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Anthony Okwong Ekere

anthony.ekere@u-pec.fr

Université Paris-Est Créteil

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Disentangling the Role of Environmental Provisions in Free Trade Agreements as a Driver of Specialization in Green Exports

Anthony Ekere^{*a}

^aERUDITE, Université Paris-Est Créteil, 94010, Créteil, France

Abstract

Environmental provisions are now standard features of free trade agreements, yet their consequences for the composition of trade remain poorly understood. This study examines whether environmental provisions in FTAs shift bilateral sectoral exports towards greener goods. The average effect of environmental provisions on green export specialization is statistically insignificant but this conceals sharp heterogeneity across provision types, country development status, and sectors. Provisions that explicitly liberalize trade in environmental goods increase green export intensity by over 140 percent, while generic environmental clauses generate no measurable effect. South-South FTAs produce the strongest and most consistent green specialization gains, while North-South agreements can impose compliance burdens that reduce developing country green export intensity. At the sector level, effects are concentrated in green minerals, plastics, construction materials, and vehicles. These findings show that what matters is not whether an FTA contains environmental provisions, but which provisions, between whom, and in which sectors — with direct implications for the design of trade agreements that genuinely promote green trade.

JEL classification: F13, F18, O19, Q56

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^{*}Corresponding author: anthony.ekere@u-pec.fr

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Declaration of Competing Interests

The author declares that there are no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

The data underlying this study are obtained from publicly available sources cited in the manuscript. Replication materials will be made available in accordance with the journal's data and code policy upon request.

1 Introduction

“Strict environmental regulations do not inevitably hinder competitive advantage against rivals; indeed, they often enhance it. Tough standards trigger innovation and upgrading” (Porter and Van der Linde, 1991)

As climate commitments deepen and the costs of inaction mount, what countries trade, not merely how much, has become a first-order policy concern. The composition of trade flows, and the degree to which they can be steered towards greener goods, is now at the center of both environmental and commercial diplomacy.

Free trade agreements (FTAs)¹ are the principal instrument through which this ambition is being pursued. The growth of FTAs is one of the defining features of the contemporary trade landscape. Driven partly by the deadlock of multilateral negotiations at the World Trade Organization, countries have turned increasingly to bilateral and regional agreements as their primary vehicle for trade liberalization (Levy, 1997). These agreements are growing not only in number but in depth, covering an ever-wider range of policy areas, such as labour standards, intellectual property, investment, and environment (Mattoo et al., 2020). Approximately 90 percent of all FTAs now contain at least one environmental provision², reflecting a broad political consensus that trade and environmental governance should travel together. A supposed tension between environmental protection and the economic gains from trade liberalization persists in both the policy debate and the academic literature (Managi et al., 2009; Abman and Lundberg, 2020; Brandi et al., 2020; Leblois et al., 2017).

Yet the mechanisms through which environmental provisions shape trade remain poorly understood. Existing evidence shows that environmental provisions do not generate uniform effects on trade. Rather, aggregate estimates can mask substantial differences according to the design of the provision and the type of goods traded. For example, Brandi et al. (2020) find no average effect of environmental provisions on green exports, but show that liberalizing provisions increase exports of green goods from developing countries, while restrictive provisions reduce exports of environmentally harmful goods. These findings establish that the design of environmental provisions matters, but leave open a more specific question: which provisions within environmental chapters actually affect green export specialization, and in which sectors and country contexts do these effects arise?

Environmental chapters contain provisions that range from broad environmental objectives and participation commitments to provisions that directly concern the relationship between environmental objectives

¹Used as a generic term to include all forms of bilateral or regional agreements which reduce or eliminate barriers to trade

²Clauses or commitments within an agreement that aim to protect and promote environmental sustainability

and trade liberalization. These provisions need not have equivalent effects on countries' trade incentives. FTAs also differ substantially in their design and enforcement (Wonnacott, 1996; Dür et al., 2014; Bastiaens and Postnikov, 2017), and this heterogeneity extends to their environmental chapters. North-North and North-South FTAs are systematically deeper than South-South agreements (Gamso and Postnikov, 2022), reflecting asymmetries in negotiating capacity and regulatory ambition that may generate correspondingly different effects on green export specialization. As Larch and Yotov (2024) emphasize, environmental provisions can affect trade through multiple channels, while recent work further documents heterogeneity by provision type, country development status, and sector (Brandi et al., 2020; Rocha et al., 2024; Mkandawire et al., 2024). The purpose of this paper is therefore to disentangle these dimensions and identify which environmental provisions are associated with changes in green export specialization.

Using a panel of bilateral trade flows for 194 exporting countries across 97 HS2 sectors from 2000 to 2019, I estimate the impact of environmental provisions on trade specialization in green exports. This is not a question about trade volumes; it is a question about trade composition. I find that, on average, the mere presence of environmental provisions has no statistically significant effect on green export specialization. Disaggregating environmental provisions by type, country development status, and sector reveals that the average effect masks substantial variation, with the strongest response concentrated in a specific provision targeting the differential liberalization of trade in environmental goods.

Identifying the effect of environmental provisions on green export specialization faces two concerns. First, country pairs already trading intensively in green sectors may selectively negotiate FTAs with ambitious environmental chapters, generating upward bias from reverse causality. Second, time-varying omitted variables may jointly determine both FTA environmental ambition and green export performance within country-pair-sector. I address these concerns through a triple high-dimensional fixed-effects structure and dynamic treatment analysis. The fixed effects — country-pair-sector, exporter-sector-year, and importer-sector-year — absorb time-invariant country-pair-sector characteristics and exporter- and importer-sector-year shocks, including variation associated with sector-specific supply and demand conditions. A leads-and-lags specification and an event study provide further evidence on the timing of the response and show no evidence of differential pre-trends before environmental provisions enter into force. The event-study estimates show a persistent positive post-entry response specifically in green sectors, consistent with an effect of the provision targeting the liberalization of trade in environmental goods on green export specialization. Together, these results provide evidence against the concern that the estimated relationship is driven by pre-existing differential trends in green export specialization.

Three findings stand out. **First**, the economic content of an environmental provision matters. Generic environmental language — aspirational goals, hortatory protection clauses, and participation commitments — generates no measurable green trade effect. The estimated response is concentrated in the clause within the Balance between Environmental and Trade/Investment Goals subcategory that explicitly mandates the differential liberalization of trade in environmental goods. This provision increases the green intensity of sectoral exports by over 140 percent.

Second, the country development context is decisive. South-South FTAs generate the strongest and most consistent green export specialization effects — over 7 percent per additional provision in green sectors — while South-North agreements are associated with reductions in green export intensity. These differences are consistent with the possibility that the effects of environmental provisions depend on the regulatory and productive environment in which firms operate: where firms have greater scope to adjust and upgrade, environmental provisions may create opportunities for green specialization, whereas adjustment and compliance costs may be more consequential in other development contexts. North-North FTAs generate null effects, consistent with the possibility that greater pre-existing regulatory convergence leaves less scope for FTA environmental provisions to alter firms' incentives.

Third, the sectoral concentration of effects is sharp. Green minerals, plastics, construction materials, and vehicles are where environmental provisions make a measurable difference. The response is therefore not a generalized shift toward greener exports, but a more localized change in export specialization concentrated in particular sectors.

These findings make three contributions to the literature. **First**, I contribute to the emerging literature on the trade effects of environmental provisions by shifting attention from the presence of environmental commitments to their *economic content*. Existing studies establish that environmental provisions can affect the composition of trade, but emphasize different forms of heterogeneity. Brandi et al. (2020) distinguish liberalizing and restrictive provisions and examine their effects on green and dirty exports from developing countries; Rocha et al. (2024) distinguish environmental provisions according to their enforceability and examine effects on dirty trade; and Mkandawire et al. (2024) examine heterogeneous sectoral effects according to provision type and exporter development. Rather than treating these dimensions as competing classifications, I disaggregate environmental provisions into seven broad subcategories³ and use the resulting variation to identify which component of an environmental chapter is associated with changes in green export spe-

³The seven subcategories are: environmental goals and objectives; balance between environmental and trade/investment goals; enforcement mechanisms; external assistance; general environmental protection; MEA compliance; and participation in promoting environmental objectives.

cialization. I identify the provision directly linked to the differential liberalization of trade in environmental goods as the provision most strongly associated with the green export response.

Second, I contribute evidence on the conditions under which environmental provisions can alter trade specialization. By estimating effects separately across North-North, North-South, South-North, and South-South country pairs, I show that the same environmental provisions do not have a uniform effect across development contexts. The particularly strong response in South-South agreements highlights the importance of the productive and regulatory context in determining whether environmental provisions translate into green export specialization. This extends the existing literature by examining the full set of bilateral development pairings within a common sector-level framework.

Third, I contribute a sector-level perspective to the literature on trade and environmental policy. I exploit variation across 97 HS2 sectors to identify where the response is concentrated rather than treating green exports as an aggregate outcome. The resulting pattern — concentrated in green minerals, construction materials, plastics, and vehicles — shows that the trade-composition effects of environmental provisions are localized in particular sectors rather than reflecting a generalized shift toward greener exports. This sector-level evidence complements the broader FTA literature, which has largely focused on the effects of trade agreements on aggregate trade volumes without distinguishing their environmental content (Baier and Bergstrand, 2007; Baier et al., 2014; Egger et al., 2011).

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes the data and estimation strategy. Section 4 presents the main results, robustness checks, and heterogeneity analyses. Section 5 concludes with policy implications and directions for future research.

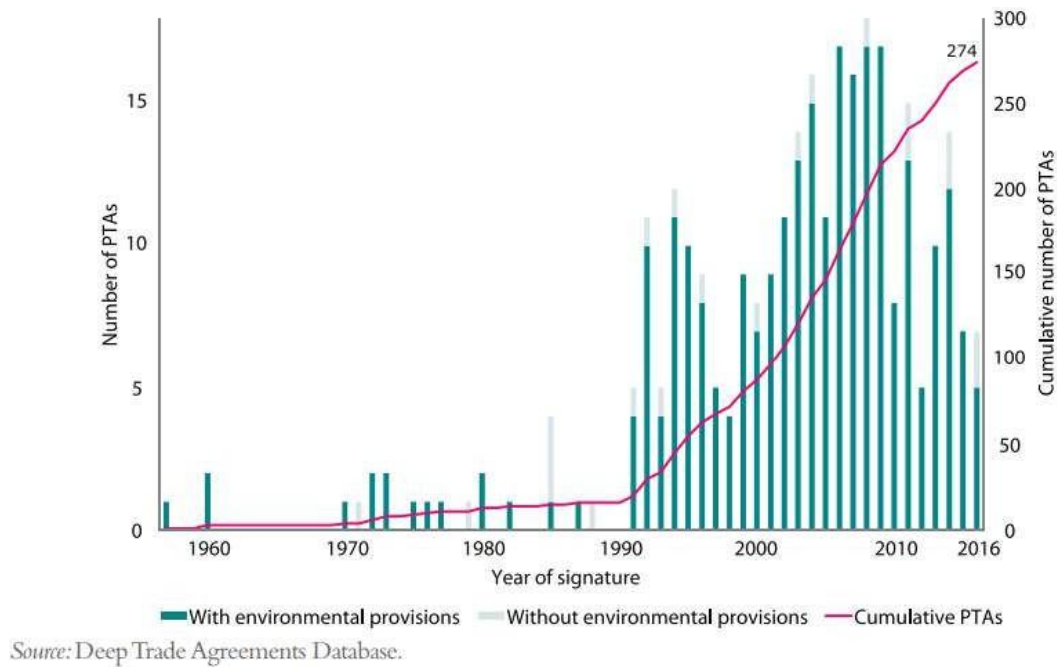
2 Literature Review

The literature relevant to this study spans three interconnected bodies of work: the design and trade effects of free trade agreements; the environmental consequences of FTA environmental provisions; and the emerging evidence on how those provisions reshape the composition of trade. This section reviews each in turn before identifying the gap that the present study fills.

2.1 The Proliferation and Design of Free Trade Agreements

As shown in Figure 2.1, the past three decades have witnessed an extraordinary expansion in the number and scope of free trade agreements. As multilateral negotiations through the World Trade Organization (WTO)

Figure 2.1: Evolution of Environmental Provisions in FTAs



stalled following the collapse of the Doha Round, countries increasingly turned to bilateral and regional agreements as the primary vehicle for trade liberalization (Levy, 1997). Today, over 350 FTAs are in force globally, and the trend shows no sign of abating.

The economic rationale for signing FTAs is primarily market access and efficiency gains from specialization (Baier and Bergstrand, 2004). However, political economy considerations are equally important: domestic interest groups, geopolitical alignments, and regulatory preferences all shape which provisions enter an agreement and how they are enforced (Grossman and Helpman, 1993). This interplay between economics and politics is particularly salient for environmental provisions, which must balance trade facilitation against regulatory protection.

FTAs differ substantially in their design, depth, and enforcement strategies (Wonnacott, 1996; Dür et al., 2014; Bastiaens and Postnikov, 2017). A shallow agreement may do little more than reduce tariffs on goods, while a deep agreement can cover services, investment, intellectual property, competition policy, labour standards, and environmental commitments (Mattoo et al., 2020). This variation in depth matters for trade: deeper agreements tend to generate larger trade effects than their shallower counterparts, because they reduce non-tariff barriers that are often more trade-restrictive than tariffs themselves (Dür et al., 2014; Hofmann

et al., 2017; Mattoo et al., 2022). The depth of an agreement is also endogenous to the trading relationship — deeper agreements are more likely between pairs with stronger economic ties, higher institutional capacity, and greater regulatory proximity (Baier and Bergstrand, 2004; Grossman and Helpman, 1993). This selection problem is a recurring identification challenge in the FTA literature, addressed in the gravity framework through high-dimensional fixed effects that absorb the time-invariant bilateral characteristics driving both FTA formation and trade outcomes (Baier and Bergstrand, 2007)

The development status of parties systematically shapes agreement architecture. North-North and North-South FTAs are deeper and more comprehensive than South-South agreements, reflecting asymmetries in negotiating capacity, regulatory ambition, and institutional infrastructure (Gamso and Postnikov, 2022). These structural differences have direct implications for the environmental content of agreements: deeper agreements are more likely to include binding environmental provisions, and the binding force of those provisions depends on the enforcement capacity of the parties. This asymmetry motivates the country grouping heterogeneity analysis at the core of this paper.

