Impact of Brazil's environmental reputation on international agro-industrial trade: evidence from the beef sector

Impacto da reputação ambiental do Brasil sobre o comércio agroindustrial internacional: evidências do setor de carne bovina.

Milena Magalhães Oliveira
Embrapa Agricultura Digital, Campinas, SP, Brasil
Sílvia Helena Galvao de Miranda
Universidade de São Paulo, Piracicaba, SP, Brasil

GT 01 - Mercados agrícolas e comércio exterior

Abstract: This study examines the role of environmental reputation in shaping Brazil's agrofood exports by developing a novel sentiment-based indicator derived from social media data and embedding it within a gravity-model framework. Focusing on fresh beef, a product frequently associated with environmental concerns in international trade, the analysis combines Twitter-based sentiment related to environmental shocks with information on trade intensity and environmental stringency in importing countries. Using PPML estimation for a panel of major destination markets over the period 2013–2024, the results indicate that environmental reputation is a statistically relevant correlate of bilateral trade flows in environmentally sensitive markets, operating as an informational channel alongside conventional trade determinant. By adopting a sector-specific approach to measuring reputational exposure, this study contributes to the literature on trade, environment, and non-tariff measures, highlighting how public perceptions shaped by environmental events influence international trade patterns.
Keywords: Environmental reputation, gravity model, agroindustrial trade.

Resumo: Este estudo examina o papel da reputação ambiental na configuração das exportações agroalimentares do Brasil ao desenvolver um indicador inédito baseado em sentimento, derivado de dados de redes sociais, e incorporá-lo em um modelo gravitacional de comércio. Com foco na carne bovina in natura, produto frequentemente associado a preocupações ambientais no comércio internacional, a análise combina sentimento extraído do Twitter relacionado a choques ambientais com informações sobre intensidade do comércio e rigor ambiental nos países importadores. Utilizando estimativas PPML para um painel de principais mercados de destino no período de 2013 a 2024, os resultados indicam que a reputação ambiental constitui um correlato estatisticamente relevante dos fluxos bilaterais de comércio em mercados ambientalmente sensíveis, atuando como um canal informacional adicional aos determinantes tradicionais do comércio. Ao adotar uma abordagem setorial para mensurar exposição reputacional, o estudo contribui para a literatura sobre comércio, meio ambiente e medidas não tarifárias, ao evidenciar como percepções públicas moldadas por eventos ambientais influenciam padrões de comércio internacional.
Palavras-chave: Reputação ambiental, modelo gravitacional, comércio agroindustrial.

1. Introduction

The advent of globalization and the information era have profoundly transformed the dynamics of trade between nations, culminating in the integration of international trade with a myriad of agendas, with a pronounced emphasis on environmental concerns and particularly climate change. Debates on environmental concerns within multilateral trade forums have assumed a leading role, progressively compelling states to establish ambitious climate objectives. This prominence is not limited to governments but also extends to consumer behavior. By disseminating values through social networks, consumers can influence organized groups, thereby exerting pressure on both the public and the private sectors to adopt more environmentally responsible decisions in their production and commercial practices. Recurrent occurrences of trade boycotts and investor mobilization regarding corporate environmental practices underscore this behavioral shift.

In the context of interstate relations, reputation plays a major role in the formation and maintenance of alliances, as well as in the negotiation and conclusion of treaties and agreements. Reputation functions as a credential, signaling the reliability of actors in honoring their commitments. In the context of international relations, reputation is of even greater significance, emerging as an essential factor for the success of negotiating and implementing multilateral and bilateral commitments (LeVeck; Narang, 2017; Crescenzi et al., 2012; Brutger; Kertzer, 2018; Downs; Jones, 2002).

In the contemporary context, there is a marked increase in the critical scrutiny by consumers and public exposure of controversial decisions made by public and private sector organizations regarding environmental issues. These exposure events frequently impose intense pressure on the responsible parties, requiring them to formulate responses. This dynamic is particularly evident in the trade of agro-industrial products related to Brazil.

Thus, the perception of the behavior of Brazilian government agents and companies on environmental issues can directly influence the volumes and values transacted in international trade, which can lead to systematic boycotts (Oliveira; Miranda, 2023a, 2023b).

Based on the evidence presented so far, it is undeniable that the environment currently plays a crucial role in shaping economic activities. In this context, it is not enough for a company to be sustainable and act sustainably; it must also appear to be sustainable. The importance of corporate reputation has been identified as a key business objective, with a positive environmental reputation serving as a gateway to accessing markets in developed

countries. In the context the proliferation of certifications for sustainable supply chains and green labels, the Brazilian market has sought to adapt to the demands and pressures of discerning consumers, particularly in the European and North American markets.

