0.022) | 0.116***<br>(0.017)  |
| 2002                           | -0.503***<br>(0.028) | -0.152***<br>(0.013) | -0.158***<br>(0.013) | -0.217***<br>(0.025) | 0.024<br>(0.020)     |
| 2003                           | -0.461***<br>(0.031) | -0.133***<br>(0.014) | -0.111***<br>(0.013) | -0.123***<br>(0.030) | -0.094***<br>(0.027) |
| 2004                           | -0.449***<br>(0.030) | -0.135***<br>(0.014) | -0.110***<br>(0.014) | -0.187***<br>(0.026) | -0.014<br>(0.024)    |
| 2005                           | -0.470***<br>(0.028) | -0.144***<br>(0.012) | -0.100***<br>(0.011) | -0.230***<br>(0.021) | 0.004<br>(0.018)     |
| 2006                           | -0.479***<br>(0.027) | -0.151***<br>(0.011) | -0.108***<br>(0.011) | -0.227***<br>(0.021) | 0.008<br>(0.018)     |
| 2007                           | -0.531***<br>(0.028) | -0.161***<br>(0.012) | -0.115***<br>(0.011) | -0.254***<br>(0.025) | -0.001<br>(0.021)    |
| 2008                           | -0.575***<br>(0.030) | -0.173***<br>(0.013) | -0.130***<br>(0.012) | -0.268***<br>(0.027) | -0.004<br>(0.023)    |
| 2009                           | -0.483***<br>(0.037) | -0.130***<br>(0.017) | -0.098***<br>(0.016) | -0.297***<br>(0.030) | 0.043*<br>(0.024)    |
| 2010                           | -0.423***<br>(0.039) | -0.111***<br>(0.017) | -0.092***<br>(0.014) | -0.276***<br>(0.031) | 0.055**<br>(0.026)   |
| 2011                           | -0.408***<br>(0.035) | -0.109***<br>(0.015) | -0.089***<br>(0.014) | -0.277***<br>(0.029) | 0.068***<br>(0.023)  |
| 2012                           | -0.383***<br>(0.032) | -0.124***<br>(0.013) | -0.090***<br>(0.012) | -0.190***<br>(0.027) | 0.022<br>(0.024)     |
| 2013                           | -0.344***<br>(0.032) | -0.118***<br>(0.013) | -0.090***<br>(0.013) | -0.169***<br>(0.027) | 0.033<br>(0.023)     |
| 2014                           | -0.315***<br>(0.032) | -0.109***<br>(0.013) | -0.087***<br>(0.012) | -0.197***<br>(0.025) | 0.079***<br>(0.021)  |
| R2                             | 0.316                | 0.375                | 0.376                | 0.336                | 0.295                |
| Observations                   | 34,118               | 34,118               | 34,118               | 34,106               | 34,106               |

Estimations are in logs. The dependent variables are reported at the head of each column. EM denotes extensive margins. Column (1) contains the overall effect of distances and columns (2) through (5) decompose this into responses of various trade margins. The coefficients in columns (2) to (5) add to those in column (1). The coefficients on fixed effects and other gravity variables are not reported since they are not of direct interest. Robust standard errors clustered at market level are in parentheses, \*p<0.10, \*\*p<0.05, \*\*\*p<0.01.

**Table A 4.6: Deconstruction of Distance Effect across Sectors**

| Dep. variables                 | Xijkt<br>(1)         | Firm EM<br>(2)       | Prod. EM<br>(3)      | Qty. M<br>(4)        | Price. M<br>(5)      |
|--------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| <b>A: Distance to port x</b>   |                      |                      |                      |                      |                      |
| 01-05_Animal                   | -1.045***<br>(0.047) | -0.543***<br>(0.020) | -0.484***<br>(0.022) | 0.114***<br>(0.042)  | -0.135***<br>(0.033) |
| 06-15_Vegetable                | -0.848***<br>(0.051) | -0.561***<br>(0.019) | -0.507***<br>(0.019) | 0.197***<br>(0.048)  | 0.023<br>(0.035)     |
| 16-24_FoodProd                 | -0.749***<br>(0.062) | -0.502***<br>(0.021) | -0.397***<br>(0.017) | 0.163***<br>(0.061)  | -0.014<br>(0.039)    |
| 25-26_Minerals                 | -0.916***<br>(0.071) | -0.516***<br>(0.025) | -0.449***<br>(0.025) | 0.194***<br>(0.057)  | -0.138***<br>(0.052) |
| 28-38_Chemicals                | -1.189***<br>(0.070) | -0.566***<br>(0.023) | -0.466***<br>(0.023) | 0.008<br>(0.056)     | -0.166***<br>(0.044) |
| 39-40_PlastiRub                | -0.894***<br>(0.054) | -0.503***<br>(0.021) | -0.403***<br>(0.020) | 0.223***<br>(0.049)  | -0.210***<br>(0.044) |
| 41-43_HidesSkin                | -1.022***<br>(0.078) | -0.582***<br>(0.029) | -0.476***<br>(0.028) | 0.027<br>(0.056)     | 0.006<br>(0.051)     |
| 44-49_Wood                     | -0.851***<br>(0.031) | -0.519***<br>(0.014) | -0.435***<br>(0.013) | 0.098***<br>(0.028)  | 0.004<br>(0.025)     |
| 50-63_TextCloth                | -0.608***<br>(0.161) | -0.509***<br>(0.036) | -0.439***<br>(0.036) | 0.342**<br>(0.134)   | -0.002<br>(0.093)    |
| 64-67_Footwear                 | -1.237***<br>(0.057) | -0.670***<br>(0.025) | -0.537***<br>(0.023) | 0.149**<br>(0.060)   | -0.181***<br>(0.054) |
| 68-71_StoneGlas                | -0.836***<br>(0.059) | -0.503***<br>(0.022) | -0.406***<br>(0.022) | -0.005<br>(0.063)    | 0.068<br>(0.059)     |
| 72-83_Metals                   | -0.775***<br>(0.066) | -0.458***<br>(0.026) | -0.397***<br>(0.032) | 0.030<br>(0.068)     | 0.048<br>(0.068)     |
| 84-85_Mach.Elect               | -1.092***<br>(0.091) | -0.507***<br>(0.034) | -0.415***<br>(0.036) | 0.011<br>(0.086)     | -0.182**<br>(0.073)  |
| 86-89_Transport                | -1.025***<br>(0.037) | -0.570***<br>(0.019) | -0.349***<br>(0.017) | -0.062*<br>(0.035)   | -0.045<br>(0.029)    |
| <b>B: Distance to market x</b> |                      |                      |                      |                      |                      |
| 01-05_Animal                   | -0.567***<br>(0.101) | -0.038<br>(0.035)    | -0.033<br>(0.027)    | -0.181*<br>(0.096)   | -0.316***<br>(0.120) |
| 06-15_Vegetable                | -0.253***<br>(0.032) | -0.120***<br>(0.013) | -0.091***<br>(0.013) | -0.041<br>(0.027)    | 0.000<br>(0.019)     |
| 16-24_FoodProd                 | -0.462***<br>(0.035) | -0.147***<br>(0.012) | -0.085***<br>(0.012) | -0.104***<br>(0.033) | -0.127***<br>(0.022) |
| 25-26_Minerals                 | -0.676***<br>(0.046) | -0.196***<br>(0.015) | -0.202***<br>(0.012) | -0.050<br>(0.045)    | -0.227***<br>(0.028) |
| 28-38_Chemicals                | -0.508***<br>(0.054) | -0.176***<br>(0.016) | -0.133***<br>(0.017) | -0.277***<br>(0.040) | 0.075*<br>(0.039)    |
| 39-40_PlastiRub                | -0.319***<br>(0.048) | -0.159***<br>(0.014) | -0.132***<br>(0.014) | -0.090**<br>(0.036)  | 0.062**<br>(0.028)   |
| 41-43_HidesSkin                | -0.438***<br>(0.040) | -0.155***<br>(0.014) | -0.132***<br>(0.014) | -0.474***<br>(0.034) | 0.323***<br>(0.032)  |
| 44-49_Wood                     | -0.745***<br>(0.055) | -0.147***<br>(0.020) | -0.126***<br>(0.019) | -0.275***<br>(0.039) | -0.197***<br>(0.035) |
| 50-63_TextCloth                | -0.356***<br>(0.025) | -0.089***<br>(0.010) | -0.038***<br>(0.010) | -0.291***<br>(0.020) | 0.062***<br>(0.016)  |
| 64-67_Footwear                 | -0.782***<br>(0.123) | -0.188***<br>(0.026) | -0.150***<br>(0.026) | -0.509***<br>(0.102) | 0.065<br>(0.071)     |
| 68-71_StoneGlas                | -0.416***<br>(0.036) | -0.085***<br>(0.014) | -0.088***<br>(0.013) | -0.188***<br>(0.040) | -0.055<br>(0.035)    |
| 72-83_Metals                   | -0.648***<br>(0.043) | -0.194***<br>(0.014) | -0.157***<br>(0.015) | -0.197***<br>(0.043) | -0.090**<br>(0.042)  |
| 84-85_Mach.Elect               | -0.654***<br>(0.052) | -0.234***<br>(0.018) | -0.165***<br>(0.023) | -0.237***<br>(0.051) | -0.016<br>(0.054)    |
| 86-89_Transport                | -0.401***<br>(0.062) | -0.211***<br>(0.021) | -0.172***<br>(0.023) | -0.173***<br>(0.060) | 0.155***<br>(0.048)  |
| R2                             | 0.285                | 0.354                | 0.354                | 0.297                | 0.276                |
| Observations                   | 34,118               | 34,118               | 34,118               | 34,106               | 34,106               |

Estimations are in logs. The dependent variables are reported at the head of each column. EM denotes extensive margins. Column (1) contains the overall effect of distances and columns (2) through (5) decompose this into responses of various trade margins. The coefficients in columns (2) to (5) add to those in column (1). The coefficients on fixed effects and other gravity variables are not reported since they are not of direct interest. Robust standard errors clustered at market level are in parentheses, \*p<0.10, \*\*p<0.05, \*\*\*p<0.01.

**Table A 4.7: Pattern of Domestic Trade**

A: Domestic Trade of Firms Located in Rahim Yar Khan  
(A town in Punjab near the border of Sind province)

| Locations of Trade Partners | Trade (PKR M) | Ethnic Region of Trade Partner | Intra-Town Distance (km) |
|-----------------------------|---------------|--------------------------------|--------------------------|
| Multan City                 | 0.39          | Same                           | 227                      |
| Okara                       | 1.06          | Same                           | 404                      |
| Karachi East                | 4.59          | Different                      | 490                      |
| Malir                       | 252.92        | Different                      | 497                      |
| Karachi West                | 0.10          | Different                      | 513                      |
| Karachi South               | 247.15        | Different                      | 550                      |
| Lahore Cantt                | 17.93         | Same                           | 540                      |
| Lahore City                 | 5.02          | Same                           | 510                      |
| Lahore                      | 1,465.85      | Same                           | 523                      |
| Gujranwala                  | 1.82          | Same                           | 558                      |
| Peshawar                    | 340.69        | Different                      | 632                      |
| Islamabad                   | 28.87         | Same                           | 646                      |
| Chota Lahore                | 49.99         | Same                           | 655                      |
| Haripur                     | 454.03        | Different                      | 667                      |

B: Domestic Trade of Firms located in Sukkur  
(A town in Sindh near the border of Punjab province)

| Locations of Trade Partners | Trade (PKR M) | Ethnic Region of Trade partner | Intra-Town Distance (km) |
|-----------------------------|---------------|--------------------------------|--------------------------|
| Malir                       | 42.5          | Same                           | 352                      |
| Hub                         | 20.6          | Different                      | 352                      |
| Karachi                     | 4,934.7       | Same                           | 365                      |
| Karachi West                | 5.1           | Same                           | 365                      |
| Karachi Central             | 16.7          | Same                           | 365                      |
| Karachi South               | 1,314.4       | Same                           | 365                      |
| Karachi East                | 1.0           | Same                           | 365                      |
| Okara                       | 0.6           | Different                      | 564                      |
| Sheikhupura                 | 0.1           | Different                      | 667                      |
| Lahore Cantt.               | 0.2           | Different                      | 682                      |
| Ferozewala                  | 25.0          | Different                      | 684                      |
| Peshawar                    | 35.8          | Different                      | 747                      |
| Chota Lahore                | 5.0           | Different                      | 780                      |
| Islamabad                   | 2.8           | Different                      | 782                      |
| Haripur                     | 444.2         | Different                      | 799                      |