The trade effects of FTAs have been extensively documented. Baier and Bergstrand (2007) show that an FTA roughly doubles bilateral trade on average, using panel data methods that address the endogeneity of agreement formation. Subsequent studies confirm large and robust positive effects across different samples, estimation methods, and agreement types (Baier et al., 2014; Bergstrand et al., 2015; Egger et al., 2011). Hoekman et al. (2023) extend this literature by examining the trade effects of non-economic provisions in trade agreements more broadly — including labour, intellectual property, and environmental chapters — finding that non-economic provisions contribute meaningfully to trade creation beyond the tariff-reduction effect. Their results suggest that the regulatory content of FTAs, not just their tariff schedules, shapes bilateral trade flows, providing a direct motivation for studying environmental provisions specifically.

2.2 Environmental Provisions in FTAs: Scope, Measurement, and Design

Environmental provisions, clauses or commitments within an FTA that aim to protect or promote environmental sustainability, have been present since the earliest modern agreements. The European Free Trade Association (EFTA), established in 1960, contained early environmental language, and today approximately 90 percent of all FTAs include at least one environmental provision (Mattoo et al., 2020). Their content spans an enormous range: some agreements contain only hortatory language affirming the importance of environmental protection, while others mandate compliance with specific multilateral environmental agreements (MEAs), establish enforceable dispute settlement mechanisms for environmental violations, or explicitly

provide for the liberalization of trade in environmental goods.

The measurement of environmental provisions has advanced considerably. Earlier studies relied on binary indicators of environmental chapter presence, conflating agreements with a single aspirational sentence with those containing dozens of binding and enforceable commitments. The World Bank's Deep Trade Agreements database now provides granular coding of 48 distinct environmental provisions across 400 FTAs, enabling the kind of subcategory analysis that aggregate measures preclude. Brandi and Morin (2023) provide the most comprehensive synthesis of this literature, examining the drivers and effects of environmental provisions across a wide range of agreements and contexts. They show that the political economy of provision inclusion is as important as its economic consequences: domestic interest groups, geopolitical alignments, and negotiating precedents all shape which environmental clauses enter an agreement and whether they carry enforcement force. This work underscores that treating environmental provisions as a homogeneous block, as much of the empirical literature implicitly does, is likely to obscure the mechanisms through which they operate.

The design of environmental provisions also varies by the development status of the parties. Lechner (2016) shows that domestic interest groups shape the content of environmental chapters in FTAs, and that the resulting provisions can be either trade-limiting, raising standards in ways that restrict market access, or trade-facilitating, harmonizing standards in ways that reduce compliance costs. This distinction between restrictive and liberal provisions anticipated by Lechner (2016) and formalized empirically by Brandi et al. (2020) is central to understanding why average effects are typically null: the two types of provisions have opposing effects that cancel in aggregate.

2.3 Environmental Provisions and Environmental Outcomes

A small but growing literature examines the environmental consequences of FTA provisions directly. Baghdadadi et al. (2013) show that FTAs containing environmental harmonization provisions lead to a convergence and reduction in CO₂ emissions relative to comparable agreements without such provisions. The effect operates through regulatory alignment: when trading partners commit to similar environmental standards, production processes converge towards cleaner technologies. This finding provides early evidence that environmental chapters in FTAs are not purely symbolic and can generate genuine regulatory discipline.

Abman and Lundberg (2020) examine the intersection of FTAs and deforestation, finding that trade liberalization generally stimulates agricultural expansion and forest loss. Abman et al. (2024) extend this analysis, confirming that the inclusion of forests and biodiversity-specific environmental provisions can nearly neutralize this effect. The protection is concentrated in tropical developing countries, those with the most

abundant biodiversity but the least capacity to enforce environmental standards unilaterally, a finding that anticipates the country-level heterogeneity documented in the present study. This reduction in forest loss however comes with an inherent trade-off: they also constrain agricultural trade. This tension between environmental protection and trade promotion is precisely the trade-off that motivates the present paper's focus on green export specialization rather than trade volume: the question is not whether provisions reduce trade, but whether they redirect it towards greener goods.

A further sectoral perspective is provided in the context of fisheries, showing that trade agreements with sustainability-oriented provisions can reduce overfishing and support more sustainable marine resource management (Bayramoglu et al., 2026). Although specific to the fisheries sector, this finding reinforces the broader point that the environmental effectiveness of FTA provisions is highly sector-dependent, a principle that this paper extends to the full universe of traded goods.

2.4 Environmental Provisions and Trade Composition

The trade composition effects of environmental provisions, as distinct from their volume effects or their environmental outcomes, constitute the most directly relevant and least developed strand of the literature. Brandi et al. (2020) is the foundational reference. Examining a panel of developing country exporters, they find that, on average, environmental provisions have no statistically significant effect on the overall share of green or dirty exports. However, disaggregating by provision type reveals that restrictive provisions reduce dirty export shares while liberal provisions increase green export shares, with effects concentrated in countries with strong domestic environmental legislation. This heterogeneity in direction, provisions pushing trade composition in opposite directions depending on their content, is the clearest early evidence that average effects are uninformative and that disaggregation is essential.

These trade composition effects can be situated within a broader political economy framework, where the design of environmental provisions reflects a negotiated balance between trade-promoting and environment-protecting objectives, and this balance ultimately determines their trade consequences. The synthesis highlights that the effectiveness of provisions depends not only on their content but also on the complementary institutions — enforcement capacity, domestic environmental law, and regulatory infrastructure — that determine whether commitments translate into observable trade and environmental outcomes (Brandi and Morin, 2023).

The empirical frontier has been advanced through an analysis of the trade effects of environmental provisions using a global sample of countries over 1995–2019, distinguishing between dirty-footloose and

dirty-non-footloose industries at the HS2 level. The results indicate that dirty goods are generally less traded between pairs covered by agreements with environmental provisions, particularly for exports of dirty-footloose industries from non-OECD to OECD countries, although sector-by-sector results within dirty goods are mixed (Rocha et al., 2024). The focus on dirty goods and enforceable versus non-enforceable provisions complements the present paper's focus on green export specialization, while the finding that effects vary by country direction and provision enforceability reinforces the case for the disaggregated approach adopted here.

A complementary sectoral perspective examines the trade effects of heterogeneous environmental provisions across product margins using a similarly disaggregated approach. The analysis of both the intensive and extensive margins of trade confirms that environmental provisions operate differently across sectors and that aggregate estimates conceal substantial within-sector heterogeneity (Mkandawire et al., 2024). The focus on the margins of trade — the number of products traded versus the value per product — complements the present paper's focus on green intensity within sectors, together providing a more complete picture of how environmental provisions reshape the sectoral composition of international trade.

Evidence from the broader literature on non-economic provisions suggests that the trade effects of specific provision types depend critically on their enforceability and the institutional capacity of the parties to implement them (Hoekman et al., 2023). This finding has direct implications for interpreting the country-level heterogeneity documented in this paper: the stronger green export specialization effects observed in South-South agreements relative to North-South agreements may reflect not only regulatory alignment but also the lower compliance cost asymmetry between partners with similar institutional capacity.

2.5 Green Export Specialization and Comparative Advantage

The concept of green export specialization connects the trade effects of environmental provisions to the broader literature on comparative advantage and regulatory competition. Porter and Van der Linde (1991); Porter and Linde (1995) argue that stringent environmental regulation, far from reducing competitiveness, can stimulate innovation and enhance international competitiveness in green sectors. Under this view, environmental provisions in FTAs may function as regulatory signals that trigger the innovation and upgrading that generate green comparative advantage, particularly in countries where firms have room to move up the quality and environmental ladder. The empirical evidence for the Porter hypothesis is mixed at the country level but more supportive at the sector level (Ambec et al., 2013), which reinforces the case for the sector-level analysis conducted in this paper.

The development dimension of this argument is particularly important. South-South trading partners, facing similar environmental challenges with comparable regulatory capacity, may respond to green regulatory signals embedded in FTA provisions more symmetrically than North-South pairs, where compliance cost asymmetries can undermine the green trade-promoting intent of provisions. This is consistent with Gamso and Postnikov (2022), who show that the effects of deep FTA provisions depend on the developmental context of the parties, and with the broader literature on South-South trade cooperation as a vehicle for mutual upgrading (UNCTAD, 2016, 2026).

3 Data and Empirical Strategy

3.1 Database and Datasets

3.1.1 Bilateral Trade Data

The dependent variable is bilateral exports of goods at the sectoral level. Using mirrored export data, I construct a panel dataset of bilateral sectoral export flows covering the period 2000–2019. The data are obtained from the United Nations Comtrade database, and all export values are measured in current U.S. dollars.

3.1.2 Data on Green Goods

Green or clean goods are generally those that help in environmental protection, limit or correct environmental harm and which have the least abatement costs (OECD and Eurostat, 1999). Defining which good or sector is green can be vague as some goods used for environmental preservation may also have other uses. There had been several attempts by UNCTAD in 1992, the OECD in 1999, APEC in 2012, and the WTO (“friends list”) in 2016, to draw up an inventory of environmental goods. I generate data on clean export goods based on a list of 132 OECD green products (OECD and Eurostat, 1999) and a list of 54 green APEC commodities (APEC, 2012), both given at the HS6 classification level. This is consistent with previous studies (Brandi et al., 2020; De Melo and Solleder, 2020). I use a combined list of 140 codes which avoids overlapping from both lists. Broadly, it covers goods that deal with pollution management (such as waste water management, solid waste management, remediation and clean-up, noise and vibration abatement), cleaner technologies and products as well as more sustainable resources management. An inherent limitation is that all environmental goods may not have been covered, and therefore not have HS codes.

3.1.3 Free Trade Agreement Data

For the main explanatory variable: Environmental Provisions in FTAs, I obtain data from the World Bank's Deep Trade Agreements database. It provides an updated, robust and detailed data set, using all encompassing yet non excessive measures. It establishes 48 varying environmental provisions in 400 signed free trade agreements that have been reported to the WTO and were either in force, or are still in force as at December 2024. For country pairs signed up to more than one FTA at a particular time, I use the highest number of environmental provisions, to avoid overlapping. This brings the total number of FTAs in the sample to 287. They cover seven broad categories which include: environmental goals and objectives, balance between environment and trade/investment goals, enforcement mechanism, external assistance, general environmental protection areas, Multilateral Environmental Agreements (MEAs) compliance and participation in promotion of environmental objectives. A limitation here is that not all extensions agreed upon by parties, that are not notified to the WTO, are captured.

I obtain data for the depth of FTA from the World Bank's Deep Integration Database (Mattoo et al., 2020). This is the horizontal depth and provides a general overview of the policy areas enshrined in an FTA. There are broadly 52 provisions covered in an FTA and 18 of these are core⁴ The core provisions are those that are most frequently incorporated in FTAs. I proxy depth based on the core 18 provisions. I also consider provisions that are legally enforceable. This implies those provisions that incorporate a dispute settlement mechanism.

3.2 Descriptive Statistics

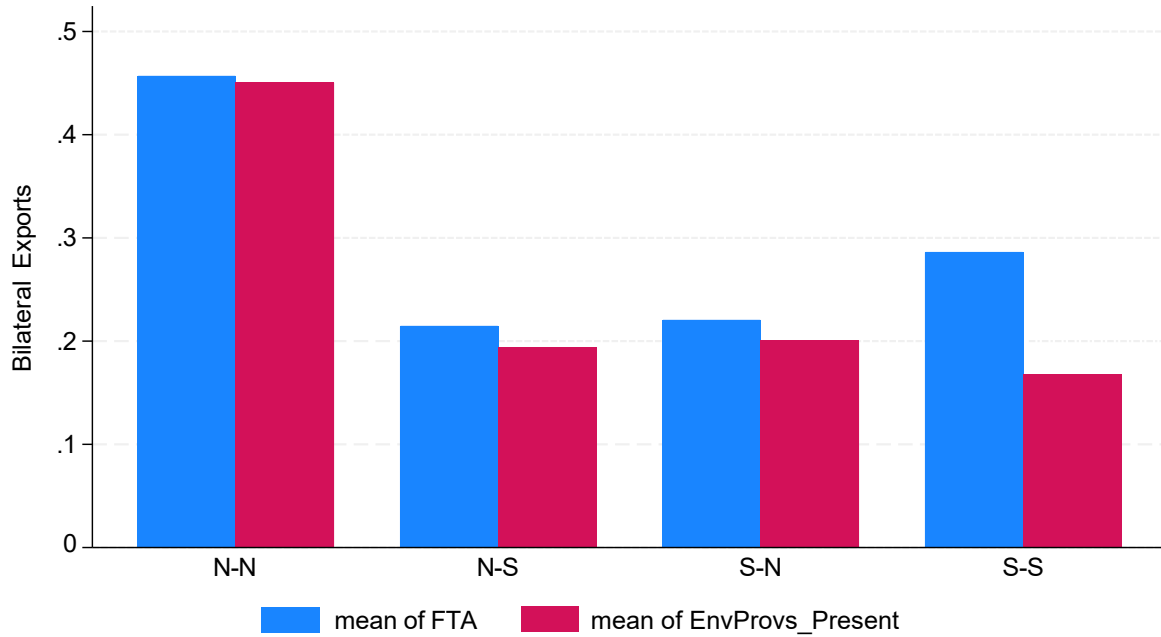
Combining the data on environmental provisions with that of bilateral trade, I obtain 25,501,776 Exporter-Importer sectoral connections, trading in 97 HS2 sectors, from 2000 to 2019. Within these, 6,441,814 pairs, representing about 28%, are involved in a free trade agreement. There are 194 exporting countries included in the sample and a list is presented in Table A.1. Countries are divided into North and South, in tandem with their economic development levels ⁵.

In the past years, the variables followed certain trends. As shown in Table A.3, 27.7% of sectoral bilateral trading relationships are covered by a free trade agreement and 22.4% of these pair contain at least

⁴Export Restrictions, Services, Investment, Movement of Capital, Intellectual Property Rights, Visa and Asylum, Rules of Origin, Trade Facilitation and Customs, Trade Remedies, Technical Barriers to Trade, Sanitary and Phytosanitary Measures, Public Procurement, Subsidies, State-Owned Enterprises, Competition Policy, Environmental Laws and Labour Market Regulations.

⁵According to the World Bank, countries are classified into four broad categories, depending on their Gross National Income (GNI). They include low, lower middle, upper middle and high income countries. In line with the existing literature, I group the global North as high income countries, while upper middle, lower middle and low income countries are categorized as the Southern pole. This classification is done using the median sample year; 2010, as the base year.

