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Rules of Origins Relaxation and Regional Supply Chains: Evidence from Europe

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Abstract

Rules of Origin (RoO) and cumulation provisions in Free Trade Agreements (FTAs) define how firms can source inputs while maintaining preferential access. Using a newly constructed database of detailed RoO regulations in the European Union, we examine how these origin requirements shape supply chains by studying two major policy changes in Europe: the PECS framework, which enabled production sharing among the EU's peripheral FTA partners, and the 2004 EU enlargement, which eliminated RoO entirely for newly acceded members. Our results show that RoO significantly affect trade patterns–a 1% increase in value requirements before relaxation led to a 0.4-0.7% rise in intermediate imports from countries where restrictions were lifted. This response is generally stronger when preferential margins for final goods are high, suggesting that RoO interact with tariff preferences to shape global value chains. These findings underscore the trade-off policymakers face between protecting regional production through origin requirements and promoting economic integration and supply chain efficiency.

JEL classification: F11, F13, F14, F15.

Keywords: Intermediate inputs trade, rules of origin, cumulation, PECS, EU enlargement, input-output tables.

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1 Introduction

Global Value Chains (GVCs) have profoundly transformed the organization of production across countries and have had a significant impact on international trade flows. According to World Bank (2020), the share of global trade occurring within GVCs surged from less than 43% in 1995 to over 50% by the early 2000s. Despite this expansion, supply linkages between 1995 and 2015 remained largely regional, concentrated within Europe, the Americas, Asia, and other regions (World Bank and the WTO, 2017). Moreover, recent disruptions from the COVID-19 pandemic and escalating international tensions have led some countries to prioritize regionalization and "friend-shoring" of trade links (Javorcik et al., 2024).

Free trade agreements (FTAs) represent a tool for bolstering regional integration. However, several studies have identified potential price distortions and reduced allocative efficiency associated with FTAs (Grossman, 1981 and Krishna, 2006). A key contributor to these inefficiencies is the local content requirements, which are governed by Rules of Origin (RoO) and cumulation systems. RoO determine which intermediate goods qualify a final product for preferential access, while cumulation systems allow materials from other countries to be considered as originating, thereby fulfilling RoO criteria. Recent research (Head et al., 2024; Ornelas and Turner, 2024; Conconi et al., 2018) has emphasized the role of RoO in shaping value chains among member and non-member countries and their impact on welfare. Additionally, RoO have been central to contemporary trade debates, such as Brexit and the United States-Mexico-Canada Agreement, highlighting their politically contentious nature (Antràs, 2021).

This study examines an unexplored mechanism: the effect of changing cumulation systems and the relaxation of European Union rules of origin on the supply chains of Central Eastern European Countries (CEECs).[1] Specifically, we focus on two events that resulted in a reduction in the restrictiveness of RoO: the implementation of the Pan-European Cumulation System (PECS) in 1997, which allowed for diagonal cumulation of RoO, and the elimination of RoO for CEECs that joined the EU Customs Union following the European enlargement in 2004.[2]

[1] CEECs includes BAFTA and CEFTA countries. BAFTA includes Estonia, Latvia, and Lithuania. CEFTA includes Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovak Republic and Slovenia.

[2] There are three types of Cumulation System of origin rules: bilateral, diagonal, and full. Bilateral cumulation occurs between two countries and allows producers in either country to use intermediates from the other country as if they originated in their own. Diagonal cumulation involves more than two countries and requires them to

We examine these events within a theoretical framework that derives gravity equations for intermediate goods, incorporating RoO restrictiveness as a trade barrier component. This component reflects both the intensity of RoO and the cumulation system in place, thereby influencing the degree of regional integration. To estimate the elasticity of intermediate import flows in response to changes in cumulation systems, we develop a novel measure of RoO restrictiveness, EU-RoO, which captures the average local content requirement needed for an input to qualify for originating status. Additionally, to account for varying incentives countries may have in complying with RoO to access FTA benefits, we compute preferential margins by tracing the evolution of preferences across European FTA treaties.

The European context of the 1990s provides an excellent case study. Following the collapse of the Soviet Union, the proliferation of various FTAs in Europe created a complex trade environment, often referred to as the "Spaghetti Bowl," for countries involved in or seeking to join value chains. To address this complex network of FTAs, the EU introduced the Pan-European Cumulation System (PECS) in 1997. PECS standardized the rules of origin protocols among the signatories and introduced diagonal cumulation. The latter allowed the use of intermediate goods from the other PECS signatories without affecting the origin status and preferential treatment of the associated final product. Subsequently, some PECS signatories joined the EU Customs Union, which eliminated the use of RoO among members. The elimination of RoO is an important development for the newly joined peripheral countries (also referred to as Spokes), as it expands their sourcing options for intermediates.[3]

Evaluating the impact of RoO relaxation on the Spokes' international supply chains presents two primary challenges. First, during our analysis period, CEECs underwent significant transformations, including rapid economic development as emerging market economies and gradual integration into the EU. These concurrent changes could have influenced sourcing strategies independently of the cumulation systems in their FTAs with the EU. To address this, we exploit the substantial heterogeneity of European RoO across products and the varying stages of cumu-

be bound together by bilateral FTAs with identical RoO. Full cumulation, which is only used between European Economic Area (EEA) partners, allows all stages of production from FTA partners to be counted towards achieving origin status, regardless of whether the processing is sufficient to confer originating status.

[3]We consider PECS signatory countries that joined the EU in 2004, which are the following CEECs: Estonia, Latvia, Lithuania, Czech Republic, Hungary, Poland, Slovak Republic and Slovenia.

lation system integration.[4] This variation allows us to isolate and identify the specific impacts of RoO on sourcing strategies for different groups of partner countries. Second, quantifying the restrictiveness of RoO embedded in trade agreements is inherently complex. We address this by developing a specialized database and employing text analysis techniques to categorize and quantify various RoO restrictions at a highly disaggregated product level.

Our analysis proceeds in four steps. First, we discuss the institutional framework in which the relaxation of European RoO occurred, and provide preliminary evidence of changes in the supply chains of the Spoke countries at both regional and international levels. We show that there is substantial variation across sectors in import growth rates sourced within the PECS area compared to those sourced externally. Moreover, when comparing differences in import growth between the two stages of RoO relaxation, we observe that following accession to the EU, there was a shift towards promoting international supply chain links over regional ones.

Second, we propose a theoretical framework to explain how RoO influence sourcing patterns. By determining the origin of a product, RoO define whether a good qualifies for preferential access. Since this depends on the content of the imported intermediates that must originate from the FTA zone, RoO function as a discriminatory restriction on imported intermediate inputs. Building on the Ricardian model of comparative advantage as in Eaton and Kortum (2002), we model RoO as additional trade costs affecting intermediate import flows, contingent on the intensity of the rule and the sourcing country. Recognizing that RoO are not always binding–since producers adjust their sourcing strategies only when the benefits of preferential access outweigh the costs of compliance–we allow for a non-linear relationship where the import elasticity depends on the level of the duty free access to the FTA. This means that when the preferential margins are high, producers are more likely to adjust their sourcing strategies to comply with RoO, absorbing the additional costs because the benefits outweigh them.

In our third step, we develop a metric to empirically quantify the restrictiveness of EU-RoO. Inspired by Conconi et al. (2018), we achieve this by encoding the content of EU-FTAs treaties pre- and post-PECS and examining the RoO restrictions for each final good product

[4]For comparison, Table 2 in Cadot et al. (2006) shows that less than 17% of European RoO are solely based on Change of Tariff Classification (CTC), compared to 89% in NAFTA. Additionally, 26% of European tariff lines rely on various combinations of CTC and Value Added requirements.

listed in these documents. Using text analysis, we identify which intermediate goods each rule restricts and the extent of these restrictions. We quantify each rule as a percentage restriction on the allowable value of non-originating intermediates. To accurately reflect the importance of each intermediate in the production of final goods, we incorporate input-output tables into our analysis. This integration allows us to calculate the EU-RoO measure as a weighted average of the value requirement restrictions that each input faces in production processes. Additionally, we compute a preferential margin for each intermediate, weighted by the importance of each intermediate in final goods production, defined as the difference between the Most Favored Nation (MFN) tariff and the preferential tariff for final goods destined for the EU. This weighted measure accounts for the role of intermediates in final goods and their associated preferential benefits. To ensure accuracy, especially for the pre-PECS period with incomplete preferential tariff data, we supplement missing information using data from FTA-EU treaties.[5]

In the final stage of our analysis, we employ the EU-RoO measure to estimate the effects of progressively relaxing RoO on intermediate goods imports. Drawing on the derived gravity equations, we analyze changes in the cumulation system on Spokes' intermediate imports from various origin countries, including other Spoke countries that signed PECS, countries from the rest of the world (RoW) with which Spokes had no FTA, and EU15 countries.[6] Our comparisons consistently involve one group of exporters affected by changes in the RoO cumulation system and another group that is not. We examine this variation across two periods of RoO relaxation: the shift from bilateral to diagonal cumulation between 1995 and 2002, and the removal of RoO following the 2004 EU enlargement between 2002 and 2006. Our identification strategy captures time variations in sourcing decisions that are specific to importer-exporter relationships and product categories.

Our results indicate that a 1% larger EU-RoO measure in the pre-liberalization period is associated with an increase ranging from 0.4% to 0.7% in intermediate imports from countries where RoO were eased. These elasticities are consistent across both episodes of RoO relaxation. Furthermore, when we allow these elasticities to vary based on the preferential margin granted to the final goods, we uncover a heterogeneous effect of RoO. Specifically, intermediates that

[5]A list of the treaties used and their references via EUR-Lex access can be found in Table 16.

[6]EU15 refers to the member countries of the EU prior to the 2004 enlargement.

are important in final goods with larger preferential margins - calculated by weighting the preferential margins of final goods by the importance of each intermediate in their production - generally exhibit stronger import responses. This suggests that intermediates critical to final goods benefiting from substantial preferential treatment are more responsive to RoO relaxations.

Our findings reveal that PECS facilitated a regional reassessment of sourcing decisions for Spoke countries by encouraging the import of intermediates from these countries relative to both the RoW and EU15. In contrast, when examining the Spokes' integration into the EU Customs Union, we observe that the removal of RoO enabled supply chains to become more global. By eliminating the need for RoO, EU enlargement allowed Spokes to overcome restrictions on the use of intermediates from third-party countries (RoW). Therefore, for intermediates that were significantly restricted by EU-RoO before 2004, we observe a substantial increase in Spokes' imports from the RoW relative to either the other Spokes or the EU15. These findings underscore that restrictive RoO and cumulation rules may hinder supply chain efficiency, leading ultimately to allocative inefficiency. Our study contributes to the literature by providing empirical evidence that the relaxation of RoO can lead to the multilateralization of regionalism (Baldwin, 2006), where regional agreements evolve to facilitate more global trade integration.

