UNIVERSIDADE FEDERAL DE SÃO CARLOS
CAMPUS SOROCABA
CENTRO DE CIÊNCIAS EM GESTÃO E TECNOLOGIA
CURSO DE CIÊNCIAS ECONÔMICAS

ANA LUIZA MARTIM SECCHES

# THE RELATIONSHIP BETWEEN SIMILARITY IN VOLUNTARY SUSTAINABILITY STANDARDS AND TRADE AMONG COFFEE-EXPORTING COUNTRIES

Sorocaba
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Trabalho de Conclusão de Curso apresentado ao Centro de Ciências em Gestão e Tecnologia da Universidade Federal de São Carlos, campus Sorocaba, para obtenção do título de bacharel em Ciências Econômicas.

Orientação: Prof.ª Dr.ª Profa. Dra. Rosane Nunes de Faria.

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**ANA LUIZA MARTIM SECCHES**

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À minha mãe, que me ensinou a valorizar
cada pequena conquista.
Ao meu pai, que me ensinou a pensar com clareza
mesmo nas dúvidas.
Aos meus avós, que me ensinaram a seguir
mesmo sem saber o plano dEle.
À minha família e aos meus amigos que fazem
qualquer trajetória valer a pena.

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## ABSTRACT

SECCHES, Ana Luiza Martim. *Are coffee-exporting countries more likely to trade with countries that have more similar Voluntary Sustainability Standards?* 2025. Undergraduate Thesis (Bachelor's Degree in Economic Sciences) – Universidade Federal de São Carlos, Sorocaba, 2025.

This study investigates the effect of institutional alignment in Voluntary Sustainability Standards (VSS) adoption on the trade intensity of coffee-exporting countries. The analysis considers whether exporters tend to trade more intensively with partners that share similar sustainability standards. The methodology integrates 2022 bilateral export data with two similarity indices (Jaccard and Cosine) and the Trade Intensity Index. Results reveal a weak but statistically significant positive correlation between VSS similarity and trade intensity across all exporters. However, this association weakens or becomes negative among major producers. This suggests that smaller exporters may use VSS alignment as a strategy to overcome entry barriers and access new markets, while major producers, already operating through consolidated export channels, tend to rely more on price competitiveness, scale, and long-standing buyer relationships than on institutional convergence.



**Keywords**: voluntary sustainability standards; coffee trade; trade intensity; exporting countries.

## RESUMO

Este estudo investiga o efeito do alinhamento institucional na adoção de normas voluntárias sustentáveis sobre a intensidade do comércio entre países exportadores de café. Analisa-se se exportadores tendem a comercializar mais intensamente com parceiros que adotam padrões sustentáveis semelhantes. A metodologia integra dados bilaterais de exportação de 2022 com dois índices de similaridade (Jaccard e Cosseno) e o Índice de Intensidade Comercial. Os resultados revelam uma correlação positiva fraca, mas estatisticamente significativa, entre a similaridade em VSS e a intensidade comercial na amostra total. No entanto, essa associação se enfraquece ou se torna negativa entre os principais produtores. Isso indica que países exportadores menores podem utilizar o alinhamento em VSS como estratégia para acessar novos mercados, ao passo que grandes produtores, que operam com canais consolidados e compradores de longo prazo, tendem a depender mais de competitividade em preço, escala e relações comerciais já estabelecidas do que da convergência regulatória.



**Palavras-chave:** normas voluntárias sustentáveis; comércio de café; intensidade comercial; países exportadores.

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4C The Common Code for the Coffee

BRC British Retail Consortium

EFI Equitable Food Initiative

EU European Union

FAO Food and Agriculture Organization of the United Nations

FEMAS Feed Materials Assurance Scheme

FSA Farm Sustainability Assessment

GRASP GLOBALG.A.P. Risk Assessment on Social Practice

GVCs Global Value Chains

HS Harmonized System

IISD International Institute for Sustainable Development

IFOAM International Federation of Organic Agriculture Movements

ITC International Trade Centre

MPS-SQ MPS Socially Qualified

NOP National Organic Program (USDA)

OECD Organisation for Economic Co-operation and Development

RTRS Round Table on Responsible Soy

SAI Sustainable Agriculture Initiative Platform

UN United Nations

UNCTAD United Nations Conference on Trade and Development

UNFSS United Nations Forum on Sustainability Standards

USDA United States Department of Agriculture

VSS Voluntary Sustainability Standards

WTO World Trade Organization

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# 1. INTRODUCTION

As environmental concerns continue to rise and the need for sustainable development becomes more pressing, governments, private enterprises, and non-governmental organizations have been implementing a range of sustainability initiatives in recent years (Martins et al., 2022). At the multilateral level, the issue gained prominence with the 1992 Rio Conference, which led to the adoption of Agenda 21, sponsored by the United Nations (UN, 1993). Over the years, successive conferences have further advanced the sustainability agenda, culminating in the adoption of the 2030 Agenda in 2015, in which all UN member states committed to pursuing 17 Sustainable Development Goals (SDGs) (UN, 1992; UN, 2015).

Meanwhile, the World Trade Organization (WTO) and the Organization for Economic Cooperation and Development (OECD) have developed regulatory frameworks to align international trade with environmental concerns. These efforts reflect a broader movement toward integrating sustainability into global economic policies, reinforcing the role of trade and governance in addressing environmental challenges (Martins et al., 2022).

Since the 1990s, growing concerns among various stakeholders, such as businesses, industry associations, and non-governmental organizations (NGOs), have made sustainability a key focus of civil society's demands. These stakeholders advocate for production practices that prioritize environmental protection, uphold labor rights, ensure worker safety, and safeguard the livelihoods of producers. They achieve this by establishing a new form of governance based on Voluntary Sustainability Standards (VSS), which are developed primarily by the private sector, public international organizations, and multi-stakeholders. VSS have emerged as responses to globalization, trade liberalization, shifting consumer preferences, and advances in information technology (Vieira; Thorstensen, 2016). The UNFSS defines VSS as

“standards specifying requirements that producers, traders, manufacturers, retailers or service providers may be asked to meet, relating to a wide range of sustainability metrics, including respect for basic human rights, worker health and safety, the environmental impacts of production, community relations, land use planning and others” (UNFSS, 2013: 3).

Increasingly recognized as key transnational governance instruments, these standards aim to ensure that products and production processes comply with a set of social, economic, and environmental requirements, making global production more sustainable (UNFSS, 2022). VSS are

actively engaged in a wide range of sectors, from agriculture and forestry to minerals and electronics (UNFSS, 2022).

VSS establishes guidelines to minimize social and environmental harm while protecting human rights. They play a pivotal role in promoting responsible production and consumption by encouraging safe working conditions, protecting natural resources and communities, and minimizing ecological degradation (UNFSS, 2025). Furthermore, these standards support broader development goals, such as climate change mitigation, food security, poverty alleviation, and job creation, while disseminating best practices across global value chains (UNFSS, 2018; UNFSS, 2022).

Despite their potential benefits, VSS presents significant challenges for producers in developing countries, especially for smallholders, because they share similarities with Non-Tariff Measures (NTMs), such as regulations, in that they can influence trade by regulating market access and establishing specific requirements that producers and processing firms must comply with (Vieira; Thorstensen, 2016). High compliance costs associated with VSS, combined with limited access to finance and governance gaps between developed countries, where the standards are designed, and developing nations, where they are implemented, can create trade barriers for small producers (UNFSS, 2022).

The fragmentation of VSS, with multiple competing and overlapping standards, increases trade costs and complicates the adoption process for producers. Developing economies are burdened by the diversity of VSS requirements, leading to high compliance costs that act as trade barriers (Fransen et al., 2019; UNFSS, 2018). Additionally, competition among VSS can raise transaction costs, and governance practices can further increase the burden for producers (Fransen et al., 2019).

Moreover, the proliferation of VSS, understood as the rapid increase in the number of available VSS developed by different private, public, and multi-stakeholder entities, has led to issues of multiplicity and fragmentation (UNFSS, 2022). Multiplicity refers to the coexistence of overlapping standards targeting similar sustainability goals in the same sector, while fragmentation indicates the lack of coordination and harmonization among them (UNFSS, 2022). This scenario complicates decision-making for producers, who must navigate a maze of varying requirements, and increases the risk of exclusion for smallholders unable to comply with multiple schemes. Each VSS typically entails distinct certification procedures, audit cycles, and reporting mechanisms,

which elevate both certification and compliance costs (UNFSS, 2022). The coexistence of various standards can lead to audit fatigue, where producers, especially in developing countries, are subjected to repeated and redundant auditing processes, consuming time and resources without yielding proportional benefits (UNFSS, 2022). These dynamics disproportionately affect small producers, exacerbating inequalities and posing significant barriers to their inclusive participation in global value chains (Auld et al., 2008; Fiorini et al., 2019; Schleifer et al., 2019).

Since the early 1990s, the number of VSS in the agricultural sector has increased significantly (Elamin & Fernandez de Cordoba, 2020). As of May 2025, the Standard Map Database from the International Trade Centre (ITC) had mapped and organized 357 VSSs, with 185 focusing specifically on the agricultural sector (ITC, 2025). Major agricultural commodities subject to VSS certification include cotton, sugarcane, cocoa, tea, soybeans, bananas, palm oil, and coffee (UNFSS, 2022).

The coffee sector remains one of the most prominent agricultural sectors in engagement with VSS. As of 2022, between 15.20% and 30.80% of the global coffee production area was certified under at least one VSS, reflecting a slight decrease from earlier estimates that ranged from 21% to 45% in 2019 (FiBL; ITC; IISD, 2024). Coffee remains one of the leading commodities in certified harvested areas, alongside cocoa and tea. Despite the broad adoption of sustainability standards, only a portion of VSS-compliant coffee is marketed as certified, suggesting persistent challenges in demand absorption and market segmentation (IISD, 2022). Between 2008 and 2019, VSS-compliant coffee production experienced rapid expansion, with compound annual growth rates (CAGR) ranging from 13% to 19%. However, between 2014 and 2019, growth slowed significantly, and some schemes even experienced contraction, with CAGRs ranging from –1% to –7%, depending on the certification system (FiBL; ITC; IISD, 2024). Latin America and the Caribbean accounted for nearly 60% of VSS-compliant coffee production in 2019, underscoring the region's central role in sustainable coffee value chains (IISD, 2022). Brazil, Colombia, and Peru remain leading producers of certified coffee, although Vietnam has emerged as the largest VSS-compliant coffee producer by volume, emphasizing the growing role of Asian economies in sustainable coffee production.

The growing relevance of these standards reflects not only heightened consumer awareness but also the increasing integration of sustainability into global trade dynamics, reinforcing the role of VSS as a determinant in international market access and competitiveness. The coexistence of

multiple and often overlapping, VSS in producing countries further complicates supply chain governance and raises questions about compatibility, mutual recognition, and the efficiency of sustainability signaling in international trade (FiBL; ITC; IISD, 2024).

While voluntary in principle, VSS often become de facto prerequisites for entering specific markets, especially in environmentally and socially conscious regions. Therefore, exporting countries may prefer trading with countries that adopt the same VSS schemes, as standards become more aligned, increasing the likelihood that their products will be accepted by consumers who value ethical or sustainable practices.

As noted by UNCTAD (2020), VSS serves not only as a mechanism for signaling quality and sustainability but also as a tool for reducing information asymmetries in international trade, thereby fostering trust between trading partners. Adopting identical or mutually recognized VSS by both exporters and importers may facilitate market access by reducing compliance costs and certification duplication. It can also diminish sunk trade costs, such as search and quality control costs, especially in sectors like agriculture, where consumer concerns over environmental and labor conditions are high. Moreover, empirical evidence from gravity model studies, such as those by Fiankor et al. (2020), indicates that certified producers tend to exhibit better export performance, and certification can even offset institutional governance gaps between countries, serving as a surrogate for weak domestic regulatory frameworks. Thus, adopting the same VSS not only aligns market preferences but also makes export relationships more attractive and resilient in a global economy increasingly shaped by sustainability standards (UNCTAD 2020).

This study examines the effect of alignment in Voluntary Sustainability Standards (VSS) adoption between coffee-exporting and importing countries, with a particular focus on differences between major and minor producers. The central hypothesis is that greater institutional similarity in VSS adoption reduces regulatory barriers and transaction costs, thereby facilitating trade. While exporters adhering to the same standards as their trade partners may benefit from lower certification burdens, the magnitude of this effect may vary. In particular, it is expected that minor coffee producers, facing greater challenges in accessing international markets, stand to gain more from institutional alignment than their major-producing counterparts.

Our results show that, on average, coffee-exporting countries engage in more intensive trade relationships with partners that exhibit greater similarity in the adoption of Voluntary Sustainability Standards. The correlations between institutional similarity and trade flows are

statistically significant. Notably, this positive relationship weakens or even turns negative when the analysis is restricted to major coffee producers. This suggests that the effect of VSS alignment on trade intensity is heterogeneous and context-dependent. For smaller producers, adopting the same standards as their trade partners may serve as a strategy to overcome market entry barriers and attract new buyers. In contrast, major producers often operate through well-established export channels, long-standing commercial relationships, or bulk trading systems that are less responsive to regulatory convergence. In such cases, factors like price competitiveness, supply capacity, and buyer loyalty may play a more decisive role than institutional alignment.

This work is organized into four chapters, in addition to an introduction. Chapter II offers a detailed exploration of VSS, outlining their definition, institutional mechanisms, and the diversity of actors involved in their development and certification. It also examines how VSS functions within global value chains and highlights variations in uptake, focusing on their adoption in developing countries and analyzing both the opportunities and barriers they present. Chapter III presents the methodological strategy adopted to investigate the central question of this work. Chapter IV presents the main findings concerning the research question. Finally, Chapter V offers concluding remarks and policy considerations.

## 2. LITERATURE REVIEW

This section begins by presenting the definitions and different types of VSS, establishing a conceptual foundation for the analysis. It then provides a brief review of key contributions related to the topic and the research objective. The growing importance of VSS in global trade and environmental governance is contextualized, with the literature highlighting influential studies on the role of VSS in shaping trade flows, particularly in sectors like agriculture. The review also examines how VSS schemes promote sustainable practices among producers and impact international market access. Furthermore, it addresses the challenges and opportunities presented by these standards and analyzes their interaction with trade policies.

### 2.1. VOLUNTARY SUSTAINABILITY STANDARDS

In recent decades, VSS have consolidated their role as relevant instruments for addressing critical sustainability challenges, including biodiversity conservation, climate change mitigation,

and the protection of fundamental human rights (UNCTAD, 2020). There is a wide diversity of approaches and institutional arrangements under which VSS are developed and implemented.

Defined by the United Nations Forum on Sustainability Standards (UNFSS, 2013, p. 3) as

> […] specifying requirements that producers, traders, manufacturers, retailers or service providers may be asked to meet, relating to a wide range of sustainability metrics, including respect for basic human rights, worker health and safety, the environmental impacts of production, community relations, land use planning and others.

Therefore, VSS are understood as voluntary, non-state, market-driven governance mechanisms (UNCTAD, 2020). Their primary goal is to promote more sustainable production and trade practices by defining and enforcing specific behavioral standards (Cashore et al., 2004). In this regard, they have become essential instruments for enabling the transition toward greener economies (Marx & Wouters, 2015).