Figure 3.1: Share of Bilateral Exports covered by an FTA and an Environmental Provision, by Country Group



Source: Authour's analysis using data from UN Comtrade and Worldbank's Deep Trade Agreement Database

one environmental provision. Almost 0.36% of world export is green and under a free trade agreement with environmental provisions. This share differs for different economic groupings. As presented in Figure 3.1 for N-N trade, 45.7% are involved in an FTA and 45.1% are covered by a minimum of one environmental provision. For other economic country groupings, this percentage is broken down into 21.5% and 19.4% for N-S pairs, 22.1% and 20.1% for S-N trading partners, as well as 28.6% and 16.8%, for S-S pairs.

3.3 Model specification

With the above data, I estimate a gravity equation of trade which details export configuration based on environmental provisions, controlling for the presence of FTAs between trading partners and the depth of these FTAs (Brandi et al., 2020). I use the Poisson Pseudo Maximum Likelihood (PPML) estimator, which is widely used in the literature. This is because their estimates are more robust, as they account for zero trade flows and give more weights to larger trade flows. They are also able to cater for heteroskedasticity in the trade data (Silva and Tenreyro, 2006; Larch et al., 2019; Larch and Yotov, 2024). My model is specified below as;

$$Y_{odst} = \exp(\beta_0 + \beta_1 ENV\ PROV\ S_{odt} + \beta_2 ENV\ PROV\ S_{odt} * Green_s + \beta_3 DEPTH_{odt} + \beta_4 FTA_{odt} + \gamma_{ods} + \gamma_{ost} + \gamma_{dst}) + \epsilon_{odst} \quad (1)$$

Where Y_{odst} is the bilateral export of goods in sector s , from origin country o to destination country d at time t and β_2 is the slope coefficient of interest, which measures the change in the green intensity of sectoral exports, occasioned by environmental provisions. ENVPROVS is the presence or absence as well as total number of environmental provisions, DEPTH is the total count of policy areas covered in the free trade agreement, FTA is a dummy variable to capture the existence of an FTA between country pairs, γ_{ei} , γ_{et} , γ_{it} are vectors for the country pair-sector, importer-year-sector and exporter-year-sector fixed effects, respectively and ϵ_{odst} is the idiosyncratic error.

The green products are coded at the product level, which is at the 6 digits Harmonized System (HS6) level. However, my study involves sectoral exports, coded at the 2 digits Harmonized System (HS2) level, which contain several HS6 products. I then calculate the green intensities⁶ of each sector. I use all three possibilities which include using a weighted average, using a simple average or tagging sectors with at least one green product. The weighted average is simply the division of total green export values by the sum of all export values, within each sector⁷. The simple average involves assigning equal weights to each product by dividing the total number of green products by the total number of products within each sector. The tag option involves assigning a binary variable 1 to each sector with at least one green product and 0 to those without. The values range between 0 and 1, indicating a zero to one hundred percent green export intensity of each sector.

I include an indicator for the existence of a free trade agreement (FTA) in force between trading partners as a control variable. This allows the estimated effect of environmental provisions to be identified separately, by comparing bilateral pairs with FTAs containing environmental provisions to pairs without an FTA or before an FTA enters into force. My analysis focuses on changes in bilateral sectoral exports following the entry into force of FTAs with environmental provisions, conditional on the green intensity of each sector. The treatment variable is coded from the year in which an FTA enters into force until the agreement terminates or, if it remains in force, until 2019, the final year of the sample.

I also control for the Depth of FTAs. Deeper Trade Agreements are more likely to increase trade more than their shallow counterparts (Dür et al., 2014; Hofmann et al., 2017; Mattoo et al., 2020, 2022). The depth of FTAs is also a confounder, as it is a parent of both export and environmental provisions. Deep

⁶The proportion of green products within each sector

⁷This is done using worldwide exports, to avoid endogeneity

trade agreements can influence export levels. Similarly, the deeper the free trade agreement, the more likely the inclusion of environmental provisions. To avoid duplication, I use the highest number of environmental provisions as well as depth for trading partners involved in more than one FTA, at a particular time.

To capture multilateral resistance, I take advantage of the panel data and introduce importer-year-sector and exporter-year-sector fixed effects for individual country time trends and time variant characteristics peculiar to countries, which may be correlated with both export levels and environmental provisions. This takes care of factors that are constant across entities at a particular time but vary within each entity over time, such as Importer and Exporter Gross Domestic Product (GDP). I also introduce country-pair-sector fixed effects, to take care of all time invariant characteristics between trading partners such as common language, common border, geographical distance, cultural distance etc, as well as other unobserved heterogeneity that are fixed overtime. Additionally, this can help with selection bias in signing free trade agreements or including different provisions therein (Baier and Bergstrand, 2007; Baier et al., 2019; Brandi et al., 2020).

Residual endogeneity concerns are addressed by two additional arguments. First, the leads and lags test in Section 4.4.1 as well as the dynamic events study in Section 4.3.1, confirm that there are no pre-existing trends in green export intensity before environmental provisions enter into force, ruling out reverse causality from pre-existing green specialization to FTA content. Second, controlling for both FTA presence and FTA depth isolates the marginal effect of the environmental provision content of agreements from the general trade-promoting effect of FTAs.

I cluster standard errors at importer-exporter-sector level to take care of similar shocks at country pairs and ensure that my estimated coefficients are not overestimated and biased. This also helps with the multi level fixed effects using the PPML estimator.

I first estimate the extensive margin of environmental provisions using a dummy variable equating 1, if there is a signed FTA with at least 1 environmental provision in force between a trading pair, at a particular time, and 0 if otherwise. For the intensive margin, I use the total number of environmental provisions to capture the environmental stringency of the free trade agreement.

4 Empirical Analysis and Results

4.1 Average Effects — The Composition Hypothesis

Before disentangling the heterogeneous effects of environmental provisions on green export specialization, I test if they have a statistically significant average effect. I estimate equation 1 and present the results in Table

Table 4.1: The Average Impact of Environmental Provisions on Green Exports Intensity

	Sectoral Exports						
	(1) (Overall)	(2) (W Intensity)	(3) (S Intensity)	(4) (T Intensity)	(5) (W Intensity)	(6) (S Intensity)	(7) (T Intensity)
EnvProvs_Present	-0.0316 (0.0435)	-0.0288 (0.0448)	-0.0357 (0.0447)	-0.0200 (0.0458)			
EnvProvs_Present * Green _s		-0.0641 (0.1402)	0.0960 (0.1336)	-0.0224 (0.0334)			
EnvProvs_Total					-0.0003 (0.0013)	-0.0005 (0.0013)	0.0002 (0.0013)
EnvProvs_Total * Green _s					-0.0133** (0.0062)	-0.0092 (0.0059)	-0.0023 (0.0015)
Depth_Core_Enf	0.0088*** (0.0026)	0.0088*** (0.0026)	0.0088*** (0.0026)	0.0088*** (0.0026)	0.0095*** (0.0028)	0.0094*** (0.0028)	0.0095*** (0.0028)
FTA	-0.0448 (0.0422)	-0.044 (0.0423)	-0.0456 (0.0422)	-0.0437 (0.0420)	-0.0677* (0.0384)	-0.0677* (0.0384)	-0.0679* (0.0387)
Constant	20.9232*** (0.0085)	20.9229*** (0.0087)	20.9236*** (0.0087)	20.9228*** (0.0083)	20.9197*** (0.0087)	20.9200*** (0.0087)	20.9199*** (0.0085)
Observations	25,501,776	25,501,776	25,501,776	25,501,776	25,501,776	25,501,776	25,501,776
(Pseudo) R ²	0.9883	0.9883	0.9883	0.9883	0.9883	0.9883	0.9883
Country-Pair-Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year-Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Year-Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the results I obtain from running a panel regression of sectoral bilateral exports on environmental provisions in FTAs from 2000-2019 for green and non-green sectors, using PPML estimator. The intensities are calculated using a weighted average (W), simple average (S) and tag of at least one green product within each sector (T). Standard errors are robust and clustered at country-pair-sector (exporter-importer-sector) level. They are enclosed in parenthesis and reported underneath their respective estimated coefficients. $p < 0.01^{***}$; $p < 0.05^{**}$; $p < 0.1^*$.

4.1. The null result on β_1 — the average baseline effect on sectoral exports, independent of green intensity — is consistent across all seven columns and all three green intensity measures. Whether measured by the binary presence of provisions (columns 1-4) or their total count (columns 5-7), environmental provisions do not have a statistically significant average effect on bilateral sectoral exports, holding other factors constant. This replicates the findings of Brandi et al. (2020) as well as Mkandawire et al. (2024) and is not surprising: provisions that target environmental composition should not be expected to uniformly increase all trade.

The coefficient of primary interest, β_2 , is also statistically insignificant for the binary measure across all intensity weighting schemes (columns 2-4). The mere presence of environmental provisions in an FTA does not shift the green composition of sectoral exports in a statistically discernible way when averaging across all provision types, all country pairs, and all sectors simultaneously. One exception is the intensive margin under the weighted intensity measure in column 5 but this is not robust and masks heterogeneity across sub categories. It is therefore pertinent to disentangle the effects.

The FTA depth coefficient (Depth_Core_Enf) is positive and highly significant across all specifications, with values ranging from 0.0088 to 0.0095. Each additional legally enforceable core policy area covered by an FTA is associated with approximately a 0.9 percent increase in bilateral sectoral exports. This is consistent with the literature on deep integration: more comprehensive agreements reduce a broader range of non-tariff

barriers, generating larger and more stable trade flows (Dür et al., 2014; Hofmann et al., 2017; Mattoo et al., 2020, 2022). The FTA binary indicator is generally insignificant or marginally negative, suggesting that once depth and environmental provisions are controlled for, the simple existence of an FTA adds little additional trade. This is consistent with a saturated fixed effects structure that already absorbs much of the bilateral pair variation.

4.2 Heterogeneity Analyses

To explore the mechanisms through which environmental provisions in FTAs may shape green export specialization, I examine heterogeneous effects across three dimensions: provision type, sector, and country development status. Throughout the heterogeneity analyses, I use the weighted-average green intensity measure, which provides the most economically meaningful assessment by weighting each product according to its trade value.

4.2.1 Environmental Provisions Sub-Category

The null average result conceals substantial variation in which types of environmental provisions matter for green export specialization. I decompose environmental provisions into its seven broad subcategories and estimate separate interaction effects for each. Results are presented in Table 4.2

Environmental Goals and Objectives: The coefficient on this subcategory is statistically insignificant for both green and non-green sectors. Provisions that merely state environmental aspirations without specifying mechanisms — the most common and least demanding type — have no discernible effect on trade composition. This is consistent with the view that hortatory language in FTAs is cheap talk without enforcement bite (Lechner, 2016).

Balance between Environmental and Trade/Investment Goals: This subcategory generates the most striking results in the paper. For non-green sectors, the coefficient is negative and statistically significant, indicating a 61.33 percent average reduction in exports. For green sectors, the corresponding coefficient is positive and large — implying over 200 percent increase in green export intensity — capturing a notable shift in the composition of exports from non-green to green goods. The most plausible mechanism is that this subcategory includes a provision explicitly promoting the liberalization of trade in environmental goods. The sector-level analysis of this provision in isolation confirms this interpretation.

Enforcement Mechanisms: Stronger enforcement of environmental provisions is associated with increased exports for non-green sectors. For green sectors, enforcement is associated with reduced export

Table 4.2: Heterogeneity Analysis -Environmental Provisions Subcategories

	(1) Sectoral Exports
EnvProvs_Obj	0.0517 (0.0466)
Env_Obj * Green _s	-0.3152 (0.3553)
Bal Env Trade	-0.4783*** (0.0790)
Bal Env Trade * Green _s	1.2777*** (0.4992)
Enf	0.4490*** (0.0700)
Enf * Green _s	-1.0114** (0.4780)
Ext_Assist	0.0298 (0.0321)
Ext_Assist * Green _s	-0.0913 (0.2386)
Env_Protect	-0.0645* (0.0348)
Env_Protect * Green _s	0.0978 (0.2416)
MEA_Comp	0.0397 (0.0425)
MEA_Comp * Green _s	0.7148** (0.2952)
Prom_Obj	-0.0745 (0.0509)
Prom_Obj * Green _s	-0.7936** (0.3892)
Depth Core Enf	0.0089*** (0.0028)
FTA	-0.0315 (0.0448)
Constant	20.9255*** (0.0096)
Observations	25,501,776
(Pseudo) R ²	0.9883
Country-Pair-Sector FE	Yes
Exporter-Year-Sector FE	Yes
Importer-Year-Sector FE	Yes

Notes: This table shows the results I obtain from running a panel regression of sectoral bilateral exports on the seven subcategories of environmental provisions in FTAs from 2000-2019 for green and non-green sectors, using PPML estimator. Standard errors are robust and clustered at country-pair-sector (exporter-importer-sector) level. They are in enclosed in parenthesis and reported underneath their respective estimated coefficients. p < 0.01***; p < 0.05**; p < 0.1*.

intensity. This asymmetry suggests that rigorous environmental enforcement increases general trade credibility — reducing regulatory uncertainty for all trading partners — but may also raise compliance costs that are disproportionately borne by green sector producers, who face stricter standards than non-green producers in the same agreement.

External Assistance: The coefficient is statistically insignificant for both green and non-green sectors. Environmental aid provisions embedded in FTAs do not translate into measurable changes in trade composition, at least within the time frame studied.

General Environmental Protection: This subcategory is associated with reduced exports in non-green sectors, consistent with the regulatory burden hypothesis: provisions that raise general environmental standards impose costs on conventional producers. The effect is positive but insignificant for green sectors, suggesting that these provisions do not provide sufficient specificity to generate green export specialization.

MEA Compliance: Provisions requiring compliance with multilateral environmental agreements generate a positive and significant effect on green sector exports. This finding is consistent with the idea that MEA-aligned provisions provide a credible and internationally recognized green standard that facilitates market access for green goods in partner countries. The effect is positive but insignificant for non-green sectors, confirming that it operates through the composition channel rather than a general trade-promotion channel.

Participation in Promoting Environmental Objectives: This subcategory is associated with reduced green export intensity, suggesting that participation-oriented clauses may be too diffuse or process-focused to generate tangible green trade specialization effects.