To ensure robustness, we address potential identification threats arising from pre-existing trends due to Europe's specific economic integration process. We conduct several robustness checks to test the validity of our results and mitigate potential limitations. Specifically, we investigate whether the observed patterns of diversion between regional and international trade persist while accounting for domestic sourcing within the regional context. Additionally, we assess the consistency of our results by focusing on exporter countries that joined PECS but did not subsequently become EU members, thereby adjusting the set of exporting countries included in our analysis. Furthermore, we consider the implications of China's accession to the WTO in 2001, account for the elimination of other trade restrictions, such as quotas, and relax assumptions about sectoral trends to ensure that our findings remain robust against alternative explanatory channels.

Related Literature

The theoretical literature on regional trade agreements and fragmentation of the production

process is vast (Ornelas et al., 2021, Blanchard, 2015, Antràs and Staiger, 2012 among others). A strand of this literature has shown that FTAs can potentially lower trade costs if the benefits from preferential access outweigh the costs of fulfilling RoO, therefore affecting a firm's sourcing decisions. Demidova et al. (2012) examines the impact of trade policy on firm sorting in a heterogeneous firm setting and finds evidence that only the more productive Bangladeshi firms choose to meet RoO when they are binding. By adding an intermediate good sector in a hub-spoke setting, Bombarda and Gamberoni (2013) show that only the most productive final good firms are able to export under preferential tariffs associated with RoO and bilateral cumulation. More recently, Ornelas and Turner (2024) propose a model with incomplete contracts and relationship-specific investment to show how stricter RoO may solve the problem of under-investment. Head et al. (2024) develop an Eaton and Kortum framework that reveals how RoO, in the form of local content requirements, can influence the relocation of production within and outside the FTA zone, leading to a so-called RoO Laffer curve.[7] Building on this literature, we propose a multi-industry version of the EK model to derive gravity equations for intermediate import flows in a world with multiple countries. This framework enables us to compare the share of intermediate imports under different cumulation systems. Following Head et al. (2024), we model how import shares respond to RoO restrictiveness by considering both rule stringency and preferential margins. This approach captures how final goods producers balance the benefits of FTA preferential access against the inefficiencies imposed by stringent RoO requirements.

The empirical literature on the impact of RoO is limited, mainly due to the complexity of RoO regulations. Synthetic indices, such as those developed by Estevadeordal and Suominem (2006) and Cadot et al. (2006), have been used in most of these studies, but they do not consider the vertical linkages between goods. In order to fill this gap, Conconi et al. (2018) created a unique dataset that captures input-output relationships within NAFTA RoO. By calculating the number of final goods subject to RoO-associated restrictions for each intermediate good, they quantify the restrictiveness of RoO along supply chains. On the contrary, our approach takes

[7]The RoO Laffer curve shows that a sufficiently low level of RoO can boost intermediate production inside the region, but further increases in RoO stringency reverse this effect, pushing production outside the region. Focusing on the car sector, they calibrate their model to assess the 2020 revision in NAFTA RoO (USMCA).

into account the fact that European RoO are largely based on value content requirements, rather than primarily relying on changes of tariff classification (Cadot et al., 2006). We offer a novel metric that interprets restrictions in terms of local content requirements, which better aligns with the characteristics of European RoO. Additionally, we propose a methodology to encode the content of EU Free Trade Agreement treaties both before and after PECS. This enables us to distinguish between the effects of changes in product-specific RoO restrictions and those resulting from alterations in the cumulation system on Spokes' intermediate supply chains.

This study adds to the limited literature on the effects of cumulation systems on trade. To our knowledge, the only related work is by Augier et al. (2005), who exclusively examined the PECS episode. Using aggregated data, they demonstrated that the absence of diagonal cumulation prior to PECS reduced trade by 10% to 50%, depending on the time period and countries analyzed. Our research diverges from Augier et al. (2005) by quantifying RoO restrictions at the product level, allowing for a more precise estimation of trade elasticities. We leverage variation from two transitions: first, the shift from bilateral to diagonal cumulation, and then from diagonal cumulation to the elimination of RoO. Moreover, unlike their study, we examine the impact of RoO on trade within global value chains. Our findings offer new evidence that diagonal cumulation of origin rules influences input sourcing within the PECS region and that removing RoO can mitigate trade diversion effects in intermediate goods.

Our paper also relates to the recent work measuring global value chains (Johnson and Noguera, 2017, Koopman et al., 2014 and Antràs et al., 2012 among others). Specifically, we relate to studies evaluating the role of government policies on the ability of a country to participate in GVCs. More closely related to our work is the recent analysis by Caliendo and Parro (2015) and Conconi et al. (2018). Caliendo and Parro (2015) study the impact of NAFTA's tariff reductions extending the Eaton and Kortum (2002) model to account for multiple-sector linkages. They find that the trade created, mostly between NAFTA members, was larger than the trade diverted from other economies. Conconi et al. (2018) consider the role of NAFTA RoO in affecting trade creation and diversion. They show that NAFTA RoO led to a sizable reduction in Mexico's imports of intermediate goods from third countries relative to NAFTA partners. In contrast to Conconi et al. (2018), our study examines whether the progressive

relaxation of RoO reverses sourcing decisions influenced by shifts in cumulation systems and customs union membership. Additionally, we show how final goods' preferential margins shape intermediate import responses to RoO changes along vertical linkages. The PECS episode is particularly well-suited for this analysis as its introduction of diagonal cumulation, unlike typical FTA creation, maintained stable preferential margins.

The paper is organized as follows: Section 2 provides preliminary evidence on the two episodes under consideration and their impact on sourcing decisions. In Section 3, we present the conceptual framework. Section 4 describes how we construct our EU-RoO measure and the data we use. Section 5 outlines the empirical strategy, presents the results regarding the role of RoO, and addresses potential identification threats. In Section 6, we investigate how the preferential margin influences imports' responses to RoO liberalization. Robustness checks are discussed in Section 7. Finally, Section 8 concludes.

2 Institutional Framework

By 1993, trade in Europe was regulated by roughly 60 bilateral and multilateral FTAs (Baldwin, 2013). These agreements were characterized by bilateral cumulation, meaning that producers in one partner country could use inputs from the other partner country as if they originated domestically. However, if inputs from a third country were used, the final product might lose its preferential access to the FTA. This bilateral cumulation system restricted the fragmentation of production processes between the EU and Central and Eastern European (CEEC) countries.[8]

To address these challenges, the EU and several CEEC countries established the Pan-European Cumulation System (PECS) in 1997, harmonizing the RoO across various FTAs. PECS was built upon the 1994 EEA agreement between the EU, the European Free Trade Association (EFTA), and CEEC countries (BAFTA and CEFTA members).[9] PECS introduced diagonal cumulation, enabling countries to use intermediates from any PECS partner without

[8]For example, in the 1990s, under the bilateral FTAs between the EU and Poland, and the EU and Lithuania, RoO required that shirts imported duty-free into the EU be made from either EU-produced or locally-produced cloth (in Poland or Lithuania). This obligated Polish producers to replace Lithuanian cloth with EU or domestic cloth in order to qualify for preferential tariffs when accessing the EU market.

[9]Table 10 in the Appendix A provides details on the dates of preferential agreements introducing diagonal cumulation between the EU and Spoke countries. The system was later extended to Slovenia, industrial products from Turkey (1999), the Faroe Islands (2005), and eventually the Mediterranean and Balkan regions.

losing the origin status or preferential treatment of the final product. While limited diagonal cumulation was already possible between BAFTA and CEFTA countries before PECS (Driessen and Graafsma, 1999), the system formalized and standardized RoO across all FTAs. Therefore, in our empirical analysis, we focus on changes in supply chains from Spoke countries belonging to different FTAs, such as BAFTA from CEFTA, and vice versa (see Section 4.2). For instance, under diagonal cumulation, Lithuanian shirt producers could now use Polish cloth and still qualify for preferential tariffs when exporting to the EU.

PECS facilitated the integration of peripheral countries, promoting the development of regional supply chains. However, the 2004 EU enlargement introduced new challenges to the region's supply chain dynamics, as RoO were eliminated for CEEC countries that joined the EU Customs Union. The removal of RoO as a consequence of this enlargement, allowed the newly integrated countries to source intermediates from any location without being constrained by RoO requirements. This gradual relaxation of RoO is expected to reshape the production structures of the new EU member states, allowing them access to a wider, global pool of intermediates. For instance, after the 2004 EU enlargement, Polish shirt producers could then source cloth not only from Lithuania but also from the RoW without restrictions when exporting to the EU.

To visually illustrate the evolution of regional and global supply chains during the two key events, Figure 1 presents changes in Spoke imports by industry, highlighting the periods before and after the implementation of PECS (shown in red) and the EU enlargement (shown in blue).[10] The horizontal axis displays the average changes in imports from the RoW for each Spoke country, while the vertical axis represents the average changes in imports from other peripheral Spoke countries. During the PECS period (1995-2002), represented by the red dots, most sectors are located well above the diagonal, indicating a faster increase in Spoke imports from other Spokes relative to imports from RoW countries.This pattern aligns with the gradual liberalization of RoO under PECS, which removed restrictions on trade between Spokes. In contrast, the EU enlargement phase (blue dots) shows a reduced distance from the 45-degree line, suggesting a relative increase in imports from the RoW following the removal of RoO

[10]We include PECS signatory countries that joined the EU in 2004. Specifically, among BAFTA: Estonia, Latvia, Lithuania; and among CEFTA: Czech Republic, Hungary, Poland, Slovak Republic, and Slovenia.

restrictions as part of the Customs Union.

The figure highlights substantial differences in the evolution of intermediate imports across sectors during these two periods, reflecting the heterogeneity of RoO impacts. These variations are central to our analysis. In the next section, we introduce a theoretical framework that incorporates RoO heterogeneity across products. This framework uses gravity equations to systematically analyze the effects of RoO relaxation during the PECS implementation and EU enlargement phases.

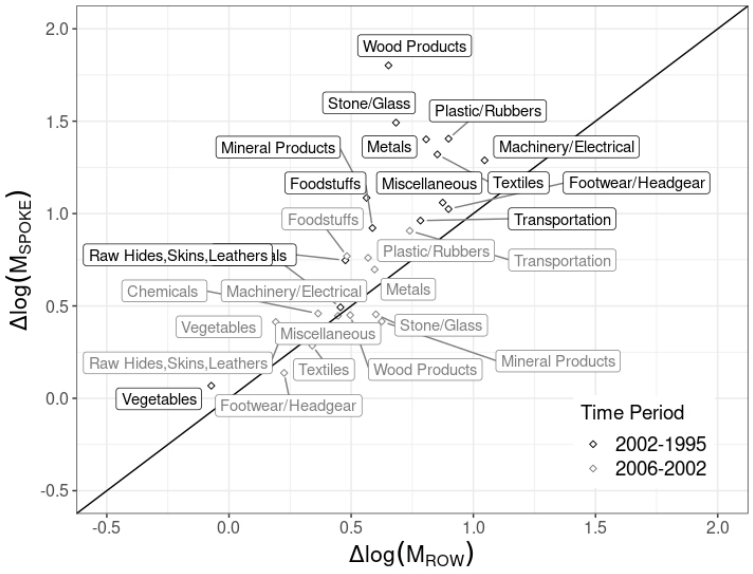


Fig. 1. Changes in Spoke's imports from other Spoke Countries vs. RoW by Sector

3 Theoretical Framework

In this section, we introduce the theoretical framework that underpins our identification strategy to examine the impact of RoOs on changes in Spokes' intermediate imports. Our analysis adopts the perspective of a Spoke country j, which becomes a member of the cumulation bloc (PECS) in 1997 and subsequently joins the EU in 2004. We assume a perfectly competitive framework where a Spoke country j imports intermediate goods from multiple sources. These intermediates are then assembled into a final product for export.