Note: Sorted in the order of distance from town

**Table A 4.8: IV Estimates**

```
. //First-stage regression
. reg inland total_output , r
```

```
Linear regression                                Number of obs = 484351
                                                F( 1,484349) =50057.45
                                                Prob > F      = 0.0000
                                                R-squared    = 0.1677
                                                Root MSE    = 1.0182
```

|              | Coef.     | Robust Std. Err. | t       | P> t  | [95% Conf. Interval] |           |
|--------------|-----------|------------------|---------|-------|----------------------|-----------|
| inland       |           |                  |         |       |                      |           |
| total_output | -.1644279 | .0007349         | -223.74 | 0.000 | -.1658683            | -.1629874 |
| _cons        | 8.419361  | .0066629         | 1263.62 | 0.000 | 8.406302             | 8.43242   |

```
.
end of do-file
```

```
. do "C:\Users\Salamat\AppData\Local\Temp\STD0j000000.tmp"
```

```
. predict inland_dist_hat
(option xb assumed; fitted values)
```

```
.
end of do-file
```

```
. do "C:\Users\Salamat\AppData\Local\Temp\STD0j000000.tmp"
```

```
.
. //Second Stage Regression
. reghdfe lexp external_dist inland_dist_hat $var4, abs(prod_year region_year)
> //second stage
(converged in 10 iterations)
```

```
HDFE Linear regression                                Number of obs = 484,351
Absorbing 2 HDFE groups                             F( 4, 483087) = 1806.57
                                                Prob > F      = 0.0000
                                                R-squared    = 0.2097
                                                Adj R-squared = 0.2077
                                                Within R-sq. = 0.0147
                                                Root MSE    = 2.1829
```

|              | Coef.             | Std. Err. | t      | P> t  | [95% Conf. Interval] |           |
|--------------|-------------------|-----------|--------|-------|----------------------|-----------|
| lexp         |                   |           |        |       |                      |           |
| external_d~t | -.1259556         | .0082544  | -15.26 | 0.000 | -.1421339            | -.1097772 |
| inland_dis~t | -.5259005         | .0099436  | -52.89 | 0.000 | -.5453896            | -.5064114 |
| ln_gdp_d     | .0679829          | .001898   | 35.82  | 0.000 | .0642628             | .071703   |
| contig       | .7695667          | .0188611  | 40.80  | 0.000 | .7325995             | .8065339  |
| Absorbed     | F(1259, 483087) = |           | 85.439 | 0.000 | (Joint test)         |           |

Absorbed degrees of freedom:

| Absorbed FE | Num. Coefs. = | Categories - | Redundant |
|-------------|---------------|--------------|-----------|
| prod_year   | 1208          | 1208         | 0         |
| region_year | 52            | 65           | 13        |

```
.
end of do-file
```

Figure A4. 1: Spatial Distribution of Population in Pakistan

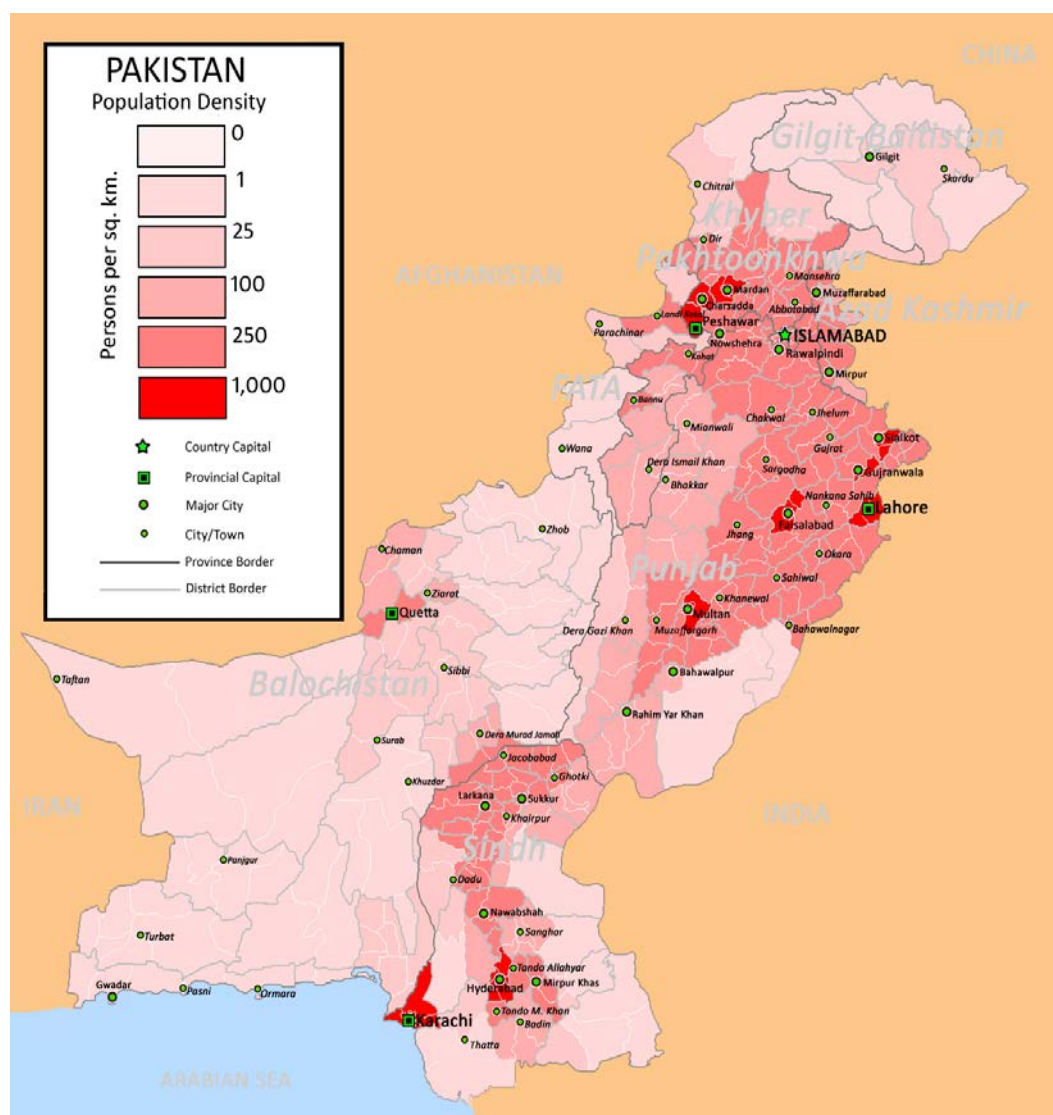
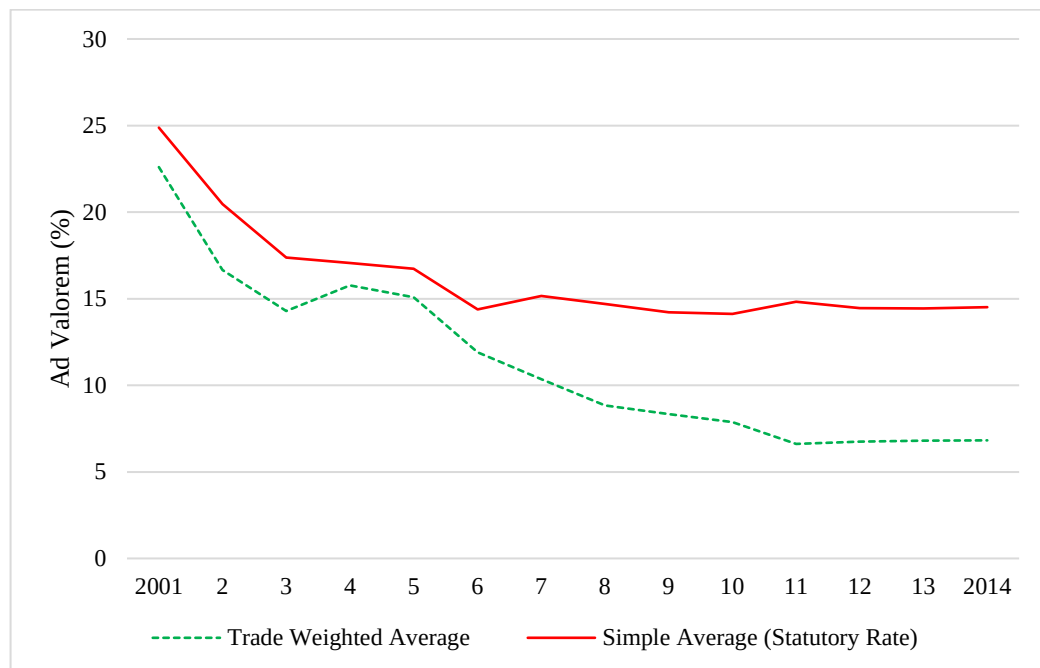


**Figure A4. 2: Pakistan's Average Customs Duty on Imports**



Notes: The chart presents the average rate of customs duty (CD) over time. Besides CD imports attract a range of para-tariffs, such as sales tax, income tax, provincial taxes and port development surcharge. Some of which were also rationalised under the policy reforms launched by the military government.

## **5 Exchange Rate Effects on Agricultural Exports: Firm-Level Evidence from Pakistan**

## 5.1 Introduction

Domestic currency depreciation has been used widely as a policy tool to stimulate exports and to improve other macroeconomic imbalances. In particular, many developing countries have employed this strategy either unilaterally or at the behest of multilateral institutions as a part of structural adjustment programmes. The response of exports to exchange rate movement has been highly debated in the existing literature and the current evidence is mixed. For example, Bernard and Jensen (2004) find no association between the exchange rate and firms' exports, whereas Bugamelli and Infante (2003), Campa (2004), Das, Roberts and Tybout (2007), Greenaway and Kneller (2008) and Greenaway, Kneller and Zhang (2010) find negative and significant effects of exchange rate appreciation on exports.

The existing micro literature in this stream focuses mainly on the responses of firms in the manufacturing sector and the behaviour of exporters in the agriculture sector remain largely unexplored<sup>44</sup>. This Chapter bridges the gap by using firm-level information on agricultural exports from Pakistan. It exploits three unique features of the dataset: (i) the information on currency used to invoice each transaction (ii) exchange rate of the currency at the transaction level, and (iii) quantity (weight) and price of each transaction. The analysis finds that firm-level exports respond positively to currency depreciation and this effect is transmitted mainly through the channel of price, with the response of quantities being relatively small. The trade response, however, varies widely across products, markets, exchange rate regime and invoicing currencies.

Effect of exchange rate on agricultural exports has rarely been examined at the micro level but investigating it is important for at least three reasons. First, during the past two decades, the focus of research on international trade has shifted from countries and industries to firms and products. However, owing to data limitations, firms in the agriculture sector have not attracted much attention. Second, agriculture, despite accounting for a comparatively small share of the global economy, remains central to the lives of a great many people. In 2012, of the world's 7.1 billion people, an estimated 1.3 billion (19%) were directly engaged in farming (World Bank, 2012).

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<sup>44</sup> A few product-level studies on the role of the exchange rate in agricultural trade also find conflicting evidence: for example, Kim, Cho and Koo (2004) show that the exchange rate has a significant impact on agricultural trade in the US, whereas Vellianitis-Fidas (1976) finds that it does not (for a survey see Auboin and Ruta, 2013).

These farmers rarely transact international business in a direct manner, but rather through intermediary firms; as such, examining the behaviour of mediating firms could shed some light on the responses of upstream producers. Third, much of the existing literature on the exchange rate has attributed the low export response to currency depreciation to the offsetting channel of intermediary inputs used in manufactured goods (Amiti, Itskhoki and Konings, 2014). As this intermediary channel is either absent or comparatively weak in the agriculture sector, the estimated trade response to exchange rate movement can be considered a direct effect of currency depreciation.

This Chapter investigates the exchange rate effect at the transaction level on intensive margins and extensive margins. Intensive margin (IM) is the value of export per product per firm by market and extensive margin (EM) are defined at four distinct levels: (i) firm EM – number of firms per product per market; (ii) product EM – number of products per firm per market; (iii) market EM – number of markets per firm per product; and (iv) consumer margins – number of clients per firm per market. The response of intensive margins is further decomposed to reactions of price and quantities and the overall effect is deconstructed across subsectors within the agriculture sector.

This Chapter finds that the domestic currency depreciation positively and unambiguously affects trade margins, both intensive and extensive. The responses of trade margins, although positive, are not commensurate with the magnitude of depreciation. A depreciation of 10% is associated with an increase in IM of 1.74% on average. Of this, around 75% of the effect is transmitted through the channel of price and 25% through quantities. The corresponding increase in EM is 0.25% along firm EM, 0.14% along product EM and 0.29% along consumer margins. These results hold to a battery of robustness checks. The heterogeneity analysis reveals that the export response is relatively large for the products that are less dependent on imported inputs. Moreover, firms exporting to developing countries show a greater response compared with those shipping to Europe or North America. Furthermore, producer currency invoicing, prior exporting experience and a fixed exchange rate regime are associated with relatively large trade responses. This focus is novel in the literature on agricultural trade. This Chapter, although it focuses

primarily on the effects of exchange rates, reveals a relatively large trade-impeding role of tariffs, as well as the complexity of tariffs and non-tariff measures (NTMs).

This Chapter provides several contributions to the existing literature on exchange rates, export diversification and invoicing currencies, besides adding a new dimension to the micro literature on trade in agriculture. The recent literature on agricultural exports looks mainly into changes in producer prices across markets (Liefert, 2011) or examines the effects of NTMs (Disdier, Fontagné and Mimouni, 2008; Fontagné et al., 2015). A few studies explore the effect of exchange rate volatility in cross-country settings using product-level information (Anderson and Garcia 1989; Cho, Sheldon and McCorriston, 2002; Kandilov, 2008; Kohler and Ferjani, 2015). Recently, Hausman et al. (2017) show that farming channels had relatively larger effect in recovery from the great depression in 1933; they also perform the analysis at the aggregate level. To the best of my knowledge, this is the first study to extend the frontier of this literature from countries and sectors to firms and products in agricultural trade at such a detailed level.