4.2.2 Liberalization of Trade in Environmental Goods

The Balance subcategory result points directly to the specific provision that determines whether the FTA provides for the differential and greater liberalization of trade in environmental goods. I focus on the specific provisions within the “*Balance between Environmental & Trade/Investment Goals*” subcategory in order to isolate and estimate its effect directly. Table 4.3 shows that this provision alone increases the green intensity of exports in green sectors by 140 percent. This is the most policy-relevant and theoretically grounded result in the paper.

The mechanism is transparent: this provision explicitly targets the removal of tariff and non-tariff barriers to trade in environmental goods, directly reducing the cost of exporting green products relative to non-green alternatives. Its effect is therefore concentrated in green sectors by design, generating the composition shift

Table 4.3: Heterogeneity Analysis -Balance between Environmental & Trade/Investment Goals

	(1)
	Sectoral Exports
EnvProvs _Present	0.0024 (0.0655)
EnvProvs _Present * Green _s	-0.9500 (0.2962)
General Env. Exception	-0.1537*** (0.0409)
General Env. Exception * Green _s	1.4021*** (0.3199)
Investment Env. Exception	0.1285*** (0.0318)
Investment Env. Exception * Green _s	0.1733 (0.2453)
No Env. Dilution (Trade)	-0.0905 (0.0562)
No Env. Dilution (Trade) * Green _s	-0.1700 (0.3797)
No Env. Dilution (Investment)	0.0394 (0.0415)
No Env. Dilution (Investment) * Green _s	-0.4448 (0.3376)
Env. Goods Liberalization	-0.0127 (0.0626)
Env. Goods Liberalization * Green _s	0.8766** (0.3897)
Science-Based Regulation	0.1415* (0.0770)
Science-Based Regulation * Green _s	-0.4953 (0.4596)
Environmental Impact Assessment	-0.0268 (0.0506)
Environmental Impact Assessment * Green _s	-0.4164 (0.3256)
Depth_Core_Enf	0.0126*** (0.0032)
FTA	-0.0510 (0.0428)
Constant	20.9152*** (0.0099)
Observations	25,501,776
(Pseudo) R ²	0.9883
Country-Pair-Sector FE	Yes
Exporter-Year-Sector FE	Yes
Importer-Year-Sector FE	Yes

Notes: This table shows the results I obtain from running a panel regression of sectoral bilateral exports on each of the environmental provisions within the balance of environmental and trade/investment objectives subcategory, from 2000-2019 for green and non-green sectors, using PPML estimator. It contains a provision directly liberalizing the trade in environmental goods (EnvProvs 12). Standard errors are robust and clustered at country-pair-sector (exporter-importer-sector) level. They are in enclosed in parenthesis and reported underneath their respective estimated coefficients. $p < 0.01^{***}$; $p < 0.05^{**}$; $p < 0.1^{*}$.

that more generic environmental provisions cannot. This finding has direct policy implications: the content of environmental provisions matters far more than their number. A single well-designed provision that specifically targets environmental goods trade can generate larger green export specialization effects than entire chapters of aspirational environmental language.

4.2.3 Heterogeneity by Sector

The most granular layer of the analysis examines how effects vary across the 21 broad WTO-named sector groups⁸ constructed from the 97 HS2 codes in the sample. A list of each sector and their respective HS2 codes are listed in Table A.8. I present the results in Figure 4.1 and Table B.1. Several patterns emerge that would be invisible at a more aggregated level of analysis.

Minerals: Environmental provisions generate a very large positive effect on exports in the green minerals sub-sector. While most minerals are non-green, a subset — including limestone flux and hydrated lime used in chemical recovery systems, wastewater management, and air pollution control — are classified as environmental goods. The result implies that FTAs with environmental provisions substantially boost trade in these specific green mineral products, consistent with growing global demand for environmentally functional raw materials.

Plastics: The plastics sector is conventionally regarded as highly polluting. However, a subset of plastic products — including reusable waste collection bins and other solid waste management goods — are classified as green. For these green plastics, environmental provisions generate a strong positive effect on export intensity, suggesting that FTAs can foster trade in sustainable plastics even within otherwise pollution-intensive sectors.

Green Stone and Cement: Stone and cement products show a positive effect, though smaller than for minerals and plastics, alongside a significant reduction in non-green sector exports. This pattern — green up, non-green down — is consistent with a composition shift driven by rising environmental standards in construction and building materials markets.

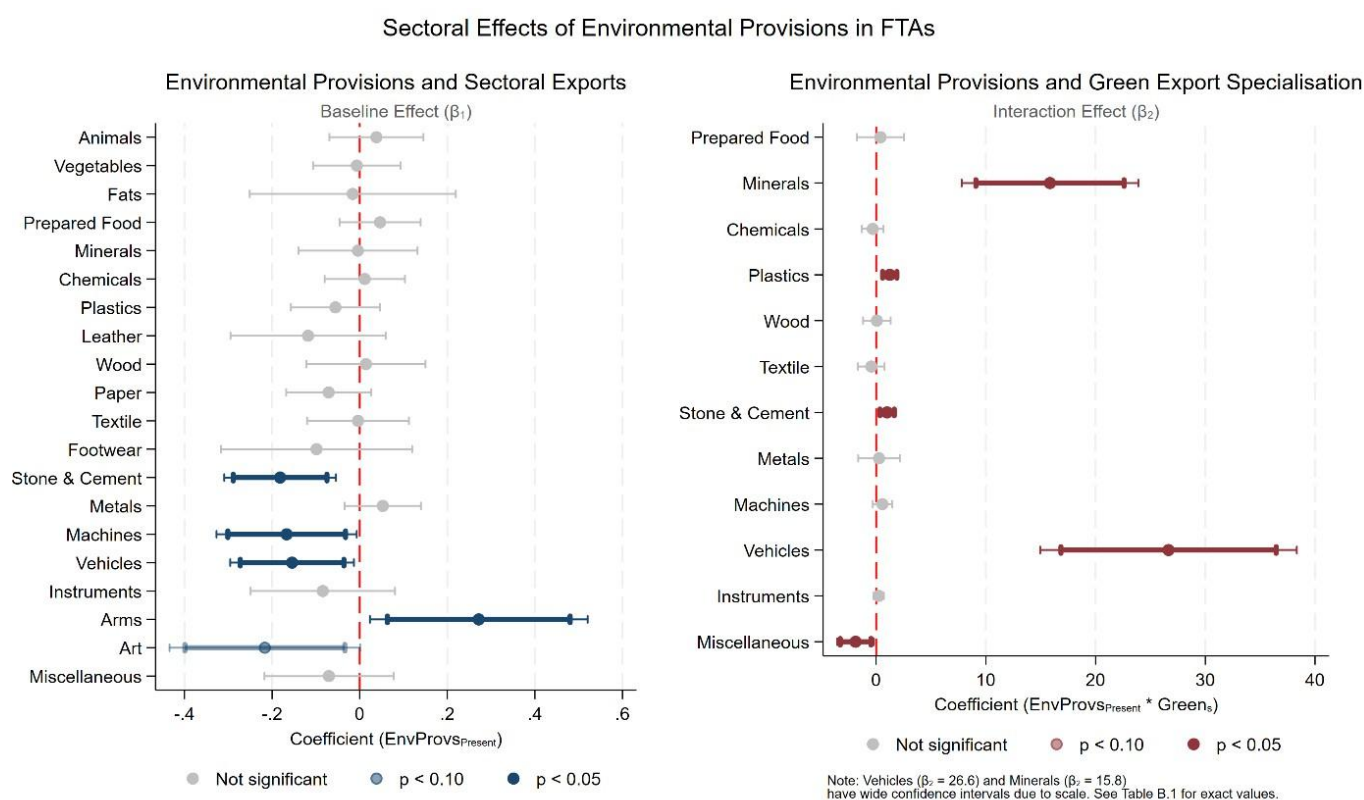
Vehicles: The vehicles sector produces the sharpest contrast in the sample. Non-green vehicle exports are significantly reduced by environmental provisions, while green vehicle exports — electric vehicles, hybrid vehicles, and related eco-friendly transportation equipment — show a large and highly significant increase in export intensity. This reflects the global regulatory momentum towards clean transportation and suggests that FTAs with environmental provisions accelerate the international market development for green vehicles

⁸https://www.wto.org/english/tratop_e/safeg_e/safeg_statindex_e.htm

by reducing trade barriers for these products specifically.

Other sectors — including animals, prepared foods, chemicals, textiles, and leather — show mixed and generally insignificant results, which is consistent with the expectation that provisions have heterogeneous sectoral effects and that the composition shift operates through specific product-market channels rather than uniformly across the economy.

Figure 4.1: Sectoral Effects of Environmental Provisions



Notes: This figure shows the CI plots of the results from a HDPE PPML regression of sectoral exports on environmental provisions in FTAs for various sectors. Standard errors are robust to heteroskedasticity and clustered at the country-pair-sector level.

4.2.4 Heterogeneity by Country Development Status

I stratify the sample into four bilateral country groupings — North-North (N-N), North-South (N-S), South-North (S-N), and South-South (S-S) — and estimate the interaction effect of environmental provisions with green intensity separately for each group. I present the results in Table 4.4.

North-North: Neither the extensive nor the intensive margin of environmental provisions generates a statistically significant effect on green or non-green export intensity for N-N pairs. This null result is consistent with the regulatory convergence hypothesis: developed countries already operate under high and

broadly harmonized environmental standards, so incremental provisions in FTAs add little regulatory signal that was not already present in domestic law. For these pairs, environmental FTA chapters may be largely redundant with existing domestic regulation.

North-South: The extensive margin is negative and significant at the 5 percent level for sectors with no green content (-0.1319), indicating that the presence of environmental provisions in North-South FTAs reduces conventional exports from developed to developing country markets. One plausible explanation is that environmental provisions in these agreements introduce regulatory requirements that raise the cost of exporting conventional goods from northern producers into southern markets, or alternatively that southern importers face higher compliance costs in processing such imports. The green sector interaction is positive but statistically insignificant. The intensive margin, however, is more informative. Each additional environmental provision is associated with a small but significant reduction in non-green exports from northern to southern markets (-0.0031), while simultaneously generating a 2.97 percent increase in green export intensity in green sectors. This pattern is consistent with environmental provisions in North-South FTAs gradually redirecting northern exports away from conventional goods and towards greener products in southern markets.

South-North: The extensive margin is insignificant for non-green sectors, but the presence of environmental provisions in the FTA reduces green export intensity by 49.8 percent for green sectors. This striking negative finding suggests that developing country exporters face severe difficulties meeting the environmental standards required by developed country importers when the agreement includes green-sector provisions. Rather than facilitating green exports from the South to the North, these provisions appear to constitute a non-tariff barrier. The intensive margin confirms this: an additional provision increases non-green exports marginally (0.43 percent) while reducing green export intensity by 4.78 percent. Developing countries exporting to developed country markets thus face a paradox: the environmental provisions designed to promote green trade instead reduce their green export competitiveness relative to non-green alternatives.

South-South: This grouping produces the most unambiguously positive results. The extensive margin is associated with a large and positive coefficient for green sectors (1.5265), indicating that the presence of environmental provisions in South-South FTAs substantially increases green export specialization. The intensive margin confirms this: each additional provision is associated with a 7.66 percent increase in green export intensity. The mechanism likely reflects mutual regulatory alignment between developing countries facing similar environmental challenges and comparable regulatory capacity, reducing the compliance cost asymmetry that undermines green export performance in South-North agreements. South-South FTAs with environmental provisions appear to function as genuine coordination devices for green trade, rather than as

Table 4.4: Heterogeneity Analysis - Economic Groupings: Binary & Total

	Sectoral Exports	
	(1)	(2)
EnvProvs Present <i>N N</i>	-0.0729 (0.0693)	
EnvProvs Present <i>N N</i> * Green _s	-0.2922 (0.1975)	
EnvProvs Present <i>N S</i>	-0.1319** (0.0584)	
EnvProvs Present <i>N S</i> * Green _s	0.4226 (0.3454)	
EnvProvs Present <i>S N</i>	0.0685 (0.0555)	
EnvProvs Present <i>S N</i> * Green _s	-0.6908*** (0.2624)	
EnvProvs Present <i>S S</i>	-0.0619 (0.0482)	
EnvProvs Present <i>S S</i> * Green _s	1.5265*** (0.4105)	
EnvProvs Total <i>N N</i>		0.0009 (0.0018)
EnvProvs Total <i>N N</i> * Green _s		-0.0140 (0.0086)
EnvProvs Total <i>N S</i>		-0.0031* (0.0018)
EnvProvs Total <i>N S</i> * Green _s		0.0293** (0.0139)
EnvProvs Total <i>S N</i>		0.0043* (0.0027)
EnvProvs Total <i>S N</i> * Green _s		-0.0467*** (0.0158)
EnvProvs Total <i>S S</i>		-0.0008 (0.0028)
EnvProvs Total <i>S S</i> * Green _s		0.0738** (0.0351)
Depth Core Inf	0.0104*** (0.0031)	0.0094*** (0.0027)
FTA	-0.0344 (0.0411)	-0.0653* (0.0361)
Constant	20.9237*** (0.0090)	20.9194*** (0.0088)
Observations	25,501,776	25,501,776
(Pseudo) R ²	0.9883	0.9883
Country-Pair-Sector FE	Yes	Yes
Exporter-Year-Sector FE	Yes	Yes
Importer-Year-Sector FE	Yes	Yes

Notes: This table shows the heterogeneous effects of running a panel regression of sectoral bilateral exports on environmental provisions in FTAs, by country grouping, from 2000-2019 for green and non-green sectors, using PPML estimator. It presents the extensive (binary) and intensive margins (total number) of the environmental provisions. Standard errors are robust and clustered at country-pair-sector (exporter-importer-sector) level. They are in enclosed in parenthesis and reported underneath their respective estimated coefficients. $p < 0.01^{***}$; $p < 0.05^{**}$; $p < 0.1^{*}$.

regulatory barriers.

A formal hypothesis test for differences across country groupings, reported in Table A.7, confirms that most bilateral groupings are statistically distinguishable from each other. The one exception — S-N and N-N — is consistent with the similarly negative or null results found for these two groupings and provides additional support for the view that the negative S-N effect reflects compliance barriers analogous to those facing developing country exporters.

