Trade Barriers or Safety Standards? Differential Impact of Mandatory SPS-based Tolerance Levels on Fruits

CRIT/CWS Working Paper Series No 99

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Do pesticide MRLs protect consumers or differentially block trade? A study of 40 importers and 42 fruit exporters, 1996–2023, suggested that each additional MRL reduces exports by 0.61% for lower-middle-income countries but increases them by 0.71% for richer ones. Capacity to comply decides who wins.

August 2026

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[1] The views expressed in this paper are those of the author(s) and do not necessarily reflect the views of the Centre for WTO Studies, the Indian Institute of Foreign Trade, or the Government of India. Errors and omissions, if any, are the author's own. The authors would like to thank Ms Hari Maya Gurung for her extensive support throughout the paper and specifically her contribution in providing CWS SPS, TBT & MRL data and Mr Visesh Agarwal, CWS intern for his support in data analysis. or any clarification, please contact muralik@iift.edu, muralikallummal@gmail.com.

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Abstract

Amid rising concern over food safety, many governments impose Maximum Residue Limits (MRLs): the highest pesticide residue concentration legally permitted in a food commodity. Whether MRLs raise food quality or operate as de facto trade barriers remains contested, and the empirical evidence is mixed. This study estimates the effect of MRLs imposed by 40 high-income importers on fruit exports from 42 countries over 1996–2023, using a structural gravity model. The effects are heterogeneous across exporters: an additional MRL notification lowers exports from lower-middle-income countries by 0.61%, but raises exports from high- and upper-middle-income countries by roughly 0.71%. Free trade agreements partially offset the adverse effect. MRLs can therefore serve simultaneously as legitimate food safety measures and as de facto barriers, with their trade impact largely determined by exporters' institutional and technological capacity to comply.

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1. Introduction

The multilateral trading system has indeed been successful in reducing tariff barriers on agricultural trade, but the caveat about non-ad valorem tariffs is important. Successive rounds of negotiation, the tariffication commitments of the Uruguay Round Agreement on Agriculture, and the proliferation of preferential trade agreements have together driven applied tariffs on most agricultural products to historically low levels. While the Uruguay Round Agreement on Agriculture (AoA) mandated tariffication and binding of tariffs, many developed countries retained complex non-ad valorem duties (specific, mixed, or compound tariffs), which limited transparency and diluted the liberalisation effect. The EU applies non-ad valorem duties, specific, compound, mixed and technical across roughly 46.5 per cent of its agricultural tariff lines, and 17.1 per cent of those covering fruit, vegetables and plants, alongside the entry price system for selected fresh produce. Ad valorem equivalents (AVEs) for these duties have been computed for our sample, so the simple average MFN rate captures both the ad valorem and non-ad valorem component of protection, which has been consistently used across the WTO for agricultural and non-agricultural negotiations (Kallummal; 2015).

However, the notional tariff liberalisation of border measures has not produced a corresponding increase in trade in agricultural goods. Instead, the locus of protection has shifted to cost-enhancing, behind-the-border measures such as technical regulations, conformity assessment procedures, and, most prominently, sanitary and phytosanitary (SPS) measures. For exporters of fresh and processed food products, the binding constraint on market access today is far more likely to be a residue tolerance, a testing protocol or a certification requirement than an ad valorem or non-ad valorem duty. This shift is neither accidental nor, in itself, illegitimate. It reflects a genuine and growing global concern with food safety. Rising incomes, urbanisation and the lengthening of agri-food supply chains have increased both consumer demand for safe food and the informational distance between producer and consumer. Pesticides are central to this concern. They play an indispensable role in protecting crops from pests and disease and in sustaining yields, but their residues persist on harvested produce and enter the human diet.

Governments and international organisations have therefore established Maximum Residue Limits (MRLs), the highest concentration of a pesticide residue legally tolerated in or on a food or feed commodity when that pesticide has been applied in accordance with good agricultural practice, to contain the risk of dietary exposure and environmental

and human toxicity (EU, 2005; Latif et al., 2011). MRLs are legally enforceable, set for specific pesticide commodity combinations, and derived from supervised residue trials and toxicological reviews. Consignments exceeding the applicable limit may not lawfully be placed on the market. Most industrialised economies operate residue surveillance programmes that cover both domestically produced and imported commodities and publish the results annually. An MRL is the highest level of a pesticide residue that is legally tolerated in or on food or feed when pesticides are applied. MRLs are legal and enforceable limits set for the different combinations of pesticides and foods, or crops. Scientists carefully review a wide variety of scientific data and information when setting pesticide food safety standards to keep everyone healthy. Food that does not meet these standards is prohibited from being distributed.

Some countries rely on the Codex Alimentarius Committee on Pesticide Residues to establish MRLs, while others set their own. Most industrialised countries have pesticide surveillance programs that cover both domestically produced and imported commodities and report the results annually. The World Trade Organisation (WTO) has an agreement on the Application of Sanitary and Phytosanitary Measures among member countries, allowing them to develop their own sanitary and phytosanitary standards and measures freely, provided they are based on recognised scientific evidence.

However, the growing application of MRLs has sparked an important debate. Some argue that MRL standards aim to protect human health and environmental sustainability. In contrast, others criticise the fact that, in recent years, MRLs set by governments have become increasingly stringent, eroding the competitiveness of exporters from developing economies. The relationships between MRLs across different products and their impact on trade remain unknown. In the empirical analysis, the trade effects of MRLs vary by importing country, product category, and the specific chemical substance under investigation. This paper aims to contribute to this discussion by providing a better understanding of the economic impact of MRLs set by high-income economies.

High- and upper-middle-income economies have proliferated the use of MRLs in recent years. A recent example is the European Union's Omnibus X package, introduced in December 2025. (EU, 2025) While the proposed regulation aims to simplify food and feed regulations, it also includes several amendments to existing pesticide MRLs that may concern exporters. The biggest concern is that it creates a legal basis to set MRLs at technical zero tolerance for certain hazardous substances, even where Codex MRLs exist. Such proposed changes reflect a shift from a risk-based assessment towards a hazard-based approach for specific categories of pesticides. Several WTO members, including India, have expressed concerns in the WTO SPS Committee, since such a proposal introduces measures that may depart from internationally recognised standards and increase compliance burdens for exporters. Also, the proposal raises questions regarding

consistency with the SPS Agreement's provisions on scientific justification, international standards, and risk assessment.

For developing economies, these policies are particularly important for their agricultural exporters. Commodities such as fruits, vegetables, and spices often face increasingly stringent MRLs in high-income markets. Such proposals will require exporters to modify pesticide use and will incur additional testing and certification costs. Overall, the governments of developing economies will need to strengthen their traceability systems to gain market access in developed economies. While some regulatory changes in the proposal, such as allowing products produced under previous MRLs to remain on the market and reducing unnecessary reviews for some contaminants, may ease administrative burdens, stricter MRLs can still create compliance challenges. (Kallummal, 2022) Hence, understanding the economic consequences of MRLs is important. Existing empirical evidence suggests that the trade effects of MRLs vary across importing countries, products, and individual pesticide substances, and their overall impact on agricultural trade remains mixed. This study therefore seeks to provide a deeper understanding of how MRLs imposed by high-income economies affect fruit trade. By quantifying their economic effects, the study aims to provide evidence to help policymakers balance legitimate food safety objectives with the need to maintain fair and predictable market access for agricultural exporters.