The use of the exchange rates of the actual invoicing currencies at the shipment level distinguishes this Chapter from the vast micro literature in this stream (for instance, Berman et al. 2012; Fabling and Sanderson, 2015; Li et al. 2015; Fung, 2008; Tomlin, 2014). In the absence of information on the actual currencies of transactions, the above studies use bilateral exchange rates between trading partners in estimations. This approach is based on the implicit assumption that firms transact business in their national currency. However, the data shows that exporters settle their transactions mainly in vehicle<sup>45</sup> currencies, and that currency use varies across and within markets, as well as over time (Figure 5.2 and Table 5.2). Given the empirical support for this multi-currency world in the dataset, the exchange rates of actual invoicing currencies are used in the estimations. The analysis finds that the effect of transaction-level exchange rates is almost half that of bilateral exchange rates between trading partners.

This Chapter also extends the narrow stream of invoicing literature. In this vein, Staiger and Sykes (2010) theoretically show that the effect of the exchange rate, *inter alia*, depends on the currency in which producers invoice their transactions.

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<sup>45</sup> 'Vehicle currency' is a term used in the literature for third country invoicing.

Gopinath et al. (2010) examine the heterogeneity of pass-through for dollar- and non-dollar-invoiced transactions. In an extension of these studies, this Chapter explores the heterogeneity of trade responses among all major currencies, such as the dollar, euro, pound and dirham, and find that the response of the intensive margins is larger in producer-invoiced transactions. Moreover, it investigates the relative behaviour of prices and quantities in tandem with that of firm-level exports, which earlier studies on invoicing do not examine (Bacchetta and Van Wincoop, 2005; Chung, 2016; Goldberg and Tille, 2008).

In addition to informing on the response of agricultural exports to exchange rate movement, this Chapter adds to the literature on connection between exchange rate movement and export diversification. Earlier literature, for instance Hummels and Klenow (2005) and Hausmann, Hwang and Rodrik (2007), highlights the role of extensive margins in export growth; however, the reaction of these margins to the exchange rate movement in the agriculture sector remains relatively unexplored. Recently, Sekkat (2015) has shown that the exchange rate does not affect diversification within the manufacturing sector. In contrast, this Chapter finds that depreciation positively affects the extensive margins of firms, products and consumers in agriculture, all of which are different dimensions of export diversification.

Finally, this Chapter contributes to the broad literature on the impact of exchange rates on firm-level exports. The existing micro literature in this stream focuses primarily on the manufacturing firms of developed economies<sup>46</sup>. For example, Berman, Martin and Mayer (2012), Fitzgerald and Haller (2014) and Greenaway, Kneller and Zhang (2010) explore the reactions of manufacturing firms in France, Ireland and the UK, respectively. This work, however, focuses on commodity-exporting firms of a developing country – a distinctive empirical setting. Even this atypical setting generates evidence on the offsetting effect of exchange rate through intermediary inputs. It shows that the trade response is larger for the primary

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<sup>46</sup> This literature has developed mainly along two dimensions: effect of currency appreciation or depreciation on trade flows and effect of exchange rate volatility. These studies focus mainly on one dimension of trade flows, exports or imports. Some authors examine the asymmetric effects of exchange rate on exports and imports (Amiti et al., 2014; Bahmani-Oskooee and Aftab, 2017; Bahmani-Oskooee and Harvey, 2011).

products that are relatively less dependent on imported inputs, which complements the findings of the above studies.

The remainder of the Chapter is structured as follows. Sections 5.2 introduce the dataset and Section 5.3 discusses the estimation strategy. Section 5.4 presents the main results and Section 5.5 explores the variation in exchange rate (ER) effects along multiple dimensions of firm and product heterogeneity. Section 5.6 contains additional robustness checks and Section 5.7 examines the reactions of extensive margins. Section 5.8 concludes with a summary of the findings and policy implications.

## **5.2 Data and Descriptive Evidence**

This section introduces the dataset and highlights a connection between exchange rate (ER) movement and the response of agricultural exports from Pakistan. It also generates descriptive evidence concerning heterogeneity in invoicing currencies across and within markets, which provides a rationale for the use of the ER of the actual currencies in estimations, rather than the bilateral exchange rate between trading partners.

### **5.2.1 The Agriculture Sector of Pakistan**

The agriculture sector accounts for 18% of gross domestic product (GDP) and a similar fraction of Pakistan's national exports.<sup>47</sup> Pakistan is an interesting case for examining this research question for the following three reasons. First, it is a net exporter of many agricultural products, including wheat, rice, cotton, milk and dates, including many other cash crops. A large number of firms export these commodities to multiple markets across the globe. In the period, 2000–2013, more than 7,758 firms<sup>48</sup> exported around 1,190 agricultural products to 85,995 clients in 162 markets. This huge geographical, sectoral and temporal coverage permits examination of the exchange rate effects along multiple dimensions of firm and product heterogeneity. Second, the agriculture sector is relatively small compared with the rest of Pakistan's economy, which lessens concerns about reverse causality

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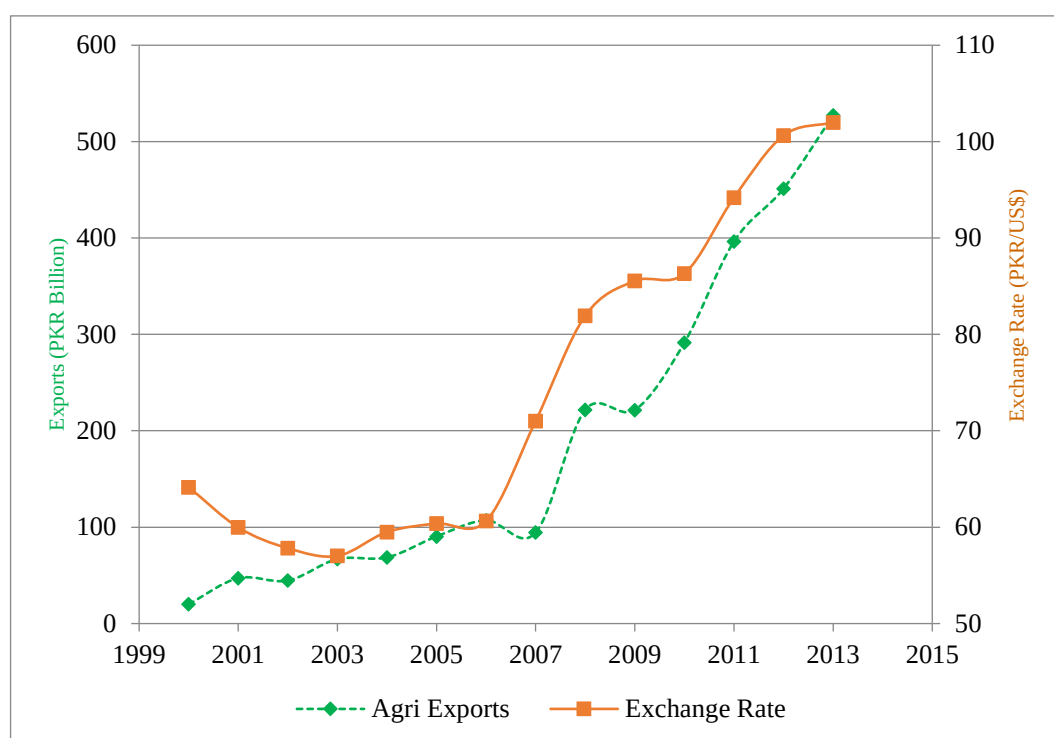
<sup>47</sup> <http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS>

<sup>48</sup> Some of these firms own agricultural farms but most of them are intermediaries. They purchase agricultural commodities from the domestic market and export them after sorting, packaging, labelling and completing other necessary requirements.

of the exchange rate effect and increases the plausibility of the causal interpretation of the findings.

Third, during the past decade, Pakistan has experienced a large exchange rate movement. It's the national currency (PKR) has depreciated almost 100%, from PKR 54 per dollar in 2003 to PKR 100 per dollar in 2013. In the same period, Pakistan's agricultural exports have almost quadrupled, from less than PKR 100 billion to more than PKR 500 billion. There seems to be a striking similarity in the movement of these series, particularly after 2007 (Figure 5.1). This apparent association between a large exchange rate movement and evolution of agricultural exports seems to suggest a strong correlation in these variables and provide an interesting empirical setting for examining the research question.

**Figure 5.1. Response Of Agricultural Exports To Exchange Rate Movement**



Note. Exchange rate is domestic currency (PKR) per unit of US dollar.  
Source: Author's own elaboration using the Pakistan Customs dataset.

### 5.2.2 Firm-Level Data of Agricultural Exports

This Chapter uses transaction-level data of firms exporting agricultural commodities classified in Chapters 1–24 of the Harmonised System (HS) of classification. This data is also sourced from Pakistan Customs and described in detail in Chapter 1<sup>49</sup>.

This raw dataset of agricultural exports contains 2.4 million transactions for the period from July 2000 to December 2015. To generate a manageable sample, the analysis is restricted to 14 years, from 2000 to 2013. The export markets with fewer than 40 transactions per year are dropped, which restricts the sample to 142 destinations<sup>50</sup>. Similarly, the observations falling below the 1st percentile and above the 99th percentile of export values are truncated to remove potential outliers, and transactions with inconsistent units of measurement are dropped. This cleaned sample is collapsed at the firm-product-currency-market-year level, which generates 703,196 observations. This final sample captures around 95% of Pakistan’s agricultural exports and provides wide geographical coverage of export markets with a good mix of developed and developing countries. Table A 5.1 and Table A 5.2 in the appendix contains the detailed list of export destinations and products, respectively. Table 5.1 contains summary statistics of the variables.

**Table 5.1: Summary Statistics**

| Variable                         | Obs.    | Mean | St. dev. |
|----------------------------------|---------|------|----------|
| Exchange rate                    | 703,196 | 76.6 | 57.3     |
| Bilateral exchange rate          | 527,488 | 48.4 | 77.6     |
| Intensive margins                | 703,196 | 2.8  | 21.3     |
| Tariffs (ad valorem)             | 703,196 | 6.6  | 16.2     |
| Standard deviation of tariff     | 703,196 | 2.8  | 8.2      |
| Quantity margins (tonne)         | 703,196 | 158  | 1704     |
| Price margins (PKR million)      | 703,196 | 0.2  | 11.6     |
| Non-tariff measures (ad valorem) | 660,501 | 222  | 71.5     |

Note: Exchange rate is PKR/currency of transaction and bilateral exchange rate is PKR/currency of trading partners.

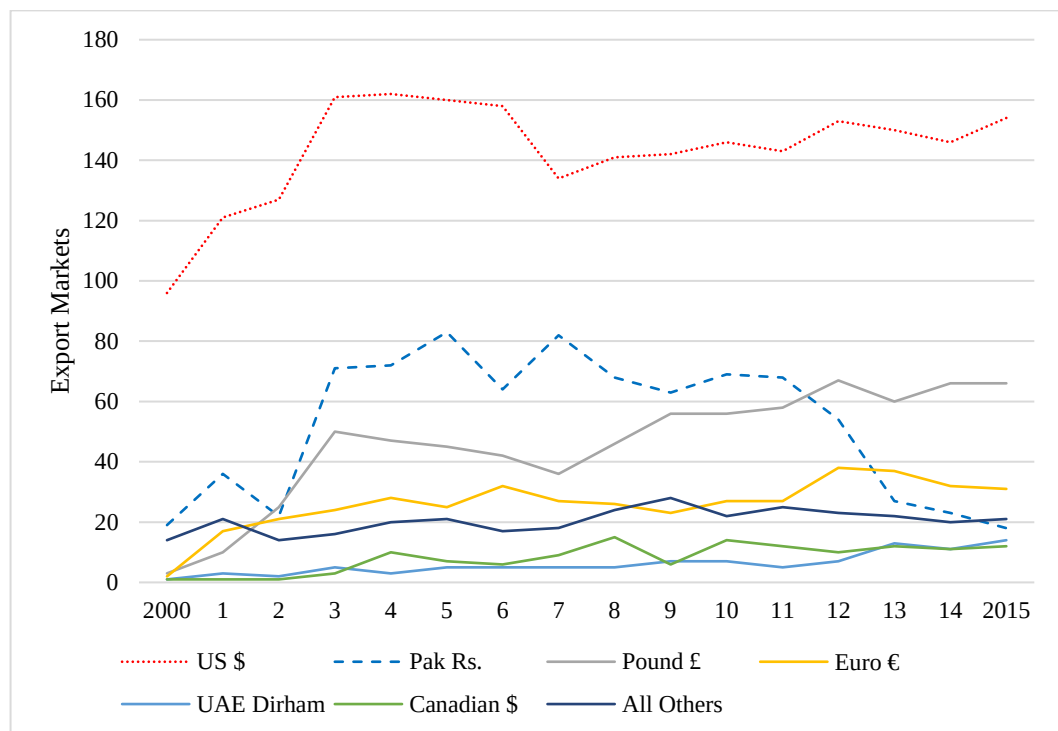
<sup>49</sup> These are propriety data of the government of Pakistan and are subject to a confidentiality agreement.

<sup>50</sup> This transformation is necessary as required information on the macro variables of many small economies is not available for the whole period.