Different terms are used to describe these standards, reflecting their diversity, ranging from "private standards" and "eco-labels" to "certification schemes" and "quality norms" and mirroring the multiplicity of purposes and institutional actors behind them (Martins et al., 2023). This semantic plurality highlights not only the complexity of the regulatory landscape but also the flexibility required to address the heterogeneous realities of international trade. As emphasized by UNFSS (2013), VSS interacts differently with national priorities and institutional capacities, which explains their variable role across developed and developing countries.

These standards are frequently classified according to the sectoral focus or thematic domain they are intended to address and are primarily implemented by producers and enterprises within the food and agricultural sectors (UNFSS, 2013). These standards can be further differentiated into single-commodity and multi-commodity schemes (Kemper et al., 2023). Single-commodity schemes are specifically designed to certify sustainability practices related to a single distinct product. In the coffee sector, an example is the Coffee Sustainability Reference Code, which focuses exclusively on coffee. Multi-commodity schemes, in contrast, are characterized by their broader applicability across multiple products and sectors, allowing for a unified sustainability framework that can be adopted by producers operating in diverse agricultural value chains (UNFSS, 2013; ISEAL, 2018). According to the ITC Standards Map, schemes such as Rainforest

Alliance and Fairtrade International include certifications not only for coffee but also for products such as cocoa, tea, bananas, cotton, sugar, flowers, and tropical fruits.

The classification of VSS can be refined by considering both their institutional origin and legal nature. Following Henson and Humphrey (2009), four generic forms of sustainability standards can be identified, each reflecting different arrangements of authority, enforcement, and stakeholder engagement. The first category comprises public, mandatory sustainability standards, which correspond to government regulations that establish legally binding requirements for general market access (Henson; Humphrey, 2009). These are formulated and enforced by national governments or governmental agencies and typically apply across entire sectors or industries (Henson; Humphrey, 2009).

The second category refers to private, which are developed through multi-stakeholder initiatives comprising actors from the private sector and civil society (Henson; Humphrey, 2009). They are not legally binding but are widely adopted to access high-value markets and respond to sustainability concerns at the global level (Henson; Humphrey, 2009). Within this category, company-specific VSS forms a notable sub-group, created and implemented by individual corporations, such as the TESCO Nurture program, to ensure compliance across their supply chains. According to Potts et al. (2014, p. 37), approximately two-thirds of these private standards utilize logos or labels to signal compliance to consumers, while the remaining third operate strictly through business-to-business arrangements without any consumer-facing certification.

In addition to these two broad types, Henson and Humphrey (2009) also emphasize the relevance of two hybrid categories. On the one hand, public VSS are initiatives established or promoted by governments yet adopted voluntarily by market participants. On the other hand, some private voluntary standards may acquire mandatory status when incorporated into legally binding public regulations. This fluidity contributes to the growing overlap between public and private forms of sustainability governance. Indeed, specific public regulations are directly inspired by previously private standards. For instance, zoning instruments initially developed by the Forest Stewardship Council (FSC) for areas of high conservation value have been integrated into public regulatory frameworks in countries such as China and Bolivia (Henson & Humphrey, 2009).

Moreover, the line between voluntary and mandatory standards is not always clear-cut. VSS may become de facto mandatory in commercial terms when dominant firms impose its adoption as a prerequisite for suppliers or when consumer preferences exert sufficient pressure on companies

to conform (Henson and Humphrey, 2009; Smith, 2009). However, despite their influence, voluntary standards often face limitations in terms of legal enforceability, remediation mechanisms, and accountability. In most cases, the most severe penalty is exclusion from the certification scheme, which neither guarantees compensation for affected parties nor ensures legal liability for companies or certification bodies in cases of non-compliance or audit failure (Henson & Humphrey, 2009).

In addition to the classification based on institutional origin and legal nature, as presented by Henson and Humphrey (2009), Lamolle et al. (2024) suggest further dimensions to distinguish VSS. These include sectoral scope (cross-sectoral or industry-specific), geographic reach (global, regional, or national), and value chain coverage (from production to final sale). VSS also differ according to the sustainability pillars they address: environmental, social, economic, and governance (Lamolle et al. 2024). Further distinctions relate to performance focus, whether centered on practices, systems, or measurable outcomes, as well as due diligence requirements, which define the responsibilities of enterprises in identifying, preventing, and mitigating negative impacts (Lamolle et al. 2024). Together, these dimensions provide a more comprehensive and nuanced understanding of how VSS operate and influence global trade and sustainability outcomes.

## 2.2. IMPLEMENTATION AND CONFORMITY ASSESSMENT PROCESSES OF VSS

The implementation of VSS follows a structured process, which includes defining sustainability criteria, creating indicators for evaluation, and conducting audits by independent certifiers. Producers seeking certification must demonstrate compliance with the established requirements and undergo initial and periodic audits to maintain their certification. Indicators are then developed for each VSS scheme to standardize and compare conformity assessments. As voluntary governance tools, any actor along a GVC can apply to a VSS and commit to implementing its sustainability standards. Upon application, an initial conformity assessment is conducted based on a management plan submitted by the applicant, outlining how conformity with the specific standards will be achieved (UNFSS, 2022). Independent certifiers usually monitor or verify the implementation of these plans (UNCTAD, 2021). If the applicant meets the VSS requirements, a certificate is granted. The validity of VSS certificates typically ranges from one to five years and can be renewed upon passing a recertification conformity assessment at the end of

the validity period. Additionally, complementary conformity assessments, such as annual "surveillance audits," are conducted to ensure ongoing compliance with the standards.

### 2.3. VSS IN GLOBAL TRADE

Studies examining the relationship between VSS and international trade can be categorized into two main types: country-level and firm-level analyses. Country-level studies typically employ gravity models to estimate the impact of VSS on international trade, using variables such as the number of certified producers and the size of certified production areas. Within this framework, several relevant studies have provided important insights into the relationship between sustainability certification and export performance.

VSS plays a dual role in trade by enhancing product quality, ensuring sustainable practices, and facilitating market access. However, they can exclude small-scale producers in developing countries due to the high costs of compliance and monitoring involved (UNCTAD, 2008). Challenges such as financial barriers, low education levels, and limited technical capacity hinder the adoption of VSS in these regions (Elder et al., 2021). While VSS can reduce transaction costs and information asymmetries (Henson and Jaffe, 2008), the compliance costs often outweigh the long-term benefits for smallholders (Ponte, 2019). Nonetheless, measures such as more equitable distribution of compliance costs and improved transparency in VSS design can help reduce burdens on smallholders and enhance inclusivity (UNFSS, 2018; Andersson, 2019).

For instance, Fiankor et al. (2019) explore how GlobalGAP certification can mitigate the adverse effects of institutional disparities between exporting and importing nations. Employing a structural gravity model with OLS and PPML estimators, the authors analyze the impact of the so-called "governance gap" between the European Union and the European Free Trade Association on the trade of apples, bananas, and grapes from 2010 to 2015. The dataset comprises 34 countries outside the EU/EFTA and 31 member countries within those blocs.

The findings reveal that institutional divergence substantially hampers agri-food trade flows. Nevertheless, this constraint is significantly reduced when exporting countries are certified under the GlobalGAP scheme, with the effect of the governance gap on trade declining from 124% to 51% in certified economies. More precisely, the detrimental influence of institutional distance on exports is markedly lower for certified nations compared to their non-certified counterparts, particularly in shipments directed to the EU and EFTA (Finkor et al., 2019). These results suggest

that certification serves as a complementary mechanism of governance, helping to bridge institutional shortcomings and fostering deeper commercial integration with high-standard markets.

Moreover, Chen et al. (2024) examine the influence of RTRS (Roundtable on Responsible Soy) certification on soybean trade flows between six countries from 2012 to 2019. The analysis focuses on the certified production area, measured in hectares, as the key explanatory variable. Their findings indicate that doubling the certified area (a 100% increase) corresponds to a 12.4% decline in bilateral trade volumes. This adverse effect is especially evident in non-OECD countries, where a 10% expansion in certified areas is associated with a 1% decline in trade. In contrast, the study finds no statistically significant effect for OECD countries.

Mangelsdorf et al. (2012) apply a gravity model to examine the influence of both compulsory and voluntary food safety regulations on China's agricultural exports to 132 trade partners over the period from 1992 to 2008. The analysis encompasses a diverse range of agricultural products, including meat, fish, horticultural goods, cereals, dairy products, tea, and sugar. The inclusion of various product categories allows the study to assess whether standard-related effects are consistent across different agri-food value chains.

The findings reveal that mandatory standards aligned with international benchmarks have a positive and statistically robust impact on Chinese export volumes, particularly in transactions involving high-income destination countries (Mangelsdorf et al., 2012). This highlights the role of regulatory convergence as a facilitator of trade integration, particularly with markets that require higher levels of compliance assurance. According to the authors, such harmonization reduces information asymmetries and enhances the trust of importers, thereby easing entry into regulated markets. On the other hand, domestic-only or non-binding voluntary standards show more modest effects, which are either weakly positive or statistically insignificant.

Bemelmans et al. (2023) investigated the trade impacts of VSS on the export performance of bananas, coffee, tea, cocoa, and palm oil. The study examined the impact of VSS adoption on the export performance of 110 countries between 2012 and 2019. Adoption was defined as the proportion of the certified production area of a given crop concerning the total production area of that crop. The results demonstrated that the adoption of VSS has a positive effect on the banana, coffee, and tea trade but a negligible impact on the cocoa and palm oil trade (Bemelmans et al., 2023). In addition, the trade benefits of VSS are more significant when there is a large income gap

between exporting and importing countries. This supports the hypothesis that VSS schemes help bridge institutional and informational gaps in asymmetric trade relationships.

Dolabella and Saeteros (2024) present an analysis of the effects of VSS on agricultural exports from developing countries, with a special focus on Latin America and the Caribbean. The survey spans the period from 2013 to 2021 and encompasses eight commodities: bananas, sugarcane, cocoa, coffee, cotton, palm oil, soybeans, and tea, as well as twelve VSS. The authors have found that a 1% increase in VSS coverage results in an average increase of 1.86% in the value of exports. The analysis also reveals a non-linear relationship in which the expansion of certification coverage may reduce trade flows. In addition, the positive effects are more robust when low-income exporters trade with high-income countries, a context in which VSS function as instruments for reducing information asymmetries.

The empirical findings presented in these studies reinforce the notion that VSS may operate as institutional mechanisms that facilitate international trade in agri-food products, particularly in environments characterized by regulatory asymmetries and heightened compliance demands. Fiankor et al. (2019) demonstrate the potential of VSS to function as alternative governance frameworks that support commercial integration with highly regulated markets. In a similar vein, Mangelsdorf, Portugal-Perez, and Wilson (2012) underscore the relevance of international harmonization. The trade-promoting capacity of VSS is further evidenced in the cross-national analysis conducted by Bemelmans et al. (2023), which finds a positive relationship between certification and export performance for key commodities. In addition, Dolabella and Saeteros (2024) corroborate these findings by demonstrating that the expansion of VSS coverage contributes to significant increases in export value for developing economies. When considered in aggregate, this body of literature suggests that although VSS can play a pivotal role in reducing barriers within global value chains, their trade-related impacts remain contingent upon commodity-specific attributes, the institutional design of VSS, and the broader regulatory architecture governing trade relations.

Nonetheless, in contexts where regulatory harmonization is lacking, such as in cases where voluntary standards are not multilaterally recognized or where the costs of compliance outweigh the expected market gains, VSS may function as trade-restrictive instruments, as evidenced by Chen et al. (2024). Although certification can contribute to mitigating institutional and informational asymmetries, its effectiveness remains contingent upon producers' ability to absorb

compliance costs and access higher-value-added markets, as noted by Fiankor et al. (2019). Therefore, while VSS plays an increasingly prominent role in the governance of global agricultural trade, their positive outcomes continue to be shaped by structural constraints that limit the universalization of their benefits, reinforcing the importance of public policies that promote inclusive and equitable participation in certified trade networks (UNFSS, 2022).

The empirical literature focusing on the impacts of certification at the firm level remains relatively limited, particularly when compared to the number of studies conducted at the national level. Latouche and Chevassus-Lozza (2014) examined the extent to which certification by the BRC and IFS standards influences the export orientation of French firms, with a particular focus on access to European Union markets. The sample consisted of 2,942 firms, including 573 certified companies. The objective of the study was to assess whether certification lowers the minimum productivity threshold required for export participation (Latouche and Chevassus-Lozza, 2014). The results suggest that firms certified under the BRC standard are more likely to engage in export activities and incur lower trade costs when accessing certain European countries compared to non-certified firms with similar productivity levels. In contrast, IFS certification had no statistically significant effect on export performance (Latouche and Chevassus-Lozza, 2014).

Based on data collected from a survey of 102 fresh produce exporters across ten sub-Saharan African countries, Henson et al. (2011) investigated the influence of GlobalGAP certification on firms' export revenues between 2000 and 2006. The authors employed a combined econometric strategy, integrating propensity score matching (PSM) with a difference-in-differences (DiD) approach, to estimate the causal effect of certification on export performance. This methodology enables the control of both observable and unobservable firm-level characteristics that remain constant over time, thereby allowing for a more accurate comparison between certified and non-certified firms (Henson et al., 2011). The findings indicate that certified firms experienced, on average, an increase of €2.6 million in export revenues. The authors conclude that, despite the high costs associated with certification, it represents a profitable investment.

In summary, the studies reviewed demonstrate that the effects of certification at the firm level vary depending on the adopted standard and the company's characteristics. Henson et al. (2011) found that GlobalGAP certification is associated with an increase in export revenues, suggesting that certification can be a profitable strategy for firms operating in international agricultural and food markets. Meanwhile, Latouche and Chevassus-Lozza (2014) observed that

the commercial advantages of certification depend on the type of standard: BRC-certified firms are more likely to export and face lower trade costs, while IFS certification did not show a significant impact. These findings indicate that the outcomes of certification are not uniform and may depend on productivity levels, market access conditions, and the role firms play in global supply chains.

## 2.4. VSS UPTAKE IN DEVELOPING COUNTRIES

The potential of VSS schemes to address sustainability issues partly depends on their level of uptake, which refers to the degree of engagement by various economic actors, including producers, traders, manufacturers, retailers, end-consumers, and governments (UNFSS, 2020). The 4th Flagship Report by UNFSS (2020) analyzed methods for measuring VSS uptake, emphasizing that countries with open economies, diverse economic sectors, strong governance, and a certain level of development are more likely to engage with VSS. In contrast, developing countries tend to have fewer active VSS.

Research shows that VSS uptake correlates with countries' income levels; developed countries adopt more VSS than developing ones because economic actors in developing countries often face financial, technical, institutional, and regulatory constraints in meeting sustainability standards (Auld et al., 2008, 2015; Marx and Wouters, 2015).

Developing countries play a crucial role in VSS dynamics, as their substantial tropical agricultural sectors are responsible for the production of extensively certified commodities, including bananas, coffee, cocoa, cotton, palm oil, sugarcane, soybeans, and tea (ITC, 2020). These countries host over half of all producers of these commodities. Given the centrality of agriculture to their economies and its significant contribution to deforestation and climate change, VSS initiatives often focus on improving agricultural practices in these regions.