Although the existing literature explores the study of environmental reputation and its impacts on companies (Karpoff et al.,2005; Henriques; Sardorsky, 1996; Lanoie et al., 1998), a gap remains regarding the relationship between environmental reputation and its effects on international trade, particularly in the agro-industrial sector. This study addresses this gap by providing a novel analysis of how environmental reputation shapes Brazil's trade in fresh beef with its main importing partners over the past eleven years. Bovine meat is selected as the focus because environmental concerns are frequently linked to livestock production due to greenhouse gas emissions, particularly methane, which leads environmental damage narratives to concentrate on specific agricultural commodities, with beef among the most salient. The eleven-year temporal scope is chosen to capture the emergence and consolidation of discourse on social media platform X, formerly Twitter, which gained widespread use during the 2010s and became a relevant channel for the diffusion of environmental narratives affecting international trade perceptions.

This study contributes to literature through three main advances. It introduces a novel empirical framework that integrates machine learning and artificial intelligence techniques with a gravity model to examine perceptions of Brazil's environmental image, as expressed on the Twitter platform, embedding this information within an extended trade specification. It also proposes a new indicator of environmental reputation tailored to agro-industrial trade, designed to reflect environmentally related preferences relevant to importing countries. Finally, the analysis explicitly accounts for heterogeneity in reputation formation by trade partner, recognizing that perceptions of a country's environmental image vary according to preferences, information sets, and attributes of the country being evaluated (Bar-Isaac; Deb, 2014; Tingley; Tomz, 2022; Brutger; Kertzer, 2018). Finally, building on the findings of Oliveira (2024) who analyzed Brazil's environmental image using an aggregated set of agro-industrial products, the results pointed to the need to examine reputational effects at the product level rather than in aggregate. Consequently, fresh bovine meat was selected due to its strong association with environmental concerns in international markets.

The results offer a detailed assessment of reputation formation by incorporating multiple dimensions and stakeholder perspectives. The empirical analysis focuses on imports by European countries, a market characterized by demanding environmental requirements, using

fresh or chilled bovine meat as a representative agroindustrial commodity subject to increased environmental scrutiny.

2. Literature Review

2.1 Reputation index for agro-industrial products

There is a well-established literature on reputation showing that it is agent-specific and shaped by preferences and information sets regarding the object being evaluated, as referenced by Bar-Isaac e Deb (2014), Brutger e Kertzer (2018) e Tingley e Tomz (2022).Within international trade, environmental reputation operates as an informational signal that conditions expectations about production practices, regulatory compliance, and sustainability performance, thereby influencing market access and trade flows. From this perspective, perceptions of Brazil's environmental image are unlikely to be uniform across importing countries, particularly in a sample that includes economies with markedly different environmental norms, regulatory frameworks, and societal sensitivities, such as the United Kingdom and China or France and Angola.

These differences imply that environmental reputation affects bilateral trade relationships in a heterogeneous manner. Accounting for this heterogeneity requires modeling reputation as a country-pair–specific factor that mediates trade costs and demand for agro-industrial products. Accordingly, the potential impact of each importing country on Brazil's agro-industrial exports must be treated individually, reflecting how environmental image interacts with national preferences, information availability, and institutional contexts in shaping international trade outcomes.

2.2 Brazil Environmental Index: Sentiment Analysis from Social Media

Although social network analysis is a relatively recent field, scholarly interest in the systematic study of opinions and sentiments predates contemporary digital platforms. Early contributions can be traced to the first half of the twentieth century, and later empirical applications examine the relationship between textual expression and attitudes in economic and informational contexts (Das; Chen, 2007; Tong, 2001; Pang; Lee; Vaithyanathan, 2002; Nasukawa; Yi, 2003; Dave; Lawrence; Pennock, 2003).The formal consolidation of this research agenda occurred in the early 2000s, when the concepts of sentiment analysis and opinion mining gained prominence following the seminal contributions of Nasukawa and Yi (2003) and Dave, Lawrence and Pennock (2003).

As digital connectivity expanded, consumption choices and belief formation became increasingly shaped by socially mediated information. Within this setting, opinion mining has become a relevant analytical instrument for examining how collective perceptions are formed and disseminated among specific audiences. Evidence of the strategic role of social media in shaping perceptions is provided by the *Twitterplomacy* Study 2015: How World Leaders Connect on Twitter, conducted by Burson-Marsteller Geneva Internet Platform (2014). This study analyzed 644 Twitter accounts belonging to heads of state, government officials, and foreign ministers from 161 countries, documenting the use of Twitter as a deliberate channel for political communication and international positioning.

Rajadesingan and Liu (2014) highlight the unique characteristics of Twitter in information sharing and the formation of public opinion. O'Connor et al. (2010) correlated consumer trust with word frequencies and sentiments extracted from tweets. Simões and Neves (2021) used text mining on Twitter to monitor the epidemiological trend of Covid-19 in Brazil, emphasizing the importance of social media in real-time monitoring of the pandemic.