Initially, we determine the relative sourcing strategy from two possible partners countries, i and i', in absence of the cumulation zone. Then, we consider what happens if the importing and exporting countries belong to a cumulation area. In this situation, the level of RoO and the preferential margin will influence the extent to which the Spoke country j will import from another Spoke country i compared to a non-cumulation member i'. In fact, when the final product is exported to the FTA area, such as the EU in our scenario, it can benefit from preferential access, provided it complies with the specific RoO detailed in the FTA. These rules determine the extent to which the Spoke country j can import intermediate goods from non-FTA regions while maintaining the originating status of its final product, thus ensuring preferential access to the EU market.

We will disregard the decision-making process of country j regarding the potential export markets for its final product. We will presume that it exclusively caters to the EU market, and thus takes into account the restrictiveness of RoO when defining its sourcing strategy.

3.1 Setup

Following Eaton and Kortum (2002) (hereafter EK), we derive gravity equations for intermediate import flows in a world with multiple countries, trade costs, and comparative advantage stemming from technological differences across countries.

Using the multi-industry version of the EK model as in Costinot et al. (2011), the productivity z of an exporting country i producing a commodity in industry k follows a Fréchet distribution:

$$F_{ik}(z) = exp\{-T_{ik}z^{-\theta}\}, \tag{1}$$

where $T_{ik} > 0$ represents the state of technology in country i and industry k, and $\theta > 1$ is the shape parameter which is common across all countries. Buyers, who in this setting are firms buying intermediate inputs, have constant elasticity of substitution (CES) preferences over product varieties within an industry k, and buy from the lowest-cost provider.

Thus, the fraction of sector k intermediates imported by country j from country i is given by:

$$\pi_{ijk} = \frac{T_{ik}(c_{ik}\mathcal{T}_{ijk})^{-\theta}}{\Phi_{jk}} \tag{2}$$

where c_{ik} is the cost of labor in country i industry k, $\mathcal{T}_{ijk} \geq 1$ the bilateral iceberg trade cost when importing k from i, and $\Phi_{jk} = \sum_i^N T_{ik}(c_{ik}\mathcal{T}_{ijk})^{-\sigma}$, with N being the number of countries. Φ_{jk} summarizes how technology in sector k, input costs, and geographic barriers around the world govern prices in each importing country j. In this scenario, in the absence of RoO, bilateral iceberg trade costs consist only of bilateral tariffs, so: $\mathcal{T}_{ijk} = \mathcal{T}_{ijk} \geq 1$, where $\mathcal{T}_{ijk} = 1 + t_{ijk}^{\text{tariff}}$, and t_{ijk}^{tariff} is the ad valorem tariff rate between countries i and j for good k.

The expenditure of country j on sector k intermediates imported from country i is obtained as:

$$X_{ijk} = \pi_{ijk} Y_j, \tag{3}$$

where Y_j is income in country j. The ratio of country j's import of intermediate k from two possible destinations, i and i', can be expressed as follows:

$$\frac{X_{ijk}}{X_{i'jk}} = \frac{\pi_{ijk}}{\pi_{i'jk}} = \frac{T_{ik}(c_{ik}\tau_{ijk})^{-\theta}}{T_{i'k}(c_{i'k}\tau_{i'jk})^{-\theta}}, \tag{4}$$

which shows that the import share of intermediate k is driven by technology, input, and tariffs costs in the two destinations, i and i'. We define the equilibrium import share strategy without RoO as $\underline{x}_{ii'jk} = \frac{X_{ijk}}{X_{i'jk}}$.

3.2 Accounting for RoO

Next, we consider how RoO affect the imports of intermediate goods for a producer in country j. Specifically, we consider two potential source countries: one within the cumulation zone and

one outside of it. Imports from the cumulation zone can be treated as domestically produced and can be used to comply with RoO to gain preferential access for the final product.

We incorporate RoO into the iceberg trade costs alongside bilateral applied tariffs, so that $\mathcal{T}_{ijk} = \tau_{ijk} r_{ijk}^{\rho_{ijk}}$. Here, $r_{ijk} \geq 1$ reflects the restrictiveness of RoO for intermediate good k, and ρ_{ijk} measures the sensitivity to these RoO restrictions.[11] Like tariffs, r_{ijk} has both a product-level and country-pair dimension. This arises because RoOs apply discriminatively, limiting access to inputs sourced from countries outside the cumulation zone. For instance, for countries i and i', where i is part of the zone and i' is not, RoOs restrict imports of intermediate good k from i', but not from i, leading to $r_{ijk} = 1$ and $r_{i'jk} > 1$, respectively.

Regarding the responsiveness to RoO restrictions, we follow Head et al. (2024) and identify two key factors: the level of RoO applied to intermediate good k, and the preferential margin m_{jk} when exporting the final good, which incorporates intermediate good k, to the FTA region (in this case, the EU market). These two factors affect sourcing decisions in a non-linear manner, as we explain below.

Depending on the level of RoO restrictiveness on imports from outside the cumulation zone, $r_{i'jk}$, country j will encounter three potential scenarios. When the restrictiveness is low, $r_{i'jk} < \underline{r}_{i'jk}$ (whenever, for example, $r_{i'jk} < \underline{x}_{ii'jk}$), thereby requiring only a small amount of imports to be sourced within the cumulation zone, the producer in country j can comply with the RoO without altering the optimal import share decision in equation (4), which remains $\underline{x}_{ii'jk}$. For intermediate levels $r_{i'jk} \in \left[\underline{r}_{i'jk}, \overline{r}_{i'jk}\right]$, the producer in country j may choose to comply with RoO to gain preferential access to the FTA market. Compliance, however, comes at a cost, as it requires deviating from the optimal sourcing strategy $\underline{x}_{ii'jk}$, by increasing the share of imports from country i (within the cumulation zone), resulting in $x_{ii'jk} > \underline{x}_{ii'jk}$. This shift impacts allocative efficiency and raises input prices for intermediate goods producers.

Finally, when RoO restrictiveness becomes excessively high, $r_{i'jk} > \overline{r}_{i'jk}$, compliance costs may outweigh the benefits of the preferential margin, leading the producer to revert to the optimal sourcing decision, i.e. $\underline{x}_{ii'jk}$. This relationship can be summarized with the following

[11] In line with this framework, we propose an RoO index at the intermediate good level in section 4.1.

piecewise function for a given preferential margin $m_{jk} > 0$:

$$\rho(r_{i'jk}, m_{jk}) = \begin{cases} 0 & \text{if } r_{i'jk} < \underline{r}_{i'jk} \\ \beta & \text{if } \underline{r}_{i'jk} \leq r_{i'jk} \leq \overline{r}_{i'jk} \quad \text{with} \quad \beta > 0 \\ 0 & \text{if } r_{i'jk} > \overline{r}_{i'jk} \end{cases} \tag{5}$$

The expression captures the varying responsiveness of import shares to RoO restrictiveness for a producer in country j: there is no response when RoO are not binding ($r_{i'jk} < \underline{r}_{i'jk}$), positive elasticity, $\beta > 0$, in the compliance region ($\underline{r}_{i'jk} \leq r_{i'jk} \leq \overline{r}_{i'jk}$), and no response when RoO are too restrictive to comply ($r_{i'jk} > \overline{r}_{i'jk}$).

In Figure 2, we present a graphical representation for an importer of intermediate good k in country j. The vertical axis shows the share of intermediate good k imported from within the cumulation zone relative to outside sources, represented by $\frac{X_{ijk}}{X_{i'jk}}$. The horizontal axis reflects the level of RoO restrictiveness on intermediate good k when imported from outside the cumulation zone, $r_{i'jk}$.

To illustrate the effect of preferential access, we consider three preferential margins for product k: $m''_{jk} > m'_{jk} > m_{jk} = 0$. When the preferential margin is zero ($m_{jk} = 0$), the importer in country j has no incentive to comply with RoO, and the sourcing strategy remains unaffected, at the level $\underline{x}_{ii'jk}$. However, as the preferential margin increases (e.g., $m'_{jk} > m_{jk}$), the benefits of preferential access to the FTA area grow, providing a stronger incentive for the importer to comply with RoO. The thresholds $\overline{r}'_{i'jk}$ and $\overline{r}''_{i'jk}$ represent different levels of RoO restrictiveness at which compliance becomes too costly relative to the benefits of preferential access indicated by m'_{jk} and m''_{jk}, respectively. At these thresholds points, the importer reverts to the baseline sourcing strategy in the absence of RoO, $\underline{x}_{ii'jk}$.

In summary, Figure 2 shows the non-monotonic relationship between the share of intermediate good k imported from within the cumulation zone and the level of RoO restrictiveness. It highlights how higher preferential margins, e.g. $m''_{jk} > m'_{jk}$, increase the likelihood of compliance with stricter RoOs, leading to a greater share of imports from within the cumulation zone.

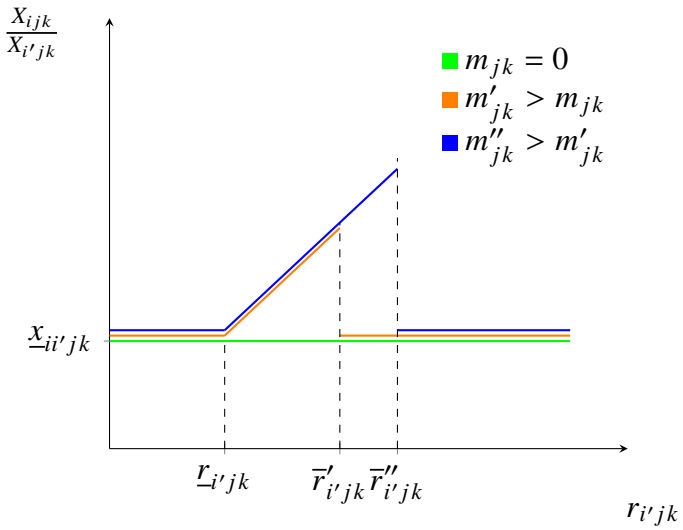


Fig. 2. Response of k's intermediate imports to RoO for three levels of preferential margin, m_{jk}.

3.3 Trade Policy Scenarios

We now examine how changes in trade policy, specifically the inclusion of a country i within the cumulation zone, affect the intermediate imports of a particular producer in country j. Unlike the static scenario in Section 3.2, where we analyzed two potential source countries (one within and one outside the cumulation zone), we now consider how import shares evolve over two time periods.

In the initial period $t-1$, imports from both exporters i and i' are subject to RoO restrictions. In the subsequent period t, country i joins the cumulation area. This means that imports from i are no longer subject to RoO constraints, while imports from i' outside the zone continue to face the same restrictions as before. By analyzing this transition, we can observe how the removal of RoO restrictions on imports from i affects the relative sourcing strategy of the producer in country j, when imports from i' remain constrained by RoOs.