However, several shortcomings persist concerning certification in developing countries. Tayleur et al. (2018) found that certification is present in biodiversity-critical regions but not in areas most in need of poverty alleviation. This reflects an income-driven self-selection effect, limiting VSS benefits for the most vulnerable populations.

Also, the high costs of adopting sustainability standards, particularly for smallholders who lack access to necessary information and markets, present a significant barrier to uptake in developing countries (UNFSS, 2022). Despite the costs, smallholder coffee farmers in Uganda have managed to comply with international standards, indicating that participation in high-value

markets is possible even for small producers under certain conditions (Chiputwa et al., 2015; Meemken et al., 2017).

There are challenges in adopting VSS in developing countries, including high certification costs, lack of incentives, sociopolitical resistance, and limited representation in VSS governance structures. One of the primary obstacles is the cost associated with certification. There are two main costs: certification and compliance (or implementation) costs (Auld et al., 2008; Fiorini et al., 2019; Schleifer et al., 2019). Certification costs include explicit expenses, such as audit fees that applicants must pay, as well as certification fees charged by some VSS organizations (UNFSS, 2022). Additionally, implicit costs can be burdensome, such as the time and effort required to develop management plans and provide data during audits. Compliance costs are incurred when producers modify their production practices to meet VSS requirements (UNFSS, 2022). These financial and administrative burdens are particularly challenging for producers in developing countries, who often lack the necessary resources and financial means.

Another challenge is the lack of incentives for certification. Producers may seek certification in the expectation of economic benefits, such as price premiums or improved access to export markets. However, these benefits are not always guaranteed, and when the financial returns are uncertain, the motivation to adopt VSS decreases (Auld et al., 2015). The effectiveness of market access as an incentive depends on whether VSS are available for the products a country exports and whether these products align with the demands of target markets (Michida et al. 2021).

Sociopolitical resistance to VSS is also a significant issue. Producers and governments in developing countries may perceive these standards as externally imposed by developed countries, which can create resistance. This tension can discourage the adoption of VSS and lead to a preference for national institutional arrangements, which may better align with local contexts and priorities (UNFSS, 2022).

Finally, there is a notable lack of inclusion of actors from developing countries in VSS governance and standard-setting processes. Despite being labeled as multi-stakeholder initiatives, many VSS exclude producers from developing countries. Bennett (2017) found that two-thirds of the 33 socially oriented VSS analyzed exhibited a democratic deficit, with minimal representation from producers in developing countries. This exclusion creates a misalignment between VSS requirements and the capacities of local producers, making adoption more difficult. Moreover, the

lack of local representation undermines the legitimacy and acceptance of VSS, potentially fostering further resistance to their implementation.

All the above-mentioned challenges thus contribute to excluding developing countries from global markets. This is a concern, as VSS schemes are becoming *de facto* mandatory and are increasingly used by lead firms as market access tools and proofs of due diligence in global value chains (GVCs) (UNFSS, 2022, p. 12).

Many VSS schemes are being adapted to better suit smallholder farmers and other stakeholders in developing countries who often have limited resources or technical capacity to meet full certification requirements. In addition, they are adopting a "continuous improvement"[1] approach (Grabs, 2020) which allows for initial certification based on compliance with a reduced set of core requirements, with additional requirements becoming mandatory in subsequent years. This method helps to make certification more accessible to producers in developing countries by accommodating their initial capacities and gradually increasing the standards they must meet over time.

## 2.5. OPPORTUNITIES OF VSS FOR DEVELOPING COUNTRIES

Since most developing economies heavily depend on agriculture, contributing to and suffering from various sustainability issues, it becomes crucial to ensure that cross-border value chains are inclusive, equitable, and sustainable, thereby contributing to achieving the SDGs. Balancing economic growth with sustainability goals in global value chains is challenging, but VSS can play a key role in making this attainable. The environmental crises, especially agriculture's contribution to climate change and biodiversity loss, have significant economic and social consequences. Agriculture emits methane and nitrous oxides, contributing to climate change, and is responsible for considerable losses in terrestrial biodiversity due to land conversion, pollution, and soil degradation (IISD, 2017a; FAO, 2021).

Regarding social sustainability, VSS can bring several benefits to smallholder farmers, such as increased productivity, access to training, and improved market opportunities through price

[1] The continuous improvement approach consists of a progressive certification model whereby producers are initially evaluated based on a limited set of core sustainability criteria. Upon receiving provisional certification, they are expected to progressively comply with more comprehensive requirements over a predefined period. This method is particularly relevant for smallholder farmers in developing countries, as it lowers initial entry barriers while fostering gradual convergence toward full compliance with sustainability standards (GRABS, 2020).

premiums (Oya et al., 2018). However, challenges like over-certification and elite capture often limit the extent of these benefits. Glasbergen (2018) notes that between 80% and 95% of the economic rents generated by VSS in the coffee and palm oil sectors are captured by processing companies, leaving farmers with only a marginal share. While VSS may contribute to better working conditions for agricultural laborers, they rarely lead to higher wages (Elamin and Fernandez de Cordoba, 2020; Swinnen, 2007). Moreover, the social impacts of VSS are highly context dependent. For instance, Fairtrade certification in central Uganda has enhanced women's control over coffee income, which has led to improved nutritional outcomes in their households (Chiputwa and Qaim, 2016). Still, the effects on food security and gender equality vary significantly depending on the context and type of certification (Schleifer and Sun, 2020).

Rather than assuming that certification alone guarantees outcomes, recent discussions emphasize that compliance with VSS depends on both the incentive structure and the support systems available to producers (UNFSS, 2022). Inconsistent price premiums and overly burdensome auditing may weaken long-term adherence, especially in contexts where producers lack sufficient technical, financial, or institutional capacity (UNFSS, 2022). In this regard, compliance should be understood not only as a matter of motivation but also as a function of institutional and operational capacity. Robust compliance mechanisms therefore require a combination of equitable benefit-sharing, flexible monitoring, and targeted capacity-building efforts. When smallholders are supported by cooperatives, certification bodies, or public–private initiatives, their ability to meet and maintain VSS requirements increases, enhancing the transformative potential of sustainability certification in global value chains (Grabs, 2020; UNFSS, 2022).

## 2.6. CHALLENGES OF VSS FOR DEVELOPING COUNTRIES

The effectiveness of VSS is influenced by their integration into broader institutional contexts and interactions with other policy instruments. Strong regulatory systems, which include institutions and policies addressing compliance, monitoring, and enforcement, enhance the adoption of VSS, especially in countries with robust private sector development and effective compliance mechanisms (Lobel, 2012; Rhodes, 2012). Well-structured private sector development policies, such as financial support, training, and technical assistance, are essential for creating an environment conducive to implementing sustainable practices and VSS (UNCTAD, 2021; Essen

and Lambin, 2021). Countries with strong governance systems and rule-compliance mechanisms also exhibit higher rates of VSS adoption, particularly where regulatory quality and government effectiveness are prioritized (Depoorter and Marx, 2022; Marx and Cuypers, 2010; UNFSS, 2020).

Furthermore, due diligence frameworks, including human rights and risk-based due diligence[2], have become crucial in regulating corporate behavior. These frameworks help companies address human rights violations and environmental issues within their supply chains. However, challenges remain in developing countries, where weak governance and labor market conditions complicate implementation (ITUC, 2020). A hybrid approach combining mandatory regulations with VSS could enhance compliance and support local adaptations, ensuring companies make sustainable changes (Agarwal, 2020; Blankenbach, 2020). Governments play a pivotal role in facilitating the adoption of VSS by creating legal frameworks, infrastructure, and policies that promote sustainability. Measures such as ensuring the rule of law, clear property rights, and transparent accountability mechanisms can support the adoption of VSS. Public-private collaborations, such as Brazil's Minas Gerais partnership with UTZ, demonstrate how governments and private standards can work together to enhance market access for producers (Glasbergen and Schouten, 2015). However, some developing-country governments may resist VSS if they fear exclusion from markets for uncertified products, prompting them to establish their own national standards (Gulbrandsen, 2014). Additionally, the rise of South-South trade has weakened the global uptake of VSS, as countries like China and India prioritize economic development over sustainability (Schleifer, 2016, 2017).

Despite these challenges, VSS can support government policies by providing legitimacy and enforcement mechanisms. For instance, the Forest Stewardship Council's "high conservation value forests" concept has influenced forest management policies in Brazil and Indonesia (Savilaakso et al., 2017). Jurisdictional approaches, which apply VSS across entire regions, foster sustainability through public-private collaboration; however, VSS have yet to achieve a large-scale

[2] Risk-based due diligence refers to an ongoing process through which businesses identify, prevent, mitigate, and account for how they address actual and potential adverse impacts in their own operations and throughout their supply chains. As stated by the OECD, it is "an approach whereby companies prioritize the most significant risks of harm, based on severity and likelihood, recognizing that it may not be possible to address all risks at once" (OECD, 2018). Similarly, the UN Guiding Principles on Business and Human Rights establish that "the responsibility to respect human rights requires that business enterprises (...) conduct human rights due diligence to identify, prevent, mitigate and account for how they address their adverse human rights impacts. The process should be commensurate with the severity of the risk" (UNITED NATIONS, 2011). The ITUC further reinforces that "risk-based due diligence is essential to prevent human rights violations and environmental harm across global supply chains by embedding responsible business conduct, assessing risks, and taking action proportionate to the identified risks" (ITUC, 2020).

environmental impact and require better integration into broader policy frameworks (Essen and Lambin, 2021).

Additionally, the competition among VSS for legitimacy and the high stringency of leading standards can create fragmentation in standard markets, resulting in increased trade costs for producers, especially in developing economies that are already burdened by diverse and costly compliance requirements (Schleifer et al., 2019). Balanced cooperation and collaboration (co-opetition) among VSS can help mitigate these challenges and reduce inefficiencies, enhancing market access and innovation.

## 3. METHODOLOGY

This study evaluates the impact of aligning sustainability standards between exporters and importers on coffee trade flows, particularly considering the potential differences between major and minor producers. Regulatory similarity is measured using two complementary indices: the Jaccard Similarity Index, which captures the absolute overlap in VSS adoption between trading partners, and the Cosine Similarity Index, which reflects proportional alignment in their regulatory approaches.

In a subsequent step, the Trade Intensity Index was calculated for each exporter–importer pair to quantify the relative strength of bilateral coffee trade. These similarity measures were then individually integrated with the Trade Intensity Index to assess whether greater institutional alignment is associated with more intensive trade flows and whether this association varies according to the exporter's position in global coffee value chains.

### 3.1. SCOPE AND DELIMITATION OF THE ANALYSIS

The analysis focuses exclusively on international trade flows of coffee, classified under the four-digit Harmonized System (HS 0901)[3] for the year 2022. The selection of coffee-exporting countries was based on their relevance in the global market. Exporters were ranked in descending order according to their export value until the cumulative share reached approximately 80% of total global coffee exports. The complete list of the seventeen exporters and their respective market

[3] Coffee (HS 0901): coffee, whether or not roasted or decaffeinated; shells and skins; substitutes containing coffee in any proportion.

shares is presented in Annex A (Table A.1). Importing countries were identified based on their participation in trade flows with the selected exporters, resulting in a comprehensive set of 1806 bilateral observations. Among these, 331 observations are missing because pairs did not report trade data**.** This criterion ensures that the analysis focuses on the most significant player in the international coffee trade while maintaining analytical feasibility. The trade data are sourced from ITC. This sampling strategy allows for the inclusion of countries with diverse trade profiles and levels of institutional integration, enabling a comparative analysis of how VSS alignment may influence trade intensity across different types of exporters.

The selection of VSS was based on their relevance to the coffee sector in 2022, which was the year of data collection. The Standard Map Database from the International Trade Centre (ITC) provides information on the VSS operating in each country. We have used the option "relevance by product" to filter the most relevant standards for coffee. While the database included a total of 85 VSSs aplicable to coffee, a subset of the 15 most relevant standards for coffee was selected. These standards are those most widely adopted within the coffee supply chain, reflecting their significant presence and influence in global coffee trade dynamics. The complete list of selected VSS is presented in Table 1.

Table 1-VSS selected for the coffee sector

| Name | Year of establishment | Typology | Communication Approach | Purpose |
|---|---|---|---|---|
| VietFarm | 2005 | International Standard | B2B and B2C | Verification / Certification |
| USDA National Organic Program - NOP | 1990 | PublicStandard | B2B | Accreditation Verification / Certification |
| GLOBALG.A.P. Crops | 1997 | PrivateStandard | B2B and B2C | Not applicable |
| MPS-Socially Qualified (SQ) | 1993 | PrivateStandard | Not applicable | Verification / Certification |
| SAI Platform - Farm Sustainability Assessment FSA | 2002 | PrivateStandard | B2B | Verification / Certification Benchmarking |
| EQUITABLE FOOD INITIATIVE - EFI | 2013 | PrivateStandard | B2B and B2C | Verification / Certification |
| Pacific Organic Standard - Crops | 2011 | Not applicable | B2B | Accreditation |
| FEMAS Responsible Sourcing Module 2021 | 2015 | PrivateStandard | B2B | Verification / Certification |

| | | | | |
|---|---|---|---|---|
| LEAF Marque | 2003 | PrivateStandard | B2C | Verification / Certification |
| Naturland Standards on Production | 1982 | PrivateStandard | B2C | Verification / Certification<br>Best practices and guidelines |
| Coffee Sustainability Reference Code | 2016 | PrivateStandard | B2B and B2C | Benchmarking |
| The Common Code for the Coffee Community - 4C | 2016 | PrivateStandard | B2B and B2C | Verification / Certification |
| Rainforest Alliance - 2020 | 1987 | PrivateStandard | B2B and B2C | Verification / Certification |
| Fairtrade International - Small Producers Organizations | 1997 | PrivateStandard | B2C | Accreditation<br>Verification / Certification |
| GLOBALG.A.P. Risk Assessment on Social Practice (GRASP) | 1997 | Multilateral | B2B and B2C | Not applicable |

Source: Author's elaboration based on ITC data (2022)

## 3.2. MEASURING VSS ADOPTION SIMILARITIES ACROSS COUNTRIES

This analysis is based on the construction of a VSS similarity framework derived from the overlap of VSS adopted by exporting countries and present in the markets of importing countries. In this context, the concept of institutional similarity refers to the degree of alignment between the regulatory frameworks of two countries, specifically in terms of the voluntary sustainability standards they adopt. Higher institutional similarity suggests greater compatibility in sustainability requirements, which may reduce compliance burdens, facilitate certification, and enhance mutual market access in international trade. Importantly, this framework enables the assessment of whether the role of VSS alignment differs across types of exporters, particularly between major producers that already have established market access and other exporters that may rely on institutional convergence to overcome trade barriers and reach new buyers. To operationalize this framework, a binary classification structure was developed from two sources: the list of leading coffee exporters identified in the trade dataset and the filtered set of 15 coffee-relevant VSS extracted from the ITC Standards Map. A binary adoption matrix was first constructed for exporters, indicating whether each country adopts or certifies against a given standard (1 = yes, 0 = no). A corresponding matrix was then generated for importers, capturing the presence of each standard within their respective markets.