Building on the discussion of sentiment analysis as a tool to capture emerging societal concerns, including the growing salience of environmental issues, the analysis turns to the integration of these signals within a gravity-model framework. Gravity models provide a well-established empirical structure for examining how policy, institutional quality, and non-tariff measures shape bilateral trade flows, making them suitable for incorporating reputational and informational channels related to environmental performance.

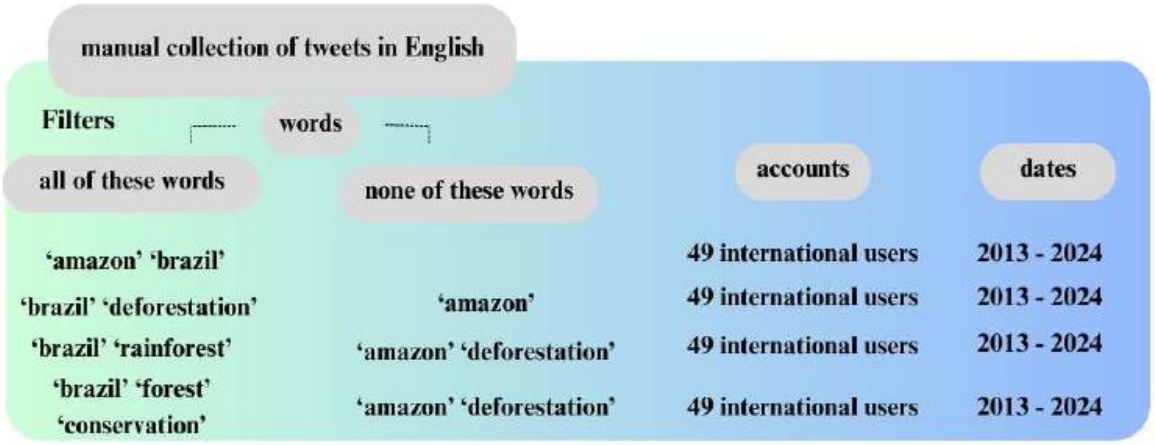
Recent contributions illustrate the expanding use of gravity models to study the interaction between environmental considerations and international trade. Cantore and Cheng (2018) examined how environmental regulation stringency relates to trade in environmental goods. Hasiner and Yu (2019) evaluated the role of exporting-country institutions in shaping China's beef imports. Zhao and Yarime (2022) assessed the trade and emissions effects of carbon tariffs, while Zhong and Su (2023) analyzed the determinants of bilateral trade in natural resources. Related work by Assogbavi and Dées (2023) and Zhong, Goh, and Su (2022) focused on how environmental and trade policies influence CO_2 emissions embedded in exports. Together, these studies highlight the relevance of environmental attributes as trade-relevant factors that operate alongside conventional cost and demand determinants.

3. Methodology

Within this empirical tradition, the present study incorporates sentiment analysis derived from social networks to construct an environmental image index for Brazil and embeds this measure into an augmented gravity model of Brazilian beef exports. The objective is to capture how environmental reputation functions as an informational signal affecting bilateral trade relationships in agro-industrial markets.

The sentiment data were obtained through a manual collection of English-language tweets, covering the period from 2013 to 2024. The search strategy relied on predefined keyword strings combining references to Brazil and the Amazon region, including terms related to deforestation, rainforest, forests, and conservation, while excluding unrelated uses of similar terms. Tweets were collected from 49 international user accounts to ensure that the sentiment reflected external perceptions rather than domestic discourse. Figure 1 summarizes the data collection procedure, detailing the filters applied, the keyword combinations used in the search strings, the set of accounts considered, and the temporal coverage. This approach allows the sentiment measure to focus on internationally relevant narratives surrounding environmental events in Brazil, which are then aggregated and used to construct the environmental reputation indicator employed in the empirical analysis.

Figure 1 – Tweet collection strategy: search filters, keywords strings, accounts, and period (2013-2024)



Source: own elaboration.

The selection of Twitter accounts was deliberately restricted to internationally relevant profiles, including major media outlets, public authorities, international organizations, non-governmental organizations, and prominent activists. These actors play a central role in shaping public discourse and the formation of international images and reputations, particularly in the

environmental domain, as highlighted in the literature on digital diplomacy and *Twitterplomacy*. By excluding private or domestic accounts, the dataset focuses on opinion leaders whose narratives are more likely to influence external perceptions of Brazil's environmental performance and, consequently, reputational dynamics in international markets. To ensure transparency and replicability, the full list of Twitter accounts included in the analysis is reported in Appendix.