We start by log-linearizing the ratio of j's expenditure on import of intermediate k from two sources from Equation 4:

$$\log\left(\frac{X_{ijkt}}{X_{i'jkt}}\right) = \log T_{ikt} - \theta \log c_{ikt} - \theta \log \mathcal{T}_{ijkt} - \log T_{i'kt} + \theta \log c_{i'kt} + \theta \log \mathcal{T}_{i'jkt} \tag{6}$$

Using properties of logarithms, we specify the change in relative demand for intermediate imports of k. Defining t and $t-1$ as consecutive periods, the log change in imports of product

k from country i compared to i' is:

$$\begin{aligned}\Delta \log\left(\frac{X_{ijkt}}{X_{i'jkt}}\right) &= \Delta \log\left(\frac{T_{ikt}c_{ikt}}{T_{i'kt}c_{i'kt}}\right)^{-\theta} - \theta\Delta \log\left(\frac{\mathcal{T}_{ijkt}}{\mathcal{T}_{i'jkt}}\right) \\ &= \log\left(\frac{T_{ikt}c_{ikt}}{T_{ikt-1}c_{ikt-1}}\right)^{-\theta} - \log\left(\frac{T_{i'kt}c_{i'kt}}{T_{i'kt-1}c_{i'kt-1}}\right)^{-\theta} - \theta \log\frac{\mathcal{T}_{ijkt}}{\mathcal{T}_{ijkt-1}} + \theta \log\frac{\mathcal{T}_{i'kjt}}{\mathcal{T}_{i'jkt-1}}.\end{aligned} \tag{7}$$

We collect the technology factors in $\delta_{ikt} = \log\left(\frac{T_{ikt}c_{ikt}}{T_{ikt-1}c_{ikt-1}}\right)^{-\theta}$ and $\delta_{i'kt} = \log\left(\frac{T_{i'kt}c_{i'kt}}{T_{i'kt-1}c_{i'kt-1}}\right)^{-\theta}$. Trade frictions take the multiplicative form discussed before, i.e. $\mathcal{T}_{ijk} = \tau_{ijk} r_{ijk}^{\rho_{ijk}}$. Since at time t country i joins the cumulation area, $r_{ijkt} = 1$, and $r_{ijk,t-1} > 1$. For country i', there is no change in RoO, so $r_{i'jkt} = r_{i'jk,t-1}$. Thus, we can rewrite equation (7) as follows:

$$\Delta \log\left(\frac{X_{ijkt}}{X_{i'jkt}}\right) = \delta_{ikt} - \delta_{i'kt} - \theta\left(\Delta \log\frac{\tau_{ijkt}}{\tau_{i'jkt}} - \rho(r_{ijk,t-1}, m_{jk,t-1}) \log r_{ijk,t-1}\right) \tag{8}$$

This equation is central to our model and will be used to identify the effect of relaxing RoO on intermediate supply networks. In our empirical analysis, we will introduce a RoO index defined at the level of intermediate goods k, analogous to the term r_{ijk} from our theoretical framework.

It is important to note that the same intermediate good k can be used in the production of multiple final goods. Consequently, the empirical counterpart of the RoO index must aggregate the restrictions associated with all the final goods that use that particular intermediate. This means the RoO index incorporates variability because intermediate good k may be subject to different RoO restrictions depending on the final goods it is used in.

Similarly, the preferential margin m_{jk}, which represents the tariff advantage when exporting final goods to the EU market, will also vary across different final goods. Each final good may have a different preferential margin, affecting the incentives for RoO compliance. Therefore, in our empirical analysis, both the RoO index (r_{ijk}) and the preferential margin (m_{jk}) will be treated as independent random variables to capture this variability.

Using Equation (8) we can highlight two implications that will be tested in the empirical section under these assumptions. First, on average, the more restrictive the RoO on intermediate good k prior to relaxation, the greater the increase in its import share from country i relative to

i' after the RoO are lifted. This will reflect the impact of RoO relaxation on import shares, and can be expressed as:

$$E\left[\frac{\partial}{\partial \log r_{ijk,t-1}} \log\left(\frac{X_{ijkt}}{X_{i'jkt}}\right)\right] = E\left[\rho\left(r_{ijk,t-1}, m_{jk,t-1}\right)\right] > 0. \tag{9}$$

Second, on average, the responsiveness of import shares to RoO restrictiveness increases with higher preferential margins. That is, intermediates used in final goods with larger preferential margins are more sensitive to changes in RoO, which can be written as:

$$E\left[\frac{\partial \rho(r_{ijk,t-1}, m_{jk,t-1})}{\partial m_{jk,t-1}}\right] > 0. \tag{10}$$

To identify variations in sourcing strategies, we analyze how the two key events in our study relaxed RoO restrictions for different groups of sourcing countries. First, we examine the PECS episode, which lifted RoO restrictions for other Spoke countries. Next, we focus on the EU enlargement, which eliminated RoO restrictions for RoW countries.

Transition from Bilateral to Diagonal Cumulation Under bilateral cumulation, which characterized the pre-PECS situation, the Spoke importer j faces no restrictions on using intermediates from the EU market (and from the country itself), but is limited in the use of imports from other Spoke countries and non-partner countries (RoW). The transition to diagonal cumulation lifts RoO restrictions on imports from other Spoke countries signing PECS, while maintaining the status quo for imports from members of the EU15 and RoW. In this scenario, with t denoting diagonal cumulation and $t-1$ bilateral cumulation, equation (8) represents the evolution of country j's intermediate import share, where i indicates another Spoke country, while i' refers to a non-member of PECS (RoW or EU15).

Transition from Diagonal Cumulation to RoO Removal The transition to the removal of RoO takes place when the group of Spoke importing countries becomes part of the EU's economic union. EU accession removes any remaining RoO restrictions, allowing final goods to move duty-free throughout the common market. While imports from RoW become unrestricted after the 2004 EU enlargement, imports from PECS members or EU15 countries were already

unrestricted under diagonal cumulation and remain so. In this scenario, where t represents the period when RoO are removed, and $t-1$ corresponds to diagonal cumulation, equation (8) captures the change in country j's intermediate import share, where i refers to RoW countries, while i' indicates the group of Spoke countries or the EU15.

4 Data

This section describes the data used in our analysis. Section 4.1 explains the construction of the EU-RoO index, which measures RoO restrictiveness while considering linkages between intermediate and final goods. This involves classifying RoO restrictions, quantifying value requirements, and incorporating the role of intermediate inputs in final goods production. We then present descriptive evidence of the EU-RoO index across agreements and sectors. Section 4.2 details the tariff and trade data used in the empirical analysis.

4.1 Construction of the EU-RoO Index

The EU-RoO Index is constructed based on three key legal agreements: the Trade Agreement of the European Communities with BAFTA, the one with CEFTA (1994), and the PECS Agreement (1997). These agreements, collectively referred to as EU-BAFTA, EU-CEFTA, and EU-PECS, include Annexes that outline the RoO at the HS product level.

RoOs are detailed guidelines that define the required processing or transformation that non-originating materials must undergo for the final product to be considered as originating within the EU or its partner countries. The determination of origin is crucial, as it establishes whether the product qualifies for preferential tariff rates within the EU. The key criteria for determining sufficient processing include Regional Value Content, Change of Tariff Classification, and Technical Requirements. These criteria specify the conditions under which non-originating materials can be used, requiring the final product to either meet a certain value-added threshold, undergo a change in tariff classification, or comply with specific production processes.[12]

The construction of the EU-RoO Index involves a five-step process:

[12]Refer to Articles 5, 6, and 7 of Protocol 4 in each Treaty.

1. **Codification of Rules:** Rules are codified at the HS6 level. When rules apply at broader levels, such as Chapter (HS2) or Heading (HS4), they are assigned to all relevant HS6 products.[13]

2. **Classification of Rules:** The textual content of the rules is classified into five primary categories: Regional Value Content, Change in Tariff Classification, Technical Requirement, Wholly Obtained, and No Rule. Each category is further subdivided based on the scope of the restriction. For example, within the Change in Tariff Classification category, we distinguish between a Change in Chapter and a Change in Heading.[14]

3. **Identification of Restricted Products:** HS6 intermediate goods that may be restricted by each rule are identified. For some categories, like Regional Value Content, this is a straightforward process since all inputs are restricted. However, for others, such as Change in Tariff Classification, only certain headings may be subject to restrictions (e.g., headings within the same Chapter as the final product).[15]

4. **Assignment of Value Requirements:** Each rule is assigned a percentage restriction, termed the Value Requirement (VR). For example, Regional Value Content rules specify the minimum value that must be added within the FTA as a percentage of the final product's value. Change in Tariff Classification and Wholly Obtained rules are similarly quantified, with restrictions assigned based on the extent of processing required within the FTA. Technical requirements, which usually demand that a significant portion of the production process takes place within the FTA, are assigned the highest level of restrictiveness. These VRs are then converted into the final product's value using an Input-Output (IO) matrix.

5. **Calculation of the EU-RoO Index:** Not all potentially restricted HS6 products enter a final good's production process. The EU-RoO Index at the intermediate level k is

[13] Techniques such as word matching are used to map text descriptions to HS6 categories when HS codes are missing.

[14] Regular expressions are used for this classification, and rules may belong to multiple categories if they impose multiple restrictions.

[15] Local searches for numeric sequences and dictionary references are used to pinpoint specific HS codes or product groups that are affected.

calculated as the weighted average of the Value Requirements that an intermediate k faces in producing a final good f,

$$\text{EU-RoO}_k = \sum_f \left(\text{VR}_{fk} \frac{dr_{fk}}{\sum_f dr_{fk}} \right). \tag{11}$$

The weight dr_{fk} is the direct requirement coefficient, representing the portion of expenditure on input k required to produce \$1 of output f. VR_{fk} is the value requirement assigned to each rule (discussed in point 4), which is defined at the final product f, and restricts the use of input k. The resulting EU-RoO_k ranges between 0 and 100.

In essence, the EU-RoO index represents a weighted average of the value restrictions that an intermediary encounters in final goods production. The weights in this calculation correspond to the relative importance of that input for the production of each output.[16]

Input-Output Data. The direct requirements dr_{fk} used to calculate our EU-RoO measure are derived from the US IO1997 table, converted to the six-digit classification of the 1988/1992 Harmonized System, as outlined in Conconi et al., 2018. While our analysis focuses on peripheral European countries, we use the US IO tables for two key reasons. First, this allows us to maintain a consistent level of disaggregation in the trade data, specifically at the HS6 level. Second, it follows the methodology of Rajan and Zingales (1998), who developed a measure of industry dependence on external finance using US data and applied it to other countries. Their approach assumes that certain industries have inherent technical dependencies on external financing that are consistent across countries. Similarly, we rely on US IO tables to identify a more efficient production process, driven primarily by technological factors and less affected by distortions such as product market restrictions.

To address potential endogeneity, we apply the same US IO1997 table to calculate the EU-RoO index both before and after the PECS agreements. This ensures that any observed variation is solely attributable to changes in RoO restrictions, rather than shifts in production processes.

[16]Further details on data construction and methodology are provided in Appendix B.

