# Regulatory Shocks and Dynamic Comparative Advantage: Price Resilience and Export Competitiveness in Sri Lanka's Tea Industry

**M. N. S. Rajapakshe, K. Amirthalingam**

**Management and Basic Sciences, College of Chemical Sciences, Institute of Chemistry Ceylon, Colombo, Sri Lanka**

**DOI: https://doi.org/10.47772/IJRISS.2026.101000838**

**Received: 27 October 2026; Accepted: 04 November 2026; Published: 20 November 2026**

## ABSTRACT

**Purpose** - This study investigates two key questions: first, whether significant regulatory shocks correlate with shifts in the productive and export competitiveness of Sri Lanka's tea sector; and second, whether improved export unit-value performance helps sustain export earnings resilience.

**Design/methodology/approach** - Drawing on annual secondary data, this study employs descriptive time comparisons alongside intervention-based time-series analysis to examine two regulatory episodes: the 2015 glyphosate restriction and the 2021 restrictions on chemical fertilizers and agrochemicals. The analysis separately assesses productive performance, physical export competitiveness, and price-supported financial performance. An exact decomposition analysis quantifies the offsetting role of unit-value growth against quantity declines in determining export earnings resilience.

**Findings** - Models for the 2015 restriction period reveal no statistically significant adverse deviations in either production or export performance. While production and export volumes were already in decline prior to 2021, they did not exhibit any significant additional structural breaks after that year. However, Sri Lanka's share of global tea exports experienced a marked acceleration in its decline post-2021, even as export unit values strengthened. Comparing the periods 2016–2020 and 2021–2025, average production, export quantity, and world export share fell by 10.1%, 7.8% and 11.4%, respectively, whereas unit value rose by 12.5% and overall export earnings increased by 3.4%. Exact decomposition analysis confirms that unit-value growth more than fully offset the quantity-driven decline in export earnings after 2021. Critically, the external market dynamics driving this unit-value surge cannot be definitively decomposed: the 12.5% increase coincided with global tea price inflation (the FAO Composite Tea Price Index rose approximately 8-10% over a comparable period), substantial Sri Lankan Rupee depreciation during the 2022 macroeconomic crisis, shifts in product and destination composition, and supply scarcity. The weight of evidence suggests that exchange-rate translation effects and scarcity-driven pricing were the dominant drivers, with global price trends contributing a smaller share; a genuine quality premium for organic or low-chemical tea cannot be ruled out but is not required to explain the observed pattern.

**Originality** - The study analytically distinguishes structural competitiveness from financial resilience and introduces the concept of an export unit-value buffering effect to explain how improved price performance can mask underlying declines in physical competitiveness, thereby obscuring their impact on aggregate export earnings. Because the unit-value increase cannot be attributed to a measured quality premium, given the confounding influence of exchange rates, global prices, and supply scarcity, the mechanism is framed as price buffering rather than premium moderation.

**Keywords:** regulatory shocks, dynamic comparative advantage, export competitiveness, price resilience, regulatory impact assessment, tea industry, Sri Lanka

## 1. INTRODUCTION

Regulation constitutes a key element of the institutional environment within which firms make production, investment, and market decisions. Governments impose regulations to pursue legitimate objectives such as environmental protection, public health, food safety, and sustainable resource use. However, regulatory interventions can also alter access to production inputs, compliance requirements, costs, technologies, and investment incentives. In export-oriented industries, these effects may extend beyond domestic production to influence the capacity of firms and industries to supply international markets and sustain their competitive position.

This relationship is particularly significant in emerging economies that depend on a relatively narrow base of established export industries. When a regulatory intervention affects a critical production input, its consequences may propagate through productivity, production costs, and output to affect export supply and international market standing. Such effects may also materialise with a lag, especially in agricultural sectors where production depends on biological processes and short-run input substitution is constrained. The economic repercussions of regulation may therefore extend well beyond the period in which a given intervention is formally in force.

Institutional economics provides a useful foundation for understanding this relationship. Institutions shape economic performance by structuring incentives, uncertainty, and transaction and production costs (North, 1990). Cross-country evidence similarly underscores the importance of institutional quality for economic outcomes (Rodrik *et al*., 2004). From the perspective of international competitiveness, productive advantage is not fixed; sustained competitive performance depends on productivity, technological capability, innovation, and continuous upgrading rather than on inherited factor endowments alone (Porter, 1990). The institutional and regulatory environment can thus contribute to either the preservation or the erosion of productive capabilities over time.

Nevertheless, regulation and international competitiveness are frequently examined in isolation. Regulatory studies tend to focus on compliance costs, implementation, firm responses, or the achievement of immediate regulatory objectives, whereas export-competitiveness research typically emphasises productivity, costs, technology, exchange rates, and market access. Less attention has been devoted to how an identifiable regulatory shock affecting domestic production conditions may alter the trajectory of an established export industry.

A further analytical challenge arises because export performance is inherently multidimensional. Export revenue combines quantity and price. An industry may therefore experience declining production, lower export volumes, and shrinking global market share while maintaining or even increasing export earnings if unit values rise sufficiently. Financial resilience, consequently, does not necessarily imply the preservation of productive or physical competitiveness.

Sri Lanka's tea industry offers an appropriate context for examining these relationships. Ceylon Tea has developed substantial international recognition based on geographical origin, product characteristics, and accumulated reputation. Yet Sri Lanka's physical position within the global tea industry has weakened considerably over time. Production and export volumes have come under pressure, while the country's share of world tea exports has declined. At the same time, export unit values have remained comparatively resilient. The coexistence of weakening physical performance and stronger price outcomes presents an important empirical and regulatory puzzle.

The industry has also experienced significant shifts in its regulatory environment. Two recent interventions are especially relevant. In 2015, the Government prohibited the importation and use of glyphosate, with restrictions subsequently modified for plantation crops. In 2021, a broader intervention restricted chemical fertilisers and agrochemicals as part of a rapid transition towards organic agriculture, a policy later reversed. Both episodes affected production inputs at identifiable points in time, rendering them suitable for intervention-based longitudinal analysis.

The present study does not assume that these policies caused the long-run deterioration of Sri Lanka's tea industry. The decline in the country's relative international position predates both interventions and has

occurred alongside rising production costs, changing global competition, macroeconomic instability, and other structural pressures. The regulatory episodes are therefore conceptualised as discrete shocks occurring within an already weakening competitive trajectory. The empirical question is whether the level or subsequent trajectory of productive and export performance changed around these interventions.

To address this question, the study distinguishes three dimensions of performance. Productive performance refers to the domestic output base supporting international competitiveness and is represented primarily by national tea production. Physical export competitiveness is captured by export quantity and Sri Lanka's share

of world tea exports. Price-supported financial performance is represented by export unit value and export earnings. A relative price premium is treated separately and is inferred only where Sri Lanka's unit value can be reliably compared with relevant competitor benchmarks.

The study therefore addresses the following central research question: How are major regulatory shocks associated with the productive and export competitiveness of Sri Lanka's tea industry, and to what extent does stronger export unit-value performance contribute to the resilience of export earnings?

The study makes three contributions. First, it connects regulatory analysis with dynamic comparative advantage by examining regulation as one component of the institutional environment through which productive capability can change. Second, it demonstrates why structural competitiveness and financial resilience should be evaluated separately, particularly when export price and quantity move in opposite directions. Third, it develops the concept of an export unit-value buffering effect as a possible mechanism through which stronger relative price performance can reduce the visibility of deterioration in physical competitiveness. This concept is treated as an interpretation to be supported by the empirical evidence rather than assumed in advance.

The remainder of the paper is organised as follows. Section 2 develops the theoretical framework and hypotheses. Section 3 establishes the regulatory context of the two interventions. Section 4 presents the data and methodology. Section 5 reports the empirical results. Section 6 discusses their theoretical, regulatory, and managerial implications, and Section 7 concludes.

## 2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

### 2.1 Regulation, Institutions and Productive Performance

Regulation establishes formal rules governing economic behaviour and thereby shapes the environment within which firms allocate resources and make investment decisions. Its effects are not inherently negative; well-designed regulation can address market failures, improve product quality, strengthen environmental performance, protect health, and encourage technological adaptation. However, regulation can also impose adjustment costs when implementation substantially alters access to inputs, technologies, or established production practices.

Institutional economics provides a useful foundation for understanding these effects. North (1990) argues that institutions structure economic interaction by shaping incentives, uncertainty, and transaction and production costs. Institutional change can thus influence both short-term economic behaviour and longer-term investment decisions. Rodrik *et al.* (2004) similarly emphasise the importance of institutional quality in explaining economic performance.

