CREDIT Research Paper

No. 16/02

Export Response to Sanitary and Phytosanitary Measures and Technical Barriers to Trade: Firm-level Evidence from a Developing Country

by

Salamat Ali

Abstract

This study empirically examines a connection between non-tariff measures (NTMs) and trade response at a micro level. It investigates the mechanism, drivers and speed of adjustment to a battery of sanitary and phytosanitary measures and technical barriers to trade. It uses an administrative dataset of Pakistan's mango-exporting firms at an eight-digit level of disaggregation and exploits a natural experiment in the identification strategy. The research finds the NTMs appear to have increased the volume of exports but through one specific channel and after some time lag. The intensive margins (IM) of trade have improved whereas the extensive margins (EM) have contracted. The increase in IM is, however, registered after a gap of four years and appears to be driven by larger quantities as well as higher prices. The contraction in the EM seems to operate mainly through a reduction in the number of customers in export markets.

JEL Classification: F1, F13, F14, O1, O2, O13

Keywords: Non-tariff measures, firms in agriculture, technical barriers to trade, sanitary and phytosanitary measures, Pakistan

Centre for Research in Economic Development and International Trade, University of Nottingham

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Outline

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Acknowledgements

I am grateful to my colleagues in the Custom Administration of Pakistan for providing access to the necessary information, answering my queries and sparing time for discussion. Special thanks go to the participants of a CREDIT seminar at the University of Nottingham for their helpful comments and suggestions. I am also grateful to the team of UNCTAD's Virtual Institute for training on collection, organisation, classification and interpretation of data on NTMs.

Disclaimer

The study uses administrative datasets of the Government of Pakistan, some of which are completely confidential in nature. I access these for research during my posting as Deputy Collector (Customs) Exports, Karachi – the largest exporting station of the country – and during my subsequent research visits to Pakistan. The research datasets may not exactly reproduce aggregates reported in the government publications. The use of statistical data in this work does not imply the endorsement of the organisations in relation to the interpretation or analysis of the information.

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Export Response to Sanitary and Phytosanitary Measures and Technical Barriers to Trade: Firm-level Evidence from a Developing Country

1 Introduction

With the steady reduction of tariffs to their historically lowest level, the role of non-tariff measures has assumed rising importance. Some studies argue that NTMs pose a major challenge to international trade regime reforms, as they can undermine the progress made so far in trade liberalisation (Evenett and Fritz, 2015; Jensen and Keyser, 2012). Others contend that the impact of NTMs on trade flows could be ambiguous: they may increase (Chen and Mattoo, 2008; Maertens and Swinnen, 2009), reduce or leave the trade flows unchanged1 depending on the additional cost they impose. This work, however, tells a different story. Using a novel dataset at a highly disaggregated level and applying an empirically robust methodology, it shows NTMs may have some benign effects: they may increase firm-level trade flows through shipping larger quantities and raising price – and the improvement comes over time. It further shows that analysing NTMs by using data at a higher level of aggregation may lead to erroneous inferences.

I examine the effect of sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT) on the trade response of mango-exporting firms in Pakistan and investigate the drivers, mechanism and speed of adjustment to the battery of non-tariff measures (NTMs). Following examination of the influence of the NTMs on firm-level trade flows, I explore their implications for quantities of shipments, unit values and the extensive margins (EM) of firms, markets and consumers in destination markets. I exploit a quasi-natural experiment in the identification strategy and use highly disaggregated transaction-level data of trade flows, at an eight-digit level of Harmonized System (HS) for the recent period, from 2002 to 2013. Existing literature in this stream is mainly limited in scope to the investigation of NTMs that developed countries impose on imports. Exporting firms in the agriculture sector of developing countries and the NTMs affecting their exports at the point of origin have not attracted much attention. This study, therefore, bridges this gap by providing evidence from a developing economy.

It is widely acknowledged that the trade effect of NTMs varies greatly depending on the nature of the measure, the type of product and the objectives of the NTM. The precise impact, however, is hard to quantify. The main obstacles in the investigation are lack of transparency in their administration, limited knowledge of the nature and scope of NTMs and un-availability of micro-level data at a finer level of aggregation. These challenges mean this important area of research remains under-explored. I overcome these issues and conduct a quantitative assessment of SPS measures and TBT, which are the most important and the least understood group of NTMs but have a wide range of products2 in their ambit.

Application of NTMs is mostly shrouded in complex legal documents, such as Acts of Parliament, Statutory Regulatory Orders (SROs) and operational rules and regulations of border agencies. These legal and technical documents are hard for analysts outside the enforcement

[1] Wilson and Otsuki (2004) and Otsuki et al. (2001) show that international standards are less trade-restrictive than regional standards, with small negative effects and even positive effects in some cases.
[2] UNCTAD (2014) shows SPS and TBT measure are applicable to 15% and 35% of agricultural products, respectively.

bodies to access and decipher. I take institutional advantage[3] and benefit from my knowledge of interpretation of legal documents, hands-on experience in commodity classification and practical experience of administering NTMs in order to investigate the effects of SPS measures and TBT levied on the exports of mangos from Pakistan.

I extract the NTM information from government archives[4]. This approach is superior to tracking the similar facts from surveys or from the international datasets of the World Trade Organization (WTO) on SPS measures and TBT. Surveys may not reflect the true picture, as uncompetitive exporters have a tendency to overstate their restrictiveness (UNCTAD, 2014). In addition, international datasets are not comprehensive since countries have different tendencies to report this information[5]. Because of these limitations, the UN Conference on Trade and Development (UNCTAD) data collection guidelines bar the use of these sources and consider as NTMs only the measures notified through government regulations (UNCTAD, 2014: 3). In light of these guidelines, then, I rely on official and authoritative information enshrined in national regulations.

The second complication in the analysis of NTMs arises from the fact that they are applied to specific products at a very high level of disaggregation, and international data sources do not go into fine details in identifying such products. During the past few years, with the availability of transaction-level datasets, the focus of analytical work on trade policy has shifted from macro to micro level, but these analyses are limited mostly to the manufacturing sectors of developed countries. There has been very little exploitation of the micro datasets of developing countries to explore the effect of NTMs at a firm level. The use of novel and disaggregated data of a developing country in this study makes it very distinctive from existing research in this area.