This article is structured as follows. Section 2 presents the theoretical model, followed by a literature review on the impacts of MRL standards on trade in Section 3. Section 4 specifies the empirical model and introduces the data and the limitations. Results are discussed in Section 5, and the study concludes in Section 7.

2. Literature Review

Maximum Residue Limits (MRLs) have attracted considerable attention in the literature as one of the most important SPS measures affecting agricultural trade. The empirical literature has sought to determine whether MRLs function primarily as legitimate food safety standards or as non-tariff barriers to trade.

Early studies generally reported that more stringent MRLs reduce trade. Using a gravity model, Otsuki et al. (2001) showed that the European Union's tightening of aflatoxin standards significantly reduced African exports of cereals, dried fruits and nuts. Similarly, Wilson et al. (2003) found that stricter antibiotic residue standards for beef reduced global beef trade. The study estimated that harmonisation with Codex standards would substantially increase trade. Extending this literature, Disdier et al. (2008) found that stringent SPS regulations imposed by OECD countries significantly constrained agricultural exports from developing countries, while having little effect on trade among developed economies. These studies established that compliance costs associated with

food safety regulations are often disproportionately burdensome for exporters from developing countries.

Subsequent research examined the effects of MRLs at more disaggregated product levels. Chen et al. (2008) found that a 10% increase in the stringency of Chlorpyrifos MRLs reduced China's vegetable exports by around 2.8%, while Tran et al. (2012) reported that stricter Chloramphenicol standards constrained crustacean exports to developed markets. In contrast, Xiong et al. (2012) found no statistically significant effect of the European Union's aflatoxin standards on African groundnut exports. These contrasting findings suggest that the trade effects of MRLs cannot be attributed solely to the stringency of regulations. Rather, they appear to depend on the regulated chemical substance, the commodity under consideration, and exporters' capacity to comply with the standards. Moreover, studies based on a single product or pesticide provide only a partial understanding of the broader trade effects of MRLs.

It is also important to recognise that differences in empirical findings stem from variations in how MRL stringency is measured. A major methodological contribution is provided by Li et al. (2014), who developed a science-based index to measure the protectionism embodied in MRL regulations. Using Codex Alimentarius standards as the international benchmark, they proposed product- and importer-level indices that aggregate multiple individual pesticide residue limits into comparable measures of regulatory stringency. Unlike simple counts of regulations, these indices distinguish between scientifically justified standards and excessively stringent requirements that exceed international norms. The authors further demonstrated that MRL protectionism varies considerably across countries and products. For example, fruit and vegetable products exhibited greater variation in regulatory stringency than meat and dairy products. These indices have since become widely adopted measures of MRL restrictiveness in empirical trade studies. Before this, researchers measured standards using individual pesticide limits, dummy variables, or counts of regulations, which made studies difficult to compare. However, Li et al. (2014) solved this by providing a consistent measure of regulatory stringency relative to Codex. Another development in the literature is a statistical approach that uses a logarithmic scale to identify notifications with higher stringencies. Based on this approach, the SPS notifications issued by a WTO member were classified into five categories; it was first proposed by Aggarwal et al. (2022) and later extended to identify tea exports to developed markets. (Pradhani et al., 2024).

A growing body of literature also distinguishes between the extensive and intensive margins of trade to understand how MRLs influence export behaviour. Using the Helpman-Melitz-Rubinstein (HMR) gravity framework, Ferro et al. (2015) make an important methodological contribution. They developed a standards restrictiveness index covering pesticide regulations for 61 importing countries and 66 agricultural products.

Their results indicate that more stringent standards primarily reduce the probability of exporting (the extensive margin), while having little or no statistically significant effect on export values once firms have entered the market (the intensive margin). These findings support the argument that compliance with MRLs primarily raises fixed market-entry costs rather than variable trading costs.

Recent studies increasingly emphasise that the impact of MRLs is heterogeneous rather than uniform. Hejazi et al. (2022) showed that while stricter MRLs generally reduced fruit and vegetable exports, the effects varied across pesticide groups. More stringent standards for insecticides and fungicides lowered the USA's exports to CPTPP markets, whereas stringent herbicide standards were associated with higher exports. This could be due to improvements in production quality and consumer confidence. Likewise, Shingal et al. (2021) reported that higher MRL stringency relative to exporters was associated with higher bilateral trade in fruits and vegetables, suggesting that compliance with high regulatory standards can improve market reputation and facilitate exports. Ishaq et al. (2015) also found an overall trade-enhancing effect of MRLs on China's food exports. Using a protectionism index, the study argued that China's domestic efforts to improve food safety enabled exporters to meet stricter foreign standards, thereby mitigating the potential trade-restricting effects of MRLs. The most recent evidence further reinforces the heterogeneous nature of MRL impacts. Zhang (2025), using highly disaggregated HS eight-digit data covering 237 agricultural products, 43 importing countries and 399 chemical substances during 2006-2021, found that a 10% increase in MRL stringency reduced China's agricultural exports by approximately 6.6%. However, the effects differed substantially across pesticide categories and destination markets. The study also demonstrated that tightening MRLs did not significantly affect the probability of exporting, indicating that MRLs primarily influence the intensive margin. Moreover, considerable regional heterogeneity was observed, with stricter standards impeding exports to the European Union and OECD countries but facilitating exports to the United States and Canada. Hence, much of the divergence in empirical findings reflects differences in the measurement of MRL stringency, product coverage, econometric specifications, and the distinction between fixed and variable compliance costs.

Another important strand of the literature focuses on regulatory harmonisation rather than absolute stringency. Rather than asking whether standards are strict, these studies examine whether similarity between exporters' and importers' regulations facilitates trade. Drogué et al. (2012) showed that greater harmonisation of insecticide MRLs significantly increased the intensive margin of trade in apples and pears. However, it had little influence on the probability of exporting. Likewise, Winchester et al. (2012) found that greater divergence between national MRLs and international standards reduced bilateral trade flows, highlighting the importance of regulatory convergence in lowering compliance costs.

Overall, the existing literature does not support a single conclusion regarding the trade effects of MRLs. While many studies find that stricter standards raise compliance costs and reduce exports, particularly for developing-country exporters, others show that compliance with higher standards can enhance product quality, improve consumer confidence, and facilitate trade. The evidence increasingly suggests that the effects of MRLs are highly heterogeneous and depend on factors such as the product, pesticide, exporter capabilities, destination market, degree of regulatory harmonisation and the margin of trade being examined. These findings underline the importance of analysing MRLs at a highly disaggregated level rather than treating SPS measures as a homogeneous category.