These two matrices were subsequently merged by the exporter–importer pair to create a joint VSS compatibility profile. For each standard, a value of 1 was assigned only when it was present in both the exporter and importer profiles, indicating that the standard was simultaneously adopted at the origin (exporter) and the destination (importer). All other configurations were scored as 0, indicating a lack of sharing. An illustrative example of this joint profile structure is presented in Annex B (Table B.1).To quantify the similarity in VSS adoption between each exporter–importer pair, two well-established indices were applied: the Jaccard Similarity Index and the Cosine Similarity Index. Although both are derived from set theory and vector mathematics, they capture distinct and methodologically complementary dimensions of institutional proximity.

The Jaccard Similarity Index, initially proposed by Jaccard (1901), quantifies the proportion of shared elements relative to the total number of distinct elements across two sets. In this research it measures the extent to which two countries, an exporter and an importer, adopt the same set of sustainability standards. Specifically, $V_i$ and $V_j$ represent binary vectors, where each element indicates the presence (1) or absence (0) of a given VSS in the exporter ($i$) and importer (j), respectively.

The mathematical formulation is expressed as equation (1):

$$Jaccard_{ij} = \frac{|V_i \cap V_j|}{|V_i \cup V_J|} \quad (1)$$

where $V_i$ and $V_j$ are the binary vectors representing the VSS adopted by countries $i$ (exporter) and $j$ (importer), respectively. The numerator $|V_i \cap V_j|$ represents the number of VSS schemes jointly adopted by the two countries, while the denominator $|V_i \cup V_j|$ corresponds to the total number of distinct VSS adopted by at least one of the countries in the pair. The index ranges from 0 to 1, where a value of 1 indicates perfect institutional alignment in VSS adoption between the countries, and a value of 0 indicates no overlap. A Jaccard score of 0 reflects a complete absence of shared VSS schemes, while a score of 1 signals complete alignment in sustainability requirements. This index is particularly suited for binary datasets and provides a direct measure of absolute institutional proximity, offering an adequate proxy for institutional compatibility in international trade relations. In the context of the coffee trade, a higher Jaccard index indicates that both countries adhere to a similar set of sustainability standards, potentially reducing regulatory frictions and compliance costs associated with market access. An illustrative example of the

application of the Jaccard Similarity Index is provided in Appendix C (Table C.1), which presents numerical calculations based on binary VSS adoption vectors for selected exporter–importer pairs.

Nevertheless, the Jaccard index is sensitive to asymmetries in the breadth of standards adopted by each country. As the denominator increases with the divergence in adoption scope, the index value can be reduced even in cases of substantial partial overlap[4]. Therefore, although it accurately captures the magnitude of absolute overlap, it does not account for whether this overlap constitutes a significant proportion relative to the total number of standards adopted by each country.

To address this limitation and capture proportional similarity, the Cosine Similarity Index, developed by Salton and McGill (1983), was incorporated into the analysis. This index measures the cosine of the angle between two vectors in an n-dimensional space. When applied to binary data, it assesses the proportional alignment in VSS adoption between two countries, regardless of the absolute number of standards each country has adopted. Its mathematical formulation is expressed as equation (2):

$$Co\sin e_{ij} = \frac{V_i \times V_j}{||V_i|| \times \left|\left|V_j\right|\right|} \qquad (2)$$

where $V_i \times V_j$ is the dot product of the binary vectors, which corresponds to the count of shared standards between the countries. The terms $\left|\left|V_i\right|\right|$ and $\left|\left|V_j\right|\right|$ represent the Euclidean norms of the respective vectors, calculated as the square root of the number of standards adopted by each country. The Cosine index also ranges from 0 to 1, with a value of 1 indicating perfect proportional similarity and a value of 0 indicating no similarity. Unlike the Jaccard index, the Cosine index is less sensitive to differences in the absolute number of standards adopted, making it particularly useful when comparing countries with asymmetrical regulatory portfolios. It evaluates whether the overlap in standards is significant relative to the regulatory scope of each country, rather than focusing solely on the total count of shared standards. However, it is important to note that the Cosine index may overestimate similarity in cases where both countries adopt very few standards

[4] Consider, for instance, a scenario in which a coffee-exporting country adopts three sustainability standards, Fairtrade, Rainforest Alliance, and UTZ, while its trading partner adopts eight standards, including those same three. Despite the complete inclusion of the exporter's standards within the importer's set, the resulting similarity score is limited to $\frac{3}{8} \cong 0{,}375$ due to the disproportionate breadth of adoption. This illustrates how, in cases of asymmetric coverage, a substantial degree of alignment may still yield a relatively low similarity value.

but happen to share those few, a characteristic common to sparse vector analysis. A detailed example of how the Cosine Similarity Index was applied in this study is provided in Appendix C (Table C.2), which displays the step-by-step numerical computation based on binary VSS adoption vectors for a selected exporter–importer pair.

The combined application of the Jaccard and Cosine indices provides a comprehensive assessment of VSS similarity adoption. While the Jaccard index captures absolute overlap in the adoption of VSS, the Cosine index captures relative proportional alignment, allowing the analysis to jointly account for both absolute and scale-adjusted measures of institutional proximity. This dual approach is essential for accurately characterizing the institutional landscape governing coffee trade, especially considering the heterogeneity in the breadth of standards adopted by different countries.

### 3.3. MEASURING THE TRADE INTENSITY INDEX

This research incorporates the Trade Intensity Index, which is developed to assess the extent to which two countries engage in bilateral trade more or less intensively than would be expected based on their relative importance in global trade. The index provides a comparative measure by evaluating whether a specific product, coffee in this case, accounts for a disproportionately higher or lower share in the bilateral trade between two countries relative to its share in the overall exports of the exporting country. This approach enables the identification of trade patterns that reflect regional or product-specific orientations. Following Yeats (1997), the index is calculated as in equation 3:

$$R_{ijk} = \frac{\frac{X_k^{ij}}{X^{ij}}}{\frac{X_k^{i}}{X^{i}}} \tag{3}$$

where $X_k^{ij}$ represents the exports of coffee from country $i$ to country $j$; $X^{ij}$ represents the total exports from country $i$ to country$j$ (all products); $X_k^{i}$ represents the total exports of coffee from country $i$ to the world; and $X^{i}$ represents the total exports of country $i$ to the world (all products). The numerator of the equation captures the share of coffee in the bilateral exports from $i$ to $j$ while the denominator captures the share of coffee in the total global exports of the country $i$. A practical illustration of the Trade Intensity Index calculation is presented in Appendix C (Table

C.3), which details the numerical values used for computing the index in the case of Brazil's coffee exports to the United States.

The interpretation of the index is that its values range from a number greater than zero to infinity ($0 < R_{ijk} < \infty$), with 1 serving as a neutral benchmark. An index value greater than one ($R_{ijk} > 1$) indicates that coffee has a higher relative importance in the bilateral exports from country $i$ to country $j$ than in the overall export structure of country *i*, reflecting bilateral trade specialization in coffee. Conversely, a value below one ($R_{ijk} < 1$) suggests that coffee plays a less significant role in the bilateral trade relationship with country *j* compared to its weight in the global export profile of country *i*. The inclusion of the Trade Intensity Index adds a critical trade-related dimension to the analysis, offering insights into whether countries with higher institutional alignment also exhibit stronger specialization in coffee trade. This indicator captures bilateral deviations from the exporter's overall trade structure by comparing the importance of coffee in each bilateral relationship to its average role in the country's total exports. It thus enables the identification of destination-specific trade patterns, highlighting whether coffee exports to a particular partner are relatively more or less significant than to other trading partners.

The analysis combines information from the Jaccard and Cosine similarity indices with the Trade Intensity Index to assess whether alignment in the adoption of VSS is positively associated with bilateral trade intensity. A dataset was constructed with one row per exporter–importer pair, including their corresponding Jaccard, Cosine, and Trade Intensity indices. This structure also enables a comparative investigation into how this relationship varies depending on the exporter's global market position. To mitigate the effect of extreme values and reduce skewness, the Trade Intensity Index was log-transformed ($\log(R_{ijk} + 1)$) before inclusion in the empirical analysis. Pearson correlation coefficients are first calculated individually for the Jaccard and Cosine similarity indices and then jointly to assess the relationship between them. Subsequently, the log-transformed Trade Intensity Index is included to explore its correlation with each of the similarity measures, with particular attention to differences in behavior between dominant and non-dominant coffee exporters.

## 4. RESULTS AND DISCUSSION

This section presents the results derived from the similarity and trade intensity indices used in the analysis, the Jaccard index, the Cosine similarity index, and the Trade Intensity Index. These indicators are examined concerning the institutional alignment between exporting and importing countries regarding VSS in the coffee sector. The analysis encompasses both the broader set of bilateral trade relationships between exporters and importers, as well as the specific subset involving coffee-exporting countries that are also major producers. This distinction enables the analysis to examine whether institutional similarity affects trade differently depending on the exporter's position in global value chains, serving as a potential market access strategy for smaller exporters, while playing a lesser role for major producers already integrated into established trade networks.

## 4.1. JACCARD SIMILARITY INDEX

### 4.1.1. Descriptive analysis

Table 2 presents the descriptive statistics of the Jaccard Similarity Index, calculated for 1806 bilateral relationships between coffee-exporting and importing countries.

Table 2-Descriptive Statistics of the Jaccard Similarity Index for Exporter-Importer Pairs

| | Min | Median | Mean | Mode | Max | Standard deviation | Sample size |
|---|---|---|---|---|---|---|---|
| Jaccard | 0.000 | 0.300 | 0.2601 | 0.000 | 0.636 | 0.182 | 1806 |

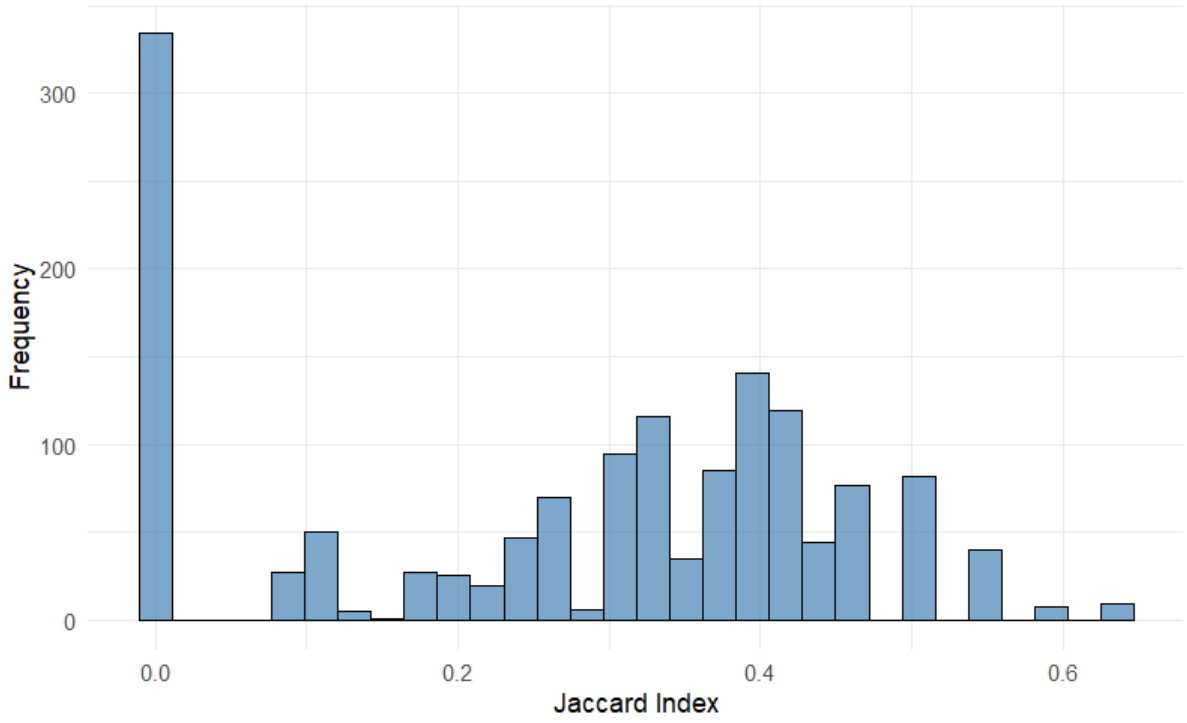
Source: Author's elaboration based on ITC data (2022)

We observe a highly asymmetric distribution. The values are predominantly concentrated at the lower end of the scale, with an average of 0.2601, a median of 0.300, and a mode of 0.000, indicating that most country pairs share only a limited subset of VSS. The index ranges from a minimum of 0 to a maximum of 0.636, with the first quartile at 0.083, the third quartile at 0.40, and a standard deviation of 0.182, reflecting substantial heterogeneity in institutional alignment.

Figure 1 shows the histogram of the Jaccard Similarity Index, which confirms the concentration of low values, with a pronounced spike at zero, indicating that a significant number of bilateral

relationships involve no shared standards at all. Additionally, the distribution exhibits a gradual decline as the index values increase, with relatively few pairs showing moderate or high institutional alignment. Based on this descriptive analysis, the results suggest that higher levels of institutional proximity in sustainability governance are infrequent in the global coffee trade.

Figure 1 - Histogram of the Jaccard Similarity Index for all exporter–importer pairs




Source: Author's elaboration based on ITC data (2022)

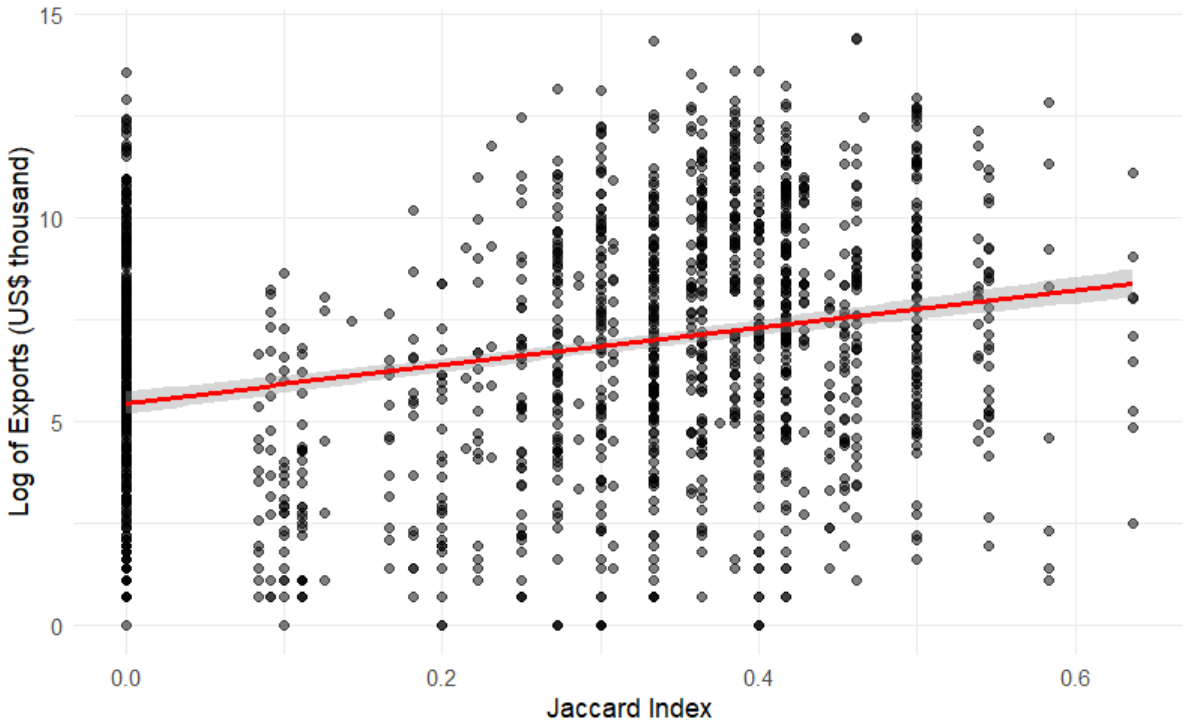
Although the Jaccard Index is mainly concentrated at lower values, the histogram also reveals a subset of country pairs with greater regulatory similarity. These cases will be examined in the following sections to explore potential associations between institutional alignment and trade intensity.