The study uses an administrative dataset of Pakistan, for a recent period, from June 2002 to December 2013. The administrative dataset is disaggregated at the eight-digit level of HS. It contains information for the universe of firms, which generates a very large sample, and is being used for the first time for research purposes. The disaggregated data allow for precise estimations of the effect of NTMs along additional dimensions and the long span permits decomposition of the trade effect over time in order to examine the speed of adjustment. In a related work, Fontagné et al. (2015) aggregate the information of 1,200 products at four-digit level and combine the data of manufacturing and agriculture. Dean et al. (2009) use UNCTAD's TRAIN database. This approach could be prone to aggregation bias as explained in Section 2.

I construct a very large panel of exporting firms and analyse this at a micro level by exploiting a natural experiment in the identification strategy. The coverage of the NTMs imposed on Pakistan's mango exports in 2007 was initially limited to shipments destined for Europe and Canada. In the subsequent years, however, its scope expanded to some markets of the Middle East and China. This geographical and temporal variation allows for estimations through finding a suitable counterfactual group. The exogenous nature of this shock and its variation across markets as well as over time provides a unique empirical setting. This difference-in-difference estimation approach has rarely been used to investigate the effect of NTMs using a firm-level dataset from a developing country. Yet the approach, if applied using transactional data, provides a direct estimate of the precise effect of NTMs by isolating other confounding factors.

[3] Because of my affiliation with the Customs Administration of Pakistan during 2002–2011.
[4] Export Policy and Procedures Orders (2007, 2008).
[5] This information on NTMs used in this paper, which I extract from government archives, is not reported in any international dataset.

An empirical analysis of these NTMs can be performed by country, by product or by measure. I, however, focus on firms. This firm-level analysis is imperative because neither countries nor industries engage in trade; firms do. Trade theory suggests NTMs distort trade, but their effect depends on the cost of compliance and associated benefits to firms. The standardised packaging and labelling might help in information exchange between buyers and sellers, signalling product quality, and thus can reduce transaction costs and facilitate trade. On the other hand, the additional burden of compliance may restrict trading activities of firms and impede trade flows. Since exporting firms can respond to the imposition of NTMs in numerous ways (through adjustments along intensive margins (IM), extensive margins (EM), prices or quantities), it is necessary to explore all the likely responses and assess the net impact of policy change.

This study directly answers policy-makers' questions about isolating the effect of specific set of NTMs levied on specific products by specific countries. Most existing studies6 in this area focus on aggregate trade flow effect, use Trade Analysis and Information System (TRAINS), World Integrated Trade Solution (WITS) or Comtrade datasets and apply the gravity model. I, however, focus on NTM implications for trade margins and examine the channels and speed of adjustment, which is important from policy perspectives but could not be explored earlier because of data limitations (Czubala et al., 2009; Henry de Frahan and Vancauteren, 2006; Moenius, 2004). Moreover, I employ a more robust empirical methodology that can isolate the effect of NTMs from other confounding factors.

Also, the analysis of a set of NTMs imposed on a product not affected by tariffs provides compelling evidence about their benign effect, which is another distinguishing feature of this work. Some studies estimate the combined effect of tariff and non-tariff measures, which could be problematic because theory suggests the combined effects may differ from those of either barrier alone (Vouseden, 1990). Since Pakistan's mango exports to most of these markets do not attract import tariffs, the entire change in trade volume across markets and over time can be attributed to the effect of NTMs. Moreover, Pakistan's mangos have had duty- and quota-free access to various markets; the analysis is devoid of other NTMs that could complicate the analysis of most agricultural products.

This work is quite distinct from existing firm-level studies in this area. I differ from Fontagné et al. (2015), Dean et al. (2009) and Chen et al. (2008) in terms of information sources on NTMs as well as in the data sources. Fontagné et al. (2015) use the data of specific trade concerns to examine the effect of NTMs on various dimensions of firm heterogeneity and Chen et al. (2008) use World Bank Surveys to conduct a cross-country study of 609 firms from 17 countries. Similarly, Dean et al. (2009) use US International Trade Commission (USITC) private sector complaints about NTMs. As discussed above, the recent UNCTAD guidelines specifically discourage the use of these sources. I, therefore, rely on official and authoritative information enshrined in national regulations, as in Piermartini and Budetta (2009). Moreover, the scope of this paper, the estimation methodology, the dataset and the results are entirely different to those of the above studies.

The study shows, in contrast with the findings of earlier work, that, following the application of these SPS and TBT requirements, firm-level exports have increased. The IM and EM show

[6] The most prominent studies in this stream are Bao and Qiu (2010), Beghin et al. (2011), Chen et al., (2008a, 2008b), Dean et al. (2009) and Looi et al. (2009).

opposite responses: the IM increase but the EM contract. The process of adjustment appears to take around four years. Shipping higher quantities and charging higher prices drives the increase in the IM, and the contraction along the EM seems to operate mainly through a reduction in the of number of customers. Although the EM of firms and markets also drops, this effect is not statistically significant. This channel of adjustment of the EM along the customer base in the destination market is a new dimension. The existing literature has discussed this channel theoretically (Arkolakis, 2010) but I examine it empirically for the first time.

The next section presents the dataset, discusses the empirical setting and develops the estimation strategy. Section 3 presents main results along with checks of their robustness. Section 4 decomposes the sources of trade gains and Section 5 concludes, with a summary of findings and their policy implications.

2 Dataset, Empirical Setting and Estimation Strategy

This section describes policy shock, introduces the dataset and presents the estimation strategy.

2.1 Policy Shock

In 2007, the Government of Pakistan vide Export Policy Order 2007–2008 (issued vide SRO. 1021 (I)/2007 dated 8 October 2007) standardised the requirements of retail packaging and labelling for exporting mangos. Serial 18 of Schedule II of the SRO[7] contains that, "*The export of mangoes to Europe and Canada shall be in standardized packaging of 2, 3, 4, 5 and 7 kilograms with 5% variation in weight on either side.*" The regulation empowered Customs authorities to enforce these standards. It further stipulated that mango shipments would not be allowed before 20 May. In the subsequent year, the government allowed additional packaging sizes of 3.5, 4.5, 6.5 and 8 kilograms and extended the scope of the legislation to shipments destined to Iran, China, Kuwait and Bahrain.

Prior to 2007, fruit- and vegetable-exporting firms could use any kind of packaging for these products. The packaging could be of any size except that firms were required to indicate gross weight on the retail packing. Therefore, firms used different units of measurement – boxes, cases, cartons, kilograms, tons – according to the size and nature of the packaging (Fig A 2).