3. Theoretical Model

The gravity model is the workhorse theoretical model in international trade, and this study employs a structural gravity model to analyse bilateral trade flows. The model predicts that trade between two countries increases with their economic size and decreases with trade costs such as distance, transport costs, and other trade barriers. Non-tariff measures, including MRL regulations, are treated as determinants of bilateral trade costs since they influence the conditions under which exporters can export.

The impact of MRLs on trade is not necessarily straightforward. On the one hand, stricter MRLs may increase compliance requirements and restrict market access for some exporters, thereby imposing significant compliance costs, including administrative costs, process improvements, and technological upgrades. Still, on the other hand, they may also improve consumer confidence by signalling higher food safety standards. As a result, MRLs can simultaneously function as trade barriers and quality assurance mechanisms. This dual nature of MRLs is acknowledged, wherein papers distinguish between two opposing channels through which MRLs affect trade. The former effect is called the trade-cost effect, where stringent regulations raise production, testing, certification, and compliance costs. These additional costs can disproportionately affect exporters with limited capacity, in turn reducing their ability to compete in international markets. The latter is the demand-enhancing effect, whereby stricter food safety standards increase consumer confidence, in turn raising their demand. Hence, the overall effect of MRLs depends on the relative strength of these two mechanisms.

It has also been theoretically established that MRL regulations may affect a firm's production decisions and product quality. Drawing on the heterogeneous firm framework developed by Melitz, it is argued that, to remain competitive, firms upgrade their production processes and improve quality when food safety standards are introduced. However, because not all firms have the resources to meet higher standards, these MRL regulations create a selection effect in which only the most productive and efficient firms

continue to export. As a result, stricter MRLs may reduce aggregate export volumes while increasing the average quality and value of exported products. (Kallummal et al; 2018)

The impact of MRLs also depends on the compatibility of regulatory systems between trading partners. The harmonisation of standards does not necessarily reduce trade costs; instead, the effect depends on how the harmonised standard compares with existing domestic regulations and the exporter's capacity to comply with the new requirement. If the harmonisation raises the required level of compliance, exporters from countries with weaker regulatory systems may face higher adjustment costs despite greater regulatory harmonisation. Conversely, exporters that already meet high domestic standards may benefit from easier market access. This once again suggests that harmonisation can generate uneven effects across countries depending on their initial regulatory capabilities.

Taken together, these theoretical perspectives suggest that the impact of MRLs cannot be viewed solely as an additional trade cost. Instead, MRLs influence trade through multiple channels, including compliance costs, consumer confidence, quality upgrading, and domestic institutional capacity. The balance between these mechanisms is likely to differ across countries.

4. Methodology

The objective of this study is to analyse the impact of MRL measures imposed by High-income (HI) countries on all fruit product imports from lower-middle, upper-middle, and high-income exporting countries. The data on MRL measures were taken from the CRIT, Centre for WTO Studies.[2] Online web databases for the period of 1995 to 2023. The importer and exporter countries are listed in Table 1 below.

Table 1: Importing & Exporting Countries in the Dataset

S. No.	Importing Countries	Exporting Countries
1.	Australia	Argentina
2.	Austria	Australia
3.	Belgium	Belgium
4.	Canada	Bolivia
5.	Chile	Brazil
6.	Croatia	Cameroon
7.	Czech Republic	Canada
8.	Denmark	Chile
9.	Finland	China
10.	France	Colombia
11.	Germany	Costa Rica

[2] Online downloadable databases on SPS and TBT measure of 166 WTO members have been linked to HS 4 digit level to capture the economic and trade impacts. The data is available at web links, SPS measures: https://cc.iift.ac.in/sps/index.asp and TBT measures: https://cc.iift.ac.in/tbt/index.asp.

S. No.	Importing Countries	Exporting Countries
12.	Greece	Cote d'Ivoire
13.	Hong Kong SAR, China	Dominican Republic
14.	Hungary	Ecuador
15.	Ireland	Egypt, Arab Rep.
16.	Israel	France
17.	Italy	Germany
18.	Japan	Ghana
19.	Korea, Rep.	Greece
20.	Kuwait	Guatemala
21.	Latvia	Honduras
22.	Lithuania	India
23.	Luxembourg	Iran, Islamic Rep.
24.	Netherlands	Israel
25.	New Zealand	Italy
26.	Norway	Kenya
27.	Oman	Mexico
28.	Poland	Morocco
29.	Portugal	Netherlands
30.	Qatar	New Zealand
31.	Saudi Arabia	Pakistan
32.	Singapore	Panama
33.	Slovak Republic	Peru
34.	Slovenia	Philippines
35.	Spain	Poland
36.	Sweden	South Africa
37.	Switzerland	Spain
38.	United Arab Emirates	Thailand
39.	United Kingdom	Tunisia
40.	United States	Turkey
41.	-	United States
42.	-	Vietnam

Source: Based on the authors' calculation

To select the importing countries from the list of all high-income importing countries for fruits, the top 40 are selected, whose combined imports from 1996-2023 account for 99% of the total fruit imports among HI importing countries. Additionally, these 40 HI countries account for 76.88% of the world. For the selected 40 importers, 42 export partners have been identified for fruits, which include the top 16 exporters from high-income (HI) countries, the top 13 exporters from upper middle-income (UMI) countries, and the top 13 exporters from lower middle-income (LMI) countries, which all together account for 93.71% of exports to the selected 40 importing countries. Therefore, the selected list of 40 importers, 42 exporters, and 28 years accounts for 72.04% of the world's total fruit trade in our dataset. To consider all fruit products, the entire Chapter 8, with 14 HS 4-digit-level codes, is considered. The HS codes along with their description are listed in Table 2 below.

Table 2: Fruit Sector HS Codes and Product Descriptions

HS Code	Product Description

0801	Coconuts, Brazil nuts and cashew nuts, fresh or dried, whether or not shelled or peeled
0802	Other nuts, fresh or dried, whether or not shelled or peeled
0803	Bananas, including plantains, fresh or dried
0804	Dates, figs, pineapples, avocados, guavas, mangoes and mangosteens, fresh or dried
0805	Citrus fruit, fresh or dried
0806	Grapes, fresh or dried
0807	Melons (including watermelons) and papaws (papayas), fresh
0808	Apples, pears and quinces, fresh
0809	Apricots, cherries, peaches including nectarines, plums and sloes, fresh
0810	Other fruit, fresh
0811	Fruit and nuts, uncooked or cooked by steaming or boiling in water, frozen, whether or not sweetened
0812	Fruit and nuts, provisionally preserved (e.g. by sulphur dioxide gas, in brine) but unsuitable in that state for immediate consumption
0813	Fruit, dried, other than that of headings 0801 to 0806; mixtures of nuts or dried fruits of Chapter 8
0814	Peel of citrus fruit or of melons, including watermelons, fresh, frozen, dried or provisionally preserved

Source: World Customs Organization (WCO). Harmonised Commodity Description and Coding System (HS), 2022 Edition.