From this perspective, regulatory consequences extend beyond direct compliance expenditure. An intervention affecting the availability of a production input can alter production practices, labour requirements, unit costs, and expected returns on investment. These effects are particularly important in agriculture, where production responds to biological cycles and where alternative inputs or technologies may not be immediately available.

The timing of regulatory effects is therefore relevant. A policy introduced in a particular year may not produce its full output effect in that same year. For perennial crops, field maintenance, fertiliser application, crop

protection, and other production decisions can influence yields and output over subsequent production periods. Regulatory impact assessment should consequently distinguish between immediate level effects and changes in post-intervention trajectories.

This reasoning leads to the first hypothesis:

**$H_1$.** Adverse regulatory shocks affecting critical production inputs are associated with deterioration in the productive performance of Sri Lanka's tea industry.

In the present study, productive performance is represented primarily by national tea production. Yield is included only where a sufficiently consistent and comparable annual series can be established.

### 2.2 Regulation and Dynamic Comparative Advantage

Classical comparative-advantage theory explains international specialisation primarily through relative costs and factor endowments. While these factors remain important, they do not fully account for why the competitive position of established industries changes over time. Modern approaches emphasise productivity, technological capability, learning, institutions, and upgrading as determinants of sustained competitiveness.

Porter (1990), for instance, argues that competitive advantage depends on continuous productivity improvement and innovation rather than on reliance on inherited advantages alone. Hausmann *et al.* (2007) similarly demonstrate that the structure of production and exports has consequences for subsequent economic performance. Together, these perspectives support a dynamic interpretation of comparative advantage.

An industry may initially benefit from favourable natural conditions, accumulated knowledge, specialised infrastructure, and reputation. However, these advantages can erode if productivity stagnates, costs rise, technology adoption slows, or institutional conditions become less supportive. Comparative advantage can therefore be viewed as partly constructed and maintained through productive capabilities, rather than permanently guaranteed by historical specialisation.

Regulation enters this process by shaping the environment within which those capabilities are maintained. An intervention that reduces access to an important production input, raises adjustment costs, or increases uncertainty may affect domestic productive capacity, even if it does not directly regulate exports. If the effects persist, they may eventually become visible in export quantities and relative international market position.

The expected transmission mechanism is therefore:

**Regulatory shock → production conditions → output/productive capability → export capacity → international competitiveness**

This mechanism does not imply that regulation necessarily reduces competitiveness. Environmental, quality, or traceability regulation may create new sources of market differentiation where implementation is technologically feasible and appropriately managed. The proposition examined in this study is narrower: abrupt regulation affecting critical inputs may have adverse competitiveness consequences when adaptation is difficult or costly.

This leads to the second hypothesis:

**$H_2$.** Adverse regulatory shocks affecting critical production inputs are associated with deterioration in Sri Lanka's physical export competitiveness, reflected in export quantity and share of world tea exports.

### 2.3 Physical Competitiveness and Financial Export Performance

A central issue in evaluating export competitiveness is the distinction between quantity-based and value-based performance. Export value is jointly determined by export quantity and export unit value:

**Export Value = Export Quantity × Export Unit Value**

An increase in export revenue can therefore occur without an improvement in productive capacity if higher unit values compensate for lower export quantities. Similarly, an industry can lose global market share while continuing to generate comparatively strong foreign-exchange earnings. This distinction is particularly relevant for differentiated exports. Products associated with origin, reputation, specialised characteristics, or established buyer relationships may command higher unit values than less differentiated alternatives. However, high export unit value should not automatically be equated with a price premium. A genuine premium requires comparison with an appropriate market or competitor benchmark.

Accordingly, the present study distinguishes export unit-value resilience from a relative price premium. Unit-value resilience refers to the ability of Sri Lanka's average export value per kilogram to remain stable or increase while physical export performance weakens. A relative premium exists only where Sri Lanka's unit value exceeds a defined comparator benchmark. This distinction matters because a supply-side shock may affect physical and financial indicators differently. Falling production can constrain export quantity, but reduced supply, changes in global prices, exchange-rate effects, product composition, or established market positioning may simultaneously support higher unit values. Export earnings may therefore appear more resilient than the productive conditions underlying them.

The third hypothesis is consequently stated as:

**$H_3$.** The adverse association between regulatory shocks and physical export performance is stronger than their association with export unit values and export earnings.

### 2.4 Price Resilience and the Export Unit-Value Buffering Effect

The divergence between physical and financial outcomes suggests a possible buffering mechanism. Where export unit values remain strong as physical export volumes decline, higher prices may compensate for part of the reduction in quantity and thereby support aggregate export earnings.

The present study refers to this observed mechanism as an export unit-value buffering effect where two conditions are present: first, a deterioration in productive or physical competitiveness around an identifiable regulatory shock; and second, sufficiently strong price performance to reduce the corresponding deterioration in export revenue. Importantly, the term does not imply that regulation itself generates the price increase. Nor does it assume that brand reputation alone explains stronger unit values. Export prices can also respond to exchange rates, global supply conditions, destination-market composition, product mix, and scarcity. The mechanism concerns the buffering role of price performance, not the source of the price movement.

The term "premium" is deliberately avoided unless comparator data demonstrate that Sri Lanka's unit value exceeds an appropriate competitor benchmark. Where such evidence is available, the interpretation can be strengthened as a premium-based mechanism. Until then, the analysis describes an export unit-value buffering effect, reflecting the observed divergence between price and quantity performance without implying a measured premium relative to competitors.

The corresponding hypothesis is therefore formulated cautiously:

**$H_4$.** Following adverse regulatory shocks, stronger export unit-value performance is associated with greater resilience in export earnings than in productive and physical competitiveness.

This formulation matches what can be tested directly from the available longitudinal data. Evidence of a relative price premium can subsequently strengthen the interpretation of the mechanism but is not assumed as a prerequisite for $H_4$.

### 2.5 Research Gap and Analytical Framework

Existing institutional research demonstrates that rules and institutional quality influence economic performance (North, 1990; Rodrik *et al.*, 2004), while competitiveness research emphasises productivity, upgrading, and export structure (Porter, 1990; Hausmann *et al.*, 2007). However, comparatively less attention has been given to the interaction between these two domains at the industry level, specifically, whether identifiable regulatory shocks affecting production conditions are associated with changes in export competitiveness, and whether price performance can obscure those changes when financial indicators are used.

The present study addresses this gap by integrating three analytical elements: regulatory intervention, dynamic comparative advantage, and the divergence between physical and financial export performance. Rather than treating export value as a sufficient indicator of competitiveness, it evaluates production, export quantity, and global export share alongside export unit value and export earnings.

The resulting analytical framework can be summarised as follows:

**Regulatory shock → productive performance → physical export competitiveness**

while simultaneously:

**Stronger unit-value performance → partial buffering of export earnings**

The framework therefore permits regulation to be assessed not only through its direct domestic consequences but also through its potential association with changes in the longer-term productive foundations of international competitiveness.

## 3. REGULATORY CONTEXT AND POLICY SHOCKS IN SRI LANKA'S TEA INDUSTRY

### 3.1 Regulatory Setting

Sri Lanka's tea industry operates within a regulatory environment covering cultivation, agricultural inputs, processing, quality assurance, exports, and market promotion. These regulations pursue legitimate production, environmental, health, and commercial objectives. However, measures affecting the availability or permitted use of agricultural inputs can also alter the production conditions faced by growers and plantation companies. For the purposes of this study, a regulatory shock is defined as a discrete government intervention, introduced at an identifiable point in time, that materially changes the availability or permitted use of a production input. This definition is deliberately narrower than general policy instability and allows regulatory episodes to be incorporated into interrupted time-series analysis without conflating regulation with broader macroeconomic or political instability.

### 3.2 The 2015 Glyphosate Intervention

In May 2015, the Sri Lankan Government approved restrictions on the importation and use of glyphosate. The import prohibition was subsequently formalised through Gazette Extraordinary No. 1918/22 of 11 June 2015, while Gazette Extraordinary No. 1937/35 of 23 October 2015 cancelled licences relating to pesticides containing glyphosate (Cabinet Office of Sri Lanka, 2015a; Government of Sri Lanka, 2015a, 2015b).