Validation of the EU-RoO Index To validate our EU-RoO measure, we compare it with the index developed by Cadot et al. (2006), which assesses the restrictiveness of RoO on final goods at the HS6 level, ranging from 1 (least restrictive) to 7 (most restrictive). Unlike our index, which considers input-output linkages, Cadot et al. (2006)'s index does not account for how RoO restrictions affect different inputs. To enable a meaningful comparison, we aggregate our index by summing all the restrictions that a final good imposes on intermediate goods, expressed as $RoO_f = \sum_k \text{EU-RoO}_{fk}$. We find a positive and significant correlation between our measure and Cadot et al. (2006)'s index, with a p-value below 0.01, indicating a strong relationship.[17]

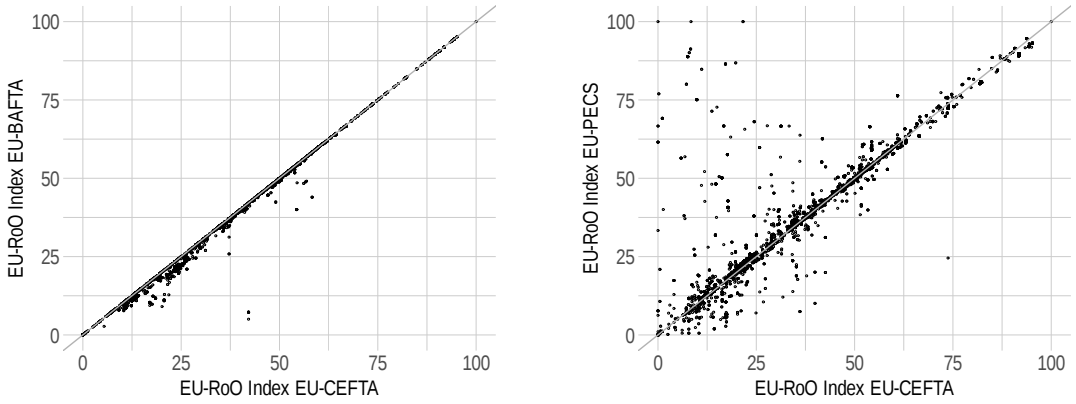
Descriptive Statistics on the EU-RoO Index The EU-RoO index allows for a comparison of RoO restrictions across the three treaties of interest: EU-BAFTA, EU-CEFTA, and EU-PECS. Figure 3 illustrates these comparisons. Panel (a) compares EU-RoO values for EU-BAFTA and EU-CEFTA agreements before PECS implementation. The alignment of data points along the 45-degree line indicates harmonized RoO rules across EU FTAs with both BAFTA and CEFTA countries prior to 1997. Panel (b) contrasts EU-RoO values for EU-CEFTA and EU-PECS. There are minimal changes in RoO after PECS, with most points near the line but a slight upward shift indicating increased stringency post-1997. This rise reflects broader HS code coverage, while rules for existing codes remained largely unchanged.

Table 1 shows that intermediate products used in final goods production must, on average, generate about 40% of their value within the FTA region. Sectoral variation is significant, with consistent industry rankings across treaties.[18] Standard deviations (in parentheses) show some heterogeneity in EU-RoO even across HS6 products within HS2 sections, though this intra-sector variation is smaller than differences between sectors.

[17] We employed Kendall's rank correlation test, which is appropriate for comparing variables of different types (Cadot et al. (2006)'s index is discrete, while ours is continuous).

[18] Textiles face the strictest requirements, averaging at least 70%, while Chemical goods are subject to more lenient rules, averaging 20%. These findings align with Cadot et al. (2006), which identifies the apparel industry as the most heavily regulated under the PECS Agreement.

Fig. 3. Comparison of EU-RoO measures across trade agreements



(a) EU-RoO pre-PECS (b) EU-RoO pre- and post-PECS

Source: Authors' computation using EU-RoO measures.

4.2 Sample Selection

Our empirical analysis considers the effect of the progressive relaxation of EU-RoO on changes in Spokes' imports. We focus on two episodes: the introduction of the PECS system in 1997 and the EU enlargement in 2004. For this purpose, we consider the years 1995, 2002 and 2006, which correspond to pre- and post-PECS years, and pre-and post-EU Integration years. Our group of importing countries is composed of the BAFTA and CEFTA members, specifically the Czech Republic, Estonia, Hungary, Lithuania, Latvia, and Poland. Romania and Bulgaria are excluded due to their later PECS entry and non-EU Customs Union status in 2004.[19] Slovak Republic and Slovenia are only included in the EU enlargement analysis due to pre-PECS tariff data limitations.[20]

Exporting countries are classified into three groups: non-participating countries (Rest of the World or RoW), EU15, and Spoke countries. Countries that had FTAs with our Spoke nations during the studied period are excluded from the RoW category to maintain a clear distinction in trade relationships.[21] In terms of import dynamics across Spokes over the PECS episode, we only track changes from Spoke countries that are part of different FTAs (e.g., BAFTA nations

[19]Romania and Bulgaria, even if members of CEFTA, joined the PECS only in 1999, and EU in 2007.

[20]We also run an estimation where we exclude these two countries also for the EU enlargement phase, and show that their exclusion does not have any significant effect on the coefficients. Results are available upon request.

[21]Tables 8 and 9 in Appendix A provide a comprehensive list of countries included in our research.

Table 1. Summary Statistics on EU-RoO Indices (%) at HS Section

	EU-RoO$_k$		
SECTOR	BAFTA	CEFTA	POST-PECS
Animal Products	47.81	47.83	64.50
	(35.73)	(35.72)	(27.23)
Chemicals	21.58	23.50	22.14
	(13.17)	(12.89)	(12.88)
Foodstuffs	15.22	15.33	17.54
	(15.29)	(15.34)	(21.25)
Footwear/Headgear	27.76	27.84	28.05
	(26.73)	(26.80)	(27.02)
Machinery/Electrical	49.92	50.33	49.88
	(18.28)	(17.89)	(18.64)
Metals	44.12	44.30	45.68
	(11.42)	(11.42)	(11.05)
Mineral Products	23.58	27.22	24.69
	(16.64)	(15.83)	(16.73)
Miscellaneous	44.42	44.87	47.88
	(15.38)	(15.42)	(13.10)
Plastic/Rubbers	38.99	39.33	40.57
	(9.98)	(9.97)	(10.94)
Raw Hides, Skins, Leathers	38.71	38.74	35.82
	(20.29)	(20.30)	(21.73)
Stone/Glass	38.52	39.07	45.21
	(16.05)	(15.68)	(16.98)
Textiles	75.00	75.01	73.44
	(15.85)	(15.83)	(15.67)
Transportation	47.56	47.77	47.40
	(17.16)	(17.00)	(17.16)
Vegetables	25.22	25.49	28.72
	(13.39)	(13.45)	(19.64)
Wood Products	32.58	32.72	36.15
	(12.42)	(12.40)	(14.51)
Total	42.74	43.33	44.43
	(24.20)	(23.77)	(23.81)

Notes: Table **??** reports averages of our EU-RoO measures (at the intermediate level) constructed from each of the treaties considered. Standard deviations in parentheses.

importing from CEFTA, and vice versa), due to existing partial diagonal cumulation agreements between some BAFTA and CEFTA members.[22]

Our dataset maintains product-exporter-importer dimensions for RoW imports at the HS6 level. However, imports from other Spokes (not in the same FTA) and EU15 are aggregated at the HS6 level, losing the exporter-importer dimension. This aggregation aims to capture third-country effects versus cumulation zone effects. Furthermore, we exclude imports from the RoW or from other Spoke countries that take the value zero in both years.

During the study period, members of EFTA (Iceland, Liechtenstein, Norway, and Switzerland) and Turkey (for industrial goods) also joined PECS. To ensure that our benchmark regression assesses the impact of RoO relaxation on a homogeneous group of countries, EFTA

[22]For our benchmark comparison Spokes versus RoW, we also conducted a falsification check where we consider imports only within the same FTAs, i.e.within BAFTA and CEFTA. Results show that our EU-RoO measure is no longer significant, aligning with the fact that diagonal cumulation was already possible pre-PECS within BAFTA (and within some CEFTA) members, as discussed in Driessen and Graafsma (1999).

members and Turkey are excluded from the set of Spoke exporting countries. However, they are included in a robustness check to evaluate the external validity of our results.

4.3 Trade and Tariff Data

We use trade data from the World Integrated Trade Solution (WITS) for the years 1995, 2002, and 2006, which we combine with tariff-level data from the UNCTAD Trade Analysis Information System (TRAINS) at the HS 6-digit level. In TRAINS, Most Favored Nation (MFN) tariff data is available for most Spokes countries during the pre-PECS period, with the exception of the Slovak Republic and Slovenia. However, data on Preferential tariffs (PRF) is largely missing, despite the presence of several bilateral and regional FTAs between Spokes countries and the EU. To fill this gap, we have constructed a database that supplements missing information on PRF tariffs between Spokes countries and the EU. Using treaties and annexes from the Global Preferential Trade Agreements Database (GPTAD) and EUR-Lex Archive, we capture all relevant preferential tariffs and calculate the preferential margin for the EU as the difference between the MFN tariff and the PRF tariff under the FTAs that the EU had with BAFTA and CEFTA.

Appendix C provides detailed information on this data construction, as well as descriptive statistics of Spoke countries' imports and average tariff levels from other Spokes, RoW countries, and the EU15, along with data on the preferential margin granted by the EU.

5 The Impact of Relaxing RoO

Building on the gravity equations from Section 3.3, we now examine the impact of two RoO relaxation events: PECS and EU accession. To assess how RoO influences supply networks, we examine intermediate imports by Spoke countries from various origins, including Spoke nations that are signatories of PECS, RoW countries without FTAs with Spokes, and EU15 countries. Our analysis consistently compares exporter groups where RoO have been relaxed with those where they have not. We focus on the first testable implication from Section 3.3, specifically whether intermediates linked to more restricted final goods experience stronger lib-

eralization effects. This section discusses the identification strategy for both episodes, addresses identification threats, and presents empirical results, including pre-trend tests.

5.1 Identification Strategy

5.1.1 Bilateral to Diagonal Cumulation

We analyze the shift from bilateral to diagonal cumulation by comparing trade patterns before and after the implementation of PECS. All Spoke countries in our study joined PECS in 1997, allowing us to examine changes in their imports between 1995 and 2002. In this context, the exporters benefiting from relaxed RoO are the other Spoke countries.

We begin by comparing changes in each Spoke's intermediate imports from the other Spokes with those from RoW countries. We use equation (8), and replace $i = SP$ to indicate the group of exporting Spokes, and $i' = RoW$ represents RoW exporters (e.g. China, USA). The term r_{ijt-1} in equation (8) refers to the period before the PECS and is therefore relabeled as $r_{SPjk}^{PRE-PECS}$.