### 5.2.3 Invoicing Behaviour of Firms

The data show that the currencies of invoicing vary across and within markets. Around 95% of all export transactions are settled in six major currencies: the US dollar, Pakistani rupee (PKR), pound sterling, the euro, Canadian dollar and the UAE dirham. The US dollar is used for negotiating exports to a large number of markets, followed by the PKR (the domestic currency) and the pound sterling (Figure 5.2). Use of the US dollar dropped slightly from, 2008 onwards, but it is still the preferred currency of invoicing. The use of other major currencies, such as the euro, pound sterling, Canadian dollar and United Arab Emirates (UAE) dirham, has varied a little over time. This pattern of invoicing in a few major currencies suggests that estimating the trade response using the bilateral exchange rate between trading partners (as is standard practice in the literature) needs modifying to avoid misrepresenting the pattern observed in the data.

**Figure 5.2. Pattern of Invoicing Currencies use over Time**



Source: Author's own elaboration using the Pakistan Customs dataset.

The invoicing behaviour varies not only across but also within markets. This heterogeneity in currency use for the four largest export markets of Pakistan is shown in Table 5.2. This data suggests that most firms use either the buyers' currency or the vehicle currency, which is typical for a small country (Goldberg and

Tille, 2008). In 2013, around 50% of export transactions with the UK and Germany were settled in the US dollar, with the remaining 50% in the currencies of the destination markets: the pound sterling and the euro, respectively. In contrast, almost all the exports to UAE and China were invoiced in the US dollar, which is neither the currency of the market of origin nor that of the destination.

**Table 5.2. Export Transactions (%) by Invoicing Currency**

| <b>for Major Export Markets, 2013</b> |                |         |        |        |
|---------------------------------------|----------------|---------|--------|--------|
| Currency                              | Export markets |         |        |        |
|                                       | UK             | Germany | China  | UAE    |
| US\$                                  | 50.77          | 49.01   | 98.8   | 95.67  |
| Euro                                  | 1.6            | 50.34   | 0.28   | 0.62   |
| STG                                   | 46.4           | 0.17    | 0.02   | 0.39   |
| Rupee                                 | 1.03           | 0.36    | 0.89   | 1.79   |
| Dirham                                | 0.12           | -       | -      | 1.52   |
| Total                                 | 55,664         | 34,252  | 44,741 | 77,532 |

Note. The Table shows the variations in invoicing currencies use within export markets. The data indicate fraction of total transactions by market.

Source: Author's calculations using the administrative dataset.

This heterogeneity in invoicing behaviour across and within markets suggests that the observed exchange rate across markets could be different from the bilateral exchange rate. For example, in 2013, the exchange rates of three major currencies against the PKR were PKR 154/pound sterling, PKR 120/euro and PKR 90/US dollar. As around 50% of exports to the markets of the UK and Germany were invoiced in US dollars, the observed exchange rates of the PKR for these markets are PKR 122/pound and PKR 110/euro,<sup>51</sup> respectively. Similarly, almost all exports to the UAE and China were invoiced in US dollars, and the data rarely reflect the dirham and the yuan, the currencies of these markets. Therefore, using exchange rates of dirham or yuan to estimate the trade effect of depreciation could misrepresent the actual behaviour of firms.

Overall, these descriptive statistics suggest that invoicing currencies vary across and within markets. Therefore, for precise estimation, this Chapter uses the exchange rates of the observed invoicing currencies, rather than the bilateral exchange rates between trading partners.

<sup>51</sup> Weighted average of exchange rates of the currencies employed.

### 5.3 Estimation Strategy

To quantify the effect of the exchange rate movement on firm-level exports, this Chapter uses the following regression equation:

$$\ln(IM)_{ijkct} = \beta_0 + \beta_1 \ln(exrt_{ijkc})_{t-1} + \beta_2 \ln(tariffs)_{jkt} + \beta_3 \ln(sd\_tariff)_{jkt} + \beta_4 \ln(net\_imp)_{jkt-1} + \alpha_{it} + \gamma_{kt} + \lambda_{jt} + \epsilon_{ijkct} \dots (1)$$

The subscripts  $i, j, k, c$  and  $t$  denote firms, markets, products, invoicing currency and time, respectively.

The dependent variable is the intensive margin (IM)<sup>52</sup>. This is the value of exports per firm at product-market-year level by currency of invoicing and is measured in PKR million. Products are identified at HS8 level, the highest level of disaggregation in this dataset. Since the value of exports, prices and quantities per firm are observed at the HS8 level, the model is estimated at the same detailed level to avoid aggregation bias.

The description of the explanatory variables is as follows:

*exrt*: Exchange rate of currency of transaction  $c$  used by firm  $i$  for exporting commodity  $k$  to market  $j$  at time  $t$ . This is the main regressor of interest and is measured as domestic currency (PKR) per unit of foreign currency. The depreciation of domestic currency appears as an increase in the exchange rate and its lagged values are used to avoid simultaneity problem.  $\beta_1$  is our main coefficient of interest and is expected to be positive.

*tariff*: Applied tariff rate in *ad valorem*; tariffs are a variable cost that are proportional to the export volume. The data on tariffs is extracted from the tariff download facility of World Trade Organization (WTO).

*sd\_tariffs*: Standard deviation of the tariff within each Chapter of the HS classifications. It measures the complexity of the tariff system of trading partners

<sup>52</sup> This concept of intensive margins (IM) is similar to that of Chaney (2008), which defines IM as the value shipped by a marginal exporter. It is different from the definition of IM used Bernard et al. (2007) and Mayer and Ottaviano (2008), which aggregate the data and then split it to number of firms and average value of exports per firm.

that can arise because of within-product variation in tariffs and seasonal tariff peaks on some commodities.

*net\_imports*: Net imports account for the foreign demand for a specific commodity. This variable represents total imports of trading partner  $j$  in product  $k$  at time  $t$  minus their imports from Pakistan at time  $t$ . This variable is constructed using trade flows from the UN Comtrade database. Its lagged values are used to avoid simultaneity problems. Some studies use GDP as a proxy for demand; others argue that export absorption is a better indicator. This analysis uses net imports in the baseline estimations and GDP in robustness checks.

$\alpha_{it}$ ,  $\gamma_{kt}$  and  $\lambda_{jt}$  are a set of time-varying fixed effects for firms, products and markets, respectively, and  $\epsilon_{ijkct}$  is an i.i.d component. Firm-year fixed effects capture the omitted variables affecting the marginal cost of firms over time. Product-year fixed effects soak up seasonal factors affecting trade in these commodities, and market-year fixed effects absorb variation in remoteness of export markets and provide a control for multilateral resistance for destination markets.

This choice of control variables is relatively close to Greenaway, Kneller and Zhang (2010) and Taglioni (2012) and the set of fixed effects is similar to Fitzgerald and Haller (2014). In addition to these fixed effects, additional control variables such as trade costs and NTMs are introduced in robustness checks. The data on these variables come from the UN Economic and Social Commission for Asia and the Pacific/World Bank trade-cost dataset, which provides an *ad valorem* equivalent of costs of exporting and splits these into tariffs and NTMs (Arvis et al., 2016).

Given the length of time the dataset covers, linear time trend is included in all the estimations. The linear time trend captures secular changes in exports over time. The trend also serves as a deflator of the nominal series used as a dependent variable and some explanatory variables (Paudel and Burke, 2015). All estimations are in logarithmic form and the estimation method is ordinary least squares (OLS). To account for autocorrelation, standard errors are clustered at the market-year level.

The same specification is employed to estimate the responses of price and quantity margins and extensive margins (EM). Existing studies define EM at different levels of aggregation and use a variety of definitions. Some authors employ binary models

to examine the probability of a firm entering into export markets; others use the number of firms and products, number of buyers per firm or number of markets per firm. This Chapter follows the second approach<sup>53</sup> and estimates the reactions of four components of EM: (1) firm EM – number of firms per product per market; (2) product EM – number of products per firm per market; (3) market EM – number of markets per firm per product; and (4) consumer margins – number of clients per firm per market.

The econometric strategy is transposed from various empirical studies that use firm-level/transaction-level datasets for the manufacturing sector. Berman et al. (2012) have similar estimation approach, both for intensive margins and for their decomposition along prices and quantities. Liu et al. (2013) also use the similar approach to examine the response of intensive and extensive margins for Chinese exports. Taglioni (2012) uses the same specification to investigate the response of intensive margins as well as extensive margins of firms but takes the intensive and extensive margins as a simultaneous decision but the other studies referred above do not.

The same specification is employed to estimate the responses of EM. Greenaway, Kneller and Zhang (2010) define extensive margins as propensity to exporting only, whereas the other recent studies take broader view of the extensive margin and examines them at multiple levels. This article follows the later approach and estimates response of EM to exchange rate movement along four different dimensions: firm EM, product EM, market EM and consumer EM.<sup>54</sup>

In an alternative specification, firm- and market-specific exchange rates are computed over time and their lagged values are used in the estimations. This transformation overcomes potential endogeneity caused by the switching of currencies. This stringent specification uses the following regression framework.

$$\ln(X)_{ijkt} = \beta_0 + \beta_1 \ln(exrt_{ijk})_{t-1} + \alpha_{it} + \gamma_{kt} + \lambda_{jt} + \varepsilon_{ijkt} \dots\dots\dots(2)$$

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<sup>53</sup> The reason is that, at a firm level, moving from zero to one products or markets is much different than moving from one to two. Moreover, these margins capture different dimensions of export diversification, which is one of secondary questions this Chapter aims to investigate.

<sup>54</sup> The reason is that, at a firm level, moving from zero to one products or markets is much different from moving from one to two. Moreover, these elements capture different dimensions of export diversification, which is one of secondary questions this article aims to investigate.

The subscript  $i$  denotes the firm,  $j$  the trading partners,  $k$  the product and  $t$  the time (year).  $\alpha_{it}$ ,  $\gamma_{kt}$  and  $\lambda_{jt}$  are sets of time-varying fixed effects for firms, products and markets to soak up other confounding factors. These two specifications provide more comprehensive estimates.

## 5.4 Main Results and Discussion

This section initially presents the response of intensive margins (IM) and then decomposes the effect along prices and quantities.

### 5.4.1 Response of Intensive Margins

Table 5.3 presents the baseline estimation results for the effect of currency depreciation on intensive margins. Column (1) contains pure variation in the data. As the results indicate, the coefficient for the exchange rate variable is positive and statistically significant at the 1% level, indicating that currency depreciation positively influences IM. As these estimations are in logs, the coefficient can be directly interpreted as an elasticity. The coefficient of 0.179 on exchange rate variable in column (1) means that, on average, a depreciation of 10% in the domestic currency is associated with an increase of 1.79% in IM.

Columns (2) to (5) add other covariates. As expected, tariff bears a negative sign and so does the complexity of tariffs of trading partners, as evidenced by the negative coefficient for the standard deviation of tariffs. In contrast, the positive coefficient for net imports suggests that greater demand in the destination market attracts more exports. The coefficient for the time trend is positive and statistically significant, showing increase in IM over time, which appears to be evidence in favour of learning through exporting. These estimates indicate that currency depreciation positively affects the IM of exports and this effect is quite stable in sign and statistical significance.

To isolate the effect of the exchange rate from the unobservable, the estimations in columns (1) to (4) include fixed effects for firms, products and markets. These dummies absorb time-invariant factors (such as distance, language, relative income level). Market fixed effects capture time-invariant reasons for the exports of firms to certain markets being larger than those to others, such as countries' geographical characteristics. The time trend accounts for the changes in these characteristics and controls for the variation in the aggregate economic performance of the market of origin over time.

**Table 5.3. Main Results:**

| <b>Responses of Intensive Margins, Price Margins and Quantity Margins</b> |                                    |                     |                      |                      |                      |                      |                     |                     |                     |                      |
|---------------------------------------------------------------------------|------------------------------------|---------------------|----------------------|----------------------|----------------------|----------------------|---------------------|---------------------|---------------------|----------------------|
| Dependent variables                                                       | Intensive margins (columns 1 to 8) |                     |                      |                      |                      |                      | Quantity            |                     | Price               |                      |
|                                                                           | Equation-1 (columns 1 to 6)        |                     |                      |                      |                      |                      | Equation-II         |                     | Equation-I          |                      |
|                                                                           | (1)                                | (2)                 | (3)                  | (4)                  | (5)                  | (6)                  | (7)                 | (8)                 | (9)                 | (10)                 |
| Exchange rate                                                             | 0.179***<br>(0.014)                | 0.183***<br>(0.014) | 0.187***<br>(0.004)  | 0.188***<br>(0.014)  | 0.174***<br>(0.014)  | 0.145***<br>(0.013)  | 0.205***<br>(0.050) | 0.272**<br>(0.110)  | 0.044***<br>(0.011) | 0.121***<br>(0.009)  |
| Additional controls                                                       |                                    |                     |                      |                      |                      |                      |                     |                     |                     |                      |
| Net imports                                                               |                                    | 0.038***<br>(0.001) | 0.037***<br>(0.000)  | 0.036***<br>(0.001)  | 0.104***<br>(0.001)  | 0.098***<br>(0.001)  |                     |                     | 0.086***<br>(0.001) | 0.018***<br>(0.001)  |
| Tariffs                                                                   |                                    |                     | -0.073***<br>(0.002) | -0.069***<br>(0.003) | -0.087***<br>(0.004) | -0.116***<br>(0.004) |                     |                     | 0.004<br>(0.003)    | -0.092***<br>(0.003) |
| St. dev. of tariffs                                                       |                                    |                     |                      | -0.025***<br>(0.003) | -0.117***<br>(0.005) | -0.126***<br>(0.006) |                     |                     | 0.002<br>(0.004)    | -0.119***<br>(0.004) |
| Time trend                                                                | 0.143***<br>(0.001)                | 0.133***<br>(0.001) | 0.132***<br>(0.001)  | 0.132***<br>(0.001)  |                      | 0.145***<br>(0.013)  |                     | 0.112***<br>(0.001) |                     |                      |
| FE (firm, product, market)                                                | Y                                  | Y                   | Y                    | Y                    |                      |                      |                     |                     |                     |                      |
| Firm-year                                                                 |                                    |                     |                      |                      | Y                    |                      | Y                   |                     | Y                   | Y                    |
| Product-year                                                              |                                    |                     |                      |                      | Y                    | Y                    | Y                   |                     | Y                   | Y                    |
| Market-year                                                               |                                    |                     |                      |                      | Y                    | Y                    | Y                   |                     | Y                   | Y                    |
| Firm-market                                                               |                                    |                     |                      |                      |                      | Y                    |                     |                     |                     |                      |
| Firm-product-market                                                       |                                    |                     |                      |                      |                      |                      |                     | Y                   |                     |                      |
| R2                                                                        | 0.704                              | 0.721               | 0.721                | 0.723                | 0.721                | 0.791                | 0.747               | 0.738               | 0.721               | 0.723                |
| N                                                                         | 703,196                            | 703,196             | 703,196              | 703,196              | 692,015              | 690,048              | 35,995              | 23,139              | 692,015             | 692,015              |

Notes: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of direct interest. The estimation method is OLS using Stata 13.0 SE. \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01. All the estimations are in logs. Columns (7) and (8) have fewer observations as these estimations are performed at a higher level of aggregation. Similarly, columns (5) - (6) and (9) and (10) have relatively smaller numbers of observation compared with those in column (4) as singleton observations are dropped by Stata. The coefficients in columns (9) and (10) add up to that in column (5). The addition of time-varying fixed effects in column (5) absorbs the effect of time trend.