The empirical application focuses on "Meat of bovine animals, fresh or chilled," classified under the Mercosur Common Nomenclature (NCM) and aligned with the Harmonized System. Bovine meat was selected given its recurrent association with environmental degradation in public and policy debates, particularly through links to deforestation, greenhouse gas emissions, and land-use change related to livestock production. The set of destination countries included in the analysis is reported in Table 1. Theses 24 countries collectively accounts for approximately 90% of Brazilian exports of fresh beef throughout the analyzed period, ensuring representative and economically meaningful coverage of Brazil's export market. The analysis spans the period from 2013 to 2024, which coincides with the expansion and consolidation of Twitter as a major arena for public discourse, supporting the relevance of the sentiment data employed.

Table 1: Major Brazilian Beef (fresh and chilled) importers: countries included in the PPML model

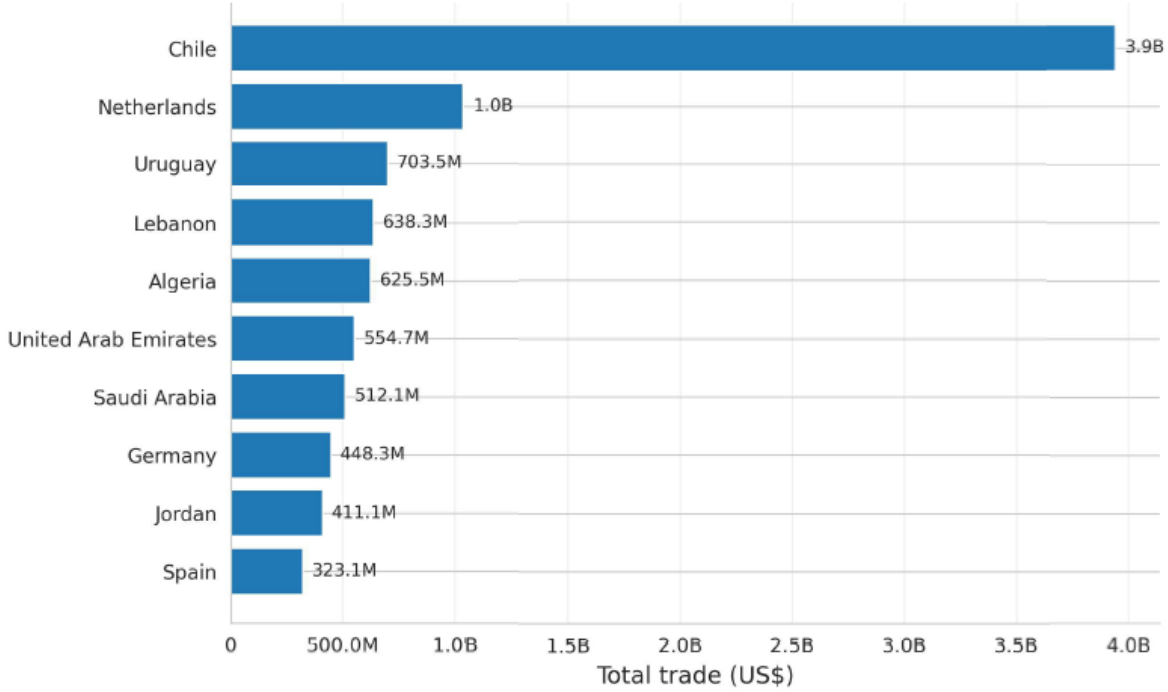
Countries included in the PPML Model	
Algeria	Paraguay
Belgium	Peru
Chile	Portugal
Curaçao	Qatar
Finland	Russia
Germany	Saudi Arabia
Israel	Spain
Italy	Sweden
Jordan	Switzerland
Lebanon	Turkey
Netherlands	United Arab Emirates
United Kingdom	United States
Uruguay	

Source: own elaboration.

Building on the country set reported in Table 1, Figures 2 and 3 show that trade concentration and reputational exposure do not align one-to-one across partners. Figure 2 indicates a highly skewed export profile, with Chile dominating cumulative trade over 2013–2024, followed by the Netherlands, then a second tier including Uruguay, Lebanon, Algeria, the United Arab Emirates, Saudi Arabia, Germany, Jordan, and Spain. Figure 3 shifts attention to the country–year combinations with the highest values of the environmental reputation indicator, which, by construction, reflect exposure to reputational risk through the interaction of sizable trade links, stronger environmental stringency in destination markets, and years with salient negative environmental shocks. The temporal scope extends through 2024, which is the most recent year for which annual data are consistently available for all variables included in the analysis.