In technical terms, this standardisation is an imported-related NTM, but it is implemented at the export stage under the mutual recognition arrangements with the importing countries. Second, this is not one but four different types of NTMs, as each of them individually imposes an additional burden on firms. According to UNCTAD (2015), these are distinct SPS measures and TBT categorised under A31 and B31 (labelling requirements), A33 and B33 (packaging requirements) and A83 and B83 (conformity assessment requirements). The legislation also stipulates the starting date of export, which is another NTM classified under P69 (measures affecting exports, n.e.c.).

2.2 Identification Strategy

This study exploits the variation in the policy change regarding the enforcement of standardised packaging, labelling and conformity assessment requirements across countries and over time

[7] Statutory Regulatory Order

using a difference-in-difference approach. The treatment group comprises a set of countries that imposed the previously mentioned NTMs; the control group is another set of countries that did not (Table 1).

Table 1: List of countries included in the analysis

#	Control group	Treatment group
1	Bangladesh	Austria
2	Brunei Darussalam	Bahrain
3	China	Belgium
4	Czech Republic	Canada
5	Greece	Denmark
6	Iran	France
7	Jordan	Germany
8	Malaysia	Hong Kong, China
9	Maldives	Ireland
10	Nepal	Italy
11	Oman	Kuwait
12	Qatar	Netherlands
13	Russian Federation	Norway
14	Saudi Arabia	Spain
15	Singapore	Sweden
16	Swaziland	Switzerland
17	United Arab Emirates	United Kingdom

The treatment came in two stages: the EU and Canada imposed these restrictions in 2007 and Iran, China, Kuwait and Bahrain followed suit in 2008. The markets of control group countries did not levy these conditions; hence, there is no change in the packaging, labelling and conformity assessment requirements for shipments to their markets. Other export regulations to both groups are similar in all respects but one: the technical regulations affect the former and not the latter. This unique feature of the setting allows a comparison of firm-level exports to these markets before and after the policy changes using a difference-in-difference estimation approach.

2.3 Data Description

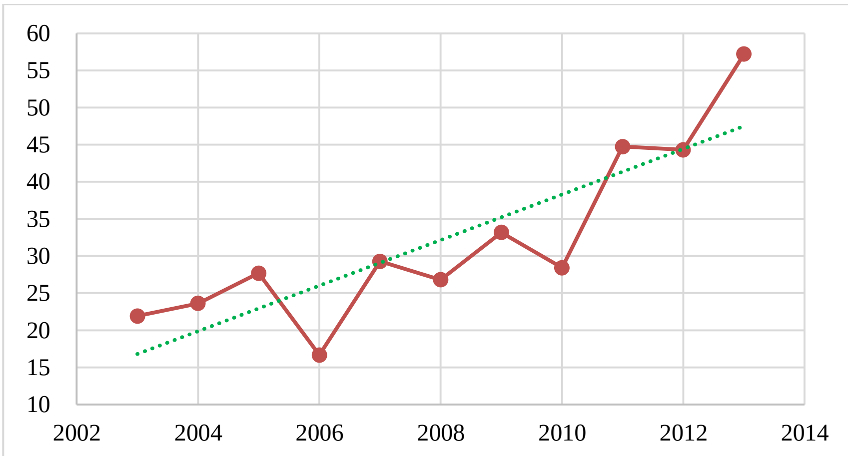
This study uses a transaction-level dataset of Pakistan Customs for the period June 2002 to December 2013[8]. Pakistan is the sixth-most populous country, with a population exceeding 200 million people. It is 26th-largest economy and the 36th-largest in terms of area, and is characterised as being amongst the emerging and growth-leading economies of the world. Agriculture is a mainstay of Pakistan's economy and it is the fifth-largest mango producer after India, China, Thailand and Indonesia (ITC, 2011), with annual exports of around 100,000 metric tonnes to more than 68 international markets. These exports are gradually rising (Figure 1). Therefore, investigations of NTMs using this dataset explain the response of a substantial share of world trade in this commodity.

The dataset is disaggregated at an eight-digit level of HS and contains information about export values, unit prices and quantities for the universe of Pakistan's mango-exporting firms. It also

[8] These data sets are subjected to confidentiality requirements. Most of the information is, however, available from the Export Dynamics Database (EDD) of the World Bank.

contains the identities of exporters in the market of origin and those of the buyers in the markets of destination for each transaction.

Figure 1: Pakistan's total mango exports (US$ millions)



Author's working use dataset of Pakistan Customs.

This dataset records each transaction of mango exports for the 12 years from 2002 to 2013. In this period, 1,122 firms shipped mangos to 68 countries across the globe. To keep the sample size manageable, I restrict the analysis to the top 34 export markets: 17 each from the control and the treatment groups. This trimmed sample has 92,795 observations for 1,110 firms that represent more than 95% of exports of this commodity from Pakistan. The sample provides broad geographical and temporal coverage: 34 markets across the globe between 2002 and 2013. Table 2 provides a sample summary and the detail of observations over time is relegated to appendix (Table A2).

In terms of data quality, my personal experience of collecting and compiling this information from 2000 to 2011 while being part of this administration, as well as consistency checks, suggests it is of high quality. However, I test the integrity and accuracy of the data by performing aggregation tests. The most credible signal of data quality is perhaps the similar aggregates reported in the publications of various institutions.

Table 2: Sample summary

	All	Sample	Control group	Treatment group
Firms	1,122	1,110	614	786
Observations	92,795	92,665	35,653	57,012
Markets	68	34	17	17

Source: Pakistan Customs.

For this kind of research, this dataset is superior to those most existing studies use. The reason is that the application and coverage of NTMs varies a great deal in narrowly defined product categories, and the precise estimation is only possible by analysing data at the highest level of disaggregation. For example, using the HS, the national tariff lines of Pakistan classify mangos and similar products grouped under Heading 0804.50 in Comtrade data to further sub-headings at an eight-digit level as follows.

i. 0804.5010-Guava
ii. 0804.5020-Fresh Mangoes
iii. 0804.5030-Mango Nectar
iv. 0804.5050-Mango Pickle
v. 0804.5090-Dates, Plums

In this detailed classification, the packaging, labelling and conformity assessment requirements discussed in the legislation affect only products at serial 'ii'. The remaining products in the above list are not subject to these measures, but they are subject to a different set of regulations. For instance, mango pickle (Sr. iv) has regulations about shelf life and mango nectar (Sr. iii) has restrictions about sugar contents. None of these three products is subject to a set of NTMs investigated in this paper. Therefore, the analysis if performed at HS2, HS4 or HS6 level of aggregation, will confound the true effect of these measures with other NTMs, since each of these products attracts a different set of NTMs.