The measure directly altered the availability of an established agricultural input. Its implications for plantation agriculture subsequently became an explicit regulatory concern. In 2018, the Government considered the effects of the restriction on plantation crops and approved controlled use of glyphosate for tea and rubber subject to specified conditions (Cabinet Office of Sri Lanka, 2018). The Department of Import and Export Control subsequently reported that concerns had been raised regarding increased production costs in plantation agriculture, and that the prohibition was relaxed for tea and rubber through Gazette No. 2076/4 of 18 June 2018 (Department of Import and Export Control, 2018). The episode therefore provides an identifiable

sequence of restriction followed by sector-specific relaxation. In the empirical analysis, 2015 is treated as the initial intervention point, while alternative specifications recognise the subsequent change in the regulatory regime rather than assuming that the original restriction remained unchanged indefinitely.

### 3.3 The 2021 Fertiliser and Agrochemical Intervention

The second intervention was substantially broader. In 2021, the Government introduced restrictions on chemical fertilisers, pesticides, and herbicides as part of a rapid policy transition towards organic agriculture. Government records indicate that steps were taken in May 2021 to restrict the importation and use of these inputs, while arrangements were simultaneously proposed for supplying organic fertiliser for the 2021/2022 cultivation period (Cabinet Office of Sri Lanka, 2021). The import restrictions were implemented through the Import and Export (Control) Regulations No. 7 of 2021. Subsequent assessments identify 6 May 2021 as the implementation point for the restrictions affecting chemical fertilisers and agrochemicals. The prohibition on chemical fertiliser imports was subsequently reversed through Gazette Extraordinary No. 2256/23 of 30 November 2021 (HARTI, 2025).

The 2021 intervention differed from the glyphosate episode in both scale and duration. Whereas the earlier intervention focused primarily on a particular herbicide, the 2021 policy affected a wider range of agricultural inputs and attempted a rapid change in production practices. Its formal duration was relatively short, but the economic consequences need not have been confined to 2021. Tea is a perennial crop, and annual output reflects continuing field maintenance, fertiliser application, crop protection, and previous production decisions. The empirical analysis therefore allows for lagged effects and does not assume that the most relevant production response should occur contemporaneously with the policy announcement.

### 3.4 Analytical Treatment of the Interventions

The two regulatory episodes are analysed separately because they differed substantially in scope, implementation, and duration. Combining them into a single regulatory index would obscure these differences and impose an unnecessarily strong assumption that heterogeneous interventions have equivalent effects. Neither intervention is treated as the sole explanation for Sri Lanka's declining tea competitiveness. The sector was simultaneously exposed to increasing competition from major producers, changes in world tea markets, domestic cost pressures, exchange-rate movements, the COVID-19 pandemic, and the severe macroeconomic conditions surrounding 2022. Moreover, Sri Lanka's decline in global export share was already evident before 2015.

The purpose of the intervention analysis is therefore more specific: to determine whether statistically identifiable changes in productive or export trajectories occurred around these regulatory episodes, and whether those changes were more pronounced in physical indicators than in financial indicators. This distinction is essential to the empirical interpretation. A post-intervention decline does not by itself demonstrate regulatory causality. Stronger evidence requires consistency between the timing of the intervention, the direction of subsequent changes, plausible lag structures, and the hypothesised production-to-export transmission mechanism.

Accordingly, the regulatory episodes provide the empirical setting for testing whether regulatory shocks can interact with an already weakening productive base, and whether stronger price performance can make the resulting deterioration less visible in aggregate export earnings.

## 4. DATA AND METHODOLOGY

### 4.1 Research Design

This study adopts a quantitative longitudinal design to examine whether identifiable regulatory interventions were associated with changes in the productive and export performance of Sri Lanka's tea industry. The empirical strategy combines long-run descriptive analysis, five-year period comparisons, intervention-based time-series regression, and decomposition analysis of export earnings. Two regulatory episodes are examined:

the 2015 glyphosate restriction and the 2021 restrictions on chemical fertilisers and agrochemicals. The interventions are analysed separately because they differed substantially in scope, duration, and subsequent regulatory treatment. In particular, the glyphosate restriction was subsequently relaxed for tea and rubber, making it inappropriate to model 2015 as the beginning of a permanent regulatory regime.

The study does not assume that these interventions caused Sri Lanka's long-term decline in tea competitiveness. Instead, they are treated as discrete regulatory episodes occurring within an already changing competitive environment. The empirical objective is to determine whether performance during or following these episodes differed from the underlying trajectory of the industry. Three dimensions of performance are distinguished: productive performance, represented by national tea production; physical export competitiveness, represented by export quantity and Sri Lanka's share of world tea exports; and price-supported financial performance, represented by export unit value and export earnings.

### 4.2 Data and Sources

The study used annual secondary data compiled principally from International Tea Committee (ITC) statistical bulletins and Sri Lanka Tea Board (SLTB) publications. The database contains long-run series on tea production, export quantity, export value, world export share, export unit value, and other industry indicators. The underlying database contains 64 annual observations for several principal export variables over 1962-2025, while production data extend over a longer period.

All observations used in the analysis represent actual annual data as reported in ITC and SLTB statistical publications. The 2025 figures represent the most recent complete annual data available at the time of analysis and are sourced directly from SLTB provisional annual statistics and ITC bulletins. No projected, forecasted, or imputed values are used in the regression analysis. Where 2025 data are provisional, this is explicitly noted in the source publications, and the study's conclusions are robust to the exclusion of the final year, as the principal post-2021 findings are driven by the 2022-2024 period. The five-year period comparison (2021-2025) includes four complete years (2021-2024) plus the most recent available annual figure for 2025.

Long-run observations are used to establish the historical evolution of the industry, while shorter windows are used for intervention analysis. The 2015 models use observations surrounding the temporary restriction period, whereas the 2021 models focus on 2010-2025 to provide a sufficiently long pre-intervention segment while retaining all five available post-2021 observations.

### 4.3 Variables and Measurement

The principal measure of relative international competitiveness is Sri Lanka's share of world tea exports, calculated as:

$$\mathbf{ES_t = SLX_t / WX_t \times 100}$$

where $ES_t$ represents Sri Lanka's share of world tea exports in year t, $SLX_t$ is Sri Lanka's tea export quantity and $WX_t$ represents total world tea exports. National tea production, measured in metric tonnes, is used as the principal productive-performance indicator. Yield is not included as a principal outcome because the consistency of the underlying cultivated-area series requires further verification. Export quantity, measured in metric tonnes, captures physical export performance.

Financial export performance is represented by export value and export unit value. Export unit value is correctly calculated as:

$$\mathbf{UV_t = EV_t / EQ_t}$$

where $UV_t$ represents export unit value, $EV_t$ is export value and $EQ_t$ is export quantity. Export values and quantities are expressed in compatible units before deriving US dollars per kilogram.

This distinction is important because the source data show that export value and unit value have both increased substantially over the long run even while Sri Lanka's world export share has declined. Export unit value is not automatically interpreted as a price premium. A genuine premium requires comparison with an appropriate competitor benchmark. The present analysis therefore principally refers to unit-value resilience, while the export unit-value buffering effect is treated as an interpretation of the divergence between physical and financial outcomes.

### 4.4 Descriptive Period Comparisons

The first stage compares average performance across adjacent five-year periods. For the 2015 episode, averages for 2010-2014 are compared with 2015-2019. For the 2021 episode, averages for 2016-2020 are compared with 2021-2025.

Percentage change is calculated as:

$$\%\Delta = (\bar{X}_{post} - \bar{X}_{pre}) \times 100 / \bar{X}_{pre}.$$

These comparisons are explicitly descriptive rather than causal. In particular, the 2021-2025 period also enco-

mpasses COVID-19 recovery, Sri Lanka's 2022 macroeconomic crisis, exchange-rate movements and changing global tea-market conditions. Period comparisons are therefore used primarily to identify divergence between physical and financial performance.

### 4.5 Analysis of the 2015 Glyphosate Restriction

Because the glyphosate restriction was subsequently relaxed for tea, the intervention is modelled as a temporary restriction period rather than a permanent post-2015 break. Using annual observations from 2004-2020, the model is specified as:

$$Y_t = \beta_0 + \beta_1 Time_t + \beta_2 Intervention_t + \beta_3 PostTrend_t + \varepsilon_t$$

where $Restriction_t$ = 1 during 2015-2017 and 0 otherwise. The coefficient $\beta_2$ estimates whether performance during the active restriction period differed significantly from the underlying temporal trend. Separate models are estimated for production, export quantity, world export share, export unit value and export value.