The heterogeneous effects of maximum residue limits (MRLs) across countries with different income levels are estimated using the following gravity model:

$$TV_{ijkt} = e^{[\beta_0 + \beta_1 MRL_{jkt} + \beta_2 MRL_{jkt} \times HI_{it} + \beta_3 MRL_{jkt} \times UMI_{it} + \beta_4 MRL_{jkt} \times FTA_{ijt} + \beta_4 Tariff_{jkt} + \beta_5 \ln(MGDP)_{jt} + \mu_{it} + \varphi_{ij}]} \times \varepsilon_{ijkt}$$

where TV_{ijkt} denotes the value of exports of product k from exporter i to importer j in year t. MRL_{jkt} measures the stringency of the importing country i's maximum residue limit for product k. To examine whether the trade effects of MRLs differ across exporting countries at different stages of economic development, the model includes interaction terms between the MRL variable and income-group dummies. HI is a dummy variable equal to 1 if the exporting country is classified as a high-income economy. In contrast, UMI equals 1 if the exporting country is classified as an upper-middle-income economy. β_1 is the estimated effect of MRLs on the low- to middle-income group. The coefficients β_2 and β_3 capture the differential impact of MRLs on high-income and upper-middle-income countries, respectively.

The interaction term MRL×FTA examines whether the presence of a free trade agreement moderates the impact of MRL regulations, reflecting the possibility that FTAs reduce compliance costs through regulatory cooperation or harmonisation mechanisms. The model further controls for the applied tariff rate and the importing country's market size, proxied by the log of GDP. The MRL data is available from 1996 to 2023; hence, 28 years are taken for all the required variables.

To analyse the impact of MRLs on fruit exports, we have used a series of specification models, with our trade data comprising 23,520 panels over 28 years, yielding 6,58,560 observations in the final panel dataset. Of these 6,58,560 observations, 60% have zero trade values, making the PPML model robust for our analysis.

To ensure the results are not affected by endogeneity, each endogeneity issue is addressed separately to minimise omitted variable bias (OVB). Interaction fixed effects (FEs) are incorporated to cover every possible factor that can affect trade. We have taken 2 FE, where the Exporter-Year (μ_{it}) FE captures all factors that vary across exporters and over time, such as exporting countries' GDP, productivity, domestic policies, infrastructure quality, political stability, and outward multilateral resistance to trade (MRT). Exporter-Importer (φ_{ij}) FE captures all time-invariant country-pair factors that vary across exporters and importers, such as historical relationships, colonial ties, common language, geographic distance, bilateral trust, and diplomatic relations.

We have dropped Importer-Year (γ_{jt}) FE, absorbing GDP, consumer preferences, import regulations, exchange rates, and Inward Multilateral Resistance and Product (δ_k) FE, absorbing product-specific constant differences, since our main variable of concern is cumulative MRL (Cum_MRL_{jkt}) notification which varies across three dimensions, since for a single exporter, an MRL notification varies across importing countries, products, and years. Therefore, the impact of the cumulative MRL (Cum_MRL) variable is likely absorbed by the Importer-Year (γ_{jt}) and Product FE (δ_k). The regression equation above includes all the required variables for our preferred regression.

4.1 Limitation

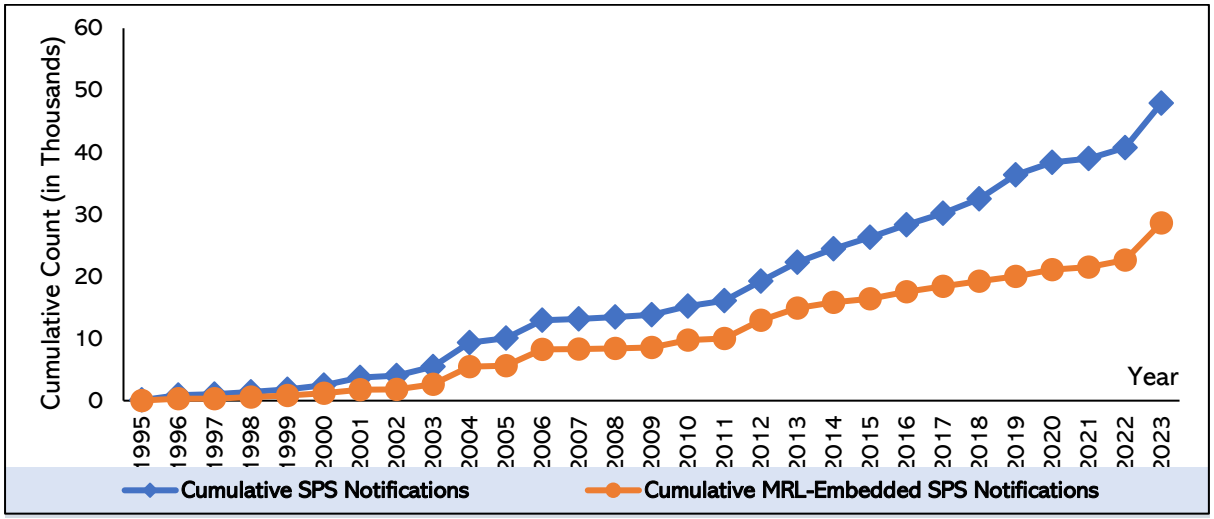
The political-economy determinants of SPS measures constitute a real literature; it is important to highlight at the outset that various socio-economic, geopolitical, and strategic factors may influence their actual notification and implementation. (Santeramo et al., 2019; Yuan et al., 2012). Trade policy and GVCs find that sectors/OEMs/Large firms with higher value-added content in imports influence the policymakers' incentives to impose trade-restrictive NTMs, much like tariffs, with effects that are heterogeneous across sectors and by the income group of the imposing country. (Ludema et al., 2021; Bown et al., 2021) As GVCs grow, the distinction between "domestic" and "foreign" interests blurs, so political economy analysis of NTMs has to model value chains explicitly. It therefore becomes important, within a sector's trade dynamics, to examine the dominant firms' share in trade, which is the key determinant of the impact of stringent NTMs. This has not been addressed in this paper.

5. Analysis and Results

5.1 Descriptive Analysis

Figure 1 tracks the cumulative stock of all SPS notifications, and MRL-specific SPS notifications issued by the 42 importing economies in the dataset for fruit HS codes 0801-0814. The figure reveals three analytically important features: the scale of cumulative SPS notifications, the acceleration in growth rates, and the progressive convergence of MRL-specific notifications toward total SPS volume.

Figure 1: Cumulative SPS Notifications and Cumulative MRL-Embedded SPS Notifications for Fruit, 1995-2023



Source: Online database of CRIT/CWS on SPS Measures https://cc.iift.ac.in/sps/index.asp.