Since the NTMs may be imposed at a much finer level, it calls for micro analysis at a sector level as suggested in Disdier et al. (2015). Therefore, for this kind of empirical work, the use of disaggregated information at an eight-digit level HS is superior in quality to most open data sources that limit the product details to six-digit level. It enables us to maintain a focus on a specific commodity within agriculture and avoids confounding the effect of the NTM with tariff or non-tariff measures levied on other sets of products, which are not revealed at a higher level of aggregation.

Moreover, tariffs can also affect the estimations at a higher level of aggregation. The export of mangos to most destination markets is duty free (Table A1); other products attract different tariff rates. The studies estimating the effect of NTMs at HS2 level or HS6 level (by using the open data sources of Comtrade or WITS) are likely to confound the effect of tariffs and non-tariff measures levied on different products within the same broader classification. The resulting measurement error may generate inference exactly opposite to the actual effect. This is because the effect of tariffs also varies widely at a micro level. This work, therefore, warns against the issue of aggregation bias in this kind of empirical study.

I extract the information about NTMs from the national Export Policy and Procedures Orders (2007, 2008). These annual documents provide detail of the nature of NTMs, the exact timing of their application, the coverage of products and markets and the authorities responsible for enforcement. The remaining information about GDP and trade costs is retrieved from open data sources of the World Bank.

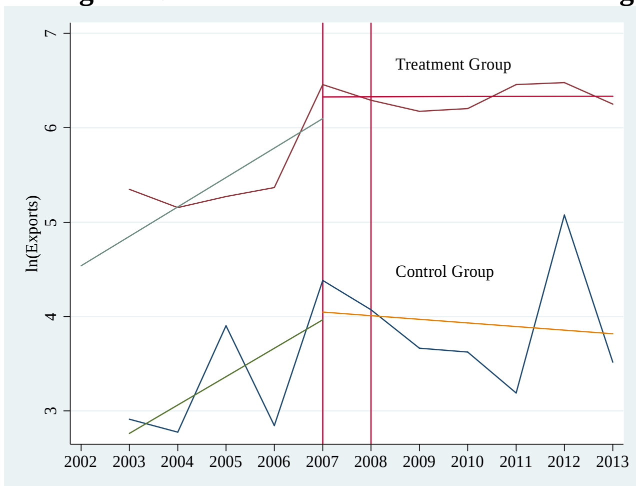
2.4 Empirical Setting

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

2.4.1 Parallel Trends

Figure 2 plots Pakistan's total mango exports to the control and treatment groups. The lines of best fit on this chart suggest evolution of exports to both markets was similar before the policy changes but differed afterwards. It appears that exports to both groups experienced an initial drop but exports to the treatment group stabilised and started rising after a few years while those to the control group continued their downward slide.

Figure 2: Evolution of control and treatment groups



More precisely, exports to both the groups were on a rising trajectory until 2007. Later on, exports to the control group declined whereas for the treatment group the earlier trend more or less continued. This shift seems to coincide with the policy changes in 2007. Another similar shift in the export pattern to both groups occurred in 2008, when the scope of NTMs was extended on shipments to other countries. Overall, the chart indicates that, before this legislation, exports to these groups were almost on a parallel path but these patterns diverged afterwards.

I further test the equality of export growth rates to these markets statistically. Table 3 presents the results of two sample t-tests on an annual basis. As columns (4) and (5) indicate, the difference between the mean growth rate of exports to the control and treatment groups is statistically insignificant. In none of the years do we find a statistically significant difference in the means, indicating that the parallel trend assumption is satisfied, and these countries not imposing NTMs represent a valid counterfactual group.

Table 3: Parallel trend tests

Δ Growth rate	Treatment	Control	Difference	t-statistics
(1)	(2)	(3)	(4)	(5)
2004	0.494	2.362	-1.868	-0.754
	(0.365)	(2.09)	(2.47)	
2005	0.343	0.336	0.007	0.021
	(0.166)	(0.252)	(0.316)	
2006	0.382	0.112	0.269	0.658
	(0.394)	(0.166)	(0.202)	
2007	0.517	11.512	-10.996	-0.761
	(0.132)	(10.74)	(14.456)	

Note: Δ Growth indicates annual growth rate of exports. Standard errors are in parenthesis. The t-statistics pertain to column (5) for the difference in the mean of treatment and control groups.

2.5 Estimation Framework

In order to quantify the magnitude of the trade effect at a firm level, I use the following regression framework:

- $\ln(X_{ijt}) = \beta_0 + \beta_1(\text{Treat})_j + \beta_2(\text{After})_t + \beta_3(\text{Treat x After})_{jt} + \beta Z'_{ijt} + \alpha_i + \gamma_j + \lambda_t + \varepsilon_{ijt}$……………….(1)
- X_{ijt} denotes the value of exports of a firm 'i' to market 'j' at a time 't' (intensive margins). The exports volume is measured in US dollars.
- 'Treat' is a dummy variable equal to '1' if an observation pertains to the treatment group and '0' otherwise.
- 'After' is dummy that is equal to '1' for EU member states and Canada from 2007 onwards and for Iran, Kuwait, China and Bahrain from 2008 onwards and '0' otherwise.
- 'Z' is a set of controls.
- α, γ and λ are a set of fixed effects for firms, markets and time.
- ε_{ijt} is an idiosyncratic error term.

I estimate the above equation using disaggregated data at an eight-digit level of customs tariff for the period 2002–2013. This long time span permits precise estimations and enables the examining of adjustments over time. The estimation method is Ordinary Least Squares (OLS) and β3 is our coefficient of interest. Its positively significant coefficient would suggest that, compared with the control groups, exports to the treatment groups have increased.

The difference-in-difference econometric approach accounts for most of the potential omitted variables. It washes out the effect of factors such as improvements in technology and infrastructure, institutional changes and economic growth that could influence exports to both the control and the treatment groups. I include fixed effects for firms and markets in order to account for time-invariant factors pertaining to these variables and add fixed effects for time to soak up any factors affecting the whole economy at a particular time. To account for autocorrelation, standard errors are clustered at firm-market-year level, as trade flows between markets tend to be highly persistent over time. This takes care of the arbitrary correlation among individual clusters.