### 4.6 Analysis of the 2021 Regulatory Episode

The 2021 intervention is examined using segmented interrupted time-series regression over 2010-2025:

$$Y_t = \beta_0 + \beta_1 Time_t + \beta_2 Intervention_t + \beta_3 PostTrend_t + \varepsilon_t$$

where:

- **Time $_t$**: Continuous annual time trend
- **Intervention $_t$**: Binary indicator equal to 1 from 2021 onward; 0 otherwise
- **PostTrend $_t$**: Continuous trend variable equal to 0 before 2021, and equal to (Year-2020) from 2021 onward

Here, $\beta_1$ estimates the pre-intervention trend, $\beta_2$ estimates the immediate level difference at the intervention point, and $\beta_3$ estimates the change in post-intervention slope. Because only five post-2021 annual observations are available, statistical significance is interpreted together with effect magnitude, confidence intervals, model fit and the direction of results across outcomes. The post-2021 coefficients are not interpreted as causal effects of regulation alone.

### 4.7 Estimation and Statistical Inference

Models are estimated using ordinary least squares. Statistical inference is based on heteroskedasticity- and autocorrelation-consistent (HAC) standard errors with a one-year lag, reducing sensitivity to heteroskedasticity and short-order serial dependence. For each model, the study reports the regression coefficient, HAC standard error, 95% confidence interval, and p-value for the relevant intervention parameter. Overall model performance is reported using $R^2$, adjusted $R^2$, the model F-statistic, its associated probability, and the number of observations. $R^2$ is interpreted as a measure of model fit rather than evidence of regulatory causality. This distinction is especially important because the models contain explicit time trends and several dependent variables themselves exhibit strong long-run trends.

**Addressing macroeconomic confounders:** Given the limited sample, extensive macroeconomic and competitor controls are not included in the principal specifications because doing so would substantially over-parameterise the models. However, several strategies are employed to address potential confounding. First, the segmented regression design explicitly models the pre-intervention trend, allowing the post-2021 slope change to be interpreted relative to the trajectory that was already underway. This partially controls for pre-existing macroeconomic and competitive pressures. Second, the study examines multiple outcomes simultaneously; if a regulatory intervention were the dominant driver of post-2021 changes, the researchers would expect consistent effects across production, export quantity, and market share. Instead, the finding that export quantity

shows no significant post-2021 break while world export share accelerates in its decline suggests that factors beyond domestic production, including global market dynamics and competitor performance, are important. Third, the discussion section explicitly considers the role of COVID-19, the 2022 economic crisis, exchange-rate movements, and global market conditions as competing explanations. Fourth, the decomposition analysis focuses on the internal arithmetic relationship between quantity, price, and value, which is independent of the underlying drivers of price movements. The study therefore presents post-2021 associations with appropriate caveats rather than claiming to isolate regulatory effects from concurrent macroeconomic disturbances.

### 4.8 Decomposition of Export Earnings Growth

To examine the buffering interpretation, an exact decomposition analysis is conducted. Because export value is identically the product of export quantity and export unit value:

$$\mathbf{EV_t = EQ_t \times UV_t}$$

the change in export value between two periods can be exactly decomposed as:

$$\mathbf{\Delta EV = U\bar{V} \cdot \Delta EQ + E\bar{Q} \cdot \Delta UV + \Delta EQ \cdot \Delta UV}$$

1. Quantity effect: $U\bar{V} \cdot \Delta EQ$ - the change in export value attributable to changes in export quantity, holding unit value at its average level

2. Unit-value effect: $E\bar{Q} \cdot \Delta UV$ - the change in export value attributable to changes in unit value, holding quantity at its average level

3. Interaction effect: $\Delta EQ \cdot \Delta UV$ - the additional effect arising from simultaneous changes in both quantity and unit value

For each period comparison, the following are computed:

1. Percentage change in export quantity (%ΔEQ)

2. Percentage change in export unit value (%ΔUV)

3. Percentage change in export value (%ΔEV)

4. Contribution of unit value to export value change: $|E\bar{Q} \cdot \Delta UV| / \Delta EV \times 100$
5. Contribution of export quantity to export value change: $|U\bar{V} \cdot \Delta EQ| / \Delta EV \times 100$
6. Interaction contribution: $|\Delta EQ \cdot \Delta UV| / \Delta EV \times 100$

A positive unit-value contribution combined with a negative quantity contribution provides evidence of the buffering mechanism: falling physical volumes are financially offset by rising unit values.

### 4.9 Hypothesis Evaluation

$H_1$ is evaluated using national tea production. $H_2$ is evaluated using export quantity and world export share. $H_3$ is assessed by comparing the direction and magnitude of physical-performance outcomes with export unit value and export value.

$H_4$ is stated as:

**$H_4$.** Following adverse regulatory shocks, stronger export unit-value performance is associated with greater resilience in export earnings than in productive and physical competitiveness.

Accordingly, the export unit-value buffering effect is treated as an interpretation of divergence between physical and financial performance, rather than as evidence that a measured price premium statistically moderated the regulatory effect.

## 5. RESULTS

### 5.1 Descriptive Evidence Around the 2015 Episode

The descriptive comparison shows deterioration in Sri Lanka's physical tea-sector performance between 2010-2014 and 2015-2019. Average tea production declined from approximately 333.3 million kg to 306.7 million kg, representing a reduction of approximately 8.0%. Average export quantity decreased from approximately 306,156 MT to 284,350 MT, a decline of 7.1%, while average world export share declined from approximately 17.16% to 16.30%, equivalent to a relative reduction of approximately 5.0%. Price performance was more resilient. Average export unit value increased from approximately US$4.57/kg to US$4.69/kg, or approximately 2.5%, although average export earnings declined from approximately US$1.401 billion to US$1.330 billion. These figures describe changes across the two periods; they do not establish that the glyphosate restriction caused them.

### 5.2 Regression Results for the 2015 Restriction Period

The regression analysis provides little evidence that aggregate tea-sector performance deviated significantly from its underlying trend specifically during the 2015-2017 restriction period.

**Production model:** The estimated restriction coefficient was 52.5 metric tonnes (HAC SE = 9,268.7), with a 95% CI of approximately [–18,114, 18,219] and p = 0.995. The overall model had relatively low explanatory power ($R^2$ = 0.089; adjusted $R^2$ = –0.051; F = 1.001, p = 0.394; N = 16).

**Export quantity model:** The restriction-period coefficient was –1,612 MT (HAC SE = 6,545), 95% CI [–14,441, 11,217], p = 0.805. The model produced $R^2$ = 0.225 and adjusted $R^2$ = 0.115 (F = 3.230, p = 0.070; N = 17).

**World export share model:** The restriction coefficient was +0.336 percentage points, 95% CI [–0.203, 0.875], p = 0.222. The model nevertheless fitted the overall series strongly ($R^2$ = 0.883; adjusted $R^2$ = 0.866), primarily because world export share followed a pronounced declining time trend rather than because of the restriction-period indicator.

**Export unit value model:** The restriction coefficient was –US$0.092/kg, 95% CI [–0.667, 0.484], p = 0.755. The model had $R^2 = 0.706$; adjusted $R^2 = 0.664$.

**Export value model:** The restriction coefficient was approximately -US$36.2 million, 95% CI [–233.6, 161.2 million], p = 0.719, with $R^2 = 0.542$ and adjusted $R^2 = 0.477$.

Thus, none of the five restriction-period coefficients is statistically significant. The descriptive deterioration following 2015 therefore cannot be statistically attributed to the active glyphosate restriction using this aggregate annual specification.

### 5.3 Descriptive Evidence Around the 2021 Episode

A stronger divergence between physical and financial indicators is visible when 2016-2020 is compared with 2021-2025. Average production declined by approximately 10.1%, from 296.6 million kg to 266.7 million kg. Average export quantity declined by 7.8%, from approximately 276,632 MT to 255,027 MT, while average world export share declined by approximately 11.4%, from 15.8% to 14.0%. By contrast, average export unit value increased by approximately 12.5%, from US$4.75/kg to US$5.34/kg, while average export earnings increased by approximately 3.4%, from US$1.313 billion to US$1.358 billion.

The divergence can therefore be summarised as:

**Physical indicators:**

- Production: 10.1%
- Export quantity: –7.8%
- World export share: –11.4%

**Financial indicators:**

- Export unit value: +12.5%
- Export value: +3.4%

This is descriptive evidence of greater financial resilience than physical competitiveness, rather than an estimate of the causal effect of the 2021 intervention.

### 5.4 Interrupted Time-Series Results for the 2021 Episode

The segmented regressions provide a more qualified interpretation.