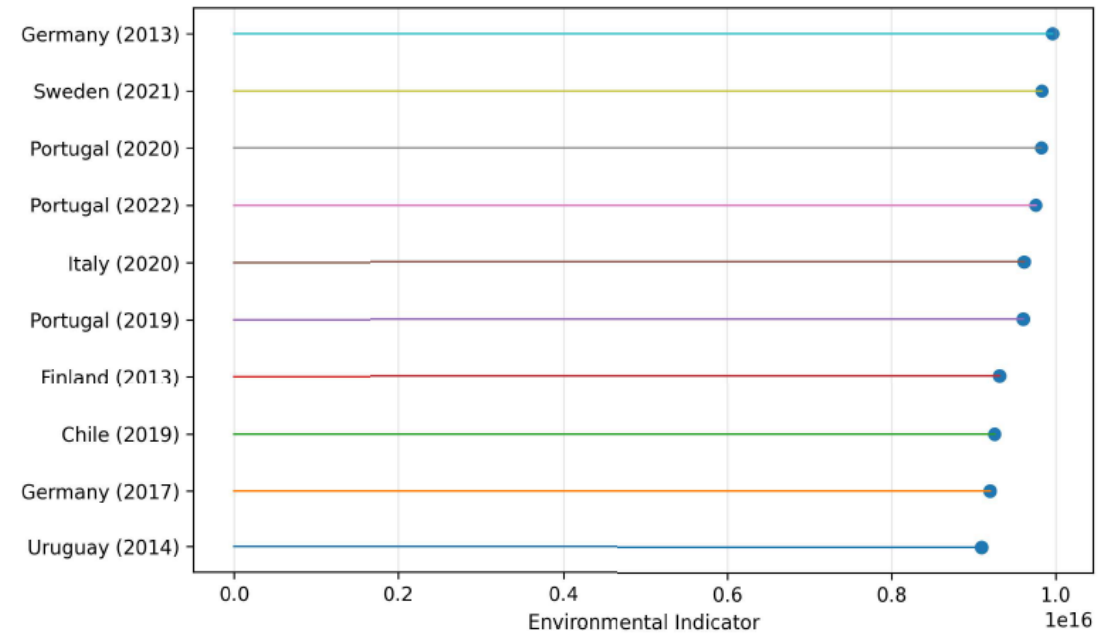
The top observations cluster in high-EPI European importers Germany (2013; 2017), Sweden (2021), Finland (2013), Italy (2020) and Portugal (2019; 2020; 2022), suggesting that reputational exposure is amplified in markets where environmental expectations are more binding and public attention to Amazon-related shocks is more likely to translate into trade-relevant scrutiny. Chile also appears among the highest indicator values (2019), consistent with its centrality in trade volumes, and Uruguay (2014) similarly combines market relevance with heightened exposure in a shock year. In contrast, several major buyers by volume in Figure 2, such as the United Arab Emirates, Saudi Arabia, Jordan, Lebanon, and Algeria, do not feature among the top indicator observations in Figure 3, which is consistent with the indicator assigning greater weight to environmentally stringent destinations rather than to trade volumes alone.

Figure 2: Top 10 trade volume



Source: own elaboration.