4.3 Identification: Addressing Endogeneity Concerns

The triple fixed effects structure absorbs the main sources of selection bias and controls for all time-varying supply and demand shocks at the sector level. However, two residual endogeneity concerns warrant direct attention. First, country pairs already developing green export capacity in specific sectors may selectively negotiate FTAs containing the provision for the differential and greater liberalization of trade in environmental goods, generating reverse causality from pre-existing green sector strength to provision inclusion. Second, time-varying omitted variables — such as shifts in bilateral environmental preferences — may jointly determine both FTA environmental ambition and green export performance within country-pair-sector cells. I address these concerns through several strategies.

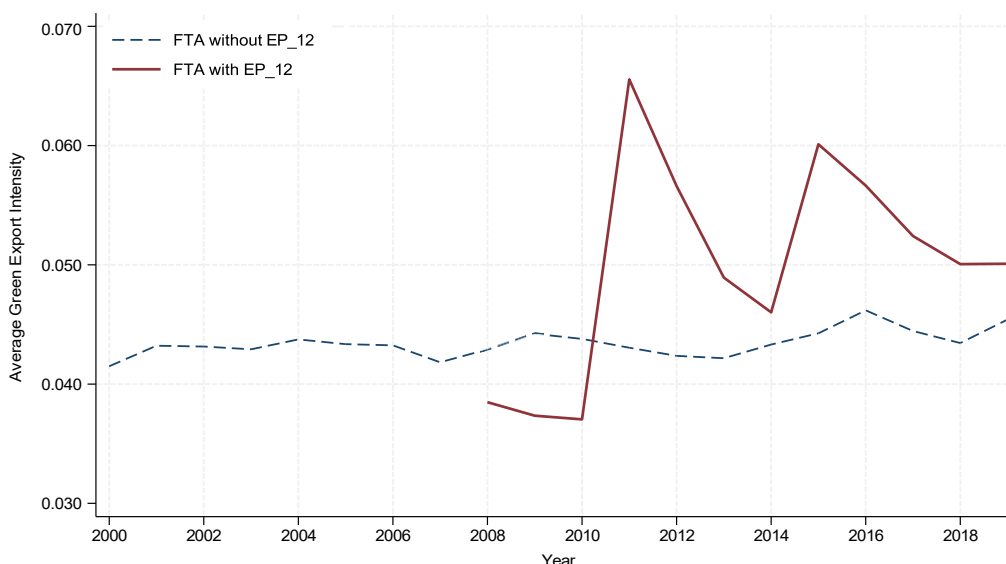
Before turning to the regression-based evidence, Figure 4.2 provides descriptive motivation. It plots the average green export intensity⁹ over time separately for pairs whose FTA contains the provision for the differential and greater liberalization of trade in environmental goods and for pairs with an FTA but without this provision. Two patterns stand out. First, prior to the adoption of this provision — which begins to appear in FTAs from 2008 — the two groups show broadly similar and nearly flat green export intensity, consistent with the absence of pre-existing differential trends between treated and untreated pairs. Second, from 2010 onwards, green export intensity among treated pairs is persistently higher than among pairs without the provision, consistent with a positive and sustained green export specialization effect following its adoption. The treated group exhibits some volatility, reflecting the relatively small number of agreements containing this provision (33 of 287 FTAs), and the sharp increase observed in 2008–2010 coincides with the global financial crisis, during which aggregate trade collapsed but green goods may have followed different recovery dynamics.¹⁰ Despite this volatility, the persistent gap in favour of treated pairs from 2010 onwards

⁹Green export intensity is the value-weighted share of green products in total sectoral exports, averaged across all country pairs within each group in each year. The treated group includes all pairs whose FTA contains the provision for the differential and greater liberalization of trade in environmental goods. The comparison group includes pairs with an FTA in force but without this provision. Never-treated pairs with no FTA are excluded from the figure for clarity.

¹⁰The volatility of the treated series relative to the comparison series is expected: with a smaller number of treated pairs, each new adoption or large trading pair entering the sample creates visible jumps in the group average. This does not affect

provides descriptive support for the composition hypothesis. The regression-based evidence below confirms this pattern after absorbing all time-invariant bilateral characteristics and time-varying country-sector confounders.

Figure 4.2: Green Export Intensity Over Time by Inclusion of the Provision for the Differential and Greater Liberalization of Trade in Environmental Goods



Notes: Green export intensity is the value-weighted share of green products in total sectoral exports, averaged across country pairs within each group in each year. The treated group includes pairs whose FTA contains the provision for the differential and greater liberalization of trade in environmental goods. The comparison group includes pairs with an FTA in force but without this provision. The region 2008–2010 coincides with the global financial crisis. Pairs with no FTA are excluded for clarity.

4.3.1 Pre-Trends: Event Study

To test formally for the absence of pre-existing trends and to examine the dynamic pattern of effects around adoption, I estimate an event study specification using the panel of country-pair-sector observations. Treatment timing is defined at the country-pair level — since the provision for the liberalization of trade in environmental goods is a bilateral FTA commitment that applies simultaneously across all sectors for a given pair — and the event-time variable measures the number of years before or after the provision enters into force for each pair. The reference period is $t - 1$, the year immediately before entry into force. Observations at five or more years before and after adoption are binned into endpoint categories to preserve the regression-based identification results that follow, which control for country pair-sector, exporter-sector-year, and importer-sector-year fixed effects.

sample size at the extremes. Never-treated pairs — those whose FTA never contains this provision — serve as the implicit control group through the fixed effects structure. The specification also controls for the other provisions in the Balance between Environmental and Trade/Investment Goals subcategory and for the general environmental provision interaction, isolating the dynamic pattern specific to the environmental goods liberalization provision.

The event study specification is:

$$Y_{odst} = \exp \left(\sum_{k=-1} \beta_k \cdot \mathbf{1}[Event_{odt} = k] + \sum_{k=-1} \delta_k \cdot \mathbf{1}[Event_{odt} = k] \times Green_s + \right. \\ \left. \beta_3 DEPTH_{odt} + \beta_4 FTA_{odt} + \gamma_{ods} + \gamma_{ost} + \gamma_{dst} + \varepsilon_{odst} \right) \quad (2)$$

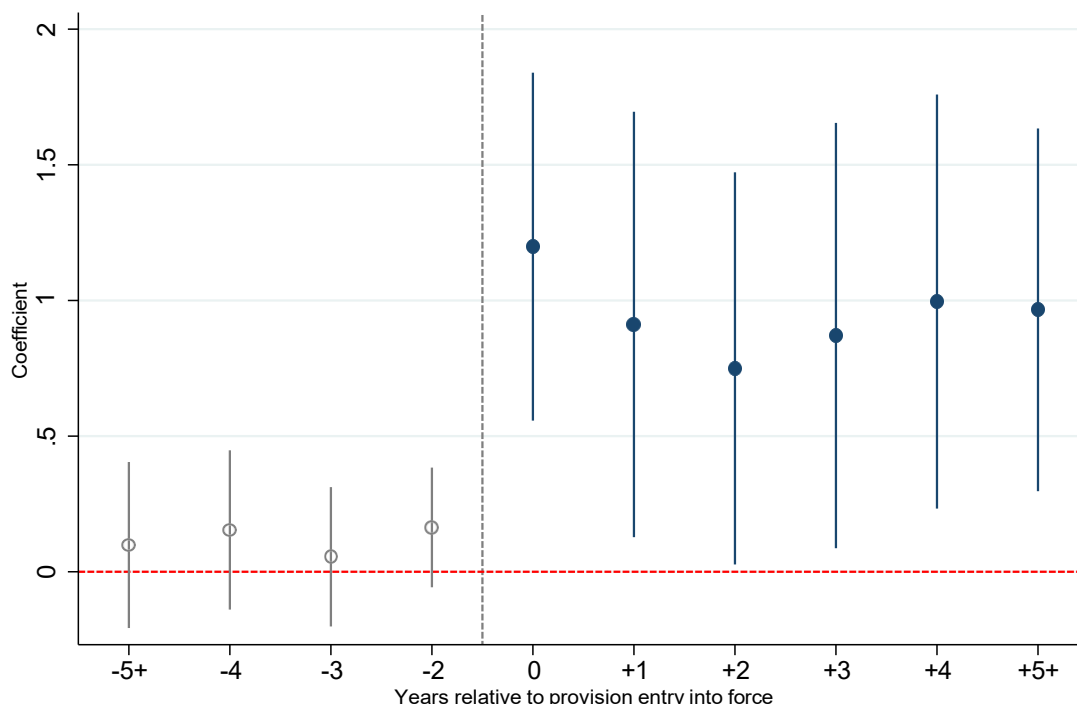
where $Event_{odt}$ denotes the number of years relative to provision entry into force for pair (o, d) at time t , $\mathbf{1}[\cdot]$ is an indicator function, and k runs from -5 (or earlier) to $+5$ (or later), with $k = -1$ omitted as the reference period. The coefficients β_k capture the average effect on total sectoral exports at each event-time horizon, and the coefficients δ_k capture the differential effect on green sectors — the dynamic analogue of β_2 in the main specification. The specification is estimated by PPML with the same three-way fixed effects and standard errors clustered at the country-pair-sector level.

Figure 4.3 presents the δ_k coefficients — the green sector interaction at each event-time horizon — with 90 percent confidence intervals. The pre-trend coefficients δ_k for $k \in \{-5, -4, -3, -2\}$ are all statistically insignificant and close to zero. A joint test of the four pre-trend green interaction coefficients fails to reject the null of joint insignificance ($\chi^2(4) = 2.10$, $p = 0.717$), directly ruling out the reverse causality story in which countries with already-growing green export sectors selectively negotiate FTAs with the environmental goods liberalization provision.

Following entry into force, the green interaction coefficients δ_k rise sharply and remain persistently positive. The effect is statistically significant from the adoption year onwards, with coefficients ranging from 0.912 at $t + 1$ to 0.966 at $t + 5$. A joint test of the six post-entry green interaction coefficients rejects the null of joint insignificance ($\chi^2(6) = 12.10$, $p = 0.0598$), confirming that the provision generates a significant and sustained green export specialization effect after adoption. A further test of treatment stability — whether the post-entry coefficients are jointly equal — fails to reject equality ($\chi^2(5) = 2.63$, $p = 0.756$), indicating that the effect does not fade over the post-entry window but remains stable in magnitude. Together, these results are consistent with a causal interpretation of the environmental goods liberalization provision on green export specialization: flat pre-trends rule out reverse causality, and a stable, persistent post-entry

effect rules out transitory adjustment dynamics.

Figure 4.3: Event Study: Pre-Trends and Dynamic Effects of the Environmental Goods Liberalization Provision and Green Export Specialization



Notes: This figure presents event-study estimates of $\hat{\delta}_k$ from Equation 2, capturing the differential effect of the environmental goods liberalization provision on green sectors at each event-time horizon. Reference period: $t - 1$. Endpoint bins: $k \leq -5$ and $k \geq +5$. Dashed vertical line separates pre- from post-entry. Controls include other Balance subcategory provisions, general environmental provision interaction, FTA depth, and FTA indicator. Three-way fixed effects: country-pair-sector, exporter-sector-year, and importer-sector-year. SE clustered at country-pair-sector level. 90 percent confidence intervals shown. Joint pre-trend test: $\chi^2(4) = 2.10$, $p = 0.717$. Joint post-entry test: $\chi^2(6) = 12.10$, $p = 0.0598$.

4.3.2 Placebo Test: Fake Treatment Timing

As an additional check, I estimate a placebo event-study by assigning treatment dates five years before the actual entry into force of the environmental goods liberalization provision. If the baseline estimates were driven by spurious trends or omitted factors rather than the provision itself, significant effects would be expected around these placebo treatment dates.

Figure C.1 shows that the placebo coefficients are statistically insignificant throughout the pre-treatment period and the first four post-treatment periods, providing no evidence of spurious treatment effects. The only significant estimate appears in the $k \geq +5$ endpoint bin, which overlaps with the actual treatment period because the placebo treatment dates are shifted five years earlier. Consequently, this coefficient

reflects contamination from the true treatment effect rather than a placebo response. Overall, the placebo test supports the validity of the baseline identification strategy by indicating that the estimated effects are not driven by differential pre-existing trends or arbitrary treatment timing.

4.4 Robustness Checks

To verify that the main results are consistent across alternative specifications and sample compositions, I conduct several robustness checks. For all estimations, I use the weighted average green intensity measure, which provides the most comprehensive assessment of green export intensity by incorporating both the number and value of green exports within each sector.

4.4.1 Anticipation and Phase-in Effects

I allow for a possible phase-in effect given that negotiations of FTAs and their constituent environmental provisions take time. In line with previous literature, I allow a three-year period for negotiations (Bastiaens and Postnikov, 2017). There is also some time lag between the signing and entry into force of FTAs; from my sample, the average time lag is 1.5 years. The leads and lags specification therefore also serves as a placebo test for anticipation effects on the average result.

As presented in Table D.1, none of the lead or lag coefficients is statistically significant, indicating no anticipatory or phase-in effects in the average specification. This is consistent with the event study evidence in Section 4.3.1, which confirms the absence of pre-existing trends specifically for the provision targeting the liberalization of trade in environmental goods. Together, these results rule out the reverse causality story in which countries with already-growing green export sectors selectively negotiate FTAs with environmental provisions, and justify the contemporaneous specification in Equation 1.

4.4.2 Excluding the General Exception Clause

The general exception clause is the most frequently occurring environmental provision, appearing in approximately 90 percent of all FTAs with any environmental content. To ensure that the Balance subcategory result — and specifically the finding on the provision liberalizing trade in environmental goods — is not driven by its co-occurrence with this dominant clause, I re-run the Balance subcategory specification excluding pairs where the general exception clause is present. Table D.2 shows that the result for the environmental goods liberalization provision remains positive, significant, and of comparable magnitude after this exclusion. The main finding therefore reflects the substantive content of the provision rather than the prevalence of the

most common environmental clause.

4.4.3 Excluding the European Union and the United States

The European Union and the United States are the two most systemically important parties to FTAs globally. The EU is involved in approximately 20 percent of FTAs in the sample and represents 23.5 percent of exporters; the US participates in approximately 3.5 percent of FTAs and accounts for 1.3 percent of exporters. Their disproportionate weight in the sample raises the concern that the economic grouping results — particularly the North-North and North-South findings — could be driven by the specific FTA designs and trade patterns of these two actors. I therefore re-run the economic grouping specifications (Section 4.2.4) excluding the EU and the US as exporters.