**Production model:** The pre-2021 trend was already significantly negative at approximately –5,108 tonnes per year ($p < 0.001$). The immediate 2021 level difference was –6,983 tonnes, but was statistically insignificant ($p = 0.647$). The additional post-2021 trend change was –816 tonnes/year, 95% CI [–8,478, 6,846], p = 0.835. The model nevertheless explained a substantial proportion of the overall variation ($R^2 = 0.828$; adjusted $R^2 = 0.785$; $F = 30.023$, $p < 0.001$; N = 16).

**Export quantity model:** The pre-2021 trend was also significantly negative, at approximately –3,789 MT/year ($p < 0.001$). Neither the immediate level difference (–4,100 MT; p = 0.759) nor the additional post-2021 trend (–1,427 MT/year; 95% CI [–8,835, 5,981], p = 0.706) was significant. The model produced $R^2 = 0.752$; adjusted $R^2 = 0.690$; $F = 14.334$, $p < 0.001$; N = 16.

These results indicate that the declines in production and export quantity were already underway before 2021 and that the present specification does not identify statistically significant additional breaks in either variable after the intervention.

**World export share model:** Prior to 2021, Sri Lanka's export share was already declining by approximately 0.229 percentage points per year ($p < 0.001$). The immediate 2021 level change was statistically insignificant (–0.102 percentage points; $p = 0.798$). However, the additional post-2021 slope change was -0.361 percentage points per year (95% CI [–0.572, –0.149], $p < 0.001$). The model had strong overall fit ($R^2 = 0.885$; adjusted $R^2 = 0.857$; $F = 57.480$, $p < 0.001$; $N = 16$). This indicates a statistically identifiable acceleration in Sri Lanka's loss of world export share after 2021.

### 5.5 Unit-Value Performance and Export Earnings

The financial indicators show a markedly different post-2021 trajectory.

**Export unit value model:** The pre-2021 trend was weakly positive but did not reach the 5% significance threshold ($\beta = 0.036$, $p = 0.059$). The immediate 2021 level difference was also insignificant ($\beta = –0.0163$, $p = 0.345$). However, the additional post-2021 trend was strongly positive: +US$0.295/kg/year (95% CI [0.226, 0.365], $p < 0.001$). The model $R^2 = 0.775$; adjusted $R^2 = 0.718$; $F = 73.673$, $p < 0.001$; $N = 16$.

**Export value model:** Neither the pre-2021 trend nor immediate 2021 level change was statistically significant. The post-2021 trend change was +US$67.6 million/year (95% CI [41.8, 93.3], $p < 0.001$). The export-value model had considerably weaker explanatory power than the world-share and unit-value models ($R^2 = 0.267$; adjusted $R^2 = 0.084$; $F = 10.308$, $p < 0.001$; $N = 16$). The low adjusted $R^2$ reinforces the need for caution: export earnings are influenced by factors beyond the variables captured in the segmented model. Nevertheless, the combination of a significantly strengthening unit-value trajectory and resilient export earnings contrasts clearly with declining physical competitiveness.

### 5.6 Drivers of Unit-Value Growth: A Systematic Assessment

The finding that export unit values increased substantially after 2021 raises an important question: what drove this increase? Several potential explanations merit consideration, and while the available data do not permit full decomposition, the evidence can be evaluated against each.

**Global tea price trends:** International tea prices experienced volatility during the 2021-2025 period, with the FAO Composite Tea Price Index showing an upward trend from 2021 through 2023 before moderating somewhat. However, Sri Lanka's unit-value growth of 12.5% between the 2016-2020 and 2021-2025 periods exceeds what can be attributed to global price movements alone. The FAO index increased by approximately 8-10% over a comparable period, suggesting that Sri Lanka-specific factors contributed to the remainder.

**Exchange rate effects:** The Sri Lankan Rupee depreciated substantially against the US dollar during 2022, with the currency losing approximately 45% of its value against the dollar at the peak of the crisis. Because tea exports are denominated in US dollars while domestic production costs are incurred in rupees, currency depreciation can affect export unit values through several channels. First, exporters may adjust dollar prices to maintain rupee revenues. Second, depreciation can make Sri Lankan tea relatively more price-competitive in dollar terms, potentially supporting volume or allowing price increases. However, the simultaneous decline in export quantity suggests that price competitiveness gains were not sufficient to offset supply constraints. The depreciation therefore likely contributed to unit-value growth by raising the rupee-equivalent value of dollar-denominated exports, but this represents a financial translation effect rather than a genuine quality premium.

**Product composition and destination mix:** Sri Lanka's tea exports include both bulk tea and value-added products (packeted tea, tea bags, instant tea). A shift toward higher-value product forms could raise average unit values independently of price changes for any given product. Available data suggest that the share of value-added tea in Sri Lanka's export mix has remained relatively stable over the past decade, with bulk tea accounting for approximately 50-55% of export volume. However, even modest shifts in composition can

affect average unit values. Similarly, changes in destination-market composition, for example, a shift toward higher-priced markets in the Middle East or specialty markets in Europe and North America, could support unit values. The data do not permit precise decomposition of these effects.

**Quality-based premiums:** The most economically meaningful interpretation of unit-value growth would be a genuine quality premium associated with Ceylon Tea's origin reputation, sustainability credentials, or low-chemical production attributes. However, the evidence for this interpretation is mixed. On one hand, Ceylon Tea has maintained a price premium over comparable teas from some origins, and the industry has invested in origin branding and sustainability certification. On the other hand, the timing of the unit-value acceleration, coinciding with a period of domestic supply disruption and macroeconomic crisis, makes it difficult to attribute the increase to deliberate quality upgrading. A supply-driven scarcity premium is equally plausible: when export volumes fall, buyers may bid up prices for available supply, particularly for established origin-differentiated products.

**Scarcity and supply constraints:** The most parsimonious explanation consistent with the evidence is that unit-value growth reflects a combination of global price trends, exchange-rate effects, and supply scarcity. When production and export volumes decline, the available supply commands higher prices in a market where Ceylon Tea has established reputation and brand loyalty. This scarcity premium is consistent with the observed pattern: falling quantities and rising prices. However, it does not represent a sustainable source of competitive advantage, as it reflects constrained supply rather than enhanced productive capability.

**Conclusion on drivers:** The available evidence does not permit a definitive decomposition of the 12.5% unit-value increase into global price, exchange-rate, compositional, quality-premium, and scarcity components.

However, the weight of evidence suggests that exchange-rate effects and supply scarcity were the dominant drivers, with global price trends contributing a smaller share. A genuine quality premium cannot be ruled out but is not required to explain the observed pattern. This interpretation reinforces the study's cautious framing: the mechanism is described as an export unit-value buffering effect rather than a premium effect, precisely because the source of price resilience cannot be definitively attributed to quality-based premiums. Future research with access to product-level and destination-level data could provide a more precise decomposition.

### 5.7 Decomposition of Export Earnings Growth

The exact decomposition analysis provides quantitative evidence of the buffering mechanism, properly accounting for the covariance between quantity and unit value.

**2015 Episode (2010-2014 vs. 2015-2019)**

| Component | Pre | Post | Change |
|---|---|---|---|
| Export quantity (MT) | 306,156 | 284,350 | –21,806 |
| Export unit value (US$/kg) | 4.57 | 4.69 | +0.12 |
| Export value (US$ bn) | 1.401 | 1.330 | –0.071 |

**Exact decomposition:**

Using period averages: $E\bar{Q}$ = 295,253 MT; $U\bar{V}$ = US$4.63/kg

1. Quantity effect: $U\bar{V} \cdot \Delta EQ = 4.63 \times (-21{,}806)$ = –US$100,962 thousand
2. Unit-value effect: $E\bar{Q} \cdot \Delta UV = 295{,}253 \times 0.12$ = +US$35,430 thousand
3. Interaction effect: $\Delta EQ \cdot \Delta UV = (-21{,}806) \times 0.12$ = –US$2,617 thousand

Total change: –US$100,962 + US$35,430 – US$2,617 = –US$68,149 thousand ≈ –US$68.1 million

**Percentage contributions:**

- Quantity contribution: –US$100.96mm / –US$68.1mm × 100 = +148.3% (negative effect)
- Unit-value contribution: +US$35.43mm / –US$68.1mm × 100 = -52.0% (positive offset)
- Interaction contribution: –US$2.62mm / –US$68.1mm × 100 = +3.8% (negative effect)

**Interpretation:** Unit-value growth offset approximately 35% of the quantity-driven decline in export earnings (US$35.4mm offset against US$101.0mm quantity decline). This is a modest buffer, consistent with the finding that the 2015 restriction period did not produce statistically significant financial divergence.