The cumulative number of SPS notifications[3] grew from 88 in 1995 to 47,908 by 2023, an increase of more than 544 times over 29 years. This growth is non-linear. Three distinct phases of acceleration are visible. In the first phase (1995-2003), growth is relatively restrained, with the total SPS notifications reaching approximately 5,499 by 2003. The second phase (2004-2006) is characterised by a sharp surge, with 3,860 annual SPS notifications issued in 2004 alone. This surge is directly attributable to the European Union's implementation of Regulation (EC) No. 396/2005, which consolidated all pesticide MRL schedules across EU member states into a single harmonised regulatory list, generating a large wave of new SPS notifications. The third phase (2010-2023) represents a sustained, steep acceleration, with 7,175 SPS notifications in 2023 alone, the highest annual figure in the entire series.

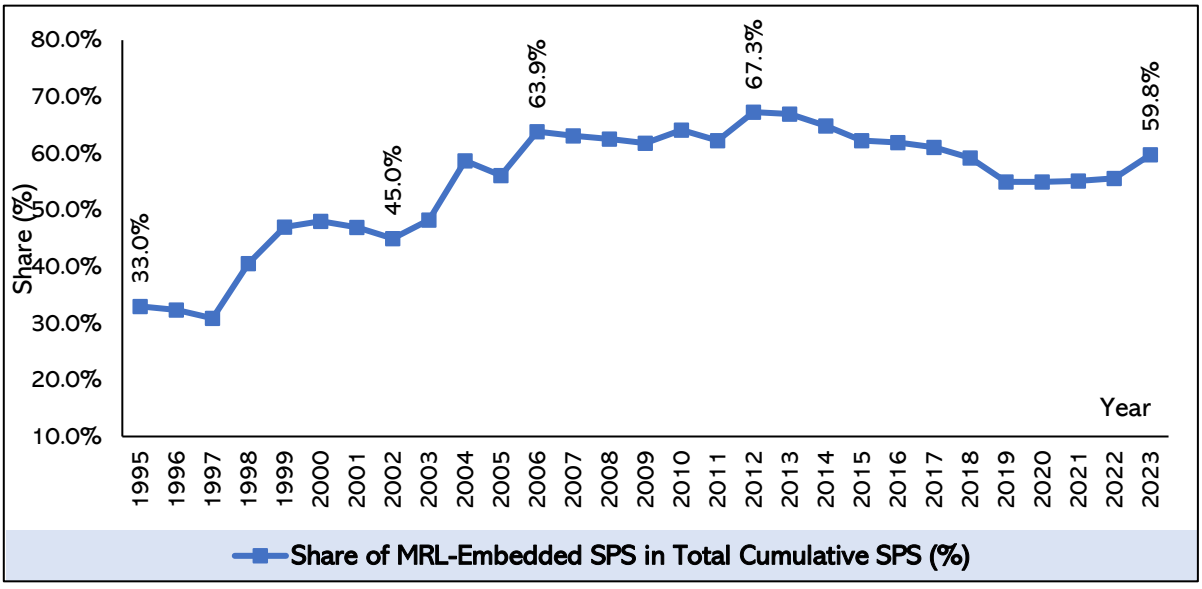
[3] An MRL notification for chlorpyrifos on apples does not cancel the MRL for imazalil on apples. Each measure adds an analyte to the required scan, a compliance step, and a possible failure point. The regulatory constraint facing an exporter in 2023 is the accumulated body of measures still in force, not the handful notified that year. So the notification flow is the first difference of the object you actually care about, and cumulating it is simply recovering the level of restrictions imposed on the exporter.

The cumulative stock of MRL under SPS notifications follows a parallel trajectory, growing from 29 in 1995 to 28,646 by 2023. As Figure 1 illustrates, the gap between total SPS and MRL-embedded SPS notifications remains relatively stable in proportional terms over the years, with a high share of MRL notifications in SPS notifications. By 2023, MRL-specific notifications accounted for 59.8 per cent of the SPS stock, indicating a high share of pesticide residue governance and underscoring the importance of regulatory modalities across all fruit products. This finding reflects the observation that MRL requirements in SPS notifications increased more than 15-fold globally over thirty years (Kallummal et al., 2025).

The 2023 annual spike (7,175 notifications) likely reflects the combined effect of the EU's Farm-to-Fork Strategy commitment to halve pesticide use by 2030, the systematic revision of active substance approval lists under Regulation (EU) No. 1107/2009, and updates to tolerance limits necessitated by EFSA's cumulative dietary risk assessments for pesticide residue combinations. This is not an isolated statistical anomaly but rather reflects a structural regulatory shift expected to persist and intensify.

Figure 2 presents the share of MRL-specific notifications among total SPS notifications over time, providing a clearer view of the compositional shift within SPS measures. The share begins at 33 per cent in 1995, reflecting that even in the first year of WTO operation, a substantial minority of SPS notifications concerned pesticide residue limits, and it exhibits a broadly upward trend, reaching 59.8 per cent by 2023.

Figure 2: Share of MRL Notifications in Cumulative Total SPS Notifications, 1995-2023 (%)



Source: Online database of CRIT/CWS on SPS Measures https://cc.iift.ac.in/sps/index.asp.

The trajectory is not monotonic. The share dips in 1997 (30.9 per cent) and again in 2007-2008 (63.1 per cent and 62.6 per cent), before climbing steeply from 2010 onward. Within these years of high share include 2006 (63.9 per cent), 2010 (64.2 per cent), 2012 (67.3 per cent), and 2013 (67.0 per cent). These peaks correspond to

specific EU regulatory milestones: the entry into force of Regulation (EC) No. 396/2005 consolidating European MRL schedules (generating the 2006 peak), then the implementation of Regulation (EU) No. 1107/2009 on plant protection products (the 2010-2013 cluster) and finally the progressive revision of active substance approvals under EFSA's risk assessment programmes.

The long-run increase in the MRL share from 33.0 per cent in 1995 to 59.8 per cent by 2023 has direct policy implications. It highlights that the centre of gravity in SPS trade governance for fruits has shifted decisively toward pesticide residue regulation. This shift can cause asymmetric costs on developing-country exporters for two main reasons. First, meeting MRL standards requires laboratory testing infrastructure, agrochemical traceability systems, and Good Agricultural Practice (GAP) protocols, all of which entail costly establishment and maintenance, placing smallholder-dependent supply chains at a structural disadvantage. Second, when MRLs are set using hazard-based rather than risk-based methodologies, as India has argued is frequently the case in WTO SPS Committee submissions (Kallummal et al., 2025), they may lack scientific justification, making compliance effectively restrictive without abandoning the use of certain agrochemicals entirely.

5.2 Results and Robustness Check

The results table shows the estimated coefficients for a series of specification models, including our preferred model, PPML, as well as OLS, Fixed Effect, and Random Effect models. The estimated OLS coefficients indicate an overall negative impact. In contrast, the fixed effect and random effect models depict a positive impact of MRL notification on trade values for all income group exporters, regardless of an FTA between trading partners. However, there are concerns about autocorrelation and heteroskedasticity within these models, and the R-squared is relatively low. Since the results were diverse and R-squared was low across all three models, we have chosen PPML as our preferred baseline model, as it accounts for heteroskedasticity in multi-dimensional trade panel data. We have also included interaction fixed effects to capture all possible factors influencing trade, and dummies for exporter income groups and for FTAs between trading partners, yielding a reliable, unbiased model with a relatively high R-squared of 58%.