By introducing a disturbance term into the gravity equation, we convert equation (8) into a linear regression model as follows:

$$\Delta \log\left(\frac{X_{SPjk}}{X_{RoWjk}}\right) = \delta_{SP} + \delta_{RoW} + \beta_1 \Delta \log\left(\frac{\tau_{SPjk}}{\tau_{RoWjk}}\right) + \\ + \beta_2 \log r_{SPjk}^{PRE-PECS} + \beta_3 \Delta \log r_{RoWjk} + \epsilon_{SP,RoWjk}. \tag{12}$$

The dependent variable in equation (12) captures the product-level changes in imports of Spoke j from other Spokes relative to the changes in imports from a RoW exporter.[23] The exporter fixed effects, δ_{SP} and δ_{RoW}, control for country-specific temporal trends, such as business cycles and exchange rate fluctuations.[24] The variables τ_{SPjk} and τ_{RoWjk} represent country j's tariffs

[23] Notice that we account for the fact that even before PECS there were already some trial of diagonal cumulation. These trials involved countries within each FTA considered, BAFTA and CEFTA. Thus, to account for that, when considering imports of a BAFTA country we aggregate imports only coming from Spokes in CEFTA, and the same for each CEFTA's importing country.

[24] Exporter-product time fixed effects could not be estimated separately from the variable of interest $r_{SPjk}^{PRE-PECS}$ because RoO are almost identical across importers j, making $r_{SPjk}^{PRE-PECS}$ exporter-product specific. Thus, we follow Conconi et al. (2018) and assume common product trends across exporters. In the robustness checks, we relax this assumption and include exporter-sector fixed effects, with sectors defined at the broader sectoral level rather than HS6. Additionally, note that since imports from other Spoke exporters are aggregated by FTA group, δ_{SP} captures all common characteristics within each exporter group (CEFTA or BAFTA).

on imports from other Spokes and RoW, respectively. The change in tariffs is calculated as the difference between the logarithms of post- and pre-period tariffs for each country group.[25]

The empirical counterpart of $r_{SPjk}^{PRE-PECS}$ is based on the EU-RoO measure computed using the two treaties preceding PECS (EU-CEFTA and EU-BAFTA) as discussed in Section 4.1.[26] In line with our theoretical framework, where trade costs (RoO and tariffs) enter multiplicatively, we use the iceberg costs transformation, i.e. $\log r = \log(1 + \text{EU-RoO}/100)$. The variable $\Delta \log r_{RoWjk}$ captures the change in the intensity of restrictions on imports from RoW. Notice that imports from RoW remain restricted under both bilateral and diagonal cumulation. This is why we simplified Equation (8), assuming $r_{RoWjt} = r_{RoWjt-1}$. However, as discussed in Section 4.1 and showed in Figure 3, the PECS treaty introduced some minor revisions in the RoO. Thus, to account for these changes that may affect j's sourcing, we include $\Delta \log r_{RoWjk} = \log(r_{RoWjt}/r_{RoWjt-1})$.

The specification in equation (12) enables us to identify the impact of RoO relaxation on intermediate imports of product k by Spoke country j, by comparing changes in imports from other Spokes relative to those from RoW. Our identification strategy leverages the variation of product k exposure to EU-RoO to assess the effects of diagonal cumulation introduced by PECS. In addition to controlling for exporter-specific trends, the triple-difference approach accounts for importer-product-level trends that similarly affect both exporter groups, such as Spokes' GDP fluctuations and changes in import demand for product k. To account for importer-specific characteristics that may have evolved differently between the two groups of exporters - such as administrative procedures and border control times, which were notably reduced among Spokes and with the EU after joining the EU's common market - we also include a set of importer fixed effects. In the triple-difference framework, these fixed effects capture the variation between importer and exporter groups, common across products.

The coefficient β_1 estimates $-\theta$, as indicated in Equation (12), and it is expected to be

[25]The change in tariff is computed as $\Delta \log \tau_{SPjk} - \Delta \log \tau_{RoWjk}$, where $\Delta \log \tau_{SPjk} = log(1 + \tau_{SPjk2002}) - log(1 + \tau_{SPjk1995})$, and $\Delta \log \tau_{RoWjk} = log(1 + \tau_{RoWjk2002}) - log(1 + \tau_{RoWjk1995})$. A similar definition for the change in tariff is applied in the other specifications.

[26]The values of $r_{SPjk}^{PRE-PECS}$ depends on whether the importing country j is part of BAFTA or CEFTA. For instance, when j is a BAFTA country, the EU-RoO measure reflects the RoO restrictions outlined in the 1994 EU-BAFTA agreement. Conversely, when j is a CEFTA country, the EU-RoO measure is based on the 1994 EU-CEFTA agreement.

negative, as a larger relative increase in the tariff wedge between Spokes and RoW reduces imports from Spokes relative to RoW. Instead, β_2 is estimating $\theta E[\rho(r_{SPjk}^{PRE-PECS}, m_{jk})]$, and following our first implication in Section 3.3, it is expected to be positive. This indicates that products subject to higher RoO restrictions in the pre-PECS period became relatively easier to import from the other Spokes relative to RoW countries after PECS. Finally, the coefficient β_3 is also expected to be positive, as a larger increase in RoO restrictions due to PECS—applied post-PECS only to intermediates from RoW partners—makes exporting from RoW more difficult relative to other Spokes.

The second comparison group refers to changes in Spoke's intermediate imports from the other Spokes, $i = SP$, with respect to imports from the EU15 bloc, $i' = EU$. Notice that in this framework our r_{ijt-1} in Equation (8) is again $r_{SPjk}^{PRE-PECS}$. Differently, Spoke's intermediate imports from the EU15 were never limited by RoO, which means $r_{EUjk}^{PRE-PECS} = r_{EUjk}^{PECS} = 1$. Consequently, equation (8) can be re-written as:

$$\Delta\log\left(\frac{X_{SPjk}}{X_{EUjk}}\right) = \delta_{SP} + \delta_{EU} + \beta_1\Delta\log\left(\frac{\tau_{SPjk}}{\tau_{EUjk}}\right) + \beta_2 \log r_{SPk}^{PRE-PECS} + \epsilon_{SP,EUjk}, \tag{13}$$

where δ_{EU} and δ_{SP} represent the exporter fixed effect for EU bloc and, depending on the j importing country considered, the exporter fixed effect for BAFTA or CEFTA.

The coefficient of interest in Equation (13) remains β_2, which, following Equation 9 in Section 3.3, is expected to be positive. This implies that the greater the $r_{SPjk}^{PRE-PECS}$ restriction, the larger the expected increase in j's imports from other Spokes relative to EU15. Intuitively, the more intermediate k was subject to RoO restrictions in the pre-PECS period, the easier it becomes after PECS to import this product k from other Spokes relative to the EU15 bloc.

5.1.2 Diagonal Cumulation to RoO Removal

We examine the shift from diagonal cumulation to the removal of RoO through EU Customs Union membership by comparing trade flows surrounding the 2004 EU enlargement. As the Spoke countries joined the EU in 2004, we analyze changes in their imports between 2002 and 2006. In this context, RoW countries are the exporters that benefit from the relaxed RoO.

We begin by comparing imports from RoW exporters (i' = RoW) with imports from other Spoke countries (i = SP). Upon accession to the EU, RoO restrictions for RoW exporters were lifted, setting $r_{ijt} = 1$. Prior to the EU enlargement, RoO restrictions were governed by the PECS treaty, denoted as $r_{ijt-1} = r^{\text{PECS}}_{\text{RoW}jk}$. In contrast, imports from other Spokes faced no RoO limitations during the period under consideration. Since RoO were established through a joint agreement with Spoke nations under PECS, $r^{\text{PECS}}_{\text{RoW}jk}$ remains constant across all importers j, allowing us to omit the j index. We thus reformulate equation (8) as follows:

$$\Delta \log \left(\frac{X_{RoWjk}}{X_{SPjk}} \right) = \delta_{RoW} + \delta_{SP} + \beta_1 \Delta \log \left(\frac{\tau_{RoWjk}}{\tau_{SPjk}} \right) + \beta_2 \log r^{PECS}_{RoWk} + \epsilon_{SP,RoW,jk}, \tag{14}$$

where δ_{RoW} represents the exporter fixed effects for RoW, while δ_{SP} captures the exporter fixed effect for the Spoke countries as a group.[27]

We expect a positive coefficient for β_2, reflecting the fact that products subject to stricter RoO restrictions during the PECS phase became relatively easier to import from RoW after the EU enlargement. This expectation is based on the removal of RoO restrictions for RoW exporters after the Spoke countries joined the EU, thereby facilitating increased imports from RoW for previously restricted products.[28]

The second comparison considers changes in each Spoke's intermediate imports from RoW with respect to imports from EU15 bloc, i.e. $i = EU$. Thus, equation (8) turns into:

$$\Delta \log \left(\frac{X_{RoWjk}}{X_{EUjk}} \right) = \delta_{RoW} + \delta_{EU} + \beta_1 \Delta \log \left(\frac{\tau_{RoWjk}}{\tau_{EUjk}} \right) + \beta_2 \log r^{PECS}_{RoWk} + \epsilon_{RoW,EU,jk}, \tag{15}$$

where δ_{RoW} represents the exporter fixed effect for the RoW, and δ_{SP} is the exporter fixed for the Spoke countries as a whole, which is captured by the constant. In equation (15), we expect β_2 to be positive, similar to the first comparison. This positive sign suggests that products which faced stricter RoO restrictions under PECS became relatively easier to import from RoW countries compared to the EU15 bloc after the EU enlargement. The rationale is that, following

[27] Note that here δ_{SP} will be captured by a constant since all the imports from other Spokes are treated as a group, given their simultaneous inclusion in PECS and accession to the EU15.

[28] Notably, in the comparison of the 2006–2002 period, changes in RoO restrictiveness during this time are not accounted for. Controlling for pre-EU enlargement levels is sufficient, as post-enlargement RoO do not influence any import origins seeking access to the Customs Union.

the EU enlargement, intermediate imports from RoW were no longer subject to RoO restrictions, thereby enhancing their competitiveness relative to imports from the EU15.

5.1.3 Threats to Identification

When evaluating trade policy impacts, addressing reverse causality is crucial, as policies may respond to existing economic conditions, biasing effect estimates (Goldberg and Pavcnik, 2016). While firms can influence trade policy to support production fragmentation (Blanchard, 2007; Blanchard et al., 2016; Blanchard and Matschke, 2015), this concern is mitigated in our context. After the Iron Curtain's collapse, production unbundling drove cross-border movement of components (Baldwin, 2013), but Spoke countries played a limited role in PECS negotiations, which were politically motivated to foster European integration and regional stability (Berlingieri et al., 2018).

Additionally, the risk of endogeneity is reduced by the stability of RoO restrictiveness across treaties, as shown by their consistent intensity over time (Figure 3), indicating these rules were not subject to renegotiation. To further address this concern, we test whether products with varying exposure to RoO exhibited different trends prior to changes in cumulation systems. This is explored in Section 4, where we estimate a similar specification for the pre-PECS period (1992-1993), focusing on Hungary as the importer due to data availability. Notably, CEFTA and BAFTA were formed after this period, in 1993 and 1994, respectively.

5.2 Empirical Results

This section presents empirical results related to the progressive relaxation of RoO occurring over the episodes considered, PECS and EU enlargement.