Tariff is not included in the regressions since export of mangoes is duty free to most of these markets. I do not add capital in the estimations as mango export is a seasonal activity, spanning the months of May to September; it does not entail setting up a capital-intensive industry, except the employment of seasonal labour for picking, sorting, grading and packing the fruit.

The effect of NTMs is exogenous for the exporting firms and even for the exporting country. The reason is that these are actually import measures but implemented at the export stage. Their enforcement is not an endogenous decision, as Pakistan had to implement these NTMs perforce in order to maintain market access. If it had been a home-grown initiative, it would not have emerged in the first place[9] or would have been extended to all markets.

Other potential estimation issues in the analysis could be measurement error and reverse causality. In order to circumvent the measurement errors that aggregation bias could induce, I estimate the model at a micro level using the transaction-level data. Second, I account for reverse causality by controlling for the market share of Pakistan in the total import of these

[9] Since it imposes additional costs on firms, and no country wants to overburden its exporters.

countries. The analysis is free of the anticipation effect that might affect the exports of other cash crops, as, unlike other cash crops, mango trees takes many years to mature and bear fruit.

3 Estimation Results and Robustness Checks

3.1 Main Results and Discussion

Table 4 presents baseline estimation results. Model (1) explains pure variation in the data. The coefficient on the interaction term (Treat x After) is positive, showing that, compared with the control group, exports to the treatment group increase by 4% and the effect is statistically significant at a 10% significance level. Models (2) through (4) add fixed effects for firms, markets and time. The magnitude of the coefficient and its statistical significance level improve once we control for the omitted variables by adding fixed effects, which also improves the values of R-squared, from 0.08 to 0.63.

The positive and significant coefficient on the 'After' dummy suggests over time improvement in the exports of the control group also. In column (4), the inclusion of time fixed effects picks up the effect of the 'After' dummy, suggesting collinearity between these variables, but the coefficient on the interaction time stays positive and statistically significant.

Table 4: Baseline estimates at HS8 level

The dependent variable is intensive margins of exports in logs

	(1)	(2)	(3)	(4)
Interaction	0.044^{*}	0.112^{***}	0.094^{***}	0.150^{***}
(treat x after)	(0.023)	(0.018)	(0.018)	(0.018)
Treat	0.059^{***}	0.207^{***}	0.768^{***}	1.077^{***}
	(0.021)	(0.018)	(0.279)	(0.283)
After	0.777^{***}	0.838^{***}	0.827^{***}	0.073
	(0.020)	(0.016)	(0.016)	(0.064)
Firm FE		Y	Y	Y
Market FE				Y
Time FE				Y
R-squared	0.078	0.501	0.535	0.631
Observations	92,665	92,665	92,665	92,665

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 s are not reported, as they are not of direct interest. These estimates were obtained using Stata 13 SE.

It appears from these estimations that the effect of NTMs is positive and statistically significant. In our preferred specification, model (4), the coefficient of 0.15 indicates that, on average, firms-level export to these restrictive markets are 15% higher compared with those to others markets that do not impose any such restrictions on packaging, labelling and conformity assessment.

These results contrast with those of most existing studies investigating the effect of NTMs on firm-level trade flows. For instance, Chen et al. (2008) find NTMs lead to a 17% drop in trade; Fontagné et al. (2015) find a 22% drop in exports; and Reyes (2011, 2012) also finds a negative effect of NTMs on Southern exporters. By contrast, these estimations show a positive effect and the main reason seems to be the data quality, which permit investigations at a highly disaggregated level. Only Augier et al. (2013) find a positive effect using Moroccan data, but they focus on productivity rather than trade margins.

This rise in exports can result through multiple mechanisms as the standardised packaging and labelling requirements may have heterogeneous effects for exporters in the market of origin and importers in the market of destination. These requirements increase the cost of doing business for exporting firms. This additional cost is a combination of fixed cost (investment in arranging packing material and printing and labelling) plus variable cost (which varies with the quantity shipped). These additional costs can relegate exporters to a comparative disadvantage, which may reduce exports to the destinations imposing the NTM. But they may confer indirect benefits by raising the quality of products and improving business practices (Maertens and Swinnen, 2009). These improvements may allow them to raise the prices or attract more customers in the destination markets.

On the other hand, buyers in the destination market may save on account of the cost of handling, stacking, storage and repacking as they receive the product in retailable form. This standardised packing could reduce information asymmetry, signal the quality of product and thus reduce transaction costs, and hence increase the demand for products. Section 4 investigates the adjustments along these channels in detail.

3.2 Robustness Checks

A battery of additional robustness tests on the baseline specification shows the results are robust to adding time-varying fixed effects and other firm- and market-related covariates. I further show the aggregation bias resulting from estimations at a higher level of aggregation can lead to erroneous inference.

3.2.1 Including Time-varying Fixed Effects

The baseline regressions include fixed effects for destination markets, firms and time, which account for time-invariant factors. Still, there may be time-varying factors that the estimates do not soak up – for instance, enhancement of firms' exporting experience over time, changes in demand for the product over time, changes in the costs of international business over time or improvement in firms' performance over time. Therefore, I include firm-year fixed effects to absorb the effect of these factors (Table 5). As the estimates show, these controls for time-varying omitted variables corroborate baseline estimation results. The coefficient of interest is positive and statistically significant at a 1% significance level and its magnitude is similar to one estimated earlier.

Table 5: Adding time-varying fixed effects

The dependent variable is intensive margins of exports in logs

	(1)	(2)
Interaction (treat x after)	0.196***	0.184***
	(0.022)	(0.022)
Firm-year FE	Y	Y
Market FE		Y
R-squared	0.705	0.737
Observations	92,665	92,665

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.

3.2.2 Including Additional Controls in Estimation

The estimations in Table 6 include controls for trade costs, gross domestic product (GDP), time trends and the market share of Pakistan. As row (1) shows, the inclusion of these covariates leave little effect on the coefficient of interaction term. The negative coefficient on trade costs indicator[10] in column (1) suggests the IM fall with the rise in the cost of trading. By contrast, the positive coefficient on the GDP indicates the income level of destination markets has a positive effect, which shows rich countries have more buying power (column 2). Similarly, the positive coefficient on time trend suggests these firms are learning with the passage of time (column 3).