Product fixed effects account for heterogeneity across commodity groups, such as supply shocks, and firm fixed effects absorb the firm-related unobservable affecting the marginal costs.

Column (5) includes time-varying fixed effects for firms, products and markets to account for other factors influencing marginal costs; these dummies control for most of the potentially omitted variables that might vary over time, for example, the improvement in firms' performance or any supply shocks. The positive sign for the coefficient of interest and its statistical significance level remain quite stable, which corroborates the stability of the estimates. The results in column (5) are used as a baseline.

Columns (6) to (8) provide initial robustness checks. Column (6) adds firm-market fixed effects, which account for the persistency of export behaviour across markets. Column (7) presents estimation results for equation (2). This alternative specification yields similar results. Column (8) adds fixed effects for firm-product-market, which eliminates concerns about the heterogeneity of product quality across markets. This relatively rigid specification generates results identical to those of the baseline estimates. As row (1) indicates, the coefficient for the exchange rate variable is positive and statistically significant at the 1% significance level in all these estimations, and its magnitude is close to that in the baseline estimates.

In the absence of firm-level studies on the effects of the exchange rate in the agriculture sector, these results are not directly comparable with any earlier work. There is a large literature on the exchange rate effects on agricultural exports from advanced economies including the US, Canada and the EU (for a survey see Kristinek and Anderson, 2002) but most of these studies use product-level data. However, when looking at similar work in the manufacturing sector, the positive effect of the exchange rate on IM is consistent with the findings of Berg and Miao (2010) and Freund and Pierola (2008). But it contradicts the results of Bernard and Jensen (2004), which find no association between the exchange rate and firms' exports. The magnitude of the effect differs from that in existing studies. For example, Berman, Martin and Mayer (2012) find that a 10% depreciation increases the exports of an average exporter by 4%. The point estimate of the elasticity found

by Fitzgerald and Haller (2014) is 0.64. Compared with these studies, the response of Pakistan's agricultural exports appears to be relatively smaller.

#### **5.4.2 Responses of Prices and Quantities**

To pin down the mechanism of the increase in exports along intensive margins, columns (9) and (10) examine the responses of price and quantity margins. The deconstruction indicates that a depreciation of 10% is associated with an increase in prices by 1.2% and quantities by 0.44%. As we use the OLS estimator to decompose the overall effect on IM into its components, the coefficients for price and quantity variables indicate their relative responses because the OLS estimator has an additive property. In relative terms, 75% of the effect of the exchange rate operates through prices and 25% through quantities. This deconstruction suggests that the increase in exports occurs largely through the channel of prices and the response of quantities is relatively smaller.

The high response of prices represents increase in profit margins. There could be many reasons for the relatively rigid behaviour of quantities. For instance, price adjustments may mitigate the need for quantity adjustment. Moreover, high airfreight charges may discourage the shipment of large quantities, as the perishable nature of most of these products means they are exported by air. Also, some agricultural products are customised, as buyers have specific packing, labelling and conformity assessment requirements. It may thus be difficult to economise on the cost of changing quantities.

## 5.5 Heterogeneity Analysis

This section examines the variation in exchange rate effect on trade margins along five dimensions of firm and product heterogeneity: across product groups, invoicing currencies, exchange rate regime type, exporting experience and over time.

### 5.5.1 Heterogeneity across Product Groups

The responses of trade margins within the agriculture sector are expected to be heterogenous as these products differ in terms of speed of supply response as well as in terms of their intensity of imported intermediary inputs, which can offset the direct effect of currency depreciation. Table 5.4 decomposes the estimated coefficient in baseline specification<sup>55</sup> across broad commodity groups. The disaggregation suggests that exports from all sectors respond positively to depreciation, but the effect is larger for primary products (animal and animal products; fruits and vegetables) and comparatively smaller for processed goods (prepared food stuff; animal or vegetable fats).

Overall, large responses appear to come from the products that are least dependent on imported intermediate inputs, such as fruits and vegetables, as these products are least likely to be affected by the offsetting channel of imported inputs. In contrast, the effect is relatively smaller for goods requiring more imported inputs for production, such as prepared food stuffs or animal or vegetable fats. As manufacturing of these value-added products requires imported chemicals or machinery, the rise in the price of imported inputs because of depreciation may partially offset the effect of the exchange rate on exports.

Columns (2) and (3) show that the positive response along the IM transmits mainly through prices and the reaction of quantities is weak, except for in fruits and vegetables. The response of quantities is statistically insignificant for animal and animal products and for animal or vegetable fats. This heterogeneity in the responses of quantities across sectors potentially coincides with the time required

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<sup>55</sup> The estimates in column 5 of Table 5.3 are used as a baseline.

for a supply response: vegetables can be grown relatively quickly but raising animals requires a substantial long-time.

**Table 5.4.Heterogeneity of Trade Response across Product Groups**

| Dependent variables         | Intensive<br>margins<br>(1) | Quantity<br>margins<br>(2) | Price<br>margins<br>(3) |
|-----------------------------|-----------------------------|----------------------------|-------------------------|
| Exchange rate x             |                             |                            |                         |
| Animals and animal products | 0.245***<br>(0.016)         | 0.020<br>(0.013)           | 0.217***<br>(0.010)     |
| Fruits and vegetables       | 0.207***<br>(0.015)         | 0.067***<br>(0.011)        | 0.131***<br>(0.009)     |
| Animals or vegetable fats   | 0.138***<br>(0.023)         | 0.020<br>(0.019)           | 0.110***<br>(0.021)     |
| Prepared food stuffs        | 0.118***<br>(0.015)         | 0.022*<br>(0.012)          | 0.086***<br>(0.010)     |
| R2                          | 0.721                       | 0.691                      | 0.570                   |
| N                           | 692,015                     | 692,015                    | 692,015                 |

Note: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of interest. The estimation method is OLS using Stata 13.0 SE. \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01. The coefficients in columns (2) and (3) add up that in column (1).

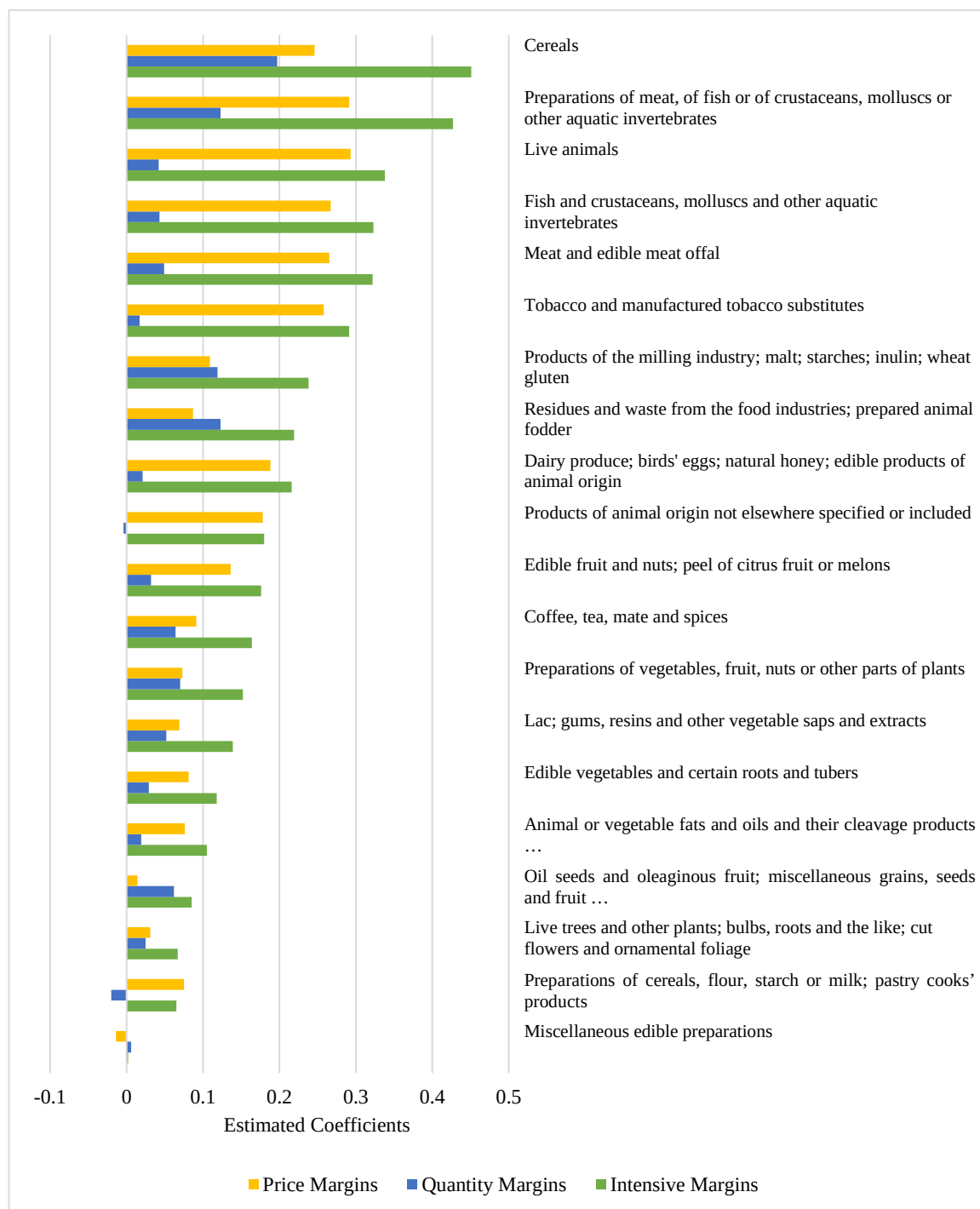
Further decomposition of the exchange rate effect across the subsectors within agriculture reveals a high degree of variation in the responses of trade margins (Figure 5.3). The detailed estimates of these sub-groups are contained in Table A 5.3 in the appendix. This chart indicates that the effect is greater for primary commodities, such as cereals, meat and fish products, than it is for processed food items, such as sugar, beverages and oils. This heterogeneity also seems to come, *inter alia*, from the offsetting channel of imported inputs, as the products that are the least dependent on imported inputs show a larger response. The deconstruction of the effect along prices and quantities reveals a relatively large effect through the channel of prices, which is consistent with the baseline results.

#### 5.5.2 Heterogeneity along Currencies and Exchange Rate Regime Type

Panel A of Table 5.5 decomposes the coefficient on the exchange rate variable along invoicing currencies to understand the differences in responses across various currency groups. These estimates show that the response of the IM is relatively large for domestic currency (PKR) invoicing compared with those using vehicle

currencies. As the US dollar is the most widely used currency, the magnitude of the coefficient for dollar-invoiced transactions is similar to that in the baseline results.

**Figure 5.3. Heterogeneity of Exchange Rate Effect across Products**



Notes: The chart plots the estimated coefficients on trade margins. The detailed estimates are reported in Table A 5.3 in the appendix. The coefficients on price and quality margins add up to that on the intensive margin.