PECS. Table 2 presents our empirical findings on how diagonal cumulation under PECS affected import flows for Spoke countries. The table combines results for two different groups of exporters and is divided into two panels. Panel (a) shows OLS estimates of equation (12), which analyzes the changes in each Spoke's imports from other Spoke countries relative to imports from RoW countries. In column (1), we include only the logarithm of our EU-RoO measure under bilateral cumulation (i.e. pre-PECS), controlling for exporter and importer

characteristics. The positive and statistically significant coefficient of $\log r_{\text{SP}k}^{\text{PRE-PECS}}$ suggests that intermediate goods subject to stricter RoO restrictions before PECS experienced significant benefits post-PECS, through improved regional supply chains. Specifically, a 1% increase in the EU-RoO measure in the pre-PECS period is associated with approximately a 0.6% increase in imports from other Spokes relative to exporters in RoW.

In column (2), we account for variations in restrictiveness resulting from revisions to RoO across different treaties, represented by $\Delta \log r_{RoWk}$. This term captures changes in product rules between the pre-PECS and PECS treaties. As expected, the coefficient is positive, indicating that an increase in RoO restrictions resulting from rule revisions, discourages sourcing from RoW countries.[29]

Column (3) includes control for tariffs. The negative and significant coefficient on the change in tariffs indicates that a 1% relative increase in tariffs applied to other Spoke countries compared to the RoW leads to an approximately 3% relative decrease in imports from Spoke countries. This elasticity aligns with estimates from existing literature using HS6 product-level trade data (Imbs and Mejean, 2017).

Panel (b) presents the OLS estimation of Equation (13), examining the impact of diagonal cumulation on changes in imports of Spoke countries from other Spokes relative to the EU15. Column (4) includes only the logarithm of our pre-PECS EU-RoO measure, while column (5) also controls for differences in tariff changes. The positive and statistically significant coefficient of $\log r_{\text{SP}k}^{\text{PRE-PECS}}$ suggests that a higher pre-PECS EU-RoO measure is associated with a larger increase in a Spoke country's imports from other Spokes relative to the EU15. Specifically, a 1% higher EU-RoO measure, based on pre-PECS treaties, is associated with approximately a 0.5% greater increase in imports from other Spoke countries relative to the EU15.

Overall, the results in both panels show that the relaxation of RoO via diagonal cumulation (PECS) fostered regional integration among Spoke countries, enhancing trade within the region.

[29] In our estimation sample, the average EU-RoO measure, increased by less than 2% due to RoO removal, making this channel less relevant compared to the liberalization of rules.

Table 2. PECS, Change in imports, Spokes vs. RoW and Spokes vs. EU15

Dependent Variable:	$\Delta\log\left(\frac{X_{SPjk}}{X_{RoWjk}}\right)$			Dependent Variable:	$\Delta\log\left(\frac{X_{SPjk}}{X_{EUjk}}\right)$	
	Panel (a)				Panel (b)	
	(1)	(2)	(3)		(4)	(5)
$\log r_{SPk}^{PRE-PECS}$	0.603***	0.770***	0.514**	$\log r_{SPk}^{PRE-PECS}$	0.554***	0.468***
	(0.193)	(0.206)	(0.237)		(0.167)	(0.168)
$\Delta\log r_{RoWjk}$		1.230***	1.455***			
		(0.449)	(0.523)			
$\Delta\log\left(\frac{\tau_{SPjk}}{\tau_{RoWjk}}\right)$			-2.975***	$\Delta\log\left(\frac{\tau_{SPjk}}{\tau_{EUjk}}\right)$		-3.454***
			(0.860)			(0.774)
Observations	52,599	52,599	39,364	Observations	9,397	9,386
R-squared	0.085	0.086	0.073	R-squared	0.062	0.064
Exporters FE	Yes	Yes	Yes	Exporters FE	Yes	Yes
Importer FE	Yes	Yes	Yes	Importer FE	Yes	Yes

Notes: OLS estimation. Changes refer to the period 1995–2002. In Panel (a), the dependent variable is the difference between changes in log imports of intermediate k from other Spoke countries compared to the RoW. In Panel (b), it represents changes in log imports of intermediate k from other Spokes relative to changes in imports from the EU15. The variable $\log r_{SPk}^{PRE-PECS} = \log(1 + \text{EU-RoO}_k/100)$ represents the pre-PECS RoO applied to inputs from Spokes, while $\Delta\log r_{RoWjk}$ captures the change in RoO criteria due to PECS revisions, applied to inputs from RoW. The term $\Delta\log\tau_{ijk}/\tau_{i'jk}$ measures the change in tariffs applied by a Spoke country on imports from other Spoke countries i versus i' (either RoW or the EU). Importing countries include the Czech Republic, Estonia, Hungary, Lithuania, Latvia, and Poland. Cluster standard errors at the (HS6-importer) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

EU Enlargement. Table 3 presents the impact of the 2004 EU enlargement on the supply chains of the Spoke countries. The results are organized into two panels, each corresponding to different comparative scenarios, and display the OLS estimates for Equations (14) and (15), respectively.

Panel (a) examines the changes in imports for Spoke countries from the RoW relative to imports from other Spokes. In column (1), we include only the logarithm of our EU-RoO measure based on the EU-PECS treaty, while controlling for exporter and importer characteristics. The positive and statistically significant coefficient for $\log r_{\text{RoW}k}^{\text{PECS}}$ indicates that intermediates subject to higher RoO restrictions during the PECS period experienced greater benefits following the 2004 EU enlargement, which eliminated RoO restrictions for RoW imports. Specifically, a 1% increase in the EU-RoO measure under PECS is associated with a 0.7% greater increase in imports from RoW compared to other Spokes. In column (2), we account for changes in tariffs by including the differences in the change of tariffs. The coefficient remains positive and significant, reinforcing the finding that intermediates with stricter RoO under PECS saw larger import increases from RoW post-enlargement.

Panel (b) in Table 3 estimate equation (15), analyzing changes in intermediate imports from RoW relative to EU15. In column (3), only the EU-RoO measure is included, while column (4) adds tariff changes. The positive and significant coefficient for $\log r^{\text{PECS}}_{\text{RoW}k}$ confirms that higher RoO restrictions before the EU enlargement facilitated easier imports from RoW after the enlargement. Specifically, a 1% higher EU-RoO measure under PECS is associated with a 0.4% increase in imports from RoW compared to the EU15.

Overall, the results from both panels demonstrate that the 2004 EU enlargement positively influenced global supply chains by removing RoO restrictions. This relaxation enabled Spoke countries to optimize their sourcing strategies, resulting in a shift of imports from PECS peripheral countries and the EU15 to RoW.

Table 3. EU Enlargement, Change in Imports, RoW vs. Spokes and RoW vs. EU15

Dependent Variable:	$\Delta\log\left(\frac{X_{RoWjk}}{X_{SPjk}}\right)$		Dependent Variable:	$\Delta\log\left(\frac{X_{RoWjk}}{X_{EUjk}}\right)$	
	Panel (a)			Panel (b)	
	(1)	(2)		(3)	(4)
$\log r^{PECS}_{RoWk}$	0.749***	0.780***	$\log r^{PECS}_{RoWk}$	0.420***	0.384***
	(0.097)	(0.104)		(0.075)	(0.080)
$\Delta\log\left(\frac{\tau_{RoWjk}}{\tau_{SPjk}}\right)$		-1.900***	$\Delta\log\left(\frac{\tau_{RoWjk}}{\tau_{EUjk}}\right)$		-1.216***
		(0.431)			(0.246)
Observations	178,621	160,260	Observations	188,595	169,516
R-squared	0.075	0.058	R-squared	0.075	0.072
Importer FE	Yes	Yes	Importer FE	Yes	Yes
Exporter FE	Yes	Yes	Exporter FE	Yes	Yes

Notes: OLS estimation. Changes refer to the period 2002-2006. In Panel (a), the dependent variable is the difference in log changes of intermediate imports from other Spoke countries compared to the RoW. In Panel (b), it represents the change in log imports of intermediate goods from the RoW compared to the change of imports from the EU12. The variable $\log r^{PECS}_{RoWk} = \log(1 + \text{EU-RoO}_k/100)$ denotes the PECS EU RoO that applies to inputs from RoW. The term $\Delta \log \tau_{ijk}/\tau_{i'jk}$ measures the change in tariffs applied by a Spoke country on imports from RoW (i) versus i' (either other Spokes or the EU). Importing countries include the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Slovak Republic and Slovenia. Cluster standard errors at the (HS6-importer) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.3 Pre-Trends

In this section, we address potential endogeneity concerns related to changes in trade policies by analyzing pre-trends. We adopt an approach similar to our main analysis but focus on the

period before the implementation of RoO, specifically the years 1992-1993.

During this time, the EU had established individual FTAs without RoO. However, starting in 1994, the EU began systematically implementing RoO bilaterally with its Spoke countries. These rules, introduced through the 1994 FTAs with several BAFTA and CEFTA members, restricted inputs sourced from other Spoke countries and the RoW. Our objective is to determine whether these RoO restrictions significantly correlate with sourcing trends prior to PECS. A significant correlation could indicate potential bias in our PECS estimates. Due to data availability constraints concerning import flows and tariffs, we restrict the analysis to imports by Hungary, the only country in our dataset with available import flow data before 1995. Additionally, our trade data for Hungary begins in 1992, limiting our ability to track changes solely over the 1992-1993 period. To facilitate comparison of pre-trend findings with our main analysis, the lower section of Table 4 presents results for the 1995-2002 period, focusing exclusively on Hungary as the importing country. We use the same two comparison groups as in Table 2. Specifically, Panel (a) displays results for changes in imports from Spokes and RoW, while Panel (b) compares imports from Spokes and the EU12.[30] In each estimation, we employ our EU-RoO measure, constructed based on RoO restrictions from the 1994 EU-Hungary trade treaty, along with relative tariff changes across groups.

The upper portion of Table 4 pertains to the 1992-1993 sub-period, while the lower portion covers the 1995-2002 period surrounding PECS implementation. For the pre-PECS sub-period, the coefficients on $r_{ik}^{\text{PRE-PECS}}$ are consistently non-significant and exhibit opposite signs compared to the post-PECS period (1995-2002). Despite the limited observations, these findings help alleviate concerns regarding the influence of product level trends on the establishment of RoO restrictions.

[30]Spokes exporting countries only include BAFTA members. Austria, Finland, and Sweden joined the EU in 1995; therefore, we use EU12 for earlier comparisons.