Critics may argue that Pakistan attracted these NTMs as a consequence of exporting larger quantities of this commodity into these markets. As discussed above, the import of mangos to most of these markets is not subjected to tariffs. Since tariffs are the easiest trade policy instrument available, duty free and quota free import of mangoes in these markets suggest that dumping of this commodity was not an issue. Second, mangos are a tropical commodity not grown in the cold weather of western countries and have to be imported anyway. In order to further ensure reverse causality does not drive the results, I include the market share of Pakistan's mangos in these countries as an additional regressor. As the estimation in column (4) indicates, the inclusion of this control has little effect on our coefficient of interest. All these estimations yield a positive coefficient on the interaction term and this effect is consistently significant at a 1% significance level.

Table 6: Robustness – including additional covariates

The dependent variable is intensive margins of exports in logs

	(1)	(2)	(3)	(4)
Interaction (treat x after)	0.250***	0.150***	0.146***	0.171***
	(0.023)	(0.018)	(0.018)	(0.017)
Trade costs	-0.539***			
	(0.025)			
Importers' GDP		0.032***		
		(0.010)		
Time trend			0.158***	
			(0.018)	
Market share				0.123***
				(0.002)
R-squared	0.599	0.553	0.595	0.611
Observations	50,261	92,665	92,665	92,665

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.

3.2.3 Heterogeneity Analysis

Table 7 presents the tests of robustness of baseline findings by including firm-related covariates capturing the effect of firm size. These estimations explore the effect of firm heterogeneity on exports. Two dimensions of firm heterogeneity included in the estimation are firm visibility and firm size. The former measures how big a firm is in a particular market, whereas the latter captures overall size of the firm relative to all firms trading this commodity. These measures are constructed following the approach of Fontagné et al. (2015). Row (1) contains estimates of our regressor of interest, which remains positive and statistically significant after including these

[10] Retrieved from the trade costs dataset developed by Arvis et al. (2015).

variables; its magnitude, however, varies marginally across various models. Positive effects of these variables suggest that larger firms increase their exports the most and the relative position of a firm in a particular market is more important than its overall size in that sector.

Table 7: Introducing firm heterogeneity in estimation

The dependent variable is intensive margins of exports in logs

	(1)	(2)	(3)	(4)	(5)
Interaction (treat x after)	0.146***	0.133***	0.139***	0.457***	0.450***
	(0.018)	(0.018)	(0.017)	(0.072)	(0.073)
Firm visibility	4.075***	3.401***			3.587***
	(0.367)	(0.328)			(0.331)
Visibility x treat x after		4.821***			4.718***
		(1.481)			(1.467)
Firm size			0.176***	0.186***	0.189***
			(0.006)	(0.007)	(0.007)
Firm size x treat x after				-0.024***	-0.025***
				(0.005)	(0.005)
R-squared	0.63	0.63	0.63	0.63	0.64
Observations	92,665	92,665	92,665	92,665	92,665

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 these coefficients are not reported, as they are not of direct interest. These estimates were obtained using Stata 13SE.

3.2.4 Estimations at a Higher Aggregation Level

Finally, I replicate the same estimations at a higher level of aggregation using the data extracted from WITS as in most of the earlier studies. The results in column (2) and (3) of Table 8 perform these estimations at HS6 and HS2 level, respectively, whereas column (1) presents baseline results for comparison. The estimation at HS6 generates a positive but statistically insignificant effect and the same at HS2 generates a negative and statistically insignificant effect.

Table 8: Comparison of estimates at various data aggregation levels

The dependent variable is the log of exports

	HS8 (1)	HS6 (2)	HS2 (3)
Interaction (treat x after)	0.15***	0.217	-0.152
	(0.018	(0.234)	(0.240)
Destination FE	Y	Y	Y
Time FE	Y	Y	Y
Firm FE	Y		
R2	0.565	0.914	0.823
N	92,665	399	406

Robust standard errors are in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01. The regressions include fixed effects but their coefficients are not reported. These estimates were obtained using Stata 13 SE.

The main reason for this difference in the results is that the higher level of aggregation does not reveal the true effect of products actually affected by the NTMs but confounds it with that of other products classified under the broader HS Headings at a higher level of aggregation. For example, the estimations at HS6 (0804.50) could confound the effect with that on mango pickle, guava, dates and other fruits (column 2). Similarly, the estimations at HS2 (08) measure the trade effect for all fruit products classified in Chapter eight of HS, not specifically mangos. Because of this aggregation bias, these estimations might yield entirely different results.

These regressions show that in order to find the effect of specific NTMs on specific set of products, the estimations need to be performed at a highly disaggregated level.

3.2.5 Anticipation Effect

Mangos are not a cash crop, such as rice or maize, which can be sowed and harvested in a short period. If these exporting firms respond to a rise in prices, they have to wait for a couple of years, as mango tree requires five to six years to grow and bear fruit. The estimation of NTMs effect on unit prices shows that the values of goods to the NTM-imposing markets drop for initial few years rather than increase, which means the anticipatory effect is not driving the results (Table 9). These robustness checks offer support to the idea that the introduction of these NTMs reinforces rather than inhibits trade. The coefficient on the regressor of interest is consistently positive and these coefficients are precisely estimated.

4 Decomposing Sources of Gain in Exports

The increase in firm-level exports to treatment group markets could be a result of shipping higher quantities, charging higher prices, adjustment along the EM or learning over time. This section decomposes the sources of gain by examining the impact of NTMs along these dimensions of firms' performance and thus inform us about the mechanisms, drivers and the speed of adjustment.

4.1 Responses of Prices and Quantities

In order to pin down the precise source of gain in exports along prices and quantities, I estimate the same baseline equation (1) by using alternative dependent variables as follows.

- Unit price = value of product per firm by destination (in dollars)
- Quantity = weight of shipment per firm by destination (in tonnes)

These estimations indicate that, relative to the control group, unit prices increase by 11% (column 1) (Table 9). The quantities exported also rise by around 3.8%, and this effect is statistically significant at a 5% significance level (column 2). It appears the incidence of a cost of meeting standards is passed on to the buyers and exporters are able to adjust their prices upwards. Moreover, they ship higher quantities as well.

Table 9: Adjustment in prices and quantities

Dep. variables	Unit price	Quantity
	(1)	(2)
Interaction (treat x after)	0.11***	0.038**
	(0.006)	(0.015)
R-squared	0.847	0.626
Observations	92,665	92,665

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.