**Table 5.5: Effects of Invoicing Behaviour and Exchange Rate Regimes****A: Heterogeneity of responses of trade margins along invoicing currencies**

| Dependent variables | Intensive<br>margins<br>(1) | Quantity<br>margins<br>(2) | Price<br>margins<br>(3) |
|---------------------|-----------------------------|----------------------------|-------------------------|
| Exchange rate x     |                             |                            |                         |
| US dollar           | 0.188***<br>(0.015)         | 0.040***<br>(0.011)        | 0.139***<br>(0.009)     |
| Pak rupee           | 0.322***<br>(0.060)         | 0.093**<br>(0.045)         | 0.223***<br>(0.068)     |
| Pound sterling      | 0.183***<br>(0.014)         | 0.044***<br>(0.011)        | 0.130***<br>(0.009)     |
| Euro                | 0.166***<br>(0.014)         | 0.051***<br>(0.010)        | 0.107***<br>(0.009)     |
| Canadian dollar     | 0.166***<br>(0.016)         | 0.029**<br>(0.012)         | 0.127***<br>(0.011)     |
| All others          | 0.286***<br>(0.023)         | 0.048***<br>(0.017)        | 0.226***<br>(0.018)     |
| R2                  | 0.721                       | 0.698                      | 0.585                   |
| N                   | 692,015                     | 692,015                    | 692,015                 |

**B: Heterogeneity of responses of trade margins across exchange rate regimes**

|                 |                     |                     |                     |
|-----------------|---------------------|---------------------|---------------------|
| Exchange rate x |                     |                     |                     |
| Fixed regime    | 0.258***<br>(0.021) | 0.137***<br>(0.016) | 0.107***<br>(0.012) |
| Floating regime | 0.115***<br>(0.016) | -0.020<br>(0.012)   | 0.130***<br>(0.011) |
| R2              | 0.729               | 0.69                | 0.57                |
| N               | 692,015             | 692,015             | 692,015             |

Note: Robust standard errors are in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . The regressions include fixed effects for firms, products and markets but their coefficients are not reported. These estimates were obtained using Stata 13 SE. These dependent variables are defined at the head of each column. The estimation method is OLS using Stata 13.0 SE. The coefficients in columns (2) and (3) add up that in column (1). The coefficients in columns (2) and (3) add up that in column (1).

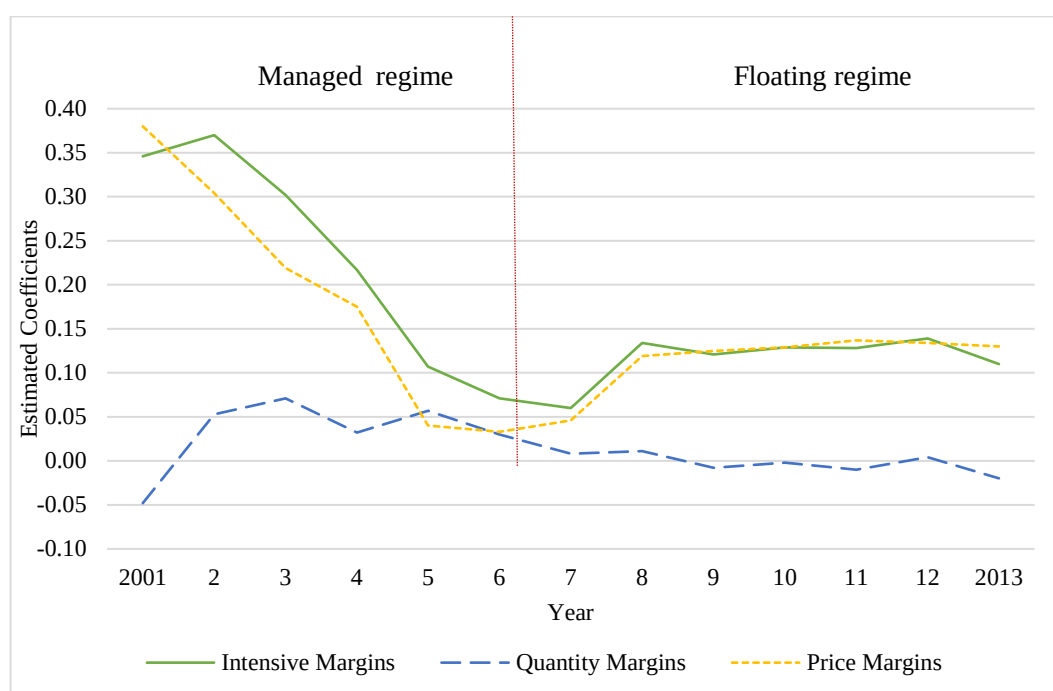
The decomposition of the response of the IM to that of price and quantity margins in columns (2) and (3) along invoicing currencies reveals that the responses of both price and quantities are positive and statistically significant. The magnitude of the effect varies along invoicing currencies, but in all these estimations, the magnitude of the effect is larger for price than quantity margins. This suggests that depreciation reduces marginal costs and exporters seem to raise their prices.

Panel B of Table 5.5 examines the heterogeneity of trade responses in fixed and floating exchange rate regimes. Pakistan's currency was initially pegged to the US

dollar, with this peg removed in 2007. A comparison of estimates shows that the response of the intensive margins is almost double in the fixed regime than in floating, suggesting that the type of exchange rate regime also matters. In the fixed regime, the responses of both quantities and prices are positive and similar in magnitude. However, in the floating regime, the entire effect is transmitted through prices, indicating firms' ability to adjust prices in response to exchange rate movement (Hoffmann, 2007).

Many studies show that the effect of the exchange rate depends on the period of the investigation: the long-run effect may differ from the short-term effect as prices are less sticky in the former. Given the long timespan of the dataset, the average effect is decomposed into yearly periods to see if any specific year drives the results. Figure 5.4 presents the results; the detailed estimates are reported in Table A 5.4 in the appendix.

**Figure 5.4. Heterogeneity in the Exchange Rate Effects over Time**



Notes: The Figure plots the estimated coefficients on the intensive margin and its two components, prices and quantities, over time. The vertical line indicates the switching of the exchange rate regime from managed to free floating.

As this decomposition suggests, the effect of the first depreciation in 2000 is large but transitory, as the magnitude of the effect decreases gradually from 2000 to 2007, whereas that of the second depreciation in 2007 appears small but somewhat persistent. This difference coincides with the changes in the exchange rate regime

as mentioned above, when the country moved from a fixed regime to a free-floating system.

The deconstruction of response of the IM into price and quantity margins indicates that the adjustment in price drives this effect. Quantities respond positively in the fixed exchange rate regime but do not respond in the floating period because the free-floating regime allows for adjustment in prices in reaction to exchange rate movement. Second, this later period is associated with the rise of protectionism following the global financial crisis. These estimates also show that the short-term effect of depreciation is relatively larger, and firms make gradual adjustments.

### 5.5.3 Heterogeneity across Markets and Exporting Experience

Panel A of Table 5.6 presents the exchange rate effect on trade margins for various market groups. It indicates that the highest response came from exports to the markets of South Asia, East Asia and sub-Saharan Africa. The larger effect for these markets of developing economies indicates a rising pattern of South–South trade. In contrast, the exchange rate effect is much smaller for the markets of North America and Europe, which could be because of stringent NTM imposed by these economies on agricultural imports (UNCTAD, 2013).

To investigate whether the increase in exports occurs because of larger exports by incumbents or entrants, panel B decomposes the estimated coefficients along firms' exporting experience: entrants (new firms) and incumbents (existing firms). Entrants started exporting at time  $t$  but did not export at time  $t-1$ ; incumbents exported at  $t-1$  and also at time  $t$  but ceased exporting at  $t+1$ . Firms are considered entrants only in their first year of exporting and are treated as incumbents in subsequent periods<sup>56</sup>. These results suggest that both cohorts respond positively to currency depreciation, but the magnitude of the effect is slightly larger for incumbents. The incumbents ship larger quantities, whereas entrants increase exports mainly through the channel of prices. This is quite intuitive as incumbents may benefit from their established presence in export markets.

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<sup>56</sup> These definitions of entrants and incumbents are adopted from Exporter Dynamic Database of the World Bank.

**Table 5.6. Heterogeneity across Markets****A: Heterogeneity across export markets**

| Dependent variables        | Intensive margins<br>(1) | Quantity margins<br>(2) | Price margins<br>(3) |
|----------------------------|--------------------------|-------------------------|----------------------|
| Exchange rate x            |                          |                         |                      |
| East Asia & Pacific        | 0.128***<br>(0.015)      | 0.029**<br>(0.012)      | 0.093***<br>(0.009)  |
| Europe & Central Asia      | 0.097***<br>(0.014)      | -0.001<br>(0.011)       | 0.091***<br>(0.008)  |
| Latin America & Caribbean  | 0.069***<br>(0.018)      | -0.006<br>(0.015)       | 0.067***<br>(0.014)  |
| Middle East & North Africa | 0.153***<br>(0.015)      | 0.063***<br>(0.011)     | 0.082***<br>(0.009)  |
| North America              | 0.047***<br>(0.015)      | -0.047***<br>(0.012)    | 0.086***<br>(0.009)  |
| South Asia                 | 0.242***<br>(0.015)      | 0.083***<br>(0.012)     | 0.149***<br>(0.009)  |
| Sub-Saharan Africa         | 0.182***<br>(0.015)      | 0.090***<br>(0.012)     | 0.083***<br>(0.009)  |
| R2                         | 0.709                    | 0.695                   | 0.575                |
| N                          | 692,105                  | 692,105                 | 692,105              |

**B: Heterogeneity across firms' exporting experience**

|                 |                     |                     |                     |
|-----------------|---------------------|---------------------|---------------------|
| Exchange rate x |                     |                     |                     |
| Entrants        | 0.151***<br>(0.023) | 0.007<br>(0.019)    | 0.142***<br>(0.018) |
| Incumbents      | 0.177***<br>(0.015) | 0.049***<br>(0.012) | 0.118***<br>(0.010) |
| R2              | 0.721               | 0.698               | 0.585               |
| N               | 692,105             | 692,105             | 692,105             |

Note: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of interest. The estimation method is OLS using Stata 13.0 SE. \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01. In panel A export markets are grouped following the regional classification of World Bank. In panel B firms are grouped as follows. Entrants started exporting at time t but did not export at time t-1, incumbents exported at t-1 and also at time t but ceased exporting at t+1. IM stands for intensive margins. The coefficients in columns (2) and (3) add up that in column (1).

## 5.6 Further Robustness Checks

This section tests the robustness of the benchmark results by including additional covariates and allowing for the differential response of firms to macroeconomic variables. It also shows the effect of using the bilateral exchange rate in estimations.

### 5.6.1 Controls for Omitted Variables

Table 5.7 shows the effect of additional regressors on the main results. In addition to the standard set of covariates incorporated in the baseline estimations, it adds NTMs, trade costs, GDP per capita and the market share of firms (columns 1 to 3, respectively). These estimations obviate the threat that our regressor of interest may be picking up the effect of any of these variables. In all these estimations, the effect of the exchange rate is positive and statistically significant, and the magnitude of the coefficient is in the range of the baseline results. Moreover, these additional covariates bear the expected signs. For example, the coefficient for NTMs and trade costs is negative, whereas that for the GDP of destination markets is positive, as expected.

**Table 5.7. Effect of Additional Covariates on the Baseline Results**

| The dependent variable is the intensive margin |                      |                      |                       |                     |                     |
|------------------------------------------------|----------------------|----------------------|-----------------------|---------------------|---------------------|
|                                                | (1)                  | (2)                  | (3)                   | (4)                 | (5)                 |
| Exchange rate                                  | 0.177***<br>(0.014)  | 0.177***<br>(0.014)  | 0.166***<br>(0.015)   | 0.185***<br>(0.014) | 0.206***<br>(0.010) |
| NTMs                                           | -0.233***<br>(0.028) |                      |                       |                     |                     |
| Trade costs                                    |                      | -0.232***<br>(0.027) |                       |                     | -0.099**<br>(0.046) |
| GDP per capita                                 |                      |                      | 0.228***<br>(0.0, 20) |                     | 0.136***<br>(0.025) |
| Market share $t-1$                             |                      |                      |                       | 0.183***<br>(0.005) | 0.321***<br>(0.008) |
| R2                                             | 0.732                | 0.732                | 0.730                 | 0.730               | 0.568               |
| N                                              | 660,502              | 660,502              | 692,105               | 692,105             | 692,105             |

Note: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of interest. The estimation method is OLS using Stata 13.0 SE. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Column (4) incorporates the lagged market share of firms in addition to the standard set of covariates. It captures how large a firm was in a particular market in the previous year. A positive and statistically significant coefficient for this regressor indicates that the effect of the exchange rate is relatively large for already

established firms. This further supports the analysis in panel B of Table 5.7 that incumbents show a larger response than entrants. A similar effect of existing market share is observed in Devereux, Dong and Tomlin (2017). Column (5) shows the combined effect of all regressors, which also supports the baseline findings.

### 5.6.2 Variable Response of Firms to Macroeconomic Factors

Fitzgerald and Haller (2014) argue that imposing the same response for all firm-market pairs to macroeconomic variables (such as tariffs and NTMs) may lead to misleading inferences as the effect of these factors may vary with firm characteristics. To examine this proposition, Table 5.8 allows for differential responses to macroeconomic variables by including the interaction of firm size<sup>57</sup> with tariffs, NTMs and the standard deviation of tariffs as additional regressors. Column (1) adds these interactions for tariffs, column (2) for NTMs and column (3) for the standard deviation of tariffs. Column (4) explores the combined effect of all these variables.