Figure D.1 presents the green interaction coefficients (δ_2) from the main specifications alongside those from the restricted sample, for both the binary and total environmental provision measures. The core findings are preserved. The South-South green specialization result remains positive and significant on both the extensive margin (1.3716, significant at the 1 percent level) and the intensive margin (0.0766, significant at the 5 percent level), with magnitudes closely comparable to the main results. The South-North negative green interaction is preserved and strengthens marginally (-0.7733 binary, -0.0472 total, both significant at the 1 percent level). The North-North null is maintained across both margins. For North-South trade, the negative baseline effect is preserved, while the positive green specialization effect remains significant on the intensive margin (0.0406, significant at the 5 percent level). The binary interaction remains statistically insignificant across both specifications. Overall, the main conclusions remain robust after excluding EU and US exporters, indicating that the principal findings are not driven solely by the export patterns of these two major trading actors.

4.4.4 South-South Result: Dominant Exporter Check

The South-South green specialization result is one of the strongest positive finding in the paper. China is the dominant South-South exporter, accounting for the largest share of both non-green and green South-South exports.¹¹ Given China's state-directed green industrial policy, I confirm that the South-South result is not driven by China or this small group of dominant exporters by excluding the top five South-South exporters from the specification.

¹¹The top five South-South exporters account for approximately 49 percent of total non-green South-South exports (China, India, Russian Federation, Mexico, and Turkey in order of size) and 50 percent of total green South-South exports (China, Mexico, India, Russian Federation, and Thailand). China tops both rankings, reflecting its dominant role in South-South trade generally and its large and growing green export capacity specifically.

Figure D.2 present the results. The South-South green interaction coefficients are virtually identical to the main results on both the extensive margin (1.5264 vs 1.5265, both significant at the 1 percent level) and the intensive margin (0.0738 vs 0.0766, both significant at the 5 percent level). All other grouping coefficients are equally stable. These results confirm that the South-South finding reflects a genuinely broad-based pattern of green export specialization across developing country pairs and is not driven by the specific contribution of China or any small group of dominant exporters.

4.4.5 Sector-Level Robustness

The sector-level results in figure 4.1 show large positive interaction coefficients for Vehicles and Minerals. To confirm these are not driven by outlier country pairs or dominant bilateral relationships within these sectors, I drop the top five country pairs by total export volume in these two sectors and re-estimate. Table D.3 presents the comparison between the main sector-level coefficients and those from the restricted sample. The main sector pattern is preserved after dropping dominant pairs: The positive and significant green interaction coefficients for Vehicles, Minerals, Plastics, and Stone & Cement are fully preserved, confirming that these reflect genuine sector-level patterns rather than outlier-driven artifacts.

5 Conclusion

This paper investigates whether environmental provisions in free trade agreements increase green export specialization. The answer is: it depends — on which provisions, between whom, and in which sectors. This three-part answer is not a hedge; it is the contribution.

The average effect of environmental provisions on green export intensity is statistically insignificant. Counting provisions does not reveal where the action is. What matters is provision specificity: The environmental provision that explicitly mandates the differential liberalization of trade in environmental goods, increases green export intensity in green sectors by over 140 percent. Aspirational environmental language, external assistance provisions, and general protection clauses generate no comparable effect. Policymakers and trade negotiators seeking to use FTAs as instruments of green trade promotion should focus on this specific type of provision rather than maximizing the count of environmental chapters.

The development context of trading partners is equally decisive. Here, South-South FTAs consistently generate the strongest green export specialization effects — over 7 percent per additional provision in green sectors — because they enable mutual regulatory alignment between countries facing similar environmen-

tal challenges with comparable institutional capacity. In contrast, South-North FTAs impose compliance burdens that reduce developing country green export intensity, producing an outcome that is the opposite of their stated environmental intent. North-North FTAs generate null effects, consistent with regulatory convergence already achieved through domestic law. These asymmetries imply that FTA design should be differentiated by the development context of the parties rather than applying a uniform template.

At the sector level, the clearest gains accrue to green minerals, green plastics, green construction materials, and — most notably — green vehicles. The vehicle result in particular is consistent with the global regulatory transition towards clean transportation and suggests that FTAs can serve as accelerators of sectoral green comparative advantage when their environmental provisions are sufficiently specific.

Three policy implications follow directly from these findings. First, future FTAs should prioritize provisions that explicitly liberalize trade in environmental goods rather than relying on general environmental clauses that have no measurable trade composition effect. Second, the design of environmental provisions in agreements between developed and developing countries should account for compliance cost asymmetries, potentially through capacity building and technical assistance that makes green compliance genuinely achievable for developing country producers. Third, sectoral targeting — tailoring environmental provisions to the specific green goods that appear in each sector — could substantially enhance their effectiveness in promoting green export specialization.

Further research can focus on how firms react to environmental provisions, in order to shed more light on the possible mechanisms.

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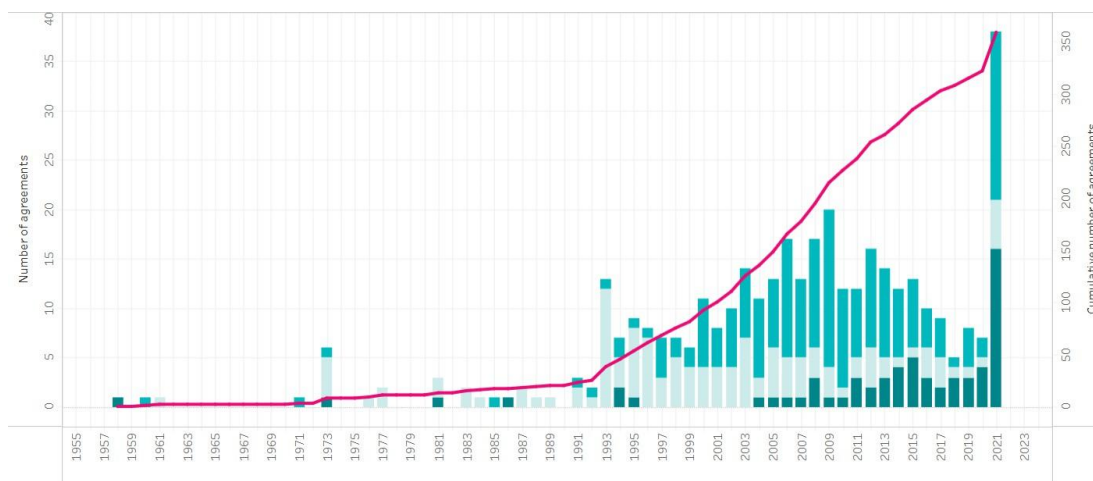
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A Data

A.1 FTA Policy Area Coverage

Figure A.1: Number of Policy Areas covered and Legally Enforceable in FTAs



Source: Deep Trade Agreements Database 1.0

Note: Number of policy areas covered in an agreement is calculated as the count of policy areas included in a PTA. The maximum number of policy areas mapped is 52. For more information on the policy areas that are mapped see Hoffman, Osniago and Ruta (2018): <https://documents.worldbank.org/curated/en/700771487791538589/Horizontal-depth-a-new-database-on-the-content-of-preferential-trade-agreements>

A.2 List of Exporting Countries in the Sample

Table A.1: List of Exporting Countries in the Sample

<i>All Countries</i>				
Afghanistan	Columbia	Hong Kong*	Morocco	Sierra Leone
Albania	Comoros	Hungary*	Mozambique	Singapore*
Algeria	Congo Republic	Iceland*	Myanmar	Slovakia*
Andorra*	Cook Islands	India	Namibia	Slovenia*
Angola	Costa Rica	Indonesia	Nepal	Solomon Islands
Anguilla	Cote d'Ivoire	Iran	Netherlands*	South Africa
Antigua and Barbuda	Croatia*	Ireland*	Netherlands Antilles	Spain*
Argentina	Cuba	Israel*	New Caledonia*	Sri Lanka
Armenia	Cyprus*	Italy*	New Zealand*	State of Palestine
Aruba*	Czech Republic*	Jamaica	Nicaragua	Sudan
Australia*	Denmark*	Japan*	Niger	Suriname
Austria*	Djibouti	Jordan	Nigeria	Sweden*
Azerbaijan	Dominica	Kazakhstan	North Macedonia	Switzerland*
Bahamas*	Dominican Republic	Kenya	Norway*	Syria
Bahrain*	Ecuador	Kiribati	Oman*	Tanzania
Bangladesh	Egypt	Kuwait*	Pakistan	Thailand
Barbados*	El Salvador	Kyrgyzstan	Palau	Timor-Leste
Belarus	Estonia*	Laos	Panama	Togo
Belgium*	Eswatini	Latvia	Papua New Guinea	Tonga
Belize	Ethiopia	Lebanon	Paraguay	Trinidad and Tobago*
Benin	Faeroe Islands*	Lesotho	Peru	Tunisia
Bermuda*	Fiji	Libya	Philippines	Turkey
Bhutan	Finland*	Lithuania	Poland*	Turks and caicos Islands*
Bolivia	Fmr Sudan	Luxembourg*	Portugal*	Tuvalu
Bosnia and Herzegovina	France*	Macao*	Qatar*	Uganda
Botswana	French Polynesia*	Madagascar	Rep. of Korea*	Ukraine
Brazil	Gabon	Malawi	Romania	United Arab Emirates*
Brunei*	Gambia	Malaysia	Russia	United Kingdom*
Bulgaria	Georgia	Maldives	Rwanda	United States of America*
Burkina Faso	Germany*	Mali	Saint Kitts and Nevis	Uruguay
Burundi	Ghana	Malta*	Saint Lucia	Uzbekistan
Cabo verde	Greece*	Mauritania	Saint Vincent & Grenadines	Vanuatu
Cambodia	Greenland*	Mauritius	Samoa	Venezuela
Cameroon	Grenada	Mayotte, Mexico	Sao Tome and Principe	Vietnam
Canada*	Guatemala	Micronesia	Saudi Arabia*	Wallis and Futuna
Cayman Islands*	Guinea	Moldova Republic	Senegal	Yemen
Central African Republic	Guinea-Bissau	Mongolia	Serbia	Zambia
Chile	Guyana	Montenegro	Serbia and Montenegro	Zimbabwe
China	Honduras	Montserrat	Seychelles	

Notes: This table shows the list of countries included in the sample. According to the World Bank classification, high income countries are defined as the northern pole and are marked "*" All other unmarked countries are the southern pole that are classified as either upper middle, lower middle or low income groups.

A.3 FTA Summary Statistics

Table A.2: FTA Summary Statistics

<i>All FTAs</i>					
Variable	Obs	Mean	Std. Dev.	Min	Max
EnvProvs_Present	287	.9163763	.2773062	0	1
EnvProvs_Total	287	8.184669	8.299299	0	34
EnvProvs_Sub	287	3.491289	2.143235	0	7
Depth_All_Enf	287	13.58885	7.652296	0	46
Depth_Core_Enf	287	10.49826	4.458726	0	18
<i>N-N</i>					
Variable	Obs	Mean	Std. Dev.	Min	Max
EnvProvs_Present	42	.9761905	.1543033	0	1
EnvProvs_Total	42	9.97619	8.648948	0	27
EnvProvs_Sub	42	3.809524	1.928453	0	7
Depth_All_Enf	42	17.92857	9.49812	3	38
Depth_Core_Enf	42	12.78571	4.534613	3	18
<i>N-S</i>					
Variable	Obs	Mean	Std. Dev.	Min	Max
EnvProvs_Present	95	.9894737	.1025978	0	1
EnvProvs_Total	95	12.8	8.962807	0	34
EnvProvs_Sub	95	4.863158	1.825415	0	7
Depth_All_Enf	95	15.84211	7.073047	3	46
Depth_Core_Enf	95	12.01053	3.384869	3	18
<i>S-N</i>					
Variable	Obs	Mean	Std. Dev.	Min	Max
EnvProvs_Present	27	.8518519	.362014	0	1
EnvProvs_Total	27	5.444444	5.826553	0	23
EnvProvs_Sub	27	2.925926	2.017728	0	7
Depth_All_Enf	27	16.2963	6.724323	5	32
Depth_Core_Enf	27	11.81481	3.475597	4	16
<i>S-S</i>					
Variable	Obs	Mean	Std. Dev.	Min	Max
EnvProvs_Present	123	.8536585	.3548938	0	1
EnvProvs_Total	123	4.609756	5.912801	0	34
EnvProvs_Sub	123	2.447154	1.847476	0	7
Depth_All_Enf	123	9.772358	5.659481	0	27
Depth_Core_Enf	123	8.260163	4.390447	0	18

A.4 Summary Statistics of Trade Flows

Table A.3: Summary Statistics of Trade Flows

<i>All FTAs</i>					
Variable	Obs	Mean	Std. Dev.	Min	Max
Exports	25,501,776	9994501	3.01e+08	0	1.60e+11
EnvProvs.Present	25,501,776	.2239763	.4169064	0	1
EnvProvs * Green _s	25,501,776	.0035239	.0240771	0	.351419
EnvProvs.Total	25,501,776	2.40179	5.863843	0	34
EnvProvs.Sub	25,501,776	.9686806	2.012326	0	7
Depth.Core.Enf	25,501,776	2.700562	5.386175	0	18
FTA	25,501,776	.2773619	.4476966	0	1
<i>N-N</i>					
Variable	Obs	Mean	Std. Dev.	Min	Max
Exports	3,742,520	3.23e+07	4.66e+08	0	1.22e+11
EnvProvs.Present	3,742,520	.4509234	.4965124	0	1
EnvProvs * Green _s	3,742,520	.0076047	.0345268	0	.351419
EnvProvs.Total	3,742,520	4.78519	6.436363	0	34
EnvProvs.Sub	3,742,520	1.972637	2.376355	0	7
Depth.Core.Enf	3,742,520	6.809006	7.988811	0	18
FTA	3,742,520	.4570378	.4981509	0	1
<i>N-S</i>					
Variable	Obs	Mean	Std. Dev.	Min	Max
Exports	6,520,060	9510293	3.91e+08	0	1.60e+11
EnvProvs.Present	6,520,060	.1939484	.395389	0	1
EnvProvs * Green _s	6,520,060	.0028059	.0219782	0	.351419
EnvProvs.Total	6,520,060	2.285511	6.099254	0	34
EnvProvs.Sub	6,520,060	.8852937	2.004897	0	7
Depth.Core.Enf	6,520,060	2.241491	4.941037	0	18
FTA	6,520,060	.2147934	.410679	0	1
<i>S-N</i>					
Variable	Obs	Mean	Std. Dev.	Min	Max
Exports	6,119,002	6920370	2.20e+08	0	1.00e+11
EnvProvs.Present	6,119,002	.2008326	.4006231	0	1
EnvProvs * Green _s	6,119,002	.0035034	.0239904	0	.351419
EnvProvs.Total	6,119,002	2.4687	6.357307	0	34
EnvProvs.Sub	6,119,002	.9422448	2.081201	0	7
Depth.Core.Enf	6,119,002	2.377672	5.083897	0	18
FTA	6,119,002	.2206392	.4146777	0	1
<i>S-S</i>					
Variable	Obs	Mean	Std. Dev.	Min	Max
Exports	9,120,194	3234865	1.46e+08	0	1.01e+11
EnvProvs.Present	9,120,194	.1678422	.3737261	0	1
EnvProvs * Green _s	9,120,194	.0023765	.0197936	0	.351419
EnvProvs.Total	9,120,194	1.461985	4.712581	0	34
EnvProvs.Sub	9,120,194	.6340519	1.64165	0	7
Depth.Core.Enf	9,120,194	1.559469	3.418621	0	18
FTA	9,120,194	.2864182	.4520872	0	1