Figure 3: Top 10 environmental indicators

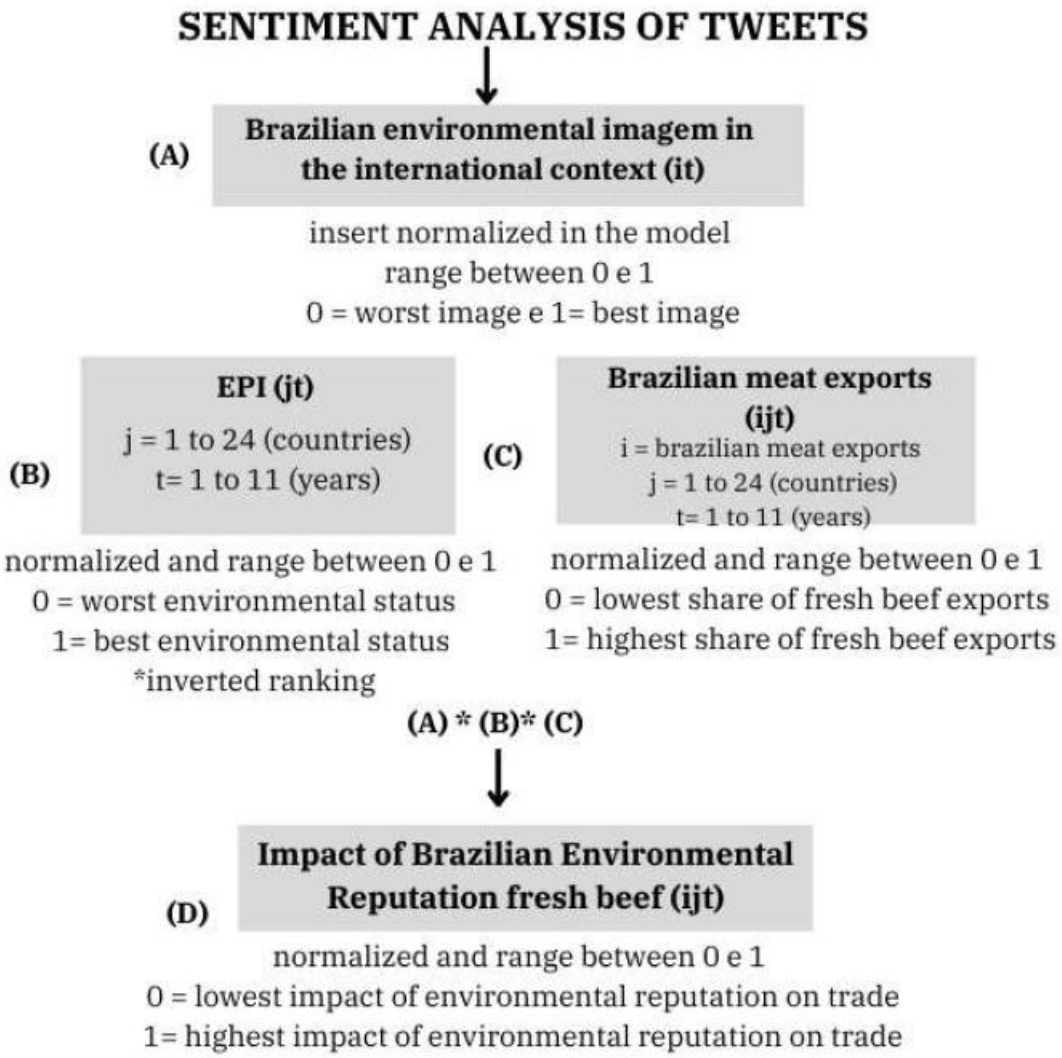


Source: own elaboration.

The construction of the reputation indicator links sentiment-based measures to two additional components: the relative importance of each importing country in Brazil's meat export portfolio and the Environmental Performance Index (EPI). This linkage allows the

indicator to reflect both sectorial market relevance and the environmental standards prevailing in destination countries. Given the different scales of trade values and the EPI, a normalization procedure was applied to transform both variables onto a common [0,1] scale.This step ensures comparability and prevents differences in magnitude from mechanically dominating the composite measure; Figure 4 illustrates the stages of the environmental reputation indicator construction process.

Figure 4: Process of constructing the environmental reputation index in fresh beef trade



Source: own elaboration.

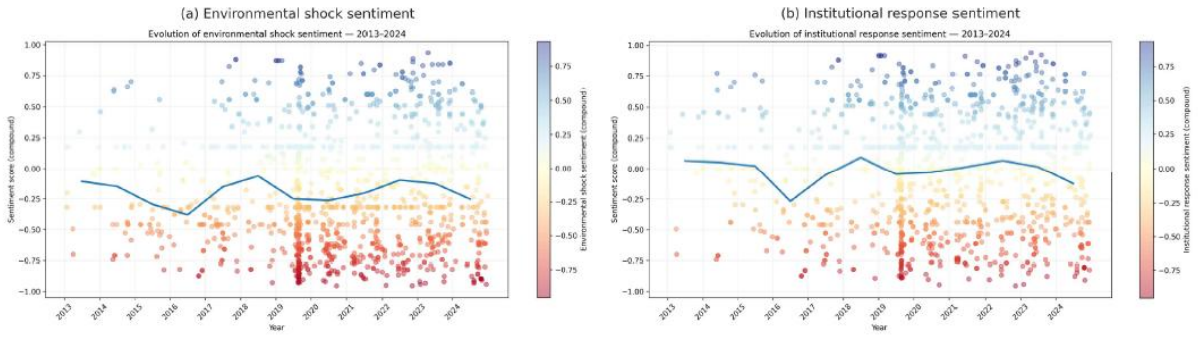
Figure 5 depicts the evolution of two distinct sentiment signals derived from Twitter data related to the Amazon region over the period 2013–2024. Panel (a) presents the environmental shock sentiment, capturing reactions to objectively adverse environmental events such as deforestation, forest fires, droughts, and illegal extractive activities in the Amazon region. The distribution of observations in this panel is clearly skewed toward negative

values, with a high density of tweets clustered below zero and a downward-biased trend line, indicating that public discourse has been persistently dominated by negative environmental shocks. This pattern suggests that adverse events generate more frequent and intense reactions, reinforcing negative perceptions of Brazil's environmental performance during periods of heightened environmental stress.

Panel (b) reports the institutional or political response sentiment, which reflects the tone associated with governance actions, including environmental protection policies, regulatory initiatives, monitoring efforts, and international cooperation. In contrast to the shock sentiment, this panel exhibits a relatively higher concentration of positive values and fewer strongly negative observations, as reflected in a more balanced trend over time. This asymmetry indicates that institutional responses are more often framed in corrective or mitigating terms, highlighting efforts to address environmental damage and promote conservation initiatives rather than amplifying negative narratives.

Together, the two panels highlight the conceptual distinction between environmental shocks and institutional responses. Although environmental shocks contribute predominantly to negative sentiment and reputational pressure, institutional responses appear to partially counterbalance these effects by signaling policy engagement and remedial action. Given the objective of capturing the reputational impact of adverse environmental events, the analysis adopts shock compound as the primary sentiment indicator. The institutional response sentiment is retained as a separate dimension for complementary analyzes and robustness checks, but it is not incorporated into the construction of the main sentiment-based environmental reputation indicator.