The baseline results hold to the inclusion of differential responses of these additional regressors; moreover, all the explanatory variables bear the expected sign. For instance, tariffs, NTMs and standard deviation of tariffs have negative and significant effects in all the estimations. However, this effect is moderated for larger firms. The positive coefficients for the interaction of firm size with tariffs and NTMs (columns 1 and 2) and for the standard deviation of tariffs (column 3) show that these barriers are relatively low inhibitors for the exports of larger firms. These estimations generate an identical effect of the regressor of interest, but they point towards the heterogeneity of the effect of macroeconomic variables across firm size.

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<sup>57</sup> Information on numbers of employees is unavailable, thus the computation of firm size is based on total sales following the approach of Fontagné et al. (2015).

**Table 5.8. Allowing Variable Response to Macroeconomic Factors**

The dependent variable is the intensive margin

|                           | (1)                  | (2)                  | (3)                  | (4)                  |
|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Exchange rate             | 0.176***<br>(0.014)  | 0.172***<br>(0.014)  | 0.177***<br>(0.014)  | 0.173***<br>(0.014)  |
| Tariffs                   | -0.300***<br>(0.005) | -0.099***<br>(0.003) | -0.096***<br>(0.003) | -0.176***<br>(0.005) |
| Tariffs # firm size       | 0.051***<br>(0.001)  |                      |                      | 0.020***<br>(0.001)  |
| NTMs                      | -0.198***<br>(0.028) | -0.496***<br>(0.027) | -0.226***<br>(0.028) | -0.453***<br>(0.027) |
| NTMs # firm size          |                      | 0.054***<br>(0.001)  |                      | 0.049***<br>(0.001)  |
| SD. of tariff             | -0.053***<br>(0.003) | -0.053***<br>(0.003) | -0.239***<br>(0.006) | -0.104***<br>(0.006) |
| SD. of tariff # firm size |                      |                      | 0.046***<br>(0.001)  | 0.013***<br>(0.001)  |
| R2                        | 0.734                | 0.739                | 0.733                | 0.740                |
| N                         | 660,5, 20            | 660, 5, 20           | 692,105              | 692,105              |

Note: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of interest. The estimation method is OLS using Stata 13.0 SE. \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01. Firm size captures the relative size of firms measured in terms of total exports of a firm in a particular year.

### 5.6.3 Effect of Using Bilateral Exchange Rate in Estimations

Since the existing literature mainly uses the bilateral exchange rate between trading partners, to reconcile the results with existing studies the baseline estimations are replicated with the alternative measure of exchange rate. Table 5.9 presents the results. For comparison of the estimates the same sample is used in both estimates.

This comparison shows that the estimations with the transaction-level exchange rate (column 2) generate a smaller effect compared with that for bilateral level exchange rates (column 1). This substitution of the key independent variable increases the magnitude of the trade effect to the tune of 50%. This large relative difference in the magnitude of coefficients suggests that ignoring the role of invoicing currency may lead to overestimation of the effect of currency depreciation.

**Table 5.9. Effect of Using Bilateral Exchange Rates in Estimations**

The dependent variable is the intensive margin

|               | Bilateral<br>exchange rate<br>(1) | Invoicing currency<br>exchange rate<br>(2) |
|---------------|-----------------------------------|--------------------------------------------|
| Exchange rate | 0.392***<br>(0.032)               | 0.177***<br>(0.016)                        |
| R2            | 0.699                             | 0.700                                      |
| N             | 527,448                           | 527,448                                    |

Note: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of interest. The estimation method is OLS using Stata 13.0 SE. \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01. The sample size in this estimation is different as bilateral exchange rate information is not available for all trading partners of Pakistan for all years. Information on bilateral exchange rates is downloaded from the Penn World Table (PWT 8.1).

### 5.7 Extension: Responses of Extensive Margins

To examine the responses of extensive margins, equation (1) is re-estimated with alternative dependent variables: extensive margins (EM) of firms, products, markets and clients.

**Table 5.10. Responses of Extensive Margins**

A: Overall effect along extensive margins

|               | Firm EM<br>(1)      | Product EM<br>(2)  | Market EM<br>(3)  | Consumer EM<br>(4)  |
|---------------|---------------------|--------------------|-------------------|---------------------|
| Exchange rate | 0.025***<br>(0.008) | 0.014**<br>(0.009) | -0.003<br>(0.005) | 0.029***<br>(0.007) |
| R2            | 0.577               | 0.478              | 0.518             | 0.245               |
| N             | 32,547              | 54,222             | 72,458            | 117,680             |

B: Heterogeneity across exchange rate regimes

|                 |                     |                    |                   |                     |
|-----------------|---------------------|--------------------|-------------------|---------------------|
| Exchange rate x |                     |                    |                   |                     |
| Fixed regime    | 0.034***<br>(0.010) | 0.028**<br>(0.013) | -0.007<br>(0.007) | 0.037***<br>(0.008) |
| Floating regime | 0.018*<br>(0.011)   | -0.004<br>(0.013)  | 0.001<br>(0.006)  | 0.021**<br>(0.010)  |
| R2              | 0.574               | 0.529              | 0.511             | 0.244               |
| N               | 32,547              | 54,222             | 72,458            | 117,680             |

Note: Robust standard errors are in parentheses. \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01. The regressions include fixed effects for firms, markets and time but their coefficients are not reported. These estimates were obtained using Stata 13 SE. These dependent variables are mentioned at the head of each column and defined as follows: firm EM (number of firms per product per market); product EM (number of products per firm per market); market EM (number of markets per firm per product); (4) consumer EM (number of clients per firm per market).

As the results in Table 5.10 indicate, the EM of firms, products and clients respond positively, which means that depreciation incentivises the entry of more firms into

exporting; moreover, firms widen their exported product set and increase penetration in existing markets (columns 1, 2 and 4, respectively). The responses of EM vary with the nature of the exchange rate regime. The relatively large effect in a fixed exchange rate regime suggests that low uncertainty or reduced volatility in the exchange rate incentivises entry into exporting and promotes diversification of the export product mix (columns 1 and 2 of panel B).

## **5.8 Conclusions and Policy Implications**

This Chapter examines the effects of exchange rate movement on the margins of trade in the agriculture sector of Pakistan using highly disaggregated transaction-level data for the recent period (2000–2013). It finds that domestic currency devaluation increases both intensive and extensive margins (IM and EM). These positive responses of trade margins are very robust for Pakistan's firms, although the magnitude of the effect is very small. The increase in IM comes mainly through the channel of prices, whereas the reaction of quantities is relatively smaller. Similarly, the increase in exports along the EM operates through the channels of entry of more firms into exporting, expansion of the export product mix and growth of the client base in existing markets. These effects are relatively stronger in the fixed exchange rate regime compared with those under a floating period. The trade response varies widely across firms, products and markets. The effect is relatively larger for traders of primary commodities than for exporters of processed goods, and it is slightly higher for incumbents compared with for entrants. Similarly, the effect is larger for exports destined to other developing countries compared with those destined for Europe or North America.

The analysis reveals that the precise estimations need to account for the exchange rates of actual currencies used for invoicing export transactions, not the bilateral exchange rate between trading partners. As most transactions are settled in a small number of currencies, the bilateral exchange rate may misrepresent the trade response. Although the Chapter focuses primarily on the effects of the exchange rate, these estimations also point to the large trade-impeding effects of non-tariff measures (NTMs) and the complexity of tariffs in the agriculture sector.

One might expect a greater response of agricultural exports to currency depreciation because of a relatively weak offsetting channel of intermediary input, but the estimated elasticity is much lower than that found in earlier studies on manufacturing sectors. This difference in estimates seems to result from the use of an alternative measure of exchange rate, as evidenced in the data, rather than bilateral exchange rates between trading partners. Another potential reason for the smaller trade response could be slow transmission of the exchange rate effect to producers because they rarely engage in exporting directly but rather rely on intermediary firms.

The pivotal role agriculture plays in the development process and its interactions with other economic sectors mean that promoting agricultural trade is a priority for most developing countries. Middle-income countries, such as China, India, Brazil and Indonesia, represent a rising share of agricultural exports (Alston and Pardey, 2014). Despite there being much interest in this area, researchers have not explored the behaviour of firms in the agriculture sector, mainly because of data limitations. This Chapter bridges this important gap in the literature and the lessons learnt from this analysis can be applied to other economies similar to Pakistan. In particular, the low elasticity of exports in agriculture to currency depreciation suggests that policy-makers need to be cautious in employing exchange rate adjustment as a tool for export development strategies.

## 5.9 Appendix

**Table A 5.1: List of Pakistan's Trading Partners Included in the Analysis**

|                      |                   |              |                      |
|----------------------|-------------------|--------------|----------------------|
| Afghanistan          | Equatorial Guinea | Libya        | Sierra Leone         |
| Albania              | Eritrea           | Lithuania    | Singapore            |
| Algeria              | Estonia           | Madagascar   | Slovak Republic      |
| Angola               | Ethiopia          | Malawi       | Slovenia             |
| Argentina            | Fiji              | Malaysia     | Somalia              |
| Armenia              | Finland           | Maldives     | South Africa         |
| Australia            | France            | Malta        | South Korea          |
| Austria              | Gabon             | Mauritania   | Spain                |
| Azerbaijan           | Gambia            | Mauritius    | Sri Lanka            |
| Bahamas              | Georgia           | Mexico       | Sudan                |
| Bahrain              | Germany           | Mongolia     | Swaziland            |
| Bangladesh           | Ghana             | Morocco      | Sweden               |
| Belarus              | Greece            | Mozambique   | Switzerland          |
| Belgium              | Guatemala         | Myanmar      | Syria                |
| Benin                | Guinea            | Namibia      | Taiwan               |
| Botswana             | Guinea-Bissau     | Nepal        | Tajikistan           |
| Brazil               | Haiti             | Netherlands  | Tanzania             |
| Brunei               | Honduras          | New Zealand  | Thailand             |
| Bulgaria             | Hong Kong         | Niger        | Togo                 |
| Cameroon             | Hungary           | Nigeria      | Trinidad and Tobago  |
| Canada               | India             | North Korea  | Tunisia              |
| Cape Verde           | Indonesia         | Norway       | Turkey               |
| Chile                | Iran              | Oman         | Turkmenistan         |
| China                | Iraq              | Pakistan     | Uganda               |
| Colombia             | Ireland           | Panama       | Ukraine              |
| Comoros              | Italy             | Paraguay     | United Arab Emirates |
| Congo                | Jamaica           | Philippines  | United Kingdom       |
| Cote d'Ivoire        | Japan             | Poland       | United States        |
| Croatia              | Jordan            | Portugal     | Uzbekistan           |
| Cyprus               | Kazakhstan        | Qatar        | Venezuela            |
| Czech Republic       | Kenya             | Romania      | Vietnam              |
| Democratic Republic. | Kuwait            | Russia       | Yemen                |
| Denmark              | Kyrgyz Republic   | Rwanda       | Zambia               |
| Djibouti             | Latvia            | Saudi Arabia | Zimbabwe             |
| Dominican Republic   | Lebanon           | Senegal      |                      |
| Egypt                | Liberia           | Seychelles   |                      |

**Table A 5.2: List of Agricultural Products Included in The Chapter<sup>58</sup>**

SECTION I: <sup>[1]</sup><sub>SEP</sub>LIVE ANIMALS; ANIMAL PRODUCTS

1. Live animals
2. Meat and edible meat offal
3. Fish and crustaceans, molluscs and other aquatic invertebrates
4. Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included
5. Products of animal origin not elsewhere specified or included

SECTION II: VEGETABLE PRODUCTS

6. Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage
7. Edible vegetables and certain roots and tubers
8. Edible fruit and nuts; peel of citrus fruit or melons
9. Coffee, tea, mate and spices
10. Cereals
11. Products of the milling industry; malt; starches; inulin; wheat gluten
12. Oil seeds and oleaginous fruit; miscellaneous grains, seeds and fruit; industrial or medicinal plants, straw and fodder
13. Lac; gums, resins and other vegetable saps and extracts
14. Vegetable plaiting materials; vegetable products not elsewhere specified or included

SECTION III: <sup>[1]</sup><sub>SEP</sub>ANIMAL OR VEGETABLE FATS AND OILS AND THEIR CLEAVAGE PRODUCTS; PREPARED EDIBLE FATS; ANIMAL OR VEGETABLE WAXES

15. Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes

SECTION IV: PREPARED FOODSTUFFS; BEVERAGES, SPIRITS AND VINEGAR; TOBACCO AND MANUFACTURED TOBACCO SUBSTITUTES

16. Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates
17. Sugars and sugar confectionery
18. Cocoa and cocoa preparations
19. Preparations of cereals, flour, starch or milk; pastry cooks' products
20. Preparations of vegetables, fruit, nuts or other parts of plants
21. Miscellaneous edible preparations
22. Beverages, spirits and vinegar
23. Residues and waste from the food industries; prepared animal fodder
24. Tobacco and manufactured tobacco substitutes

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<sup>58</sup> The numbers correspond to the relevant chapter of the Harmonised System of classification.