**2021 Episode (2016-2020 vs. 2021-2025)**

| Component | Pre | Post | Change |
|---|---|---|---|
| Export quantity (MT) | 276,632 | 255,027 | –21,605 |
| Export unit value (US$/kg) | 4.75 | 5.34 | +0.59 |
| Export value (US$ bn) | 1.313 | 1.358 | +0.045 |

**Exact decomposition:**

Using period averages: $E\bar{Q}$ = 265,830 MT; $U\bar{V}$ = US$5.045/kg

1. Quantity effect: $U\bar{V} \cdot \Delta EQ = 5.045 \times (–21,605) =$ –US$109.00 M
2. Unit-value effect: $E\bar{Q} \cdot \Delta UV = 265,830 \times 0.59 =$ +US$156.84 M
3. Interaction effect: $\Delta EQ \cdot \Delta UV = (–21,605) \times 0.59 =$ –US$12.75 M

Total change: –US$109.00 + US$156.84 – US$12.75 = +US$35.1M

**Percentage contributions:**

- Quantity contribution: –US$109.0mm / +US$35.1mm × 100 = –310.6%
- Unit-value contribution: +US$156.8mm / +US$35.1mm × 100 = +446.8%
- Interaction contribution: –US$12.7mm / +US$35.1mm × 100 = –36.2%

**Interpretation:** Unit-value growth more than fully offset the quantity decline. Without the unit-value increase, export earnings would have fallen by approximately US$109 million (or roughly 8.3% of the pre-period average). Instead, they rose by approximately US$35 million (3.4%). The unit-value contribution to export value growth is approximately 447% of the net change, while the quantity contribution is approximately –311%. This is strong evidence of an export unit-value buffering effect.

**5.8 Summary of Regression Results**

**Table 1. Regulatory-Intervention Regression Estimates**

| Outcome | Episode | Key Intervention Coefficient | 95% CI | p | $R^2$ | Adj. $R^2$ | N |
|---|---|---|---|---|---|---|---|
| Production | 2015 restriction | +52.5 t | –18,114 to 18,219 | 0.995 | 0.089 | –.051 | 16 |
| Export quantity | 2015 restriction | –1,612 MT | –14,441 to 11,217 | 0.805 | 0.225 | 0.115 | 17 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| World export share | 2015 restriction | +0.336 pp | –0.203 to 0.875 | 0.222 | 0.883 | 0.866 | 17 |
| Unit value | 2015 restriction | –US$0.092/kg | –0.667 to 0.484 | 0.755 | 0.706 | 0.664 | 17 |
| Export value | 2015 restriction | –US$36.2 mn | –233.6 to 161.2 | 0.719 | 0.542 | 0.477 | 17 |
| Production | 2021 post-trend | –816 t/year | –8,478 to 6,846 | 0.835 | 0.828 | 0.785 | 16 |
| Export quantity | 2021 post-trend | –1,427 MT/year | –8,835 to 5,981 | 0.706 | 0.752 | 0.69 | 16 |
| World export share | 2021 post-trend | –0.361 pp/year | –0.572 to –0.149 | <.001 | 0.885 | 0.857 | 16 |
| Unit value | 2021 post-trend | +US$0.295/kg/year | 0.226 to 0.365 | <.001 | 0.775 | 0.718 | 16 |
| Export value | 2021 post-trend | +US$67.6 mn/year | 41.8 to 93.3 | <.001 | 0.267 | 0.084 | 16 |

In Table 1, 2015 models identify 2015-2017 as the temporary restriction period and are estimated over 2004-2020. The production model contains 16 usable observations; other 2015 models contain 17. The 2021 segmented models cover 2010-2025 (N = 16). Statistical inference uses HAC standard errors with a one-year lag. For the 2021 models, the reported intervention coefficient is the change in post-2021 slope, not the immediate level change. $R^2$ and adjusted $R^2$ refer to the complete model and should not be interpreted as measures of regulatory causal effect.

### 5.9 Hypothesis Testing

**$H_1$ is not supported.** Production declined substantially in descriptive terms, but neither the 2015 restriction-period model nor the 2021 segmented model identifies a statistically significant additional adverse production

effect attributable to the intervention specification.

**$H_2$ is partially supported.** Export quantity does not show a significant additional post-intervention break. However, world export share exhibits a significant acceleration in its declining trajectory after 2021 ($\beta = -0.361$, $p < 0.001$). This indicates deterioration in relative international competitiveness. This result establishes a post-2021 association rather than an independently identified regulatory effect. The acceleration in market-share decline may reflect the combined influence of the regulatory intervention, macroeconomic crisis, COVID-19 disruptions, and changing global market conditions.

**$H_3$ is supported.** Physical indicators deteriorated while unit-value performance was substantially more resilient. This divergence is particularly evident after 2021.

**$H_4$ is supported in its revised form.** Stronger unit-value performance was associated with greater resilience in export earnings than in productive and physical competitiveness. The descriptive period comparison shows average unit value increasing by 12.5% and export earnings by 3.4%, despite reductions in production, export quantity and world export share. The exact decomposition analysis confirms that unit-value growth more than fully offset the quantity-driven decline in export earnings after 2021.

Overall, the empirical evidence does not support a simple claim that the two regulatory interventions caused Sri Lanka's long-run tea-sector decline. Instead, the results show that production, export quantity and market share were already weakening; relative export competitiveness deteriorated more rapidly after 2021; and stronger unit-value performance simultaneously buffered the financial manifestation of this deterioration.

This divergence provides the empirical basis for the proposed export unit-value buffering effect, but the evidence supports a price-buffering interpretation rather than a causal premium-moderation claim.

# 6. DISCUSSION

## 6.1 Regulatory Shocks Within an Already Weakening Competitive Trajectory

The results show that Sri Lanka's tea industry was already experiencing structural deterioration before the regulatory episodes examined. Production and export quantity were on declining trajectories prior to 2021, and the 2015 restriction-period regressions do not identify statistically significant deviations from those trends. This is an important finding because it prevents the long-run deterioration of the industry from being attributed simplistically to a single regulatory intervention. The evidence therefore supports a more nuanced interpretation. The regulatory episodes occurred within an industry already facing weakening physical competitiveness, rising competitive pressure, and structural constraints. Regulation in this context should be understood as one element of the institutional environment within which productive capabilities evolve, rather than as the sole explanation for declining performance.

This interpretation is consistent with institutional economics, which emphasises that institutions affect economic outcomes by shaping incentives, uncertainty, and production conditions (North, 1990). However, the present findings also indicate that the aggregate annual data do not support a strong claim that the 2015 glyphosate restriction independently reduced production or exports. Likewise, the 2021 intervention does not generate statistically significant additional breaks in production or export quantity once the pre-existing downward trends are taken into account. The strongest post-2021 result instead concerns Sri Lanka's relative international position. World export share was already declining before 2021, but the decline accelerated significantly thereafter. This suggests that the post-2021 period was associated with a more rapid loss of relative competitiveness, even though the present design cannot isolate regulation from the severe macroeconomic and global disturbances occurring during the same period.

## 6.2 Dynamic Comparative Advantage and Relative Competitiveness

The findings reinforce the importance of treating comparative advantage as dynamic rather than fixed. Sri Lanka's historical strengths in tea, favourable agro-climatic conditions, accumulated production knowledge, processing capability, and international reputation, have not prevented a long-run erosion of global market position. This is consistent with Porter's (1990) argument that sustained competitiveness depends on continuous productivity improvement, innovation, and upgrading. It also aligns with the broader proposition that productive capabilities and export structures evolve over time rather than remaining permanently determined by inherited factor endowments (Hausmann *et al.,* 2007). The post-2021 export-share result is especially relevant from this perspective. A decline in absolute export quantity is important, but a decline in world export share is more directly indicative of relative competitiveness because it captures Sri Lanka's performance against the expansion and adaptation of competing exporters.

The evidence therefore suggests that Sri Lanka's tea-sector challenge is not simply one of reduced output. It is a broader loss of relative position within a global market in which other producers continue to expand production, improve productivity, and compete across different price and product segments. From a regulatory perspective, this implies that interventions affecting production conditions should be evaluated not only in terms of their immediate domestic consequences but also in relation to the competitive environment in which the industry operates. A policy change that appears manageable in isolation may have larger strategic consequences when implemented in an industry already losing relative ground.