In the baseline PPML model, the coefficients represent semi-elasticities, indicating that a one-unit increase in the independent variable changes trade by approximately ($\beta \times 100$)%. In contrast, for log variables, it is a direct elasticity.

Since the log of exporter GDP varies across exporters and years, its impact is absorbed by Exporter-Year (μ_{it}) FE, and the colonial relationship, language, and bilateral neighbours variables vary across exporters and importers; Exporter-Importer (φ_{ij}) FE absorbs their impact.

Table 3: Effect of Maximum Residue Limits on Bilateral Trade Flows

Dependent Variable: Trade Value (USD) for PPML; Log Trade Value for OLS, FE, and RE

	(1) PPML	(2) PPML	(4) PPML	(3) PPML	(4) OLS	(5) Fixed Effect	(6) Random Effect
Variable	Baseline	Lagged MRL	USA Dropped (Importer)	Robustness Mexico-US Dropped	Pooled	Within	GLS
MRL Variables							
Total_Cum_MRL	−0.0061***	—	−0.0039*	−0.0051**	−0.0101***	0.0030***	0.0010***
	(0.0021)		(0.0021)	(0.0021)	(0.0003)	(0.0002)	(0.0002)
Total_Cum_MRL_lag1	—	−0.0066***	—	—	—	—	—
		(0.0023)					
MRL_high (×High income)	0.0073***	0.0076***	0.0071***	0.0075***	—	—	—
	(0.0021)	(0.0023)	(0.0019)	(0.0022)			
MRL_U_middle (×Upper Middle)	0.0070**	0.0075**	0.0044*	0.0037	—	—	—
	(0.0031)	(0.0033)	(0.0025)	(0.0030)			
MRL_fta (×FTA)	0.0045***	0.0048**	0.0051***	0.0030**	—	—	—
	(0.0017)	(0.0019)	(0.0014)	(0.0015)			
Gravity Controls							
SimpleAvg	0.0118***	0.0117***	0.0124***	0.0113***	−0.0228***	0.0008	−0.0002
	(0.0024)	(0.0024)	(0.0025)	(0.0025)	(0.0005)	(0.0005)	(0.0005)
log_M_GDP	0.8341***	0.8213***	1.0334***	0.8239***	0.8285***	1.2807***	0.9805***
	(0.0888)	(0.0873)	(0.0924)	(0.0914)	(0.0048)	(0.0128)	(0.0102)
log_X_GDP	Omitted	Omitted	Omitted	Omitted	0.9545***	0.1637***	0.4756***
					(0.0040)	(0.0121)	(0.0095)
col45	Omitted	Omitted	Omitted	Omitted	2.3989***	Omitted	1.6840***
					(0.0859)		(0.3761)

comlang_off	Omitted	Omitted	Omitted	Omitted	−0.0380*	Omitted	−0.0776
					(0.0225)		(0.0982)
contig	Omitted	Omitted	Omitted	Omitted	4.5161***	Omitted	6.6079***
					(0.0455)		(0.1955)
fta_wto_raw	—	—	—	—	2.6610***	0.1105***	0.1863***
					(0.0150)	(0.0156)	(0.0152)
Constant	−7.133***	−6.763***	−12.601***	−6.845***	−42.813***	−33.548***	−33.910***
	(2.541)	(2.498)	(2.580)	(2.601)	(0.158)	(0.231)	(0.223)
Dep. Variable	TradeValueUSD	TradeValueUSD	TradeValueUSD	TradeValueUSD	log_Trade	log_Trade	log_Trade
Fixed Effects	EX×YR; EX×IM	EX×YR; EX×IM	EX×YR; EX×IM	EX×YR; EX×IM	None	StataID	StataID
Observations	644,378	644,378	628,348	643,986	658,560	658,560	658,560
Groups/Clusters	23,072	23,072	22,498	23,058	—	23,520	23,520
R^2 / Pseudo R^2	0.5851	0.5847	0.5591	0.5574	0.2127	0.0752[1]	0.1525[2]
Model Test Stat	chi^2=119.31	chi^2=118.96	χ^2=185.44	chi^2=111.50	F=22246	F=8146	chi^2=45588
Prob > test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: Columns (1)–(3) use Poisson Pseudo-Maximum Likelihood (PPML) with high-dimensional fixed effects (ppmlhdfe); the dependent variable is TradeValueUSD in levels. Columns (4)–(6) use log-transformed trade value (log_TradeValueUSD) as the dependent variable. Column (1) is the baseline PPML with contemporaneous MRL. Column (2) replaces MRL with its one-year lag. Column (3) drops the Mexico–United States pair. Column (4) is pooled OLS. Column (5) is within (fixed-effects) estimation grouped by StataID. Column (6) is GLS random-effects estimation. EX×YR = Exporter × Year FE; EX×IM = Exporter × Importer FE. Standard errors in parentheses; PPML SEs clustered at StataID. MRL_high and MRL_U_middle are interactions of MRL with High income and Upper Middle income dummies (reference: Low income). MRL_fta interacts MRL with an FTA indicator. "Omitted" denotes variables dropped due to collinearity with fixed effects. "—" denotes variables not included in that specification.
[1] Overall R^2 for FE model. [2] Overall R^2 for RE model. *** p < 0.01 ** p < 0.05 * p < 0.10

The baseline model results, depicts that, among different country group, the impact of MRL on exporters varies, where for LMI exporter without an FTA with its importing partner, an additional MRL notification in a year for a particular product, decreases their exports by 0.61%, for UMI exporters, the effect of MRL is neutralised, as an additional MRL notification leads to 0.09% increase in their exports, and for HI exporters, it increases their exports by 0.12%.

The model further distinguishes the impact of MRLs for exporters from different income groups based on whether the exporting country has an FTA with the importer; the results show that, for LMI exporters with an FTA with their importing partner, an additional MRL notification leads to a 0.16% decrease in exports. For UMI exporters, the effect of MRL is again neutralised, as an additional MRL notification leads to a 0.54% increase in their exports. For HI exporters, exports increase by 0.57%. The effect of other variables, such as MFN tariffs, is positive on exports, with a 1.18% increase; this could be due to reverse causality. For the log of importer GDP, a 1% increase in MRL notifications is associated with a 0.83% increase in trade value, consistent with gravity model predictions.