A.5 Subcategories of Environmental Provisions

Table A.4: Subcategories of Environmental Provisions in FTAs

Serial No.	Subcategories of Environmental Provisions in FTAs	Provision Numbers
1	Environmental Goals and Objectives	Prov.02 - Prov.06
2	Balance between Environment and Trade/Investment Goals	Prov.08 - Prov.14
3	Enforcement Mechanism	Prov.16 - Prov.19
4	External Assistance	Prov.21
5	General Environmental Protection Areas	Prov.23 - Prov.33
6	Multilateral Environmental Agreements (MEAs) Compliance	Prov.35 - Prov.50
7	Participation in Promotion of Environmental Objectives	Prov.52 - Prov.55

A.6 Balance between Environment and Trade/Investment Goals

Table A.5: Balance between Environment and Trade/Investment Goals

S/N	Code	Provision Description
1	Prov.08	Does the agreement provide for a general exception to other obligations for environmental reasons?
2	Prov.09	Does the investment chapter provide for an environmental exception?
3	Prov.10	Does the agreement prohibit dilution of environmental protection to promote trade?
4	Prov.11	Does the agreement prohibit dilution of environmental protection to promote investment?
5	Prov.12	Does the agreement provide for differential and greater liberalization of trade in environmental goods?
6	Prov.13	Does the agreement require states to take science into account when preparing and implementing environmental regulation?
7	Prov.14	Does the agreement require states to prepare an environmental impact assessment of the PTA?

A.7 Core Provisions in Free Trade Agreements

Table A.6: Core Provisions in Free Trade Agreements

Serial No.	Core Provisions in FTAs
1	Preferential Tariffs
2	Export Restrictions
3	Services
4	Investment
5	Movement of Capital
6	Intellectual Property Rights
7	Visa and Asylum
8	Rules of Origin
9	Trade Facilitation and Customs
10	Trade Remedies
11	Technical Barriers to Trade
12	Sanitary and Phytosanitary Measures
13	Public Procurement
14	Subsidies
15	State-Owned Enterprises
16	Competition Policy
17	Environmental Laws
18	Labour Market Regulations

A.8 Hypothesis Test for Country Groups

Table A.7: Hypothesis Test Results for Country Groupings

Test	Chi-squared	p-value
envprovs.greenS.N = envprovs.greenS.S	22.70	0.0000
envprovs.greenS.N = envprovs.greenN.S	6.33	0.0119
envprovs.greenS.N = envprovs.greenN.N	1.56	0.2117
envprovs.greenS.S = envprovs.greenN.N	15.84	0.0001
envprovs.greenS.S = envprovs.greenN.S	5.08	0.0242
envprovs.greenN.S = envprovs.greenN.N	4.28	0.0400

A.9 HS2 Codes for Different Sectors

Table A.8: HS Codes for Different Sectors

Product Category	HS Codes
Animals	HS:01, HS:02, HS:03, HS:04, HS:05
Vegetables	HS:06, HS:07, HS:08, HS:09, HS:10, HS:11, HS:12, HS:13, HS:14
Fats	HS:15
Prepared Foods	HS:16, HS:17, HS:18, HS:19, HS:20, HS:21, HS:22, HS:23, HS:24
Minerals	HS:25, HS:26, HS:27
Chemicals	HS:28, HS:29, HS:30, HS:31, HS:32, HS:33, HS:34, HS:35, HS:36, HS:37, HS:38
Plastics	HS:39, HS:40
Leather	HS:41, HS:42, HS:43
Wood	HS:44, HS:45, HS:46
Paper	HS:47, HS:48, HS:49
Textile	HS:50, HS:51, HS:52, HS:53, HS:54, HS:55, HS:56, HS:57, HS:58, HS:59, HS:60, HS:61, HS:62, HS:63
Footwear	HS:64, HS:65, HS:66, HS:67
Stone Cement	HS:68, HS:69, HS:70
Precious	HS:71
Metals	HS:72, HS:73, HS:74, HS:75, HS:76, HS:78, HS:79, HS:80, HS:81, HS:82, HS:83
Machinery	HS:84, HS:85
Vehicles	HS:86, HS:87, HS:88, HS:89
Instruments	HS:90, HS:91, HS:92
Arms	HS:93
Miscellaneous	HS:94, HS:95, HS:96
Art	HS:97

B Heterogeneity Analysis

B.1 Sectoral Heterogeneity

Table B.1: Sectoral Effects of Environmental Provisions

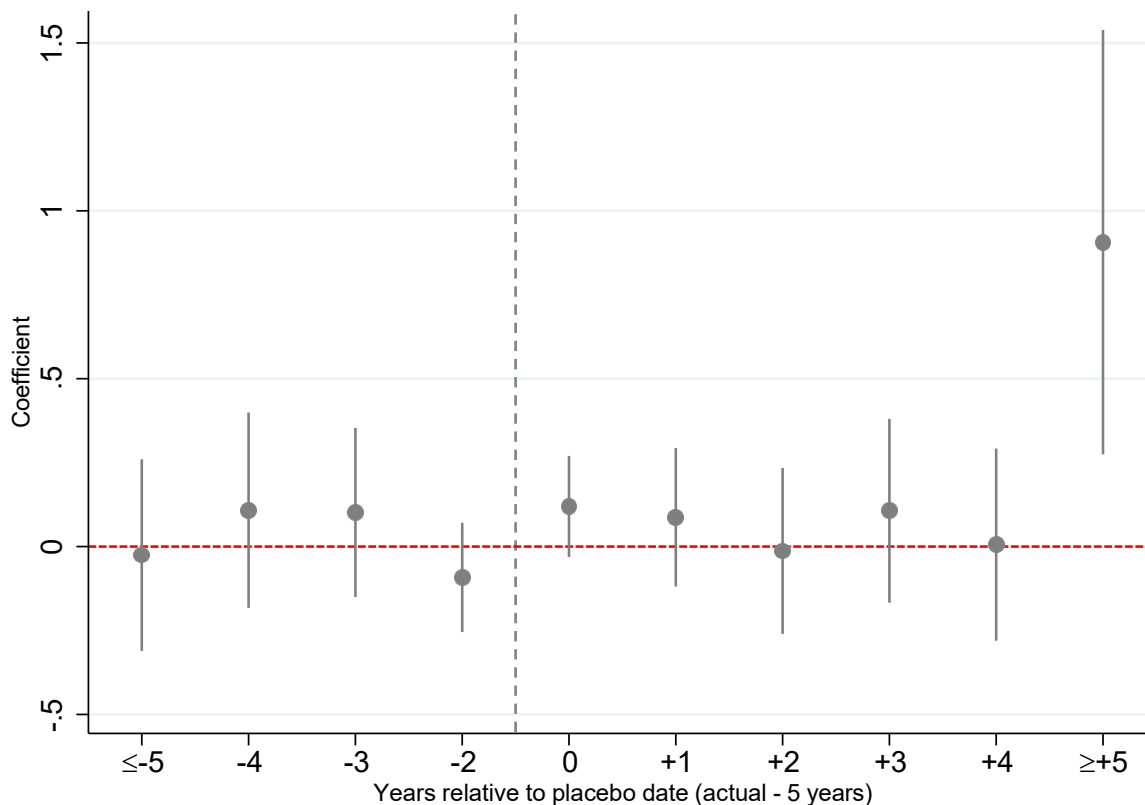
Sector	Env. Provisions	Env. Provisions * Green
Agriculture		
Animals	0.0382 (0.0548)	–
Vegetables	-0.0065 (0.0510)	–
Fats	-0.0159 (0.1200)	–
Prepared Food	0.0466 (0.0472)	0.4061 (1.0974)
Natural Resources		
Minerals	-0.0040 (0.0695)	15.8455*** (4.1045)
Manufacturing		
Chemicals	0.0117 (0.0468)	-0.3069 (0.5000)
Plastics	-0.0553 (0.0519)	1.2448*** (0.3973)
Leather	-0.1178 (0.0903)	–
Wood	0.0142 (0.0694)	0.0703 (0.6406)
Paper	-0.0709 (0.0494)	–
Textile	-0.0038 (0.0593)	-0.4380 (0.6167)
Footwear	-0.0985 (0.1113)	–
Heavy Industry		
Stone & Cement	-0.1816*** (0.0650)	1.0048** (0.3982)
Metals	0.0529 (0.0444)	0.2664 (0.9685)
Machines	-0.1667** (0.0817)	0.5780 (0.4512)
Vehicles	-0.1543** (0.0720)	26.6472*** (5.9630)
Other Sectors		
Instruments	-0.0841 (0.0841)	0.2391 (0.2410)
Arms	0.2719** (0.1268)	–
Art	-0.2165* (0.1110)	–
Miscellaneous	-0.0701 (0.0752)	-1.8676** (0.8530)
Observations	25,501,776	
(Pseudo) R^2	0.9883	
Country-Pair-Sector FE	Yes	
Exporter-Year-Sector FE	Yes	
Importer-Year-Sector FE	Yes	

Notes: This table presents the results from a HDFE PPML regression of sectoral exports on environmental provisions in FTAs for various sectors. Standard errors are robust to heteroskedasticity and clustered at the country-pair-sector level. The statistical significance is indicated by: $p < 0.01$ (***) ; $p < 0.05$ (**); $p < 0.1$ (*).

C Identification

C.1 Placebo Test: Fake Treatment Years

Figure C.1: Placebo Test: Environmental Goods Liberalization vs Fake Treatment Years



Notes: This figure presents placebo event-study estimates of $\hat{\delta}_k$ from Equation 2, where treatment dates are artificially assigned five years prior to the actual entry into force of the environmental goods liberalization provision. The coefficients capture the estimated differential effect on green sectors relative to the placebo treatment date. Reference period: $t - 1$. Endpoint bins: $k \leq -5$ and $k \geq +5$. Dashed vertical line separates placebo pre- from post-treatment periods. Controls include other Balance subcategory provisions, the general environmental provision interaction, FTA depth, and the FTA indicator. Three-way fixed effects: country-pair-sector, exporter-sector-year, and importer-sector-year. Standard errors are clustered at the country-pair-sector level. 90 percent confidence intervals are shown. No systematic placebo effects are observed in the pre-treatment or immediate post-treatment periods; the significant estimate in the $k \geq +5$ endpoint bin reflects overlap with the actual treatment period following the five-year backward shift in treatment timing.

D Robustness

D.1 Anticipation and Phase-in Robustness

Table D.1: Leads and Lags for Anticipation and Phase-in Effects

	Sectoral Exports				
	(1)	(2)	(3)	(4)	(5)
EnvProvs _Present	-0.0600 (0.0431)	-0.0412 (0.0426)	-0.0337 (0.0418)	-0.0078 (0.0402)	-0.0144 (0.0395)
EnvProvs _Present * Green _s	0.1870 (0.1289)	0.1846 (0.1227)	0.2277 (0.1502)	0.2324 (0.1520)	0.2969 (0.1937)
EnvProvs _F1	0.0279 (0.0164)	0.0024 (0.0182)	0.0049 (0.0190)	-0.0002 (0.0200)	-0.0049 (0.0207)
Envprovs _F1 * Green _s	-0.1905 (0.0292)	-0.0888 (0.1306)	-0.1905 (0.1268)	-0.1518 (0.1371)	-0.0676 (0.1420)
EnvProvs _F2		0.0294 (0.0184)	0.0093 (0.0206)	0.0225 (0.0207)	0.0192 (0.0226)
Envprovs _F2 * Green _s		0.0268 (0.1093)	0.2045 (0.1494)	0.0030 (0.1457)	0.0018 (0.1617)
EnvProvs _F3			0.0189 (0.0169)	0.0043 (0.0170)	0.0092 (0.0176)
Envprovs _F3 * Green _s			-0.1292 (0.1356)	0.0923 (0.1376)	0.0477 (0.1397)
EnvProvs _F4				-0.0057 (0.0173)	-0.0079 (0.0199)
Envprovs _F4 * Green _s				0.0130 (0.0986)	-0.0952 (0.1457)
EnvProvs _F5					-0.0075 (0.0174)
Envprovs _F5 * Green _s					0.1083 (0.0810)
EnvProvs _L1	0.0321 (0.0195)	0.0308 (0.0194)	0.0305 (0.0195)	0.0226 (0.0195)	0.0266 (0.0194)
Envprovs _L1 * Green _s	-0.2127 (0.1337)	-0.2176 (0.1300)	-0.2007 (0.1337)	-0.1548 (0.1360)	-0.1880 (0.1398)
Depth _Core _Enf	0.0079*** (0.0027)	0.0076*** (0.0027)	0.0078*** (0.0027)	0.0066*** (0.0025)	0.0068** (0.0028)
FTA	-0.0444 (0.0448)	-0.0572 (0.0446)	-0.0734* (0.0444)	-0.0845* (0.0439)	-0.0942** (0.0442)
Constant	20.9105*** (0.0107)	20.8905*** (0.0120)	20.8832*** (0.0133)	20.8928*** (0.0149)	20.8962*** (0.0164)
Observations	23,315,166	21,771,263	20,097,138	18,455,074	16,852,990
(Pseudo) R ²	0.9886	0.9888	0.9891	0.9895	0.9898
Country-Pair-Sector FE	Yes	Yes	Yes	Yes	Yes
Exporter-Year-Sector FE	Yes	Yes	Yes	Yes	Yes
Importer-Year-Sector FE	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the results I obtain from running a panel regression of sectoral bilateral exports on the leads and lag of environmental provisions, from 2000-2019 for green and non-green sectors, using PPML estimator. This gives indication to anticipation and phase-in effects as well as possible endogeneity. Standard errors are robust and clustered at country-pair-sector (exporter-importer-sector) level. They are enclosed in parenthesis and reported underneath their respective estimated coefficients. p < 0.01***; p < 0.05**; p < 0.1*.