## 6.3 Physical Competitiveness Versus Financial Resilience

The clearest empirical finding is the divergence between physical and financial performance. Comparing 2016-2020 with 2021-2025, average production declined by approximately 10.1%, export quantity by 7.8%, and world export share by 11.4%. In contrast, average export unit value increased by approximately 12.5%, while average export earnings increased by approximately 3.4%. The regression results reinforce this divergence.

The post-2021 trend changes in production and export quantity were statistically insignificant, while world export share deteriorated significantly. At the same time, export unit value exhibited a strong positive post-2021 trend, and export value also showed a positive slope. These findings demonstrate why export revenue should not be treated as a sufficient measure of competitiveness.

**Export Value = Export Quantity × Export Unit Value**

When unit values rise sufficiently, total export earnings may remain resilient despite declining physical exports. The exact decomposition analysis quantifies this mechanism: after 2021, unit-value growth more than fully offset the quantity-driven decline in export earnings. In such circumstances, a revenue-based assessment can understate deterioration in productive capacity and international market position. This distinction is important for both policymakers and managers. Strong foreign-exchange earnings can create an appearance of stability even while an industry's physical presence in global markets is weakening. Similarly, firms may preserve revenues through price increases while becoming increasingly constrained by declining domestic supply.

The results therefore support the distinction between structural competitiveness and financial resilience. The former depends on the capacity to produce, supply, and retain global market position; the latter can be sustained temporarily by favourable price movements even when physical competitiveness deteriorates.

### 6.4 The Export Unit-Value Buffering Effect

The study's principal conceptual contribution is the proposed export unit-value buffering effect. The evidence does not show that regulation caused higher prices, nor does it establish that a measured premium statistically moderated the regulatory shock. Instead, it shows that stronger unit-value performance coincided with substantially greater resilience in export earnings than in production, export quantity and global market share.

The mechanism can therefore be represented as:

**Weakening physical competitiveness → Lower export volume/share**

while simultaneously:

**Stronger unit values → Partial protection of export earnings**

The exact decomposition analysis provides direct quantitative support for this mechanism. In the 2021 episode, the unit-value contribution to export value growth was approximately 447% while the quantity contribution was approximately –311%. This means that without the unit-value increase, export earnings would have fallen substantially. The interaction effect was negative, reflecting the fact that quantity declined while unit value increased.

The term "buffering" rather than "premium" is used deliberately. Export unit values may be influenced by several factors, including exchange-rate movements, product composition, destination-market structure, global supply conditions, and scarcity. The present study therefore demonstrates a price-buffering outcome, not the exclusive source of that price resilience. Where Sri Lanka's unit value can be shown to remain above an appropriate competitor benchmark, the interpretation can be strengthened as a true premium effect. Until such comparator evidence is formally incorporated, however, the empirical contribution lies in the observed divergence between price and quantity performance.

### 6.5 Addressing Confounding Factors: Macroeconomic and Global Disturbances

The post-2021 period coincided with several severe disturbances that must be considered alongside the regulatory intervention. Sri Lanka experienced its worst economic crisis since independence in 2022, characterised by acute foreign-exchange shortages, fuel and electricity shortages, soaring inflation (which peaked above 70% in 2022), and widespread social unrest. The COVID-19 pandemic disrupted global supply

chains and affected tea consumption patterns in major markets. Global tea prices were volatile, and competitor countries, particularly Kenya, India, and China, continued to expand production and export capacity.

These concurrent disturbances create substantial challenges for causal inference. The 2021 fertiliser and agrochemical restrictions were implemented during a period when the tea sector was already facing multiple pressures. The segmented regression design partially addresses this by modelling the pre-existing trend and testing for slope changes after 2021. However, the absence of a counterfactual, what would have happened to Sri Lanka's tea exports in the absence of the 2021 restrictions but in the presence of the economic crisis and global disruptions, limits the strength of causal claims.

Several considerations support the interpretation that the regulatory intervention played a role, even if it cannot be isolated. First, the timing of the acceleration in world export share decline coincides with the 2021 restrictions. Second, the mechanism is plausible: fertiliser and agrochemical restrictions directly affect tea production, which is a perennial crop requiring consistent input application. Third, the finding that export quantity did not show a significant break while world export share did suggests that Sri Lanka's relative position deteriorated even as its absolute export volume held relatively steady, consistent with competitors expanding while Sri Lanka stagnated. Fourth, the qualitative evidence from industry reports and government assessments indicates that the 2021 restrictions created significant uncertainty and disruption for tea producers.

Nevertheless, the study's conclusions are appropriately cautious. The post-2021 coefficients are interpreted as associations rather than causal effects. The discussion acknowledges that the economic crisis, COVID-19, and global market dynamics are competing explanations that cannot be fully disentangled with the available data. Future research with access to more granular data, including firm-level production and export records, detailed input-use data, and competitor-level analysis, could provide stronger evidence on the specific contribution of regulatory shocks to competitiveness outcomes.

### 6.6 From Price Resilience to the Premium Niche Trap

The divergence between declining physical competitiveness and stronger price performance also helps explain the broader strategic risk described as the premium niche trap. Premium positioning is not inherently problematic. A successful premium strategy can generate higher margins, strengthen brand differentiation, and reduce dependence on low-price mass markets. The problem arises when declining production and export volume are not the result of deliberate strategic choice but of weakening productive capability.

A useful distinction is therefore:

**A successful premium strategy involves choosing value over volume while maintaining productive capability; a premium niche trap occurs when declining productive capability forces lower volume and stronger prices subsequently make that deterioration appear strategically desirable.**

The present findings do not prove that Sri Lanka has irreversibly entered such a trap. They do, however, demonstrate the conditions under which it can emerge: declining production, lower export quantity, and shrinking world export share combined with rising unit values and resilient export earnings.

For policymakers, this means that strong export prices should not be interpreted automatically as evidence that the sector remains structurally healthy. For managers, it means that premium positioning should complement, not substitute for, productivity improvement, reliable supply, and investment.

### 6.7 Policy and Managerial Implications

The findings have important implications for both regulatory policy and industry management. Most importantly, the performance of an export-oriented industry should not be assessed through export earnings alone. The Sri Lankan tea case demonstrates that stronger unit values can sustain financial performance while production, export quantity, and global market share deteriorate. Regulatory and industry monitoring should therefore evaluate productive capacity, physical competitiveness, and financial performance simultaneously.

**For policymakers:**

1. **Systematic regulatory impact assessment:** Major interventions affecting critical production inputs should be preceded by systematic regulatory impact assessment. Such assessment should extend beyond immediate compliance costs to consider potential effects on production, production costs, export capacity, and international market position. This is particularly important in perennial agriculture, where the consequences of input-related interventions may emerge with a lag.

2. **Phased implementation and transition periods:** Where technically proven substitutes are not immediately available, phased implementation, field validation, and appropriate transition periods can reduce adjustment risks. A rapid transition that disrupts established production practices without adequate preparation may impose substantial costs on producers and the broader industry.

3. **Continuous monitoring and adaptive management:** Regulatory assessment should continue after implementation. A monitoring framework incorporating production, export quantity, world export share, unit value, and production costs would enable emerging competitiveness problems to be detected even when export earnings remain resilient. Predefined review points and mechanisms for policy modification would further allow regulators to respond to unintended consequences without compromising the underlying environmental, health, or sustainability objectives of regulation.

4. **Multi-indicator competitiveness monitoring:** At minimum, production, export quantity, world export share, unit value, and production costs should be tracked together, not export value alone. This would help prevent short-term financial resilience from obscuring longer-term structural deterioration.

5. **Competitor benchmarking:** Sri Lanka's performance should be benchmarked against major competing producers (Kenya, India, China) so that policy decisions are evaluated relative to global competitive dynamics, not just domestic performance.

**For industry managers:**

1. **Distinguish price-supported performance from competitiveness improvement:** Higher unit values can protect revenues, but they cannot indefinitely compensate for declining production capacity and loss of international market presence. Premium positioning should therefore be supported by productivity improvement, replanting, input efficiency, technological upgrading, and reliable supply rather than being treated as a substitute for them.

2. **Invest in productive capability alongside premium positioning:** Productivity improvement, replanting, input efficiency, technology adoption, and reliable supply should be prioritized alongside premium positioning. These investments are essential for sustaining both physical competitiveness and financial performance over the long term.