### 4.1.2. Correlation between the Jaccard Index and export values

Figure 2 presents the relationship between the Jaccard Similarity Index and the logarithm of coffee export values for all exporter-importer pairs included in the dataset. The x-axis represents the degree of similarity in VSS, and the y-axis displays the natural logarithm of bilateral coffee export values in 2022 (in thousands of current US dollars). Each dot represents a bilateral

relationship between a coffee-exporting country and an importing country. The sample includes all exporting countries, along with their respective trade partners, providing an aggregate view of the international coffee trade from the exporters' perspective, without restricting the analysis to producing countries at this stage.

Figure 2 - Relationship between the Jaccard Similarity Index and the logarithm of coffee export values (2022)




Source: Author's elaboration based on ITC data (2022)

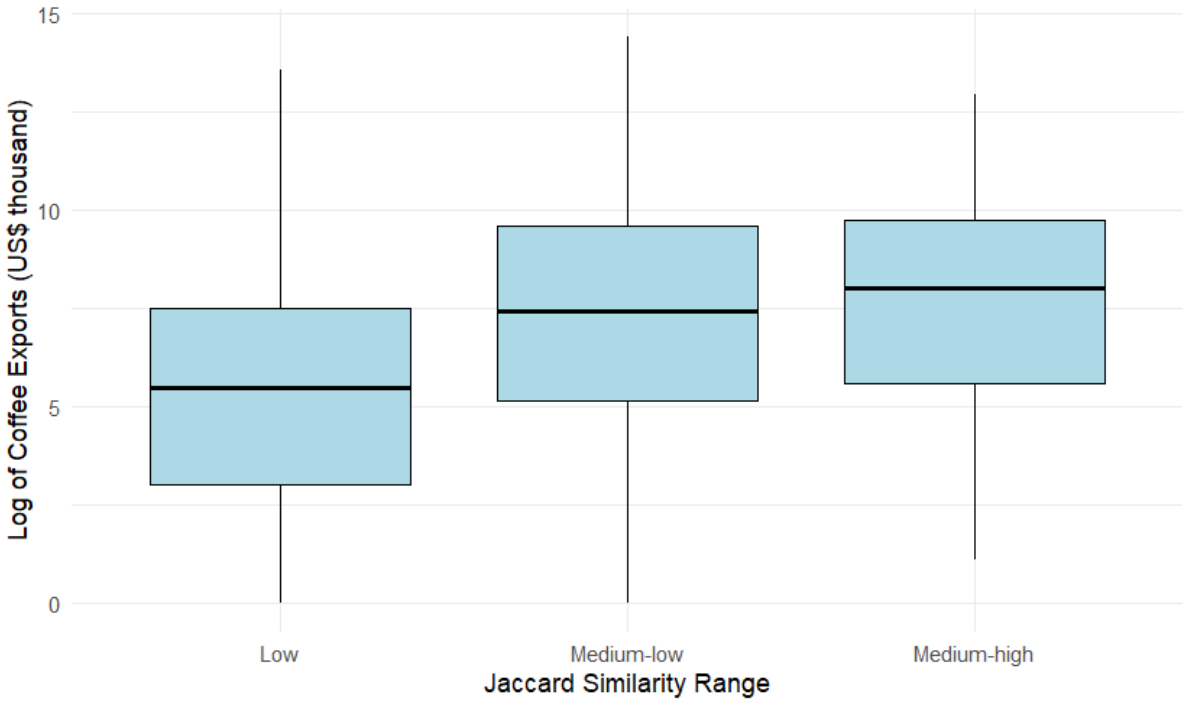
The distribution of points reveals a large concentration at a Jaccard value of zero, where many country pairs show low or moderate export volumes, though some outliers with high trade are also visible. As similarity increases from around 0.1, the data become more dispersed, and the fitted red regression line indicates a gradual upward trend in export values.

The results show a positive and statistically significant correlation, with a Pearson correlation coefficient of 0.10 ($\rho < 0.001$) and a 95% confidence interval between 0.050 and 0.152. Although the strength of the association is low, the direction of the result suggests that, on average, country pairs with greater alignment in sustainability standards tend to report higher coffee export

values. This outcome highlights a modest but consistent relationship between institutional similarity and trade intensity, even if other factors also influence trade flows.

To further support this analysis, Figure 3 displays a boxplot of the log-transformed values of coffee exports, grouped according to levels of institutional similarity between countries, based on the Jaccard index. The level of similarity was constructed as follows: values of the Jaccard index below 0.25 were categorized as “Low”; values between 0.25 and 0.5 as “Medium-low”; and values between 0.5 and 0.75 as “Medium-high”.

Figure 3 - Coffee exports by Jaccard similarity range




Source: Author’s elaboration based on ITC data (2022)

The results reveal a positive association between similarity levels and export performance. The low-similarity group exhibits the lowest median export value and the greatest concentration of low-trade observations, with few cases exceeding the average export value of 6.71. In contrast, the medium-low and medium-high similarity groups show higher medians and a broader spread toward higher export values, suggesting that more aligned institutional relationships are associated with stronger trade flows.

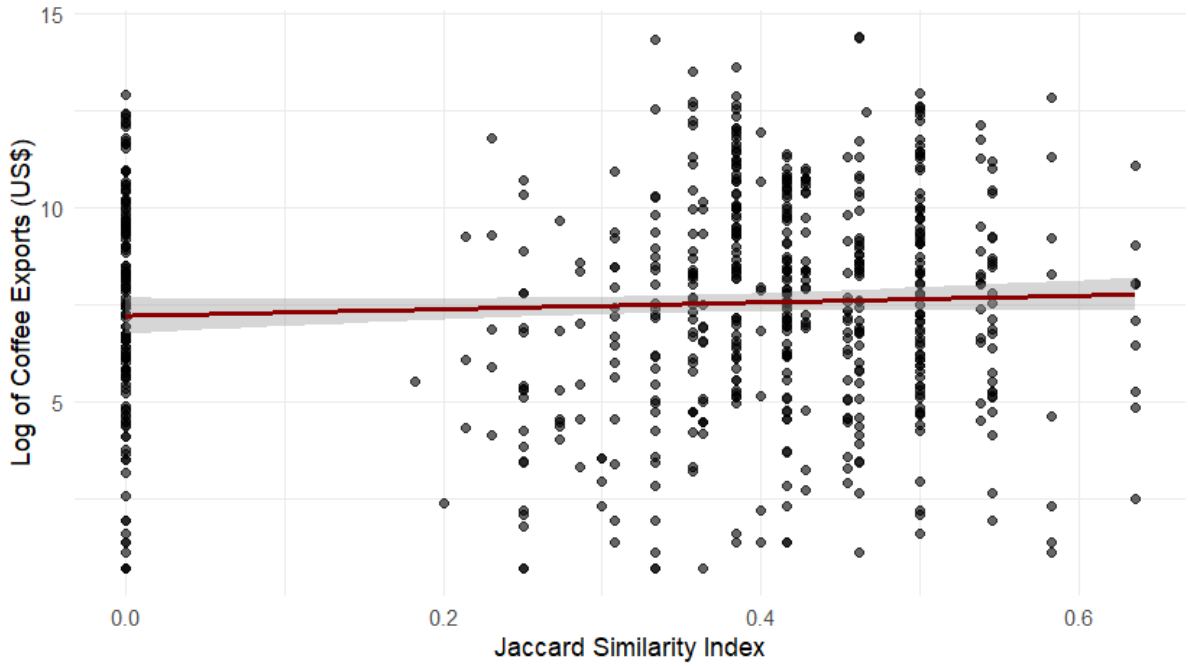
Overall, Figure 3 reinforces the previous findings that bilateral relationships with higher similarity in sustainability standards tend to be associated with higher export volumes, even though the observed association is not deterministic.

Since VSS schemes set standards for how coffee is grown, processed, and managed, they may be more important in producing countries than in countries that only export coffee, as the implementation of sustainability practices typically occurs at the production level. To assess whether the patterns observed in the full sample change when considering only producing countries, we created a subgroup of major producers, which includes the following countries: Brazil, Colombia, Ethiopia, Guatemala, Honduras, Indonesia, Peru, Uganda, and Vietnam.

The objective is to examine whether the previously observed relationship between institutional similarity and trade performance holds, or becomes more pronounced, among countries that play a central role in global coffee production.

Figure 4 shows the relationship between the Jaccard Similarity Index and the logarithm of coffee export values for all bilateral trade flows originating from the major producing countries, totaling 654 observations.

Figure 4 - Relationship between the Jaccard Similarity Index and the logarithm of coffee export values (2022) - Bilateral relationships of major producing countries



Source: Author's elaboration based on ITC data (2022)

A concentration of country pairs with a Jaccard value of zero is observed, although the data become more dispersed as similarity increases, particularly between 0.2 and 0.4. The fitted regression line shows a very mild upward slope, indicating a weak and statistically non-significant association between institutional similarity and export values among producing countries.

The Pearson correlation coefficient is 0.056, with a p-value of 0.155, and a 95% confidence interval ranging from -0.021 to 0.132. Although the direction remains positive, the strength of the association is weak and not statistically significant, suggesting that, for major coffee producers, institutional alignment in sustainability standards does not appear to be a strong determinant of trade intensity.

## 4.2. COSINE SIMILARITY INDEX

### 4.2.1. Descriptive analysis

Table 3 presents the descriptive statistics for the Cosine Similarity Index, calculated for the bilateral relationships between coffee-exporting and importing countries.

Table 3-Descriptive Statistics of the Cosine Similarity Index for Exporter-Importer Pairs

| | Min | Median | Mean | Mode | Max | Standard deviation | Sample size |
|---|---|---|---|---|---|---|---|
| Cosine | 0.000 | 0.535 | 0.502 | 0.589 | 0.778 | 0.151 | 1806 |

Source: Author's elaboration based on ITC data (2022)

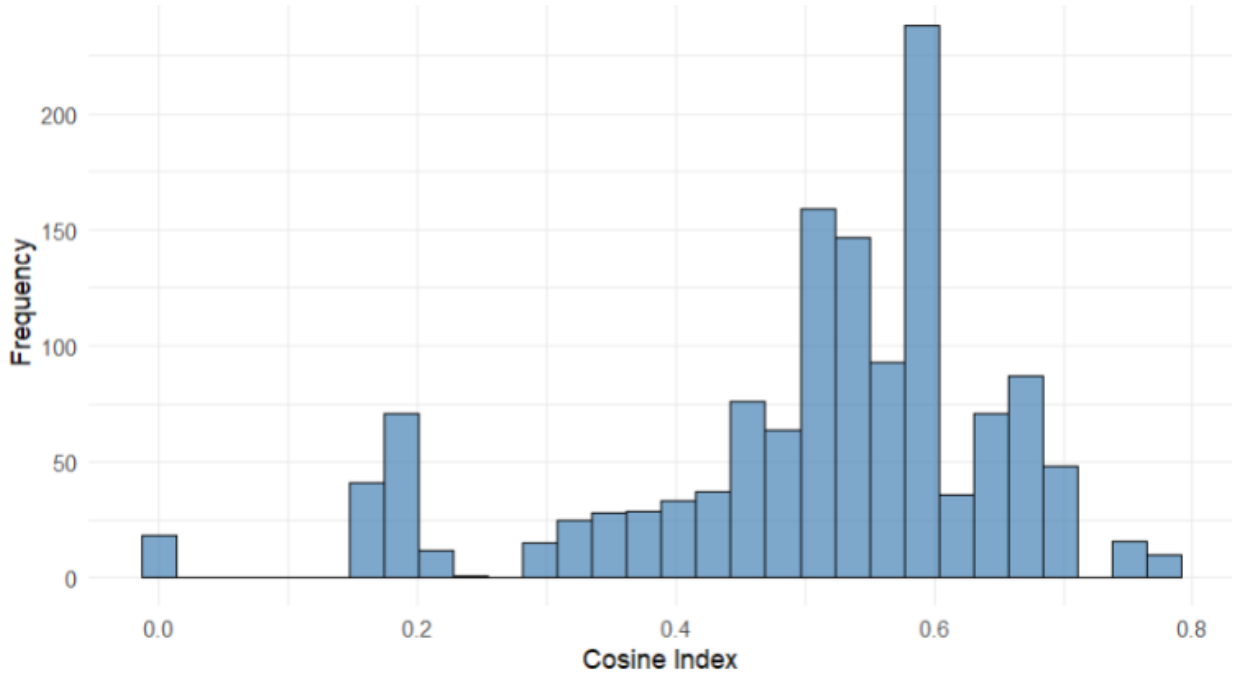
We observe a slightly skewed distribution, with values concentrated in the intermediate range. The average value of the Cosine Similarity Index is 0.502, while the median is 0.535, suggesting that, in general, exporter-importer pairs share a moderate degree of similarity in their VSS profiles. The minimum and maximum values are 0.000 and 0.778, respectively, indicating a wide range of regulatory alignment. The mode is 0.589, which reinforces the concentration of

observations in the middle-to-upper interval. The standard deviation is 0.151, reflecting moderate dispersion and a relatively higher degree of homogeneity compared to the Jaccard Index.

The distribution of the Cosine Index differs from that of the Jaccard Index in that it shows a lower frequency of extremely low values. While the Jaccard Index is highly sensitive to the presence or absence of specific shared standards, the Cosine Index captures the directional alignment between binary vectors representing the adoption of standards, regardless of the number of standards adopted. As a result, even country pairs that share few specific standards but exhibit similar institutional structures related to the adoption of sustainability standards may display medium to high Cosine Index values.

Figure 5 reveals a significant concentration of observations between 0.4 and 0.6, with a smoother and more continuous distribution compared to the Jaccard histogram. There is a lower incidence of values near zero, indicating that institutional compatibility between coffee-exporting and importing countries, while not perfect, is commonly found at moderate levels. Few pairs reach the highest levels of similarity, reinforcing the notion that strong regulatory alignment remains a relatively rare phenomenon.