Figure 5: Evolution of environmental and institutional response sentiment



Source: own elaboration

3.1 Modelling the trade impact of environmental reputation

To evaluate the impact of environmental reputation on international trade, the analysis relies on a gravity-model framework rooted in the seminal contributions of Tinbergen (1962), Pöyhönen (1963), Linnemann (1966), Bergstrand (1985), Deardorff (1998), and Baier and Bergstrand (2007). The empirical specification follows Anderson and Van Wincoop (2003, 2004), which provides structural treatment of bilateral trade costs and multilateral resistance terms. The authors contend that the structural gravitational model, when augmented with extensions that more effectively address issues such as aggregation, endogeneity, and refined estimates of the elasticity of substitution, provides a more robust and accurate analysis of trade costs in international flows.

To address the issue of zero trade flows, we utilized the Poisson Pseudo-Maximum-Likelihood (PPML) estimation technique introduced by Santos Silva and Tenreyro (2006), which provides unbiased estimates in the presence of heteroscedasticity and remains robust even when the proportion of zero observations is substantial (Santos Silva and Tenreyro, 2011).

Building on the structural framework proposed by Anderson and Van Wincoop (2003), and incorporating both traditional and extended variables identified in the literature, the empirical specification of our model estimates exports of product k from country i to country j in year t in a multiplicative form, as shown in Equation (1):

$$\begin{aligned} ln(X_{ijt}^{k}) = c \; &+ \gamma_{jt} + \gamma_{ij} + \beta_1 ln(Envrmnt\_Ind_{ijt}) + \beta_2 ln(Tarif_{ijt}) \\ &+ \beta_3 ln(Notif_{jt}) \\ &+ \beta_4 ln(Deforestaton_{it}) + \beta_5 (Pop_{jt}) + \beta_6 ln(GDP_{jt}) + \varepsilon_{ijt}^{p} \end{aligned} \quad (1)$$

We estimate the Eq.(1) for product k (bovine animal meat, fresh or chilled). The definition of each variable is presented in Table 2.

Table 2: Definition of variables

Variable name	Definition	Data source
X_{ijt}^{k}	Total exports of meat of bovine animals, fresh or chilled, from the exporting country (i) (Brazil) to the importing country (j) in period (t), in current US dollars.	ComexStat (MDIC)
$Envrmnt\_Ind_{ijt}$	Indicator of the impact of Brazil's environmental reputation on trade, based on English-language texts related to the exporting country (i) (Brazil) as perceived by the importing country (j) in period (t).	Twitter, ComexStat, and EPI
$Tarif_{ijt}$	Tariffs applied to agro-industrial products imported by the importing country (j) from the exporting country (i) (Brazil) in period (t).	WITS

Variable name	Definition	Data source
$Notif_{jt}$	Notifications of environmental nature submitted by the importing country (j) within the framework of the World Trade Organization in period (t).	WTO
$Deforestaton_{it}$	Annual deforestation in the exporting country (i) (Brazil) in period (t).	MapBiomas
GDP_{jt}	Gross domestic product of the importing country (j) in period (t), in current US dollars.	World Bank
Pop_{jt}	Total population of the importing country (j) in period (t).	World Bank

Notes: All variables are compiled by the authors from the sources indicated above.

The Environmental Reputation Index is expected to enter positively, as the importing countries in the sample place strong weight on environmental considerations—reflected in their high Environmental Performance Index (EPI) scores—so that a more favorable perception of Brazil's environmental image is likely to support trade flows. Tariffs are expected to have a negative effect, given their role in raising trade costs. The expected sign of notifications is ambiguous, since they may either facilitate trade by improving standards and compliance or hinder trade when they operate as non-tariff barriers. Deforestation is expected to have a negative effect and is included as an instrumental variable, under the assumption that it influences bilateral trade only indirectly through its impact on Brazil's environmental reputation, thereby helping to isolate the exogenous component of the reputation measure.

To ensure the robustness of the results, alternative model specifications were estimated, including three-year windows (Yotov, 2016), models with one-period lags, and models incorporating additional explanatory variables. Nevertheless, the results presented in Table 3 proved to be the most consistent with the empirical patterns observed in the data.

Empirical analysis combines different computational tools. The PPML gravity models were estimated using STATA, while Python was employed for data processing and sentiment analysis of social media content.