**Table A 5.3: Heterogeneity across Sub-Sectors**

| Dependent variables |                                                                                            | Intensive<br>margins | Quantity<br>margins  | Price<br>margins     |
|---------------------|--------------------------------------------------------------------------------------------|----------------------|----------------------|----------------------|
| Sr.                 | Exchange rate x                                                                            |                      |                      |                      |
| 1                   | Live animals                                                                               | 0.338***<br>(0.020)  | 0.042**<br>(0.017)   | 0.293***<br>(0.016)  |
| 2                   | Meat and edible meat offal                                                                 | 0.322***<br>(0.022)  | 0.049***<br>(0.017)  | 0.265***<br>(0.015)  |
| 3                   | Fish and crustaceans, molluscs and other aquatic invertebrates                             | 0.323***<br>(0.017)  | 0.043***<br>(0.015)  | 0.267***<br>(0.011)  |
| 4                   | Dairy produce; birds' eggs; natural honey; edible products of animal origin                | 0.216***<br>(0.017)  | 0.021<br>(0.014)     | 0.188***<br>(0.012)  |
| 5                   | Products of animal origin not elsewhere specified or included                              | 0.180***<br>(0.020)  | -0.004<br>(0.017)    | 0.178***<br>(0.015)  |
| 6                   | Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage | 0.067***<br>(0.020)  | 0.025<br>(0.018)     | 0.031*<br>(0.017)    |
| 7                   | Edible vegetables and certain roots and tubers                                             | 0.118***<br>(0.015)  | 0.029***<br>(0.011)  | 0.081***<br>(0.010)  |
| 8                   | Edible fruit and nuts; peel of citrus fruit or melons                                      | 0.176***<br>(0.014)  | 0.032***<br>(0.011)  | 0.136***<br>(0.010)  |
| 9                   | Coffee, tea, mate and spices                                                               | 0.164***<br>(0.015)  | 0.064***<br>(0.012)  | 0.091***<br>(0.010)  |
| 10                  | Cereals                                                                                    | 0.451***<br>(0.015)  | 0.197***<br>(0.012)  | 0.246***<br>(0.010)  |
| 11                  | Products of the milling industry; malt; starches; inulin; wheat gluten                     | 0.238***<br>(0.017)  | 0.119***<br>(0.013)  | 0.109***<br>(0.012)  |
| 12                  | Oil seeds and oleaginous fruit; miscellaneous grains, seeds and fruit ...                  | 0.085***<br>(0.015)  | 0.062***<br>(0.012)  | 0.014<br>(0.011)     |
| 13                  | Lac; gums, resins and other vegetable saps and extracts                                    | 0.139***<br>(0.026)  | 0.052**<br>(0.026)   | 0.069***<br>(0.024)  |
| 14                  | Vegetable plaiting materials; vegetable products not elsewhere specified                   | -0.073***<br>(0.016) | -0.016<br>(0.013)    | -0.066***<br>(0.013) |
| 15                  | Animal or vegetable fats and oils and their cleavage products ...                          | 0.105***<br>(0.022)  | 0.019<br>(0.018)     | 0.076***<br>(0.021)  |
| 16                  | Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates   | 0.427***<br>(0.018)  | 0.123***<br>(0.015)  | 0.291***<br>(0.012)  |
| 17                  | Sugars and sugar confectionery                                                             | -0.006<br>(0.015)    | -0.038***<br>(0.011) | 0.024**<br>(0.010)   |
| 18                  | Cocoa and cocoa preparations <sup>SEP</sup>                                                | -0.016<br>(0.024)    | -0.046**<br>(0.022)  | 0.024<br>(0.0, 20)   |
| 19                  | Preparations of cereals, flour, starch or milk; pastry cooks' products                     | 0.065***<br>(0.015)  | -0.020*<br>(0.012)   | 0.075***<br>(0.011)  |
| 20                  | Preparations of vegetables, fruit, nuts or other parts of plants                           | 0.152***<br>(0.015)  | 0.070***<br>(0.012)  | 0.073***<br>(0.010)  |
| 21                  | Miscellaneous edible preparations                                                          | 0.002<br>(0.017)     | 0.006<br>(0.013)     | -0.014<br>(0.012)    |
| 22                  | Beverages, spirits and vinegar                                                             | -0.007<br>(0.019)    | 0.048***<br>(0.014)  | -0.067***<br>(0.014) |
| 23                  | Residues and waste from the food industries; prepared animal fodder                        | 0.219***<br>(0.016)  | 0.123***<br>(0.013)  | 0.087***<br>(0.011)  |
| 24                  | Tobacco and manufactured tobacco substitutes                                               | 0.291***<br>(0.024)  | 0.017<br>(0.022)     | 0.258***<br>(0.021)  |
|                     | R2                                                                                         | 0.72                 | 0.69                 | 0.58                 |
|                     | N                                                                                          | 692,015              | 692,015              | 692,015              |

Note: Robust standard errors clustered at market-year are in parentheses. The coefficients for fixed effects and other covariates are not reported as they are not of interest. The estimation method is OLS using Stata 13.0 SE. \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01.

**Table A 5.4: Effects of Currency Depreciation on Trade Margins over Time**

| Dependent variables | Intensive<br>margins<br>(1) | Quantity<br>margins<br>(2) | Price<br>margins<br>(3) |
|---------------------|-----------------------------|----------------------------|-------------------------|
| Exchange rate x     |                             |                            |                         |
| 2001                | 0.346***<br>(0.026)         | -0.048**<br>(0.022)        | 0.380***<br>(0.019)     |
| 2002                | 0.370***<br>(0.021)         | 0.053***<br>(0.016)        | 0.304***<br>(0.014)     |
| 2003                | 0.302***<br>(0.018)         | 0.071***<br>(0.014)        | 0.219***<br>(0.012)     |
| 2004                | 0.217***<br>(0.017)         | 0.032**<br>(0.013)         | 0.175***<br>(0.011)     |
| 2005                | 0.107***<br>(0.015)         | 0.057***<br>(0.012)        | 0.040***<br>(0.010)     |
| 2006                | 0.071***<br>(0.014)         | 0.030***<br>(0.011)        | 0.033***<br>(0.009)     |
| 2007                | 0.060***<br>(0.014)         | 0.008<br>(0.011)           | 0.046***<br>(0.009)     |
| 2008                | 0.134***<br>(0.014)         | 0.011<br>(0.010)           | 0.119***<br>(0.009)     |
| 2009                | 0.121***<br>(0.014)         | -0.008<br>(0.011)          | 0.125***<br>(0.009)     |
| 2010                | 0.129***<br>(0.015)         | -0.002<br>(0.011)          | 0.129***<br>(0.010)     |
| 2011                | 0.128***<br>(0.016)         | -0.010<br>(0.012)          | 0.137***<br>(0.011)     |
| 2012                | 0.139***<br>(0.018)         | 0.004<br>(0.013)           | 0.134***<br>(0.012)     |
| 2013                | 0.110***<br>(0.0, 20)       | -0.020<br>(0.015)          | 0.130***<br>(0.013)     |
| R2                  | 0.730                       | 0.698                      | 0.600                   |
| N                   | 692,015                     | 692,015                    | 692,015                 |

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 regressions include fixed effects for firms and markets, but their coefficients are not reported as they are not of direct interest. Pakistan moved to a free-floating exchange rate regime in 2007.

**Table A5.5: List of Dependent Variables**

- *Intensive margin (IM)*: value of sales in PKR million per exporter at product-market-year level by currency of invoicing. The intensive margins can be split in two components: Quantity margins and price margins defined as:
  - o Quantity margin: quantity sold by exporter at product-market-year level by currency of invoicing
  - o Price margin: price received by exporter at product-market-year level by currency of invoicing
  
- *Extensive Margins (EM)*: EM are defined at four different levels as follows:
  - o Firm extensive margin: number of firms per product per market
  - o Product extensive margin: number of products per firm per market
  - o Market extensive margin: number of markets per firm per product
  - o Consumer extensive margin: number of clients per firm per market

## **6 Thesis Conclusion**

## **6.1 Findings, Policy Implications and Further Research**

Recently, the concept of trade costs has broadened, from tariffs to non-tariff, and from beyond the borders to at- and behind-the borders. Moreover, the focus of empirical research on international trade has shifted from countries and industries to firms and products, as it is widely recognised that neither countries nor industries engage in trade; firms do. Therefore, understanding firm-level drivers and determinants of trade flows has assumed a rising importance for the design and assessment of economic policies. In this wider context, this thesis explores the effects of traditional and non-traditional sources of trade costs on the composition of developing countries exports, and examines the responses of multiple margins to costs associated with security policy, domestic spatial frictions and the exchange rate movement. The analysis helps to understand the role these costs play in the shaping export pattern of developing economies in general and Pakistan in particular.

## **6.2 Main Findings**

This thesis finds that high trade costs negatively influence export share of various industries in developing countries. The effect is relatively higher for high trade cost sensitive industries located in relatively high trade cost regions, especially sub-Saharan Africa. The evaluation of the impact of intrusive scanning imposed on Pakistan in the wake of changes in the US security policy shows that Integrated Cargo Containers Control (IC3) programme had some intended and some unintended trade effects. Overall, this project impeded trade flows rather than facilitating those, especially for the firms that had to switch port to meet these mandatory scanning requirements.

The thesis further finds that the trade-inhibiting effect of domestic transportation distance are much larger than that of its international segment. Moreover, both segments of distance operate through different channels: domestic distance has a sort of selection effect on firms and products, whereas the international distance operates mainly through quantities. These findings suggest that reducing domestic and international transportation costs could increase trade flows through different channels.

Finally, the thesis shows that the effect of currency depreciation on agricultural exports is positive; however, the trade response is incommensurate with the level of depreciation. The depreciation mainly operates through the channel of prices and the reaction of quantities, although positive is relatively small. It further finds that using exchange rates of actual currencies of invoicing attenuates the trade response by almost a half. As expected the trade response is relatively larger for products less dependent on the use of imported inputs.

### **6.3 Policy Implications**

This thesis suggests that reducing trade costs will encourage a shift in the composition of developing country exports in favour of relatively more trade cost intensive industries which are also likely to be more technologically advanced. The heterogeneity of the response across industries to trade cost reductions has implications for economic growth in developing countries, because the mix of goods a country exports affect its growth and development prospects. Literature shows that all goods are not similar in terms of their economic significance; specialising in some products brings higher growth opportunities than specialising in others for both demand and supply-side reasons. Since the response to trade cost reduction by more trade cost sensitive sectors is shown to be relatively large, the lowering of developing countries' trade costs can be expected to disproportionately promote exports of more trade cost sensitive good and these goods can be expected to be relatively more technologically sophisticated. This offers an opportunity for increasing the growth-enhancing and technological upgradation effects of export expansion.

The analysis of effect of security policy on trade flows has implications for the ongoing drive to deploy similar technologies for facilitating trade, in addition to enhancing the security of the supply chain. It shows how adding another layer of security on already very thick national borders can influence the behaviour of exporting firms and disrupt existing trade flows. In the wake of the emerging security situation in different parts of the world, similar scanning arrangements if implemented at other ports might present a serious blow to the market access of affected economies. These findings further imply that policy-makers need to focus on domestic constraints and the potential unintended effects of internal trade

diversion, which can offset the effect of improvements at- and beyond-the-borders. The security considerations have assumed a rising importance in the wake of the emerging terrorism threat in other parts of the world. In 2016, the WCO launched a strategic trade control project, operation Cosmo, which is aimed at preventing the smuggling of chemical and nuclear weapons<sup>59</sup>. Therefore, understanding the trade and security interface is of particular relevance at this juncture.

Examination of the effect of internal remoteness of firms manufacturing facilities from trade-processing facilities emphasises the need of improving connectivity or providing trade-processing facilities near the manufacturing regions. The analysis shows that the trade-impeding effect of inland transportation is three-time than that of international leg, on average. Although the effect of international segment of distance has dropped over time the effect is relatively smaller for domestic segment. Since inland distance has a sort of selection effect on trade, it implies that reducing inland transportation costs could boost exports through the channels of entry of more firms into exporting as well as through widening of the export product set.

Regarding the effect of currency depreciation, the low responsiveness of exports in the agricultural sector to currency depreciation suggests that policy-makers need to be cautious in employing exchange rate adjustment as a tool for export development. Although exports respond positively to an exchange rate movement, the important source of this gain is the direct effect of depreciation on prices, rather than on quantities. The analysis shows that the precise estimations need to account for the exchange rates of actual invoicing currencies, rather than the bilateral exchange rate between trading partners. Since most export transactions are settled in a few major currencies, the bilateral exchange rate might misrepresent the actual trade effect of depreciation. The analysis further points to the large trade-impeding effects of non-tariff measures (NTMs) and the complexity of tariffs in the agricultural sector.

## **6.4 Further Research**

This thesis exploits only a few features of Pakistan's rich transaction-level datasets; location of manufacturing facilities and those of export processing stations, modes

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<sup>59</sup> <http://www.wcoomd.org/en/media/newsroom/2016/july/strategic-trade-control-enforcement-expert-trainer-certification-workshop.aspx>

of shipment and currencies of transactions. This data has a wealth of information which is quite unique. Some interesting features which remain untapped are the relationship with importers (suppliers) in destination (origin) markets (name of buyers, their geographical location and ports of entry and exit), the nature of interaction with buyers (direct export or through intermediary firms, information on letter of credits and contracts), the mechanisms of realisation of export proceeds (advance deposit, payment on delivery or on agreed terms), the frequencies of transactions, mode of shipments (air, land and sea), the names of mediating banks on the both sides of the supply chain and time spent by various agencies (customs brokers, freight forwarders, port operators, and customs officials) in processing export and import shipments at borders. Moreover, these datasets have unique information on domestic sales and purchase by exporters and non-exporters. This wealth of information can be used to test predictions of many existing trade models and extend the frontiers of the relevant literature.

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- Representatives of shipping lines (Maersk, Safe marine, UASC and APL) at Port Qasim, Karachi