Figure 5 - Histogram of the Cosine Similarity Index for all exporter–importer pairs



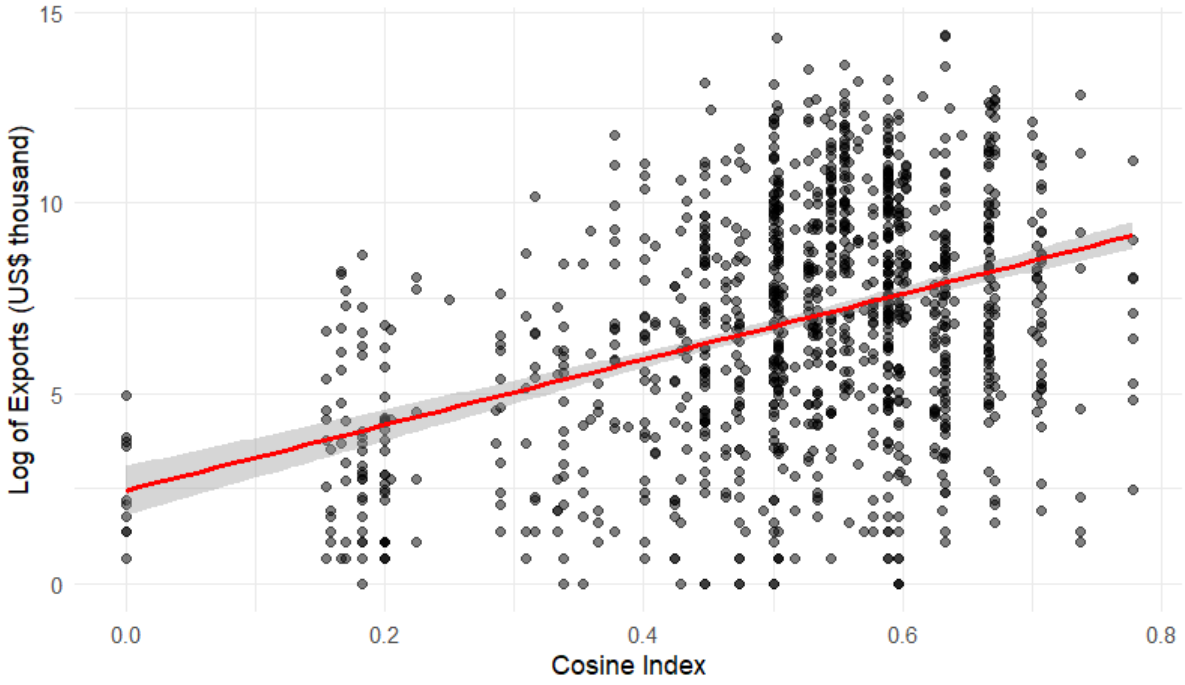

Source: Author's elaboration based on ITC data (2022).

Overall, the results indicate that while perfect institutional alignment is uncommon, there is a significant prevalence of moderate compatibility between countries' regulatory profiles. This pattern may be associated with the international diffusion of common sustainability principles, convergence driven by market demands, or the influence of multilateral frameworks that guide sustainability governance in the coffee sector.

### 4.2.2. Correlation between the Cosine Index and export values

This section aims to examine the relationship between the Cosine Similarity Index and the bilateral export values of coffee for all countries included in the dataset. Figure 6 displays the scatterplot in which the x-axis represents the degree of institutional similarity in terms of VSS, and the y-axis shows the natural logarithm of coffee export values in 2022 (in thousands of current US dollars). Each point represents a trade relationship between an exporting country and an importing country.

Figure 6 - Relationship between the Cosine Similarity Index and the logarithm of coffee exports (2022)




Source: Author's elaboration based on ITC data (2022).

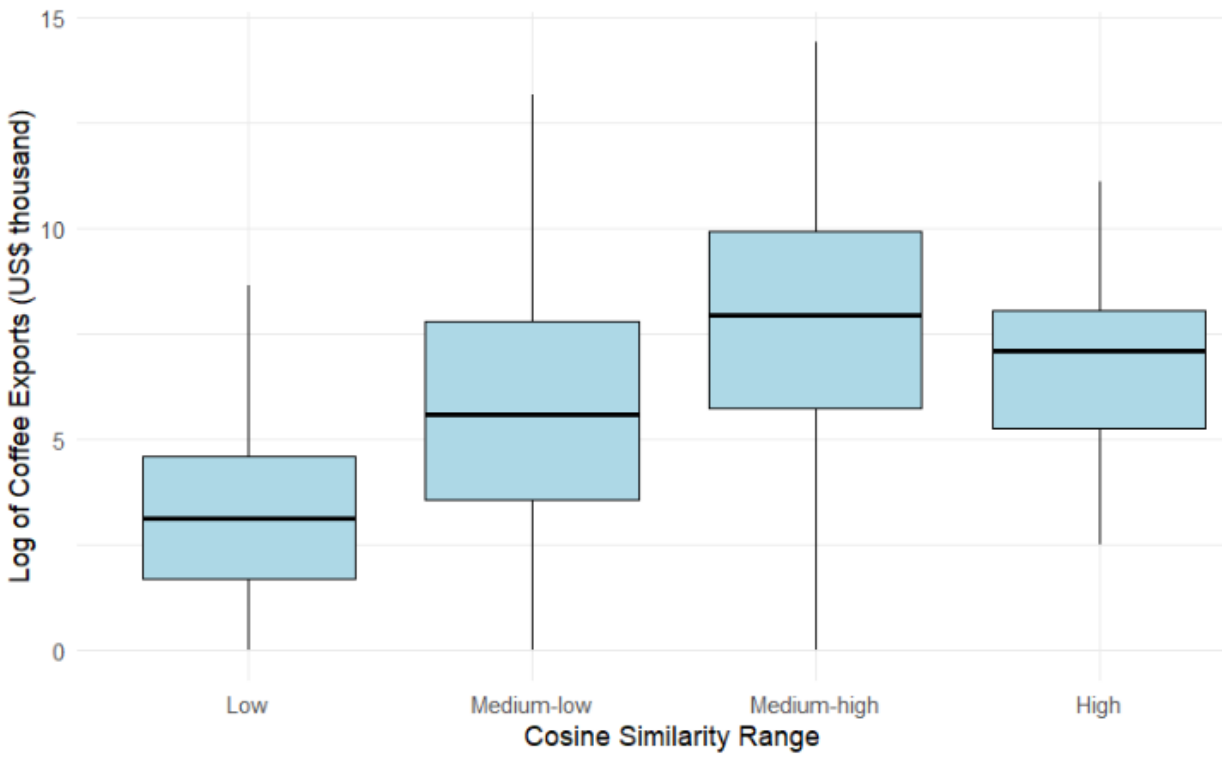
The distribution of points reveals a high density of trade pairs in the intermediate range of the index (between 0.4 and 0.7), reflecting the patterns observed in the descriptive analysis. A

residual presence of cases with similarity values close to zero is also noted, many of which are associated with low export volumes; however, some outliers indicate exceptions. The fitted trend line shows a positive slope, suggesting that greater institutional compatibility is associated with higher export values.

From a statistical perspective, the Pearson correlation between the Cosine Similarity Index and the logarithm of export values is 0.11, with a highly significant p-value ($p = 0.0002$) and a 95% confidence interval ranging from 0.052 to 0.167. This result indicates a weak but statistically positive association between regulatory alignment and trade performance. In other words, the greater the convergence between the VSS profiles of exporting and importing countries, the higher the coffee export values tend to be, while other factors such as income and distance also play a role in shaping trade flows.

Figure 7 presents a boxplot of the log-transformed export values, grouped into four ranges of Cosine Similarity: low, medium-low, medium-high, and high. The level of similarity was constructed as follows: values of the Cosine Index below 0.25 were categorized as “Low”; values between 0.25 and 0.5 as “Medium-low”; and values between 0.5 and 0.75 as “Medium-high”. Observations with a Cosine Index equal to or above 0.75 were classified as “High”.

Figure 7 - Coffee exports by Cosine Similarity range (2022)




Source: Author's elaboration based on ITC data (2022)

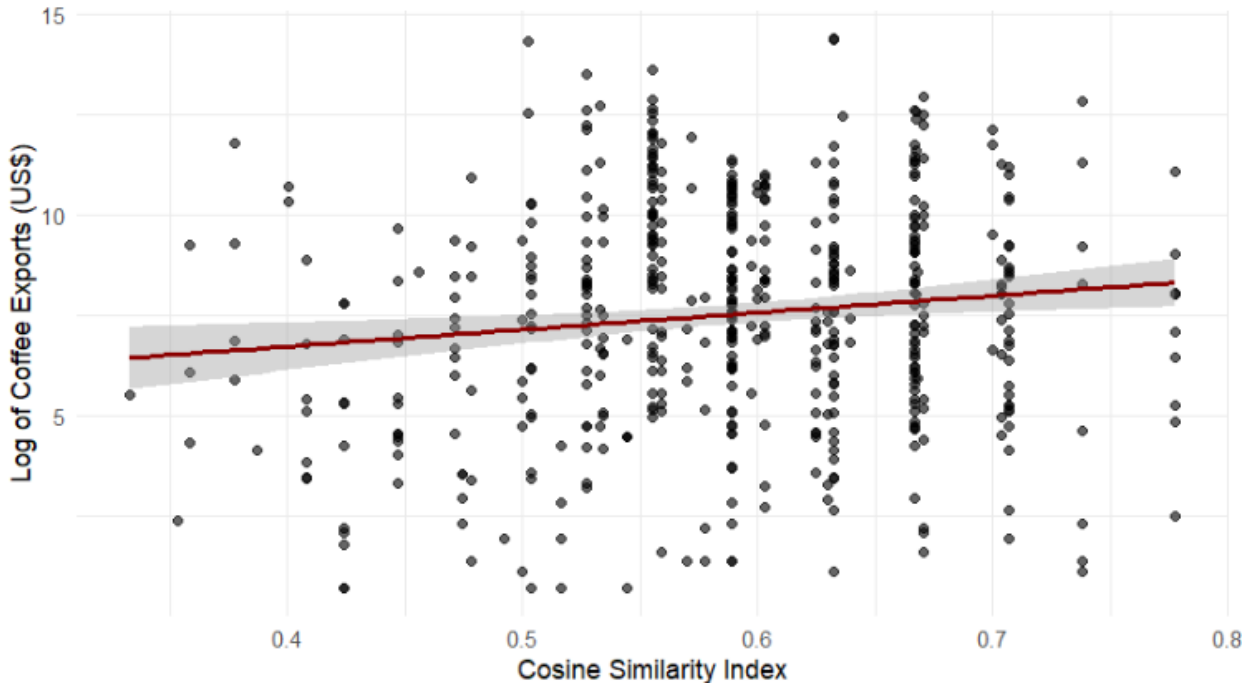
We notice a positive trend in the median export values as institutional similarity increases. The low similarity group exhibits the lowest median and an intense concentration of cases, with most observations falling below the overall average of 6.87. The medium-low group demonstrates improved performance, indicating a rise in export values, while the medium-high similarity group stands out with the highest export volumes and greater dispersion, suggesting more dynamic trade flows. The high similarity group, although smaller, maintains elevated export values, slightly below those of the previous group, possibly reflecting the influence of other unobserved factors.

Therefore, the results indicate a positive relationship between institutional compatibility in sustainability standards and the volume of coffee exported, although this relationship should not be interpreted as inherently causal or sufficient on its own to determine trade flows. In other words, while greater regulatory alignment tends to facilitate trade, it operates in conjunction with other factors that also influence export performance.

From the perspective of the group of major producers, Figure 8 presents the relationship between the Cosine Similarity Index and the log-transformed bilateral coffee export values in 2022.

The observations are concentrated between 0.4 and 0.7 on the x-axis, and the fitted regression line displays a positive slope, suggesting a moderate upward association between institutional similarity and export values in this subset of countries.

Figure 8 - Relationship between the Cosine Similarity Index and the logarithm of coffee exports (2022) - Major producing countries




Source: Author's elaboration based on ITC data (2022).

The Pearson correlation coefficient is 0.125, statistically significant ($p = 0.0043$) with a 95% confidence interval ranging from 0.040 to 0.209. This indicates a positive and statistically significant, yet weak, association between institutional similarity and export values. This result is very similar to that observed for the full sample of exporters ($r = 0.11$), suggesting a consistent pattern whereby greater regulatory alignment, measured through the Cosine Similarity Index, is modestly associated with higher export values, regardless of whether the analysis is restricted to major producers or encompasses all exporters.

It is important to highlight that, despite the high correlation observed between the Jaccard and Cosine Similarity Indices ($r = 0.986$), the two measures are based on distinct conceptual foundations. The Jaccard Index calculates the ratio of shared standards to the total number of standards adopted by at least one of the countries in a given pair, rendering it particularly sensitive

to asymmetries in the absolute volume of standard adoption. The Cosine Similarity Index, on the other hand, measures the angle between two binary adoption vectors, thereby capturing the proportional alignment between regulatory profiles, regardless of their overall magnitude. It is normalized by the size of each country's VSS adoption vector.

## 4.3. TRADE INTENSITY INDEX

### 4.3.1. Descriptive analysis

Table 4 shows the descriptive statistics of the Trade Intensity Index ($R_{ijk}$), calculated for all bilateral coffee trade flows in the dataset.

Table 4 - Descriptive Statistics of the Trade Intensity Index for Exporter-Importer Pairs

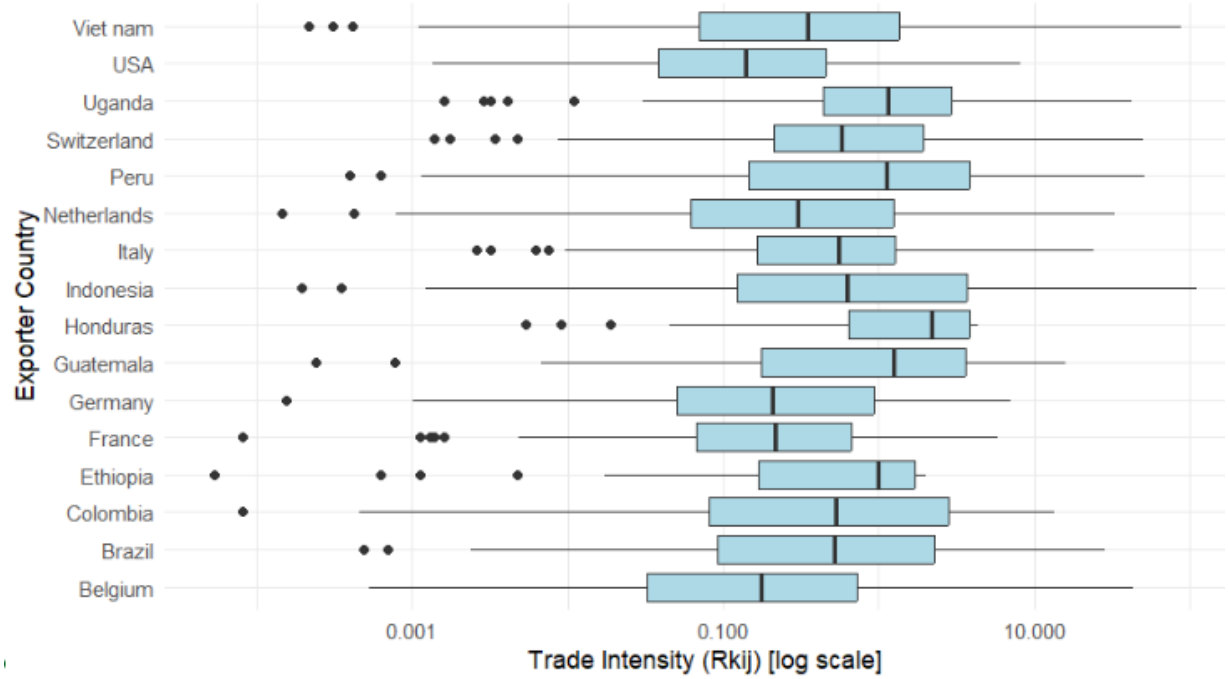
| | Min | Median | Mean | Mode | Max | Standard deviation | Sample size |
|---|---|---|---|---|---|---|---|
| Trade Intensity | 0.000 | 0.462 | 1.946 | 2.038 | 109.818 | 6.017 | 1470 |

Source: Author's elaboration based on ITC data (2022)

It reveals a highly skewed distribution. Values range from a minimum of 0.000 to a maximum of 109.818, with an average of 1.946 and a standard deviation of 6.017, indicating the presence of extreme outliers. Nevertheless, the median is substantially lower (0.462), and the interquartile range, from the first quartile (0.095) to the third quartile (1.611), shows that the majority of trade flows concentrate at relatively moderate levels of intensity.