4. Results and Discussion

Table 3 reports the PPML estimates of the gravity model linking environmental reputation to Brazilian exports of fresh or chilled bovine beef. The coefficient on the Environmental Indicator (log) is positive and statistically significant at the 1% level, indicating that higher values of the indicator are associated with larger bilateral trade flows. Given the

construction of the indicator, this result should be interpreted as evidence that periods and destinations characterized by greater reputational exposure, arising from the interaction between trade intensity, stringent environmental standards in importing countries, and salient negative environmental shocks (measured by the environmental reputation indicator), are systematically correlated with higher observed trade volumes. This finding is consistent with the idea that reputational pressures are most pronounced precisely in economically relevant markets, where trade links are dense and environmental scrutiny is stronger, rather than implying any improvement in Brazil's environmental performance.

Table 3: Environmental Indicator and Trade: PPML Gravity Model for Brazilian fresh beef exports (2013–2024)

Variable	PPML (1)
Environmental Indicator (log)	0.128***
	(0.017)
Tariff	0.009
	(0.007)
Notification	-0.002
	(0.005)
Deforestation (log)	-0.142
	(0.113)
Population (importer)	-0.048
	(0.036)
GDP (importer)	0.012
	(0.029)
Importer–time effect	0.013
	(0.009)
Pair fixed effect	-0.155
	(0.115)
Constant	4.960***
	(0.900)
Observations	287
Pseudo (R^2)	0.404
Clusters (pair)	24

Notes: PPML estimator. Robust standard errors clustered by country-pair in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Traditional trade policy variables display limited explanatory power in this specification. Tariffs and notifications enter with small and statistically insignificant

coefficients, suggesting that, within this narrowly defined product and destination set, reputational and informational factors may be more salient than conventional border measures in shaping trade patterns. The coefficient on deforestation (log) is negative, as expected, but not statistically significant, which may reflect collinearity with the sentiment-based indicator or the fact that deforestation affects trade primarily through reputational channels rather than as a direct quantity constraint.

Importer-specific controls also behave in line with gravity-model expectations, although they are imprecisely estimated. Importer population enters with a negative sign, while importer GDP is positive, albeit insignificant, which is plausible in a sample dominated by relatively high-income countries where per-capita income and quality preferences may matter more than market size alone. The inclusion of importer-time effects and country-pair fixed effects absorbs a substantial share of unobserved heterogeneity, reinforcing the interpretation that the estimated effect of the environmental indicator reflects within-pair variation over time rather than cross-sectional differences across partners.

Overall, the results suggest that environmental reputation, as captured through sentiment linked to adverse environmental shocks, is a statistically relevant correlate of Brazilian beef exports in environmentally sensitive markets. The magnitude and significance of the indicator underscore the importance of accounting for reputational exposure alongside standard gravity controls when analyzing agro-food trade flows under heightened environmental scrutiny.

Table 4 shows that the environmental indicator is strongly correlated with trade volumes, while exhibiting low pairwise correlations with tariffs, notifications, deforestation, and importer characteristics. This pattern is consistent with the PPML results, in which the environmental indicator remains statistically significant after controlling standard gravity covariates and fixed effects. The high correlation with trade reflects the construction of the indicator, which embeds trade relevance by design, rather than mechanical collinearity with policy or structural variables. At the same time, the modest correlations among the remaining regressors suggest limited multicollinearity, supporting the stability and interpretability of the PPML estimates reported in Table 3.

Table 4: Correlation matrix

	Trade	Tarif	Notif	Deforest	GDPImp	PopImp	Distance	Indicator
Trade	1.000							
Tarif	0.016	1.000						
Notif	-0.032	-0.061	1.000					
Deforest	0.0387	-0.0160	-0.025	1.000				
GDPImp	-0.1029	0.0776	-0.5927	0.0264	1.0000			
PopImp	-0.1274	0.1740	0.5401	-0.1274	0.0069	1.0000		
Distance	-0.3118	-0.0518	-0.0947	0.0000	-0.0579	-0.0007	1.0000	
Indicator	0.7874	-0.0203	0.0817	0.0308	-0.0678	-0.1023	-0.2507	1.0000

Notes: Pearson correlations computed using the complete-case estimation sample (N = 288). NTB denotes non-tariff barriers. GDP and population refer to the importing country.

5. Final considerations

This study advances literature by proposing a novel, sentiment-based indicator of environmental reputation and embedding it within a gravity-model framework applied at the sectoral level. By focusing on fresh or chilled beef, an agriculture product frequently associated with environmental concerns in international trade, the analysis demonstrates how reputational exposure linked to environmental shocks can be quantified and empirically connected to bilateral trade flows. The results show that environmental reputation operates as a relevant informational channel in environmentally sensitive markets, complementing standard trade determinants.

The analysis faces limitations related to data construction, notably the manual collection and processing of open-access Twitter data, which constrains scalability and may limit temporal and thematic coverage. Future research could extend this approach to other Brazilian export products that are strongly associated with environmental issues, such as soybeans, to assess whether reputational effects differ across commodities and markets. Expanding the methodology to additional platforms or automated data pipelines would also allow for broader comparisons and more granular analysis of environmental reputation in international trade.

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