Since we use OLS estimator to decompose the overall trade effect to its components, prices and quantities, the coefficient on these variables indicate the relative contribution because OLS has additive property. It seems that around 70% increase in exports occured through rise in prices and 30% through shipping higher quantities.

4.2 Speed of Adjustment

The estimated effect on firm-level trade flows in the baseline specification represents the average treatment effect over the period of estimation. As Figure 2 shows, exports to the treatment group also decline in the initial few years. Since the data contain multiple cross-sections, they allow for using a slightly complicated model to decompose the effect of NTMs on exports over time.

Table 13 splits the interaction variables for individual periods, for export values, prices and quantities. It suggests a very strong negative effect on firm-level exports in the initial three years but a rebound after four years. Since the treatment occurred in two different time periods – some countries imposed the packaging and labelling requirements in 2007 and others did so in 2008 – a comparison of the magnitude of the coefficient for these years suggests the effect of the first policy shock was relatively severe. It appears these firms struggled in the first few years and improvement came over time. After five years of the shock, exports to treatment groups relative to the control groups see large growth.

The adjustment in exports during the initial few years occurs mainly through reduction in prices (column 2). Although firms ship larger quantities even in the initial year, the opposite response of prices tends to attenuate their overall effect on exports.

Table 10: Speed of adjustment – decomposing trade effect along time

	(1) Exports	(2) Prices	(3) Quantity
int_2007	-0.419***	-0.436***	0.017
	(0.020)	(0.012)	(0.017)
int_2008	-0.176***	-0.221***	0.045***
	(0.020)	(0.012)	(0.016)
int_2009	0.001	-0.112***	0.112***
	(0.020)	(0.012)	(0.016)
int_2010	-0.086***	-0.157***	0.071***
	(0.020)	(0.012)	(0.016)
int_2011	0.226***	0.097***	0.129***
	(0.019)	(0.011)	(0.016)
int_2012	0.292***	0.214***	0.078***
	(0.019)	(0.011)	(0.016)
int_2013	1.116***	1.237***	-0.121***
	(0.020)	(0.013)	(0.017)
R-squared	0.598	0.613	0.624
Observations	92,665	92,665	92,665

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 these are not reported as they are not of direct interest.

4.3 Adjustments along the Extensive Margins of Firms, Markets and Customers

The extensive margin can be defined at different levels of aggregation, and empirical work uses a variety of definitions and methods. Some authors use binary models to study the probability of a firm's entering into export markets (Baldwin and Di Nino, 2006; Berthou and Fontagné, 2008; Helpman et al., 2008); others use the number of firms that export (Dennis and Shepherd, 2007; Eaton et al., 2004; Flam and Nordström, 2006; Hilberry and Hummels, 2008; Hillberry and McDaniel; 2002). I follow the second approach but, instead of taking the log of the dependent variable as in Eaton et al. (2004) and Hillberry and Hummels (2008), I use a standard count data model, Poisson Maximum Likelihood Estimator (PPML), as used by Berthou and Fontagné (2008), Dennis and Shepherd (2007) and Persson (2013).

The disaggregated nature of the data allows me to measure the EM in multiple dimensions, such as number of firms per market, number of buyers per firm per market and number of markets per firm. Each of these variables captures various dimensions of export diversification activities of firms. I estimate the same baseline equation (1) using the following dependent variables.

- Customers: number of buyers per firm per market
- Markets: number of markets per firm
- Firms: number of firms per market

Table 11: Adjustment along extensive margins

Dependent variables	Customers	Markets	Firms
	(1)	(2)	(3)
Interaction (treat x after)	-0.108***	-0.038	-0.153
	(0.011)	(0.090)	(0.232)
R2_p	0.682	0.247	0.705
N	92,665	2,617	404

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 PPML estimator using Stata 13 SE.

As the results in Table 11 indicate, the effect is negative in all estimations but statistically significant only in column (1), which measures changes in the number of customers per market per firm. It shows the effect of NTMs on EM operates mainly through shrinkage of the customer base. Since the EM shrink (Table 11), the unit values of the commodity and prices rise (Table 9), it seems export mainly increase because of shipping higher quantities and raising value of goods.

5 Conclusion and Policy Implications

Using an administrative dataset of a developing economy, this article provides empirical evidence about the positive effect of sanitary and phytosanitary (SPS) measures and technical barriers to trade (TBT) on firm-level trade flows. It shows these regulatory requirements facilitate exports over the longer period, although they may inhibit it in the short run. Moreover, not all NTMs are trade barriers: SPS measures and TBT have some benefits that may offset their trade-retarding effect. However, they promote exports through a particular mechanism: through shipping higher quantities and raising the value of goods rather than increasing the diversification of markets or enhancing import penetration in existing markets or incentivising more firms in to exporting.

The study highlights the importance of using highly disaggregated data to avoid measurement error in this kind of empirical work. It shows that estimations at HS2, HS4 or HS6 levels can confound the actual effect of NTMs with other tariffs and non-tariff measures applicable on other products classified in the broader product groups. Nevertheless, the highly disaggregated data can reveal the precise impact of a specific set of NTMs on a specific product. The main reason this paper has found an effect different to those reported in existing studies relates to the quality of the data, which makes it possible to isolate the precise effect on the products actually affected by the NTMs.

It also highlights the need to extract NTM information from national data sources and to improve data collection efforts at international levels. These national documents usually provide detail of the nature of NTMs, the exact timing of their application, the coverage of products and markets and the authorities responsible for enforcement. Existing international datasets (maintained by the WTO and ITC) on SPS measures and TBT are not as comprehensive, as countries have different tendencies to report this information. Moreover, the national sources are also superior to survey datasets, as affected exporters may have a tendency to overstate the magnitude of problem in survey questionnaires.

NTMs are very much relevant to developing countries, as they are believed to impose additional costs on exporting firms and to reduce the comparative advantage these countries possess because of the low cost of labour. Moreover, export-related NTMs are quite common and are almost as diverse as most import-related measures are. However, there is no systematic study of their impact on the export-oriented firms of developing countries. To fill this gap in the literature, this paper investigates the impact on firm-level exports of TBT and SPS measures levied on the exports of mangos from a large developing country. The results have wider implications for promoting the exports of agricultural products from developing countries.