To ensure the PPML results are robust and not driven by a single large importer or trading partner, we have identified the largest importer of fruits by trade value and removed all observations in which the USA is an importer. Even after excluding the USA as an importer, the estimated coefficients are in the same direction as in the baseline PPML model, with approximately equivalent coefficients and a slight decrease in R-squared. Additionally, the largest trading partners for exporters and importers are Mexico and the USA, respectively. After excluding them from the dataset, we still obtain similar results, with coefficients that closely align with those of the baseline model. These two models indicate that a major importer or trading partner does not drive the baseline results. To further provide robust support to the baseline model, a one-period lag of MRL notification has been used, and the PPML model again estimated similar coefficients in the same direction for all exporting income groups. These models ensure that the baseline model estimates are unbiased, not influenced by a major importer and trading partner, and address autocorrelation and the unknown nature of heteroskedasticity in the regression results.

6. Policy Recommendations

Based on the paper's findings, the following policy recommendations are suggested.

Firstly, developing exporting countries should work towards strengthening their domestic capacity to comply with SPS and TBT, particularly MRL requirements. Improving their regulatory systems can reduce the adjustment costs exporters face and help them compete in high-value markets (Kallummal et al., 2026).

Secondly, FTAs should be used to promote regulatory cooperation between countries, as the findings above show that FTAs can reduce the negative effects of MRLs. FTAs tend to facilitate cooperation on regulatory issues by including provisions on information exchange, technical assistance, and advance notification of regulatory changes, which can improve transparency and reduce compliance costs for exporters.

Additionally, harmonisation between national MRL standards and Codex requirements should be encouraged wherever the latter exists. Harmonisation can reduce trade costs for exporters while maintaining food safety protections. Choosing national MRL standards that are more stringent than Codex should be supported by transparent scientific risk assessments and accompanied by reasonable transition periods to allow exporters sufficient time to adjust (Kallummal et al., 2026).

Finally, developed countries and international organisations should continue to support capacity-building initiatives and provide financial support to developing countries. These initiatives help countries reduce compliance gaps between countries and enable exporters to meet food safety requirements more effectively.

Collectively, these measures can help strike a better balance between protecting public health and ensuring that food safety regulations do not create unnecessary obstacles to trade. While we work toward striking a balance, we need to address the alarming increase in 0.01 PPM notifications.[4] Across developed markets, this suggests limited use of certain generic agro-chemicals (Kallummal et al; 2016), as the industrial world developed newer alternatives. Under the WTO, this trend may lead to an imbalance in addressing the overall objective of balanced trade opportunities for all income-group countries, as most low-income countries depend on agricultural exports.

7. Conclusion

This paper quantifies the impact of MRLs on fruit products using a structural gravity model, which includes 40 high-income importing economies, 42 exporters, and the

[4] In many cases, this means the substance can no longer be used on crops destined for the EU, and every such change is notified to the WTO SPS Committee. The default applies wherever a substance is not specifically listed, and the legislation covers roughly 1,100 pesticides currently or formerly used inside or outside the EU. Renewal dossiers under Regulation 1107/2009 cost millions of euros. For a patented molecule, one firm captures the returns and funds the dossier. For an off-patent generic manufactured by many producers, no single firm has the incentive to pay for a renewal that benefits all competitors, so the substance lapses for want of a sponsor rather than for want of safety. The MRL then automatically falls to the LOQ. Developing-country growers, who disproportionately rely on cheap off-patent actives, lose the tool; developed-country growers have already transitioned to patented alternatives their own suppliers registered. It is a straightforward externality in the regulatory financing structure, producing a lopsided distributional pattern.

period 1996-2023. The paper diverges from the existing literature in the way it models MRL measures. In the literature, MRL measures are assumed to have uniform effects; however, our findings demonstrate that the impact of MRLs is heterogeneous across exporters at different levels of development.

The results show that an additional MRL notification reduces exports from lower-middle-income countries, suggesting that compliance costs associated with MRL regulations remain an important barrier for these exporters. This could be due to relatively weaker regulatory systems and limited technical capacity in these countries. The effect for high-income exporters and upper-middle-income countries is statistically positive. These findings support the argument that stringent food safety standards can have a demand-enhancing effect on exporters with the technological capability and institutional infrastructure to comply. As a result, MRLs should not be seen solely as non-tariff barriers; they also function as quality signals that reward exporters capable of meeting these regulatory requirements.

The study also finds that FTAs reduce the adverse effects of MRLs, suggesting that provisions on regulatory cooperation, information exchange, and harmonisation mechanisms within FTAs can lower compliance costs and facilitate market access. The robustness of these findings is confirmed through various robustness checks undertaken in the paper.

Overall, the findings indicate that the effects of SPS regulations such as MRLs depend on exporters' ability to comply with them. As high-income economies continue to strengthen food safety regulations, differences in countries' regulatory capacity are likely to become an important determinant of competitiveness in global agricultural markets.

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6. References

Agarwal M., Murali K., & Sangeta S. (2022). Imposition of tolerance limits in active ingredients on fruits: Analysis of the impact on India's exports. **SSRN Working paper**. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4150110

Bown C. P., Erbahar A., & Zanardi Maurizio **(2021).** Global value chains and the removal of trade protection**.** **European Economic Review**. November. 140. **https://doi.org/10.1016/j.euroecorev.2021.103937.**

Chen, C., Yang, J., & Findlay, C. (2008). *Measuring the effect of food safety standards on China's agricultural exports.* **Review of World Economics, 144**(1), 83–106. https://link.springer.com/article/10.1007/s10290-008-0138-z.

Disdier, A.-C., Fontagné, L., & Mimouni, M. (2008). *The impact of regulations on agricultural trade: Evidence from SPS and TBT agreements.* **American Journal of Agricultural Economics, 90**(2), 336–350.

Drogué, S., & DeMaria, F. (2012). *Pesticide residues and trade, the apple of discord?* **Food Policy, 37**(6), 641–649.

European Union (2005). Regulation (EC) No 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC. EUR-LEX: Access to European Union law. European Union (2025). Simplification. Omnibus Packages**.** https://commission.europa.eu/law/law-making-process/better-regulation/simplification-implementation-and-enforcement/simplification_en.

EUROPEAN COMMISSION. (2025). Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Regulations (EC) No 999/2001, (EC) No 1829/2003, (EC) No 1831/2003, (EC) No 852/2004, (EC) No 853/2004, (EC) No 396/2005, (EC) No 1099/2009, (EC) No 1107/2009, (EU) No 528/2012, (EU) 2017/625 as regards the simplification and strengthening of food and feed safety requirements.

Ferro, E., Otsuki, T., & Wilson, J. S. (2015). *The effect of product standards on agricultural exports.* **Food Policy, 50**, 68–79.

Garcés I., Vogt Achim. (2024). Global value chain integration and non-tariff measures**. Economics Letters**. 34. https://doi.org/10.1016/j.econlet.2024.111518.

Hejazi, M., Grant, J. H., & Peterson, E. (2022). *Trade impact of maximum residue limits in fresh fruits and vegetables.* **Food Policy, 106**, 102203. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L:2005:070:TOC.