D.2 Excluding the General Exception Clause

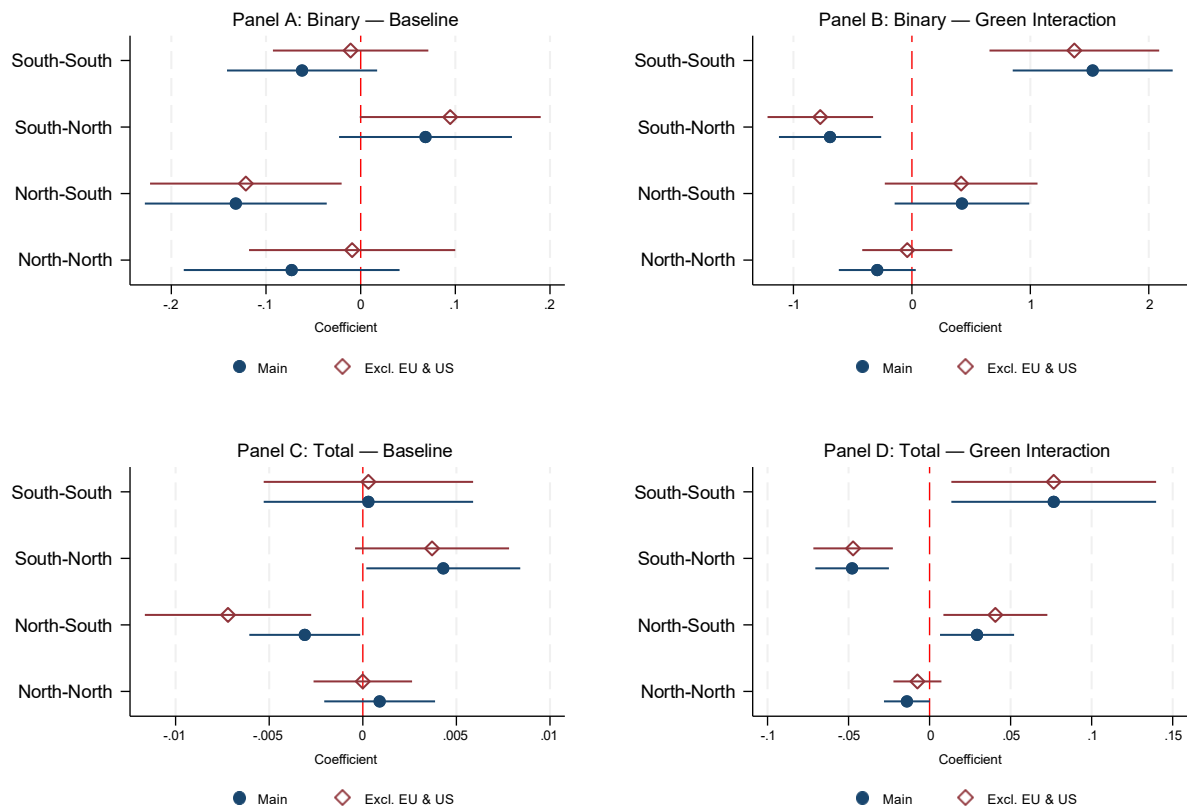
Table D.2: Robustness: Excluding the General Exception Clause (EP 08)

	(1) Main Results Sectoral Exports	(2) Excl. General Exception Clause Sectoral Exports
EnvProvs _Present	0.0024 (0.0655)	−0.0595 (0.0547)
EnvProvs Present × Green _s	−0.9500 (0.2962)	0.0725 (0.2157)
General Env. Exception	−0.1537*** (0.0409)	—
General Env. Exception × Green _s	1.4021*** (0.3199)	—
Investment Env. Exception	0.1285*** (0.0318)	0.1006*** (0.0327)
Investment Env. Exception × Green _s	0.1733 (0.2453)	−0.0006 (0.2442)
No Env. Dilution (Trade)	−0.0905 (0.0562)	−0.0738 (0.0562)
No Env. Dilution (Trade) × Green _s	−0.1700 (0.3797)	−0.3284 (0.3756)
No Env. Dilution (Investment)	0.0394 (0.0415)	0.0224 (0.0408)
No Env. Dilution (Investment) × Green _s	−0.4448 (0.3376)	−0.2207 (0.3326)
Env. Goods Liberalization	−0.0127 (0.0626)	−0.0068 (0.0631)
Env. Goods Liberalization × Green _s	0.8766** (0.3897)	0.7975** (0.3885)
Science-Based Regulation	0.1415* (0.0770)	0.1149 (0.0774)
Science-Based Regulation × Green _s	−0.4953 (0.4596)	−0.2366 (0.4557)
Environmental Impact Assessment	−0.0268 (0.0506)	−0.0420 (0.0502)
Environmental Impact Assessment × Green _s	−0.4164 (0.3256)	−0.3405 (0.3236)
Depth _Core _Enf	0.0126*** (0.0032)	0.0132*** (0.0030)
FTA	−0.0510 (0.0428)	−0.1063** (0.0426)
Constant	20.9152*** (0.0099)	20.9258*** (0.0101)
Observations	25,501,776	25,501,776
(Pseudo) R ²	0.9883	0.9883
Country-Pair-Sector FE	Yes	Yes
Exporter-Year-Sector FE	Yes	Yes
Importer-Year-Sector FE	Yes	Yes

Notes: Column (1) presents the main results for the Balance between Environmental and Trade/Investment Goals subcategory decomposition. Column (2) excludes the general exception clause from the regression, testing whether the environmental goods liberalization result is driven by its co-occurrence with the most prevalent environmental provision (present in approximately 90 percent of all FTAs with any environmental content). Standard errors in parentheses, robust to heteroskedasticity and clustered at the country-pair-sector level. Statistical significance: p < 0.01 (***); p < 0.05 (**); p < 0.10 (*).

D.3 Excluding the European Union and the United States

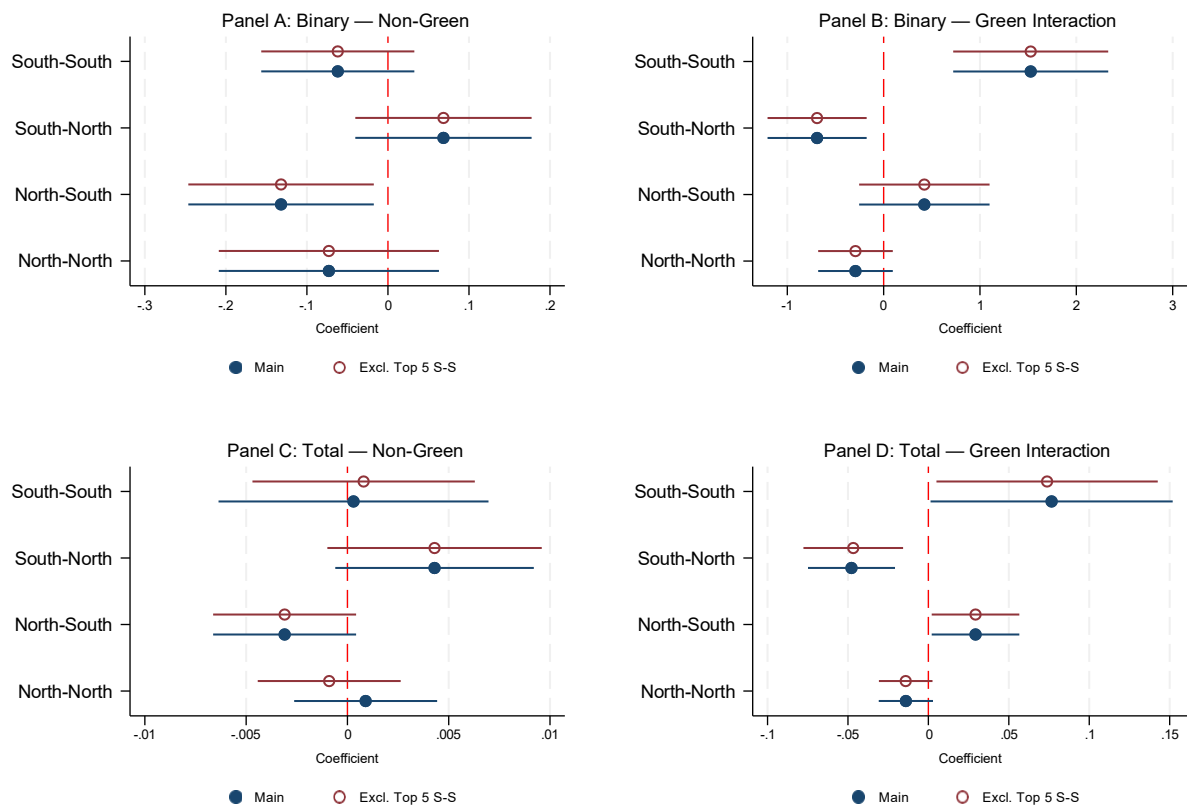
Figure D.1: Green Export Specialization by Country Group: Main Results vs Excluding EU and US as Exporters



Notes: This figure shows the coefficient plot of the green sector interaction (β_2 : $\text{EnvProvs} \times \text{Greens}_s$) by bilateral country group. Filled navy circles: main results (full sample). Hollow maroon diamonds: results excluding the EU and US as exporters. Panel A: binary environmental provisions, non-green effect. Panel B: binary environmental provisions, green sector interaction. Panel C: total environmental provisions, non-green effect. Panel D: total environmental provisions, green sector interaction. Horizontal bars show 90 percent confidence intervals. Reference line at zero. SE clustered three-way.

D.4 South-South Result: Dominant Pair Checks

Figure D.2: South-South Robustness: Excluding Top Five South-South Exporters



Notes: Coefficient plots comparing main results (filled navy circles) against results excluding the top five South-South exporters by total bilateral trade volume (hollow maroon circles). Panel A: binary environmental provisions, non-green effect ($\hat{\theta}_1$). Panel B: binary environmental provisions, green sector interaction ($\hat{\theta}_2$). Panel C: total environmental provisions, non-green effect. Panel D: total environmental provisions, green sector interaction. The top five South-South exporters are excluded only when appearing in South-South pairs; all other groupings are unaffected. Horizontal bars show 95 percent confidence intervals. Reference line at zero. SE clustered three-way.

D.5 Sector-Level Robustness

Table D.3: Sectoral Effects of Environmental Provisions: Main Results and Robustness

Sector	Main Results		Excl. Top 5 Pairs	
	Env. Prov.	Env. Prov. × Green	Env. Prov.	Env. Prov. × Green
Agriculture				
Animals	0.0383 (0.0548)	–	0.0383 (0.0548)	–
Vegetables	–0.0064 (0.0510)	–	–0.0064 (0.0510)	–
Fats	–0.0159 (0.1200)	–	–0.0159 (0.1200)	–
Prepared Food	0.0466 (0.0472)	0.4063 (1.0974)	0.0466 (0.0472)	0.4063 (1.0974)
Natural Resources				
Minerals	–0.0040 (0.0695)	15.8455*** (4.1045)	–0.0043 (0.0696)	15.8566*** (4.1051)
Manufacturing				
Chemicals	0.0117 (0.0468)	–0.3069 (0.5000)	0.0117 (0.0468)	–0.3069 (0.5000)
Plastics	–0.0553 (0.0519)	1.2448*** (0.3973)	–0.0552 (0.0519)	1.2448*** (0.3973)
Leather	–0.1178 (0.0903)	–	–0.1177 (0.0903)	–
Wood	0.0143 (0.0694)	0.0703 (0.6406)	0.0143 (0.0694)	0.0703 (0.6406)
Paper	–0.0709 (0.0494)	–	–0.0709 (0.0494)	–
Textile	–0.0038 (0.0593)	–0.4380 (0.6167)	–0.0038 (0.0593)	–0.4380 (0.6167)
Footwear	–0.0985 (0.1113)	–	–0.0984 (0.1113)	–
Heavy Industry				
Stone & Cement	–0.1816*** (0.0650)	1.0048** (0.3982)	–0.1816*** (0.0650)	1.0048** (0.3982)
Metals	0.0530 (0.0444)	0.2665 (0.9685)	0.0530 (0.0444)	0.2665 (0.9685)
Machines	–0.1667** (0.0817)	0.5780 (0.4512)	–0.1666** (0.0817)	0.5780 (0.4512)
Vehicles	–0.1543** (0.0720)	26.6472*** (5.9630)	–0.1539** (0.0722)	26.6208*** (5.9940)
Other Sectors				
Instruments	–0.0841 (0.0841)	0.2391 (0.2410)	–0.0840 (0.0841)	0.2391 (0.2410)
Arms	0.2719** (0.1268)	–	0.2720** (0.1268)	–
Art	–0.2165* (0.1110)	–	–0.2164* (0.1110)	–
Miscellaneous	–0.0701 (0.0752)	–1.8676** (0.8530)	–0.0700 (0.0752)	–1.8676** (0.8530)
Observations	25,501,776		25,501,766	
(Pseudo) R^2	0.9883		0.9883	
Country-Pair-Sect FE	Yes		Yes	
Exporter-Yr-Sect FE	Yes		Yes	
Importer-Yr-Sect FE	Yes		Yes	

Notes: This table presents results from a HDPE PPML regression of sectoral exports on environmental provisions in FTAs. The main results use the full sample. The robustness columns exclude the top five country pairs by total bilateral export volume within the Vehicles and Minerals sectors only; all other sectors are unaffected. The near-identical results across both columns confirm that the main findings are not driven by dominant bilateral pairs in these sectors. Cells marked (–) indicate that no green products are identified within that sector in the OECD/APEC classification and the interaction term is therefore omitted. Standard errors in parentheses, robust to heteroskedasticity and clustered at the country-pair-sector level. Statistical significance: $p < 0.01$ (***); $p < 0.05$ (**); $p < 0.10$ (*).