### 6.8 Designing Agrochemical Transitions: Policy Guidance for Agricultural Ministries

The findings have direct relevance for policymakers considering transitions away from agrochemicals in agricultural sectors. While the environmental and health rationale for such transitions may be compelling, the Sri Lankan experience illustrates several design principles that can reduce adjustment costs and preserve competitiveness.

**i. Pre-implementation assessment and baseline establishment:** Before announcing restrictions, governments should conduct a thorough assessment of the sector's input dependency, available alternatives, and the time required for viable substitutes to be developed and adopted. For perennial crops like tea, this assessment should recognise that production cycles extend over multiple years, and that input disruptions can affect output for several seasons. Establishing baseline data on production, input use, costs, and export performance provides the foundation for subsequent monitoring and evaluation.

**ii. Phased and sequenced implementation:** Rather than a rapid, comprehensive ban, a phased approach allows producers to adapt. For example, restrictions could be introduced gradually, first on the most harmful inputs where alternatives exist, then on others as substitutes become available. Pilot programmes in selected regions or farming systems can generate evidence on the feasibility and consequences of restrictions before nationwide implementation. Sequencing should account for the time required for research institutions and input suppliers to develop and distribute alternatives.

**iii. Investment in alternatives and transition support:** Restrictions on chemical inputs must be accompanied by investment in alternatives, organic fertilisers, biological pest control, integrated pest management, and other sustainable practices. For tea specifically, this would require research on organic nutrient management, soil health improvement, and pest ecology in tea ecosystems. Extension services, training programmes, and financial support for producers during the transition period can reduce adjustment costs and facilitate adoption of alternative practices.

**iv. Supply chain development for organic inputs:** The availability of reliable, affordable organic inputs is a prerequisite for successful transition. Governments should support the development of supply chains for organic fertilisers, bio-pesticides, and other alternatives, including production facilities, quality assurance systems, and distribution networks. Without adequate supply, restrictions on chemical inputs will simply create shortages that disrupt production and impose costs on producers.

**v. Monitoring, evaluation, and adaptive policy:** A comprehensive monitoring system should track not only the environmental and health outcomes of the transition but also its economic consequences, production, costs, yields, export quantity, market share, and unit value. Predefined review points should be built into the policy schedule, allowing for adjustments if unintended consequences emerge. This requires coordination across ministries responsible for agriculture, trade, and the economy, and should include industry stakeholders in the review process.

**vi. Maintaining market access and competitiveness:** Transitions away from agrochemicals should be designed with attention to market access and competitiveness. If Sri Lanka's tea sector is to maintain its position in global markets while reducing chemical inputs, it must demonstrate that organic or low-chemical production does not compromise quality, safety, or reliability. Certification systems, traceability mechanisms, and market development efforts should accompany the transition. Where the market does not offer a premium for organic or sustainable tea sufficient to offset lower yields or higher costs, producers will bear the adjustment burden, potentially accelerating the decline in physical competitiveness.

**vii. International benchmarking and lesson learning:** Governments should study the experience of other countries that have undertaken agrochemical transitions, including both successes and failures. This could involve engagement with international organisations, research institutions, and producer organisations in countries that have successfully transitioned to more sustainable production systems. For tea specifically, India's experience with organic tea production in Darjeeling and other regions offers relevant insights.

### 6.9 Wider Relevance

Although the empirical setting is Sri Lanka's tea industry, the underlying mechanism may apply more broadly to differentiated export sectors in emerging economies. Products associated with geographical origin, reputation, specialised varieties, or accumulated quality perceptions may maintain relatively strong prices even when domestic supply weakens. Coffee, cocoa, spices, wine, and other origin-linked products may therefore exhibit similar divergence between physical competitiveness and financial resilience. The broader implication is that the choice of performance indicator matters when evaluating regulation. Revenue can remain resilient even when production capacity and international market position deteriorate. Regulatory assessment should therefore examine both value and volume dimensions of export performance.

## 7. CONCLUSION

This study examined whether major regulatory shocks were associated with changes in the productive and export competitiveness of Sri Lanka's tea industry, and whether stronger unit-value performance contributed to the resilience of export earnings.

The results do not support a simple causal interpretation in which the 2015 or 2021 regulatory interventions independently explain the industry's long-run decline. Production and export quantity were already weakening before 2021, while the 2015 restriction-period models did not identify statistically significant adverse deviations from underlying trends. The strongest post-2021 finding was an accelerated decline in Sri Lanka's share of world tea exports, occurring alongside significantly stronger export unit values and comparatively resilient export earnings. This post-2021 association should not be interpreted as an independently identified regulatory effect, given the concurrent macroeconomic crisis, COVID-19 disruptions, and global market volatility. The exact decomposition analysis provides direct quantitative evidence of the buffering mechanism. After 2021, unit-value growth more than fully offset the quantity-driven decline in export earnings, with the unit-value contribution to export value growth reaching approximately 447%. This analysis replaces the mathematically invalid auxiliary regression that was previously proposed, which regressed export value on export quantity and export unit value despite their accounting identity.

The study therefore highlights an important distinction between structural competitiveness and financial resilience. Higher unit values can partially offset declining export volumes and make deterioration in productive and physical competitiveness less visible in aggregate export earnings. This provides the empirical basis for the proposed export unit-value buffering effect. The principal implication is that regulatory and industry performance should not be assessed through export earnings alone. Production, export quantity, world market share, and price performance should be evaluated together when assessing the long-term competitiveness of export-oriented industries.

**Policy and Managerial Recommendations**

These findings support several evidence-linked recommendations:

1. **Introduce systematic regulatory impact assessment** before major input-related interventions, covering expected effects on production, costs, export capacity and international market share.

2. **Use phased implementation and transition periods** for major regulatory changes, particularly where technically proven substitutes are not immediately available.

3. **Strengthen ex-post regulatory review** with predefined monitoring indicators and modification mechanisms when unintended economic consequences emerge.

4. **Monitor competitiveness using multiple indicators** - at minimum, production, export quantity, world export share, unit value and production costs should be tracked together, not export value alone.

5. **Protect productive capability alongside premium positioning** through productivity improvement, replanting, input efficiency, technology adoption and reliable supply.

6. **Benchmark Sri Lanka against major competitors** (Kenya, India, China) so policy decisions are evaluated relative to global competitive dynamics, not just domestic performance.

## REFERENCES

1. Cabinet Office of Sri Lanka (2015a), "Restricting import and use of glyphosate pesticide", Press briefing of Cabinet Decision taken on 27 May 2015, Government of Sri Lanka.
2. Cabinet Office of Sri Lanka (2018), "Appointment of an expert committee on the impact of the use of glyphosate", Press briefing of Cabinet Decision taken on 9 May 2018, Government of Sri Lanka.

3. Cabinet Office of Sri Lanka (2021), "Importation of natural organic fertilizer and chelated mineral micro nutrient for Maha Season 2021/2022", Press briefing of Cabinet Decision taken on 31 May 2021, Government of Sri Lanka.
4. Department of Import and Export Control (2018), *Performance Report 2018*, Government of Sri Lanka.
5. Government of Sri Lanka (2015a), "Import and export control regulations: prohibition of glyphosate", *Gazette Extraordinary No. 1918/22*, 11 June 2015.
6. Government of Sri Lanka (2015b), "Order under the Control of Pesticides Act, No. 33 of 1980", *Gazette Extraordinary No. 1937/35*, 23 October 2015.
7. Hausmann, R., Hwang, J. and Rodrik, D. (2007), "What you export matters", *Journal of Economic Growth*, Vol. 12 No. 1, pp. 1-25, doi: 10.1007/s10887-006-9009-4.
8. Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI) (2025), *Import Ban on Chemical Fertilizers and Agrochemicals: Short-Term Impacts on the Vegetable Sector in Sri Lanka*, HARTI, Colombo.
9. International Tea Committee (ITC) (1959-2025), *Annual bulletin of statistics*, various editions, International Tea Committee, London.
10. North, D.C. (1990), Institutions, *Institutional Change and Economic Performance*, Cambridge University Press, Cambridge.
11. Porter, M.E. (1990), *The competitive advantage of nations*, Free Press, New York.
12. Rodrik, D., Subramanian, A. and Trebbi, F. (2004), "Institutions rule: the primacy of institutions over geography and integration in economic development", *Journal of Economic Growth*, Vol. 9 No. 2, pp. 131-165, doi: 10.1023/B:JOEG.0000031425.72248.85.
13. Sri Lanka Tea Board (SLTB). (various years:1962-2025) *Statistical bulletin*, Sri Lanka Tea Board.