Ishaq, M., Ping, Q., Haq, Z., Li, C., & Tong, C. (2016). *Maximum residue limits and agrifood exports of China: Choosing the best estimation technique.* **Agricultural Economics – Czech, 62**(2), 78–92.

Kallummal M & Prabhaka Prerna, (2016). India and EU Trade in Chemical Sector: Evidence on Pollution Haven Hypothesis, in edited book by Dastidar, A.G. and Y. Gupta, **Contemporary Issues in Trade, Environment and Policy**, Ane Books, 222 pages. New Delhi. ISBN-13 : 978–9385462344.

Kallummal M., & Gurung H.M. (2020). Urgent Need for Market Access Disciplining of Agriculture Trade: Profiling of Stringent and Non-Codex SPS-based MRL Standards. CRIT/CWS Working Paper Series. CWS/WP/200/60. https://wtocentre.iift.ac.in/workingpaper/MRL%20standards.pdf.

Kallummal Murali (2015). North–South Imbalances in the Doha Round: The Use of Specific Duties as a Trade Policy Instrument. **Agrarian South: Journal of Political Economy**. V.4 (1). https://journals.sagepub.com/doi/10.1177/2277976015574052.

Kallummal Murali (2022). Changing the Scale of Detection and the NTMs (SPS and TBT Measures): Applicational Differences in MRLs by Canada, the EC, Japan and the USA. (July 30, 2022). Available at Social Science Research Network (SSRN): https://ssrn.com/abstract=4177058 or http://dx.doi.org/10.2139/ssrn.4177058

Kallummal Murali, Mandiratta, D. & Singh Seema (2018). US Import Refusals of Agricultural Products and Their Impact on the Participation of Indian Firms. **Agrarian South: Journal of Political Economy** 7(1). https://doi.org/10.1177/2277976018758079.

Kallummal, M., Gurung, H. M., & Khosla, S. (2025). *Global trends in SPS measures and stringent SPS-based MRL notifications.* **CWS Policy Brief No. 10.** **https://wtocentre.iift.ac.in/PolicyBrief/Policy%20Brief%20SPS%20and%20MRLs%2019062025.pdf**.

Kallummal, M., Khosla, S., & Kundu, A. (2026). Have the non-tariff measures and the FTAs impacted food security challenges? *Foreign Trade Review*. https://doi.org/10.1177/00157325261420592

Li Yuan & Beghin, J.C. (2012). *A meta-analysis of estimates of the impact of technical trade barriers.* ***Journal of Policy Modelling. 34(3). 497-511. Elsevier.*** ***10.1016/j.jpolmod.2011.11.001***.

Li, Yuan & Beghin, J. C. (2014). *Protectionism indices for non-tariff measures: An application to maximum residue levels.* **Food Policy,** 45, **57–68.** https://www.sciencedirect.com/science/article/abs/pii/S0306919213001838.

Ludema, R. D., Mayda, A. M., Yu, Z., & Yu, M. (2021). The political economy of protection in GVCs: Evidence from Chinese micro data. *Journal of International Economics*, *131*, 103479.

Otsuki, T., Wilson, J. S., & Sewadeh, M. (2001). *What price precaution? European harmonisation of aflatoxin regulations and African groundnut exports.* **European Review of Agricultural Economics, 28**(3), 263–284.

Pradhani M. R., Chakraborty D. & Ghosh T.P. (2024). How Product Standards Influence Tea Exports? Empirical Evidence from India. FIIB Business Review. 15(4). https://doi.org/10.1177/23197145241258835.

Santeramo F. G., & Lamonaca E. (2019). The Effects of Non-tariff Measures on Agri-food Trade: A Review and Meta-analysis of Empirical Evidence. **Journal of Agricultural Economics**. 70(3) 595–617. https://doi.org/10.1111/1477-9552.12316

Shingal, A., Ehrich, M., & Foletti, L. (2021). *Re-estimating the effect of heterogeneous standards on trade: Endogeneity matters.* **The World Economy, 44**(3), 756–787.

Tran, N., Wilson, N. L., & Anders, S. (2012). *Standard harmonisation as chasing zero (tolerance limits): The impact of veterinary drug residue standards on crustacean imports in the EU, Japan, and North America.* **American Journal of Agricultural Economics, 94**(2), 496–502.

Wilson, J. S., & Otsuki, T. (2003). *Food safety and trade: Winners and losers in a non-harmonised world.* **Journal of Economic Integration, 18**(2), 266–287.

Winchester, N., Rau, M. L., Goetz, C., Larue, B., Otsuki, T., Shutes, K., Burnquist, H. L., de Souza, M. J. P., & de Faria, R. N. (2012). *The impact of regulatory heterogeneity on agri-food trade.* **The World Economy, 35**(8), 973–993.

Xiong, B., & Beghin, J. (2012). *Does European aflatoxin regulation hurt groundnut exporters from Africa?* **European Review of Agricultural Economics, 39**(4), 589–609.

Yawar Latif, S.T.H. Sherazi, & M.I. Bhanger. (2011). *Assessment of pesticide residues in commonly used vegetables in Hyderabad, Pakistan*. **Ecotoxicology and Environmental Safety**, 2299 - 2303

Zhang, S. (2025). *Maximum residue limits and agricultural trade: Evidence from China.* **Sustainability, 17**(8), 3435.

Annexure

Table 4: List of concerned variables with this description

Variable Name	Code	Description	Type	Expected Sign of Coefficient
Trade Value	TV_{ijkt}	Trade Value from exporter *i* to importer *j* in USD for product *k* in year *t*	Continuous	
Maximum Residual Limit	MRL_{jkt}	Total number of MRL notifications imposed on a product *k* by importer *j* in year *t*	Integer	Positive or Negative
MFN Tariff	$Tariff_{jkt}$	Tariff levied on a product *k* by importer *j* in year *t*	Continuous	Negative
Free Trade Agreement	FTA_{ijt}	If exporter *i* and importer *j* are engaged in a regional trade agreement in year *t* (Source: WTO)	Dummy	Positive
High Income Exporter	HI_{it}	Whether exporter *i* is a High Income country in year *t*	Dummy	
Upper middle Income Exporter	UMI_{it}	Whether exporter *i* is an upper-middle-income country in year *t*	Dummy	
Lower Middle Income Exporter (Not included as a variable)	LMI_{it}	Whether exporter *i* is a Lower-middle Income country in year *t*	Dummy	
Exporter GDP	$XGDP_{it}$	GDP of exporter *i* in year *t*	Continuous	Positive
Importer GDP	$MGDP_{jt}$	GDP of importer *j* in year *t*	Continuous	Positive
Contiguous	$contig_{ijt}$	Whether exporter *i* and importer *j* are contiguous (bilateral neighbours)	Dummy	Positive
Common Language	$CLang_{ij}$	Whether exporter *i* and importer *j* share a common or primary language	Dummy	Positive
Colonial Relationship post 1945	$Col45_{ij}$	Whether exporter *i* and importer *j* are or were in a colonial relationship post 1945	Dummy	Positive

Source: Based on Data.

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