Figure 9 presents the distribution of the index by exporting country, with the x-axis shown on a logarithmic scale to accommodate the wide range of variation.

Figure 9 - Distribution of the Trade Intensity Index (R_ijk) by Exporting Country (log scale)



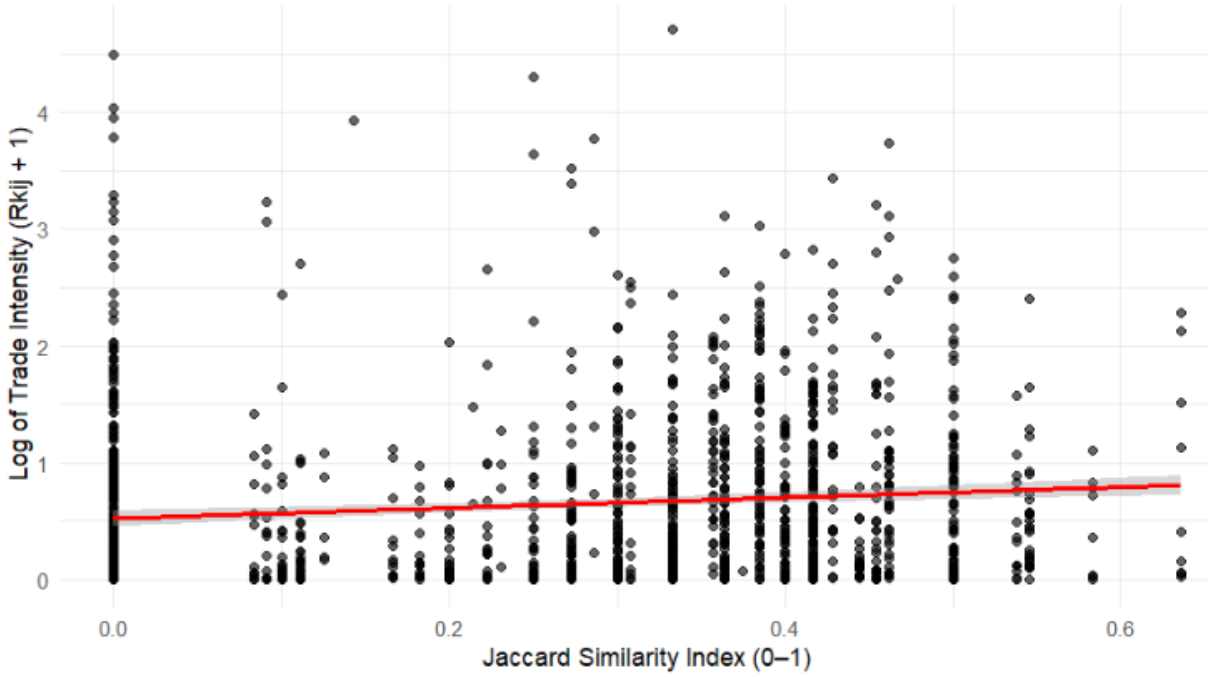

Source: Author's elaboration based on ITC data (2022)

Figure 9 illustrates considerable heterogeneity among exporters. Countries such as Belgium, Brazil, and Colombia exhibit wider interquartile ranges and higher median values, suggesting more intense trade relationships in the coffee sector. In contrast, exporters like Vietnam and Uganda display lower and more compact distributions, while others, such as Switzerland and Italy, present numerous outliers at the lower end of the scale. These patterns highlight asymmetries in trade intensity and may indicate structural differences in market destinations or the presence of niche partnerships.

### 4.3.2. Trade Intensity Index and Jaccard Index

Figure 10 explores the relationship between institutional alignment and trade intensity, using the Jaccard Similarity Index and the log-transformed Trade Intensity Index. The scatterplot displays this relationship across all exporter–importer pairs in the dataset.

Figure 10 - Relationship between the Jaccard Similarity Index and the Trade Intensity Index (log-transformed)




Source: Author's elaboration based on ITC data (2022)

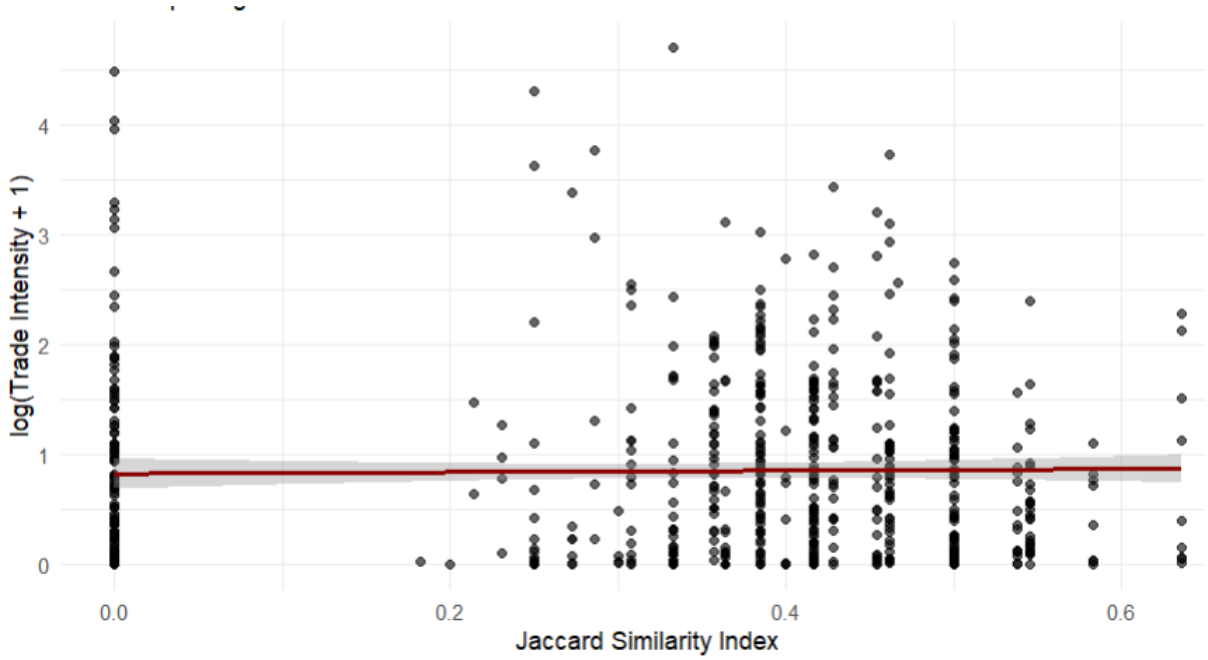
A Pearson's correlation test was performed to assess the strength and direction of the association. The results reveal a statistically significant but weak positive correlation between the two variables ($r = 0.109$, $p < 0.001$), with a 95% confidence interval ranging from 0.058 to 0.160. This suggests that, on average, country pairs with greater alignment in sustainability standards tend to exhibit slightly higher levels of trade intensity.

Despite the modest correlation coefficient, the fitted regression line in the scatterplot shows a slight upward trend, reinforcing the presence of a positive, though limited, association. This outcome supports the hypothesis that institutional similarity, as reflected in shared VSS, may facilitate more intense trade relationships. However, this outcome also underscores that trade patterns are shaped by a broader set of structural and economic factors, such as countries' income levels (e.g., GDP), geographic distance between trading partners, the presence of trade agreements, tariff barriers, and historical trade relationships, which may outweigh the effects of institutional alignment.

Note that a specific analysis was conducted to investigate whether the relationship between institutional similarity and trade intensity behaves differently when considering only the major producing countries.

Figure 11 presents the relationship between the Jaccard Similarity Index and the log-transformed Trade Intensity Index, where each point represents a bilateral trade relationship. In contrast to the positive association observed in the full sample, the fitted regression line here is nearly flat, indicating that, among major producers, higher levels of institutional similarity do not appear to translate into greater trade intensity.

Figure 11 - Relationship between the Jaccard Similarity Index and the Trade Intensity Index (log-transformed) formajor coffee producers




Source: Author's elaboration based on ITC data (2022)

The Pearson correlation coefficient is 0.056, with a p-value of 0.155 and a 95% confidence interval ranging from -0.021 to 0.132. The result is not statistically significant at the 5% level, and the nearly flat slope of the fitted regression line reinforces the absence of a strong association between institutional similarity and coffee export values among major producers.

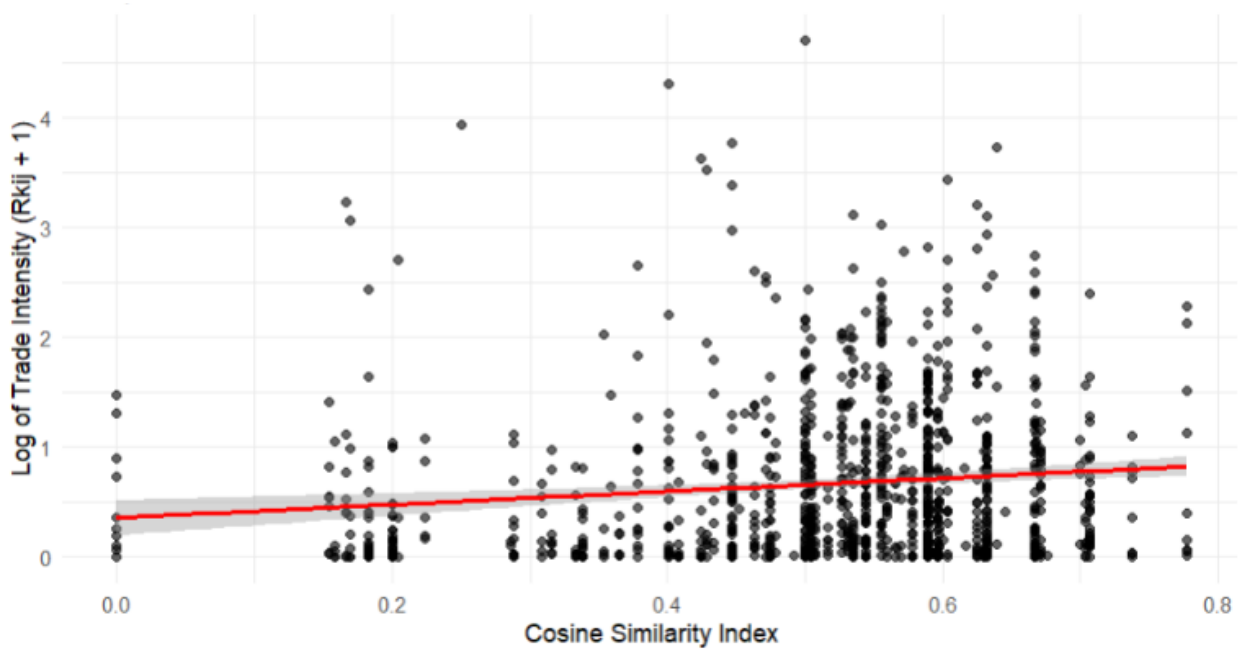
Visually, the scatterplot reveals a broad dispersion of trade values across all levels of similarity, with no clear upward or downward pattern. This suggests that, for coffee-producing countries, alignment in VSS adoption does not appear to systematically translate into higher export values.

Several interpretations may be considered. Major producers often operate through well-established export channels, long-standing buyers, or bulk trading systems that are less influenced by regulatory convergence. In such cases, market access may depend more on price competitiveness, supply capacity, or existing commercial relationships than on institutional alignment. This finding contrasts with the modest positive association observed in the broader sample and highlights the distinctive trade dynamics that characterize core producing countries.

### 4.3.3. Trade Intensity Index and Cosine Index

Figure 12 shows the relationship between the Trade Intensity Index and the Cosine Similarity Index, which captures the structural alignment between exporter-importer pairs and the trade intensity.

Figure 12 - Relationship between the Cosine Similarity Index and the Trade Intensity Index (log-transformed), for all exporters




Source: Author's elaboration based on ITC data (2022)

As shown in Figure 12, the distribution of observations suggests a slight upward trend. The fitted regression line, although subtle, suggests that higher levels of institutional similarity, as

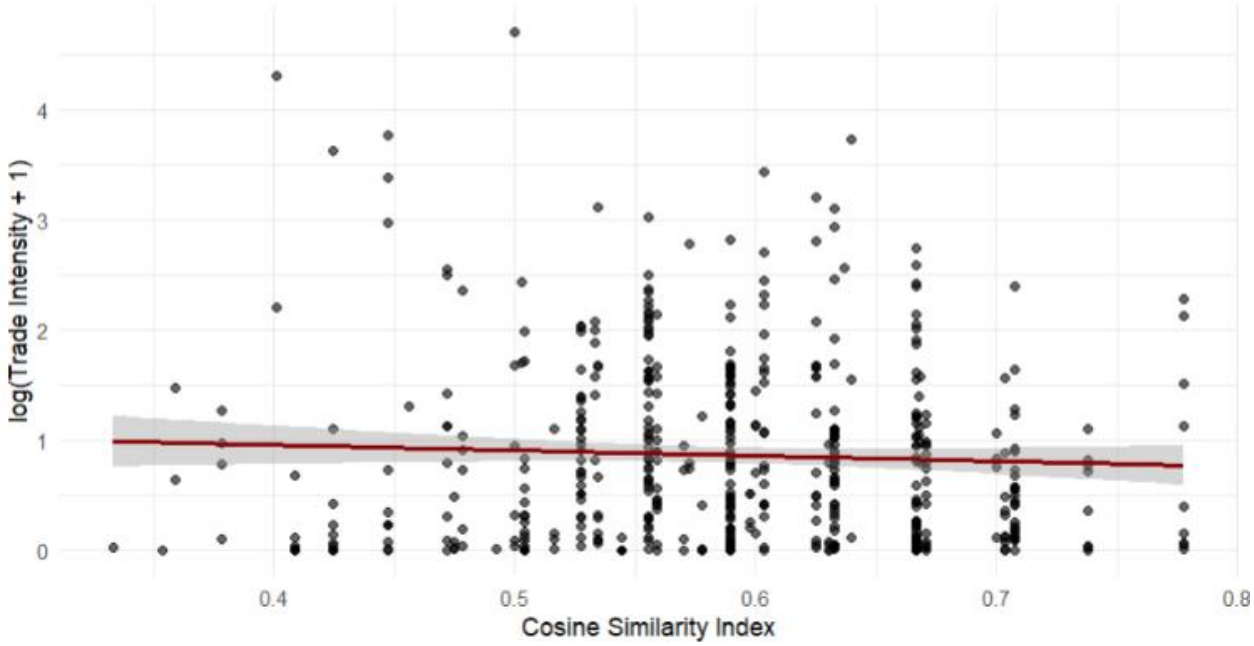
measured by the Cosine Similarity Index, tend to correspond with greater trade intensity. The Pearson correlation coefficient is 0.117, with a 95% confidence interval ranging from 0.059 to 0.174 and a p-value of less than 0.001. These results confirm the existence of a statistically significant, albeit weak, positive relationship between institutional similarity and trade intensity among all countries that export coffee.