First, these NTMs are of particular concern to developing countries, since similar types of measures are applicable to many products originating from these economies but their producers have low productivity levels and they are ill equipped to overcome the fixed and variable costs of these barriers. National governments cannot avoid their application but can certainly facilitate their adaptation by launching complementary policies, such as reducing import taxes levied on raw material used in packaging and labelling and/or providing a conformity assessment mechanism. Since these measures have a wide coverage,[11] the aid-for-trade programme needs to target specific products and build the capacity of exporting firms to meet these standards.

Second, it is widely acknowledged that the effect of NTMs varies greatly according to the nature of the measure, the type of product and the objectives of the NTMs. Information on the effects of a particular NTM imposed by a certain trading partner on a specific set of products can equip policy-makers in furthering multilateral trade negotiations, progress on which is stalled mainly because of issues pertaining to trade in agriculture.

[11] UNCTAD (2013) indicates that SPS measures and TBT are applicable to 15% and 30% of products, respectively.

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7 Appendix

Table A1: Applied tariff rates on mangos in various markets (ad valorem)

	Number of observation subjected to tariffs							
Year	Tariff (%) 0	5	5.63	7.5	10	15	25	35
2002	24	0	0	0	0	0	0	0
2003	71	0	0	0	0	0	0	0
2004	340	0	0	0	0	1	3	0
2005	8,986	0	0	13	0	67	32	1
2006	6,819	1	0	0	0	50	12	0
2007	9,535	0	0	0	0	0	13	0
2008	10,496	0	0	0	0	63	0	0
2009	10,473	0	5	0	11	94	0	0
2010	9,988	0	0	0	5	0	0	0
2011	10,031	0	19	0	3	0	0	0
2012	11,356	0	36	0	0	0	0	0
2013	12,369	0	0	0	0	0	0	0
2014	1,952	0	0	0	0	0	0	0
Total	92,394	1	60	11	19	286	60	1

Source: WTO.

Table A2: Data description

	Observations		Value (US$ Million)		Weight (Tonnes)	
year	Control	Treatment	Control	Treatment	Control	Treatment
2002	10	8	0.64	0.53	21.6	23.3
2003	30	40	1.00	1.50	130	98.00
2004	131	204	15.1	13.9	691	520
2005	2,495	6,601	215	531	10,849	19,163
2006	2,485	4,388	321	410	21,070	13,321
2007	3,345	6,197	338	814	16,014	19,712
2008	4,072	6,479	539	983	23,637	19,744
2009	4,351	6,224	750	1,085	29,865	19,095
2010	4,018	5,964	739	837	27,609	17,208
2011	3,643	6,396	804	1,178	18,249	18,234
2012	4,304	7,076	1,119	1,384	26,386	19,382
2013	5,519	6,829	2,734	3,187	62,431	15,542

Source: Pakistan Customs.

7.1.1.1.1 Figure A1: Major export destinations of Pakistan's mangos

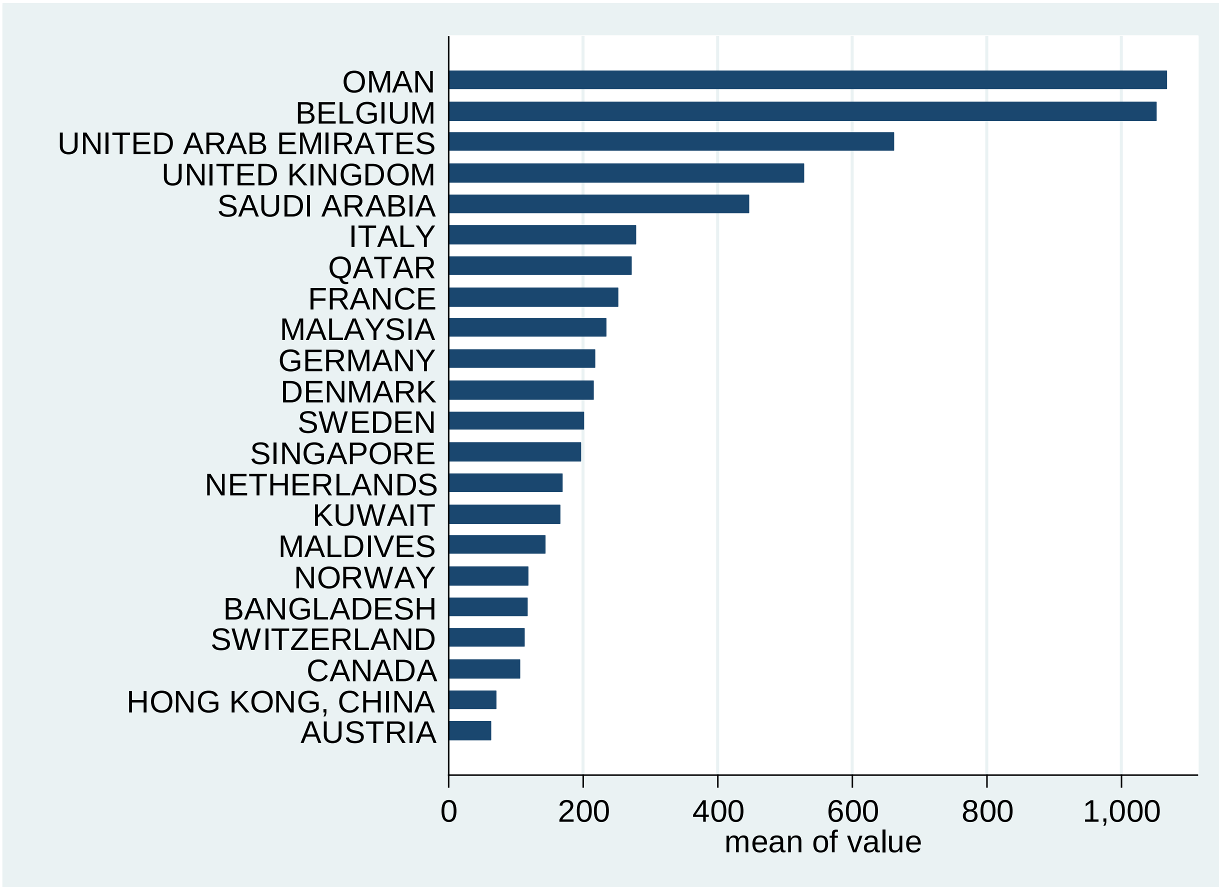

Figure A2: Effect of SPS measures and TBT on mangos

Packaging and labelling before and after the policy change