Although the strength of the association is modest, its statistical significance reinforces the hypothesis that regulatory convergence, reflected in shared VSS schemes, may help reduce trade barriers and enhance compatibility between exporters and importers.

Focusing exclusively on the major coffee-producing countries, the relationship between the Cosine Similarity Index and the log-transformed Trade Intensity Index is examined. This restricted sample aims to assess whether the pattern observed among general exporters holds for countries at the origin of coffee supply chains.

As illustrated in Figure 13, the fitted regression line reveals a very slight downward slope, diverging from the positive association identified earlier in the full sample. The Pearson correlation coefficient is –0.050, with a p-value of 0.261 and a 95% confidence interval ranging from –0.136 to 0.037. These results indicate a weak and statistically non-significant negative relationship between Cosine-based institutional similarity and trade intensity among coffee-producing exporters.

Figure 13 - Relationship between the Cosine Similarity Index and the Trade Intensity Index (log-transformed) for major coffee producers




Source: Author's elaboration based on ITC data (2022)

While no definitive association can be inferred from the data, the visual distribution of observations, particularly the concentration of lower Trade Intensity Index values at higher levels of similarity, suggests that increased alignment in sustainability standards does not necessarily translate into more intense trade for this subgroup.

In summary, we observe heterogeneity in the results. Within the full sample of coffee-exporting countries, both the Jaccard and Cosine indices display weak yet statistically significant positive correlations with export values and with the Trade Intensity Index. These results suggest that higher levels of institutional similarity in VSS are modestly associated with more intense trade flows. This observed convergence supports the hypothesis that regulatory compatibility, even when based on voluntary standards, can facilitate international trade by reducing transaction costs, lowering informational asymmetries, and enhancing access to regulated markets. This finding is further supported by the empirical observation that approximately 80% of the standards considered in this study are private, which aligns with the argument made by Andersson (2019) that private standards can serve as market-enabling tools by mitigating informational frictions and promoting compatibility between exporters and importers.

However, this pattern is reversed when the analysis is restricted to countries that are both exporters and major producers of coffee. In this more targeted subset, both similarity indices (Jaccard and Cosine) lose explanatory power and begin to exhibit negative correlations with trade intensity, albeit weak and not always statistically significant. This reversal suggests that institutional convergence in VSS does not necessarily promote more intense trade relationships among core producing countries. This outcome is consistent with the findings of Dolabella and Saeteros (2024), who argue that while VSS may open access to premium markets, they can also contribute to the saturation of established trade routes or introduce structural constraints that limit the expansion of export volumes. Similarly, Bemelmans et al. (2023) note that voluntary standards often benefit emerging or non-traditional exporters seeking to access new markets, whereas established producers tend to rely on entrenched commercial networks that are less responsive to regulatory convergence.

## 5. FINAL CONSIDERATIONS AND CONCLUSIONS

This study investigated whether institutional similarity in the adoption of Voluntary Sustainability Standards is associated with greater trade intensity in the global coffee market. To this end, bilateral export data for the year 2022 were analyzed using the Jaccard and Cosine similarity indices, which measure absolute and proportional regulatory alignment, respectively, alongside the Trade Intensity Index, which captures the relative weight of coffee in each bilateral trade relationship. Although the Jaccard and Cosine indices are based on different mathematical foundations, the results obtained from both measures are remarkably similar. In both the full sample and the subset of major coffee producers, the indices exhibit weak but positive correlations with trade intensity, which is statistically significant in the full sample but insignificant among major producers. This convergence suggests that the Cosine Similarity Index reinforces the patterns already captured by the Jaccard Index. Thus, both measures appear to reflect the same underlying structure of institutional alignment in VSS adoption.

The empirical results revealed a weak but statistically significant positive association between VSS similarity and trade intensity when considering the full sample of coffee-exporting countries. This finding suggests that institutional alignment in sustainability governance may facilitate trade flows by reducing informational asymmetries and signaling credibility in markets with more stringent sustainability expectations.

However, when the analysis is restricted to the group of major coffee producers, the association between regulatory similarity and trade intensity becomes considerably weaker and statistically insignificant. In this subset, the existence of long-standing trade relationships, established logistics infrastructures, and volume-oriented strategies appears to play a more decisive role in shaping trade flows than alignment in voluntary standards.

These contrasting patterns reinforce the interpretation that VSS are more frequently used as strategic instruments by countries seeking to enter new markets, rather than by those already established in the global coffee trade. In this context, the adoption of VSS is often driven by the strategic intent to access specific markets, especially those where regulatory alignment serves as a prerequisite for entry. That is, the adoption of VSS reflects an adaptive strategy to meet the institutional expectations of destination markets, especially those that prioritize sustainable sourcing practices. For newer or less traditional exporters, aligning with the standards of key importers may serve to overcome market entry barriers and differentiate their product in a competitive environment.

Therefore, this study concludes that while VSS have the potential to facilitate international trade through regulatory convergence, their influence is neither uniform nor automatic. Instead, their trade-related effects are heterogeneous and highly dependent on the structural position of each exporting country within global value chains. Recognizing this variation is crucial for understanding the strategic application of sustainability standards and for informing policies that aim to promote more equitable and inclusive participation in international markets.

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# ANNEX A – DATA ON THE MAIN COFFEE EXPORTERS IN 2022

TABLE A.1 – Main coffee exporters, export value, and global market share in 2022

| *Coffe Exporters* | *export_value_in_2022 (USD)* | *global _market_share (%)* |
|---|---|---|
| World | 46231096 | 0,00% |
| Brazil | 8542533 | 18,48% |
| Viet Nam | 2952035 | 6,39% |
| Switzerland | 3422252 | 7,40% |
| Germany | 3467743 | 7,50% |
| Colombia | 4108629 | 8,89% |
| Italy | 2372490 | 5,13% |
| Indonesia | 1149168 | 2,49% |
| Ethiopia | 1513246 | 3,27% |
| Netherlands | 1107711 | 2,40% |
| France | 1185700 | 2,56% |
| Honduras | 1488760 | 3,22% |
| Belgium | 1468239 | 3,18% |

| | | |
|---|---|---|
| Uganda | 859488 | 1,86% |
| Peru | 1236149 | 2,67% |
| United States of America | 1199286 | 2,59% |
| Guatemala | 1114754 | 2,41% |
| *Total* | *37949023* | *82,09%* |

Source: Author's elaboration based on ITC data (2022).

## ANNEX B – EXAMPLE OF JOINT VSS PROFILES

Table B.1 presents an illustrative example of the joint presence of Voluntary Sustainability Standards (VSS) for two exporter–importer pairs: Brazil–USA and Germany–Poland. Each row corresponds to one of the 15 coffee-relevant VSS selected for the analysis. The columns indicate whether each standard is adopted by the exporter and/or present in the importer's market. A value of 1 in the "Shared" column indicates that the standard is present in both countries of the pair, thereby qualifying as a shared regulatory element in the computation of institutional similarity.

Table B.1 – Joint presence of VSS for selected exporter–importer pairs (2022)

| VSS | Brazil exp | USA imp | Shared | Germany exp | Poland imp | Shared |
|---|---|---|---|---|---|---|
| VietFarm | 0 | 1 | 0 | 0 | 1 | 0 |
| USDA National Organic Program – NOP | 1 | 1 | 1 | 1 | 0 | 0 |
| GLOBALG.A.P. Crops | 1 | 1 | 1 | 1 | 1 | 1 |
| MPS-Socially Qualified (SQ) | 1 | 0 | 0 | 1 | 0 | 0 |
| SAI Platform - Farm Sustainability Assessment FSA | 1 | 1 | 1 | 1 | 1 | 1 |
| EQUITABLE FOOD INITIATIVE – EFI | 0 | 1 | 0 | 0 | 1 | 0 |
| Pacific Organic Standard – Crops | 0 | 1 | 0 | 0 | 1 | 0 |
| FEMAS Responsible Sourcing Module 2021 | 1 | 0 | 0 | 0 | 0 | 0 |
| LEAF Marque | 0 | 1 | 0 | 1 | 1 | 1 |
| Naturland Standards on Production | 0 | 0 | 0 | 1 | 0 | 0 |
| Coffee Sustainability Reference Code | 1 | 0 | 0 | 0 | 0 | 0 |
| The Common Code for the Coffee Community - 4C | 1 | 1 | 1 | 0 | 1 | 0 |
| Rainforest Alliance – 2020 | 1 | 1 | 1 | 1 | 1 | 1 |
| Fairtrade International - Small Producers Organizations | 1 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| GLOBALG.A.P. Risk Assessment on Social Practice (GRASP) | 1 | 1 | 1 | 1 | 1 | 1 |
| Total | 10 | 10 | 6 | 8 | 9 | 5 |

Source: Author's elaboration based on ITC data (2022)

## ANNEX C – CALCULATION OF SIMILARITY INDICES

Table C.1 presents the calculation of the Jaccard similarity index $Jaccard_{ij}$ for two selected exporter-importer pairs: Brazil-USA and Germany-Poland. The index is defined as the ratio between the number of VSS shared by both countries $(V_i \cap V_j)$ and the total number of distinct standards adopted by at least one of them $(V_i \cup V_j)$. The values illustrate the degree of institutional similarity based on the adoption of coffee-related VSS.

Table C.2 presents the calculation of the Cosine similarity index $(Cosine_{ij})$ for a selected exporter-importer pair. The binary vectors $V_i$ and $V_j$ represent the adoption of coffee-related VSS by the exporter and importer, respectively. A value of 1 indicates that the VSS is adopted by the country; 0 indicates it is not. The term $V_i \times V_j$ corresponds to the element-wise multiplication of the two vectors, and the $||V_i||$ and $||V_j||$ denote the Euclidean magnitude of each vector. The resulting Cosine index measures the angle-based similarity between the two vectors, ranging from 0 (no similarity) to 1 (identical profiles).

Table C.3 presents the calculation of the Trade Intensity Index $R_{ijk}$ for coffee exports from Brazil to the United States. This index, adapted from Yeats (1998), assesses the relative importance of a bilateral trade flow compared to the exporting country's total exports and the partner's total imports. The variable $V_j^i$ represents the value of exports from country $i$ (Brazil) to country $j$ (USA), while $V_k^i$ refers to Brazil's total exports to the world. $V^i$ is the total imports of the partner country (USA), and $V_k^j$ is the value of global imports of the product by all countries. The resulting value of $R_{ijk}$ indicates the intensity of the trade relationship: values above 1 suggest that the bilateral flow is stronger than expected based on global trade patterns.

Table C.1 - Jaccard similarity index for selected exporter–importer pairs (2022)

| $V_i$ | $V_j$ | $V_i \cap V_j$ | $V_i \cup V_j$ | $Jaccard_{ij}$ |
|---|---|---|---|---|
| Brazil | USA | 6 | 13 | 0,461538 |

| | | | | |
|---|---|---|---|---|
| Germany | Poland | 5 | 12 | 0,416667 |

Source: Author's elaboration based on ITC data (2022)

Table C.2 - Cosine similarity index for selected exporter–importer pair (2022)

| VSS | $V_i$ | $V_j$ | $V_i \times V_j$ | $\lvert\lvert V_i \rvert\rvert$ | $\lvert\lvert V_j \rvert\rvert$ | $Cosine_{ij}$ |
|---|---|---|---|---|---|---|
| VietFarm | 0 | 1 | 0 | 3 | 3,162278 | 0,632456 |
| USDA National Organic Program - NOP | 1 | 1 | 1 | 3 | 3,162278 | 0,632456 |
| GLOBALG.A.P. Crops | 1 | 1 | 1 | 3 | 3,162278 | 0,632456 |
| MPS-Socially Qualified (SQ) | 0 | 0 | 0 | 3 | 3,162278 | 0,632456 |
| SAI Platform - Farm Sustainability Assessment FSA | 1 | 1 | 1 | 3 | 3,162278 | 0,632456 |
| EQUITABLE FOOD INITIATIVE - EFI | 0 | 1 | 0 | 3 | 3,162278 | 0,632456 |
| Pacific Organic Standard - Crops | 0 | 1 | 0 | 3 | 3,162278 | 0,632456 |

| | | | | | | |
|---|---|---|---|---|---|---|
| FEMAS Responsible Sourcing Module 2021 | 1 | 0 | 0 | 3 | 3,162278 | 0,632456 |
| LEAF Marque | 0 | 1 | 0 | 3 | 3,162278 | 0,632456 |
| Naturland Standards on Production | 0 | 0 | 0 | 3 | 3,162278 | 0,632456 |
| Coffee Sustainability Reference Code | 1 | 0 | 0 | 3 | 3,162278 | 0,632456 |
| The Common Code for the Coffee Community - 4C | 1 | 1 | 1 | 3 | 3,162278 | 0,632456 |
| Rainforest Alliance - 2020 | 1 | 1 | 1 | 3 | 3,162278 | 0,632456 |
| Fairtrade International - Small Producers Organizations | 1 | 0 | 0 | 3 | 3,162278 | 0,632456 |
| GLOBALG.A.P. Risk Assessment on Social Practice (GRASP) | 1 | 1 | 1 | 3 | 3,162278 | 0,632456 |
| Total | 9 | 10 | 6 | - | - | - |

Source: Author's elaboration based on ITC data (2022)

Table C.3 - Trade intensity index (Yeats) for Brazil–USA coffee exports (2022)

| $V_i$ | $V_j$ | $V_k^{ij}$ | $V_k^i$ | $V^{ij}$ | $V^i$ | $R_{ijk}$ |
|---|---|---|---|---|---|---|
| Brazil | USA | 1718679 | 8542233 | 37643829 | 334463079 | 1,787630471 |

Source: Author's elaboration based on ITC data (2022)