Table 4. Pre-Trends for the Case of Hungary

Dependent Variable:	Log Imp. Change from Spokes (i) vs. RoW (i')		Log Imp. Change from Spokes (i) vs. EU12 (i')	
	Panel (a)		Panel (b)	
	(1)	(2)	(3)	(4)
Sample: 1992-1993				
$\log r_{ik}^{PRE-PECS}$	-1.312	-0.995	-1.123	-1.009
	(0.970)	(0.880)	(0.807)	(0.863)
$\Delta \log \frac{\tau_{ijk}}{\tau_{i'jk}}$		-7.204**		1.996
		(3.098)		(9.797)
Observations	1,971	1,525	485	236
R-squared	0.429	0.486	0.008	0.007
Sample: 1995-2002				
$\log r_{ik}^{PRE-PECS}$	1.600*	1.668*	1.368*	1.162
	(0.828)	(0.857)	(0.777)	(0.790)
$\Delta \log \frac{\tau_{ijk}}{\tau_{i'jk}}$		1.496		-4.625
		(2.838)		(3.251)
$\Delta \log r_{jk}$	5.937***	5.908***		
	(1.286)	(1.288)		
Observations	5,571	5,571	543	543
R-squared	0.075	0.075	0.005	0.009

Notes: OLS estimation is conducted using Hungary as the sole importing country. Spokes exporting countries are BAFTA countries. In Panel (a), the dependent variable is the difference between the changes in the logarithm of intermediate imports from Spoke countries and the corresponding changes in imports from the RoW. In Panel (b), the dependent variable is the difference between the changes in the logarithm of intermediate imports from other Spoke countries and the changes in imports from the EU12. The variable $\log r_k^{PRE-PECS} = \log(1 + \text{EU-RoO}_k/100)$ represents the pre-PECS RoO, while $\Delta \log r_{RoW\,jk}$ captures the change in RoO criteria due to PECS revisions. $\Delta \log \tau_{ijk}/\tau_{i'jk}$ represents the change in tariffs applied by a Spoke country to imports from Spokes (i) compared to country i' (either RoW or EU). The group of exporting Spoke countries includes BAFTA members. Cluster standard errors at the (HS6-importer) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.4 Quantification

We now pass to quantify the effects of RoO liberalization during the two episodes considered. Table 5 summarizes the estimated coefficients for the key variables. Specifically, we report the magnitude of the coefficients for $\log r_{SPk}^{PRE-PECS}$ and $\Delta \log r_{RoW\,jk}$ for the PECS episode (Table 2) and $\log r_{RoWk}^{PECS}$ for the EU enlargement (Table 3). The table also shows the average values of $r_{SPk}^{PRE-PECS}$, Δr_{RoWk}^{PECS}, and r_{RoWk}^{PECS} for each sample, which help quantify the restrictiveness of RoO relative to intermediate input sourcing.

For the PECS episode, we analyze the impact of diagonal cumulation, which removed RoO restrictions for Spokes countries but maintained them for RoW. Using the coefficient from column (3) of Table 2 and the average $r_{SPk}^{PRE-PECS}$ for the selected groups, we estimate that transitioning from bilateral to diagonal cumulation (reducing $r_{SPk}^{PRE-PECS}$ from 1.453 to 1) leads to an approximate 21.3% increase in imports from Spokes countries relative to RoW.[31] This

[31]This is calculated using $[(\bar{r}_{SPk}^{PRE-PECS})^{\hat{\beta}_2} - 1] \times 100\%$. Using the estimated coefficient $\hat{\beta}_2 = 0.518$, we compute: $(1.453^{0.518} - 1) \times 100\% \approx (1.213 - 1) \times 100\% \approx 21.3\%$.

effect accounts for approximately 30.2% of the total observed increase in imports from Spokes countries relative to RoW during the PECS episode.[32] Comparatively, studies on NAFTA found that RoO reduced Mexican imports from non-NAFTA countries by 48.4 log points, or 44.209% of the average change in imports (Conconi et al., 2018). Additionally, the PECS episode introduced minor revisions to RoO rules that further tightened restrictions on RoW, leading to a modest 1.5% increase in imports from Spokes relative to RoW. This additional effect accounts for roughly 2% of the total observed increase in import shares during the PECS episode. When comparing Spokes to EU15, and using average $r_{SPk}^{PRE-PECS}$, the diagonal cumulation increased imports from Spokes by 17.6% relative to EU15, representing around 35.8% of the total growth in import shares from these sources.

For the EU enlargement episode, using the average $r_{\text{RoW}k}^{\text{PECS}}$, we find that the removal of RoO led to an increase in imports from RoW by approximately 32.9 percent relative to Spokes countries. This represented a negative 54.6% of the total change. The negative sign of the total change in imports indicates that over the period 2006-2002 imports increase more from the other Spokes than from RoW. While the 2004 EU enlargement has indeed strengthened the relationship with RoW, other factors have influenced sourcing strategies, leading to a greater emphasis on imports from within the spokes. Finally, for intermediates facing the average $r_{\text{RoW}k}^{\text{PECS}}$, RoO removal increased imports from RoW by 15% relative to the EU15. However, this increase represented a negative 57.9% of the total change in imports, indicating that after the EU enlargement, imports from the EU15 grew at a faster rate than those from RoW. This suggests that the advantages of eliminating RoO were counterbalanced by other factors that favored sourcing within the EU.

[32]The average change (increase) in imports from Spokes relative to RoW is 64 log points. Then, to compute the contribution of diagonal cumulation to the change in imports, we use $\frac{\text{Effect in log points}}{\text{Avg. Change in log points}} \times 100\%$. Since the effect in log points is given by $\beta_2 \times \log r_{RoWjk} = 0.193$, this gives a contribution of $\frac{0.193}{0.64} \times 100\% = 30.2\%$.

Table 5. Statistics for the Quantification

	PECS (Diagonal Cumulation)	
Exp 1 \ Exp 2	RoW	EU15
Spokes	$\hat{\beta}_2 = 0.514$, $\bar{r}^{PRE-PECS}_{SPk} = 1.455$ $\hat{\beta}_2 = 1.455$, $\Delta\bar{r}^{PECS}_{RoWk} = 1.01$	$\hat{\beta}_2 = 0.468$, $\bar{r}^{PRE-PECS}_{SPk} = 1.426$

	EU Enlargement (RoO Removal)	
Exp 1 \ Exp 2	Spokes	EU15
RoW	$\hat{\beta}_2 = 0.780$, $\bar{r}^{PECS}_{RoWk} = 1.453$	$\hat{\beta}_2 = 0.384$, $\bar{r}^{PECS}_{RoWk} = 1.452$

Notes: This table reports the magnitude of the elasticities associated with the diagonal cumulation (PECS) and removal of RoO (EU enlargement). Exporter 1 and 2 refer to the comparison group of exporters under consideration. The $\bar{r}$ refers to the average r in that estimation sample, thus avg$(1 + \text{EU-RoO}_k/100)$ across observations.

6 Non-linearities and the Preferential Margin

In this section we consider for the role of the preferential margin in shaping the responsiveness of intermediate inputs to RoO liberalization. Specifically, we augment the models presented in Equations (12), (13), (14), and (15) by adding an interaction term with the preferential margin. Considering the change in each Spoke's intermediate imports from the other Spokes relative to RoW countries, Equation (12) becomes:

$$\begin{aligned}\Delta \log\left(\frac{X_{SPjk}}{X_{RoWjk}}\right) =& \delta_{SP} + \delta_{RoW} + \beta_1 \Delta \log\left(\frac{\tau_{SPjk}}{\tau_{RoWjk}}\right) + \beta_2 \log r^{PRE-PECS}_{SPjk} \\ &+ \beta_3 \log r^{PRE-PECS}_{SPjk} \times m^{PRE-PECS}_{jEUk} + \beta_4 \Delta \log r_{RoWjk} + \epsilon_{SP,RoWjk}. \end{aligned} \tag{16}$$

In Equation (16), $m^{PRE-PECS}_{jEUk}$ represents the preferential margin pre-PECS, which is the difference between the MFN tariff and the preferential tariff granted to Spoke country j when exporting to the EU market.[33] This variable, constructed similarly to the EU-RoO, accounts for vertical linkages by reflecting the weighted average of the preferential margin for final goods that use intermediate input k. As previously, the weight captures the relative importance of

[33]This margin refers to the pre-PECS period, calculated using data prior to 1997, as detailed in Section 4.3. The EU preferential margins for subsequent periods are defined as follows: m^{PECS}_{jEUk} represents the margin for the post-PECS period, calculated in 2002, while m^{EU-ENL}_{jEUk} corresponds to the margin after the EU Enlargement, calculated in 2006.

intermediate k in the production of the final good. Unlike the specification in Equation (12), the coefficient β_2 in Equation (16) represents the average effect of RoO when the preferential margin is zero. The coefficient β_3 measures how the effect of RoO liberalization varies depending on the size of the preferential margin. As discussed in Section 3.3, we expect β_3 to be positive (Equation 10). Specifically, a positive β_3 would indicate that the responsiveness of intermediate imports to RoO liberalization is stronger for products with a higher preferential margin.

While our theoretical framework does not explicitly model country j's decision-making process for selecting export markets for its final products, we recognize the role of preferential margins in influencing these decisions. To account for this, we estimate a version of Equation (16) that includes separate controls for the preferential margins granted to the Spoke countries by the EU during the different periods considered. These margins reflect the EU's preference for imports from Spoke countries over non-FTA members, thus capturing the incentive for CEECs to export to the EU. It is important to note that the introduction of diagonal cumulation under PECS did not alter these preferential margins, which remained largely stable. In contrast, the 2004 EU enlargement brought significant changes, including the establishment of a common external tariff and the implementation of a duty-free regime within the area, leading to substantial adjustments in the margins. As a result, isolating the effects of preferential margins through their influence on RoO becomes more challenging during the EU enlargement period compared to the PECS period.

6.1 Empirical Results

We will first examine the role of the preferential margin within the context of diagonal cumulation, and subsequently discuss its implications in relation to EU enlargement.

PECS. Similar to Table 2, Table 6 presents results related to diagonal cumulation for two distinct groups of exporters: Panel (a) shows Spokes versus RoW, while Panel (b) shows Spokes versus the EU.

Column (1) of Panel (a) presents OLS estimates of Equation (16). Columns (2) to (3) add controls for the preferential margin in the pre and post-PECS periods. The interaction between our EU-RoO measure and the pre-PECS preferential margin, $\log r_{SPk}^{PRE-PECS} \times m_{jEUk}^{PRE-PECS}$,

results in a positive and statistically significant coefficient. As expected, intermediates facing substantial RoO restrictions during the pre-PECS period and used in final goods with a large preferential margin, are more responsive to RoO relaxation, which boosts imports from Spokes relative to RoW countries. In Panel (a) of Figure 4, we visualize this effect across different bins of preferential margins. We observe that RoO increase Spokes' intermediate imports from other Spokes compared to RoW when large preferential margins are involved.

The OLS estimates for the comparison Spokes versus EU is proposed in Panel (b) of Table 6. Columns (4) to (6) show that the interaction between our RoO restrictiveness measure and the preferential margin prior to PECS, $\log r_{SPk}^{PRE-PECS} \times m_{jEUk}^{PRE-PECS}$, yields a positive and statistically significant coefficient. This suggests that, with diagonal cumulation, those intermediates previously exposed to large RoO restrictions and associated with large preferential margins are now relatively more likely to be imported from Spokes than from the EU. Figure 4 Panel (b), visually illustrates the impact of RoO across different bins of preferential margins.

The coefficient on $\log r_{SPk}^{PRE-PECS}$ alone, in both Panels (a) and (b), reflects the average effect of our RoO restrictiveness index when there is no preferential margin, i.e. $m_{jEUk}^{PRE-PECS} = 0$. However, this coefficient has limited economic significance in our framework, as our sample includes almost no intermediates that are used exclusively in the production of final goods receiving a zero preferential margin.

The role of preferential margins on intermediate import flows for the pre- and post-PECS periods is captured by the coefficients $m_{jEUk}^{PRE-PECS}$ and m_{jEUk}^{PECS}. To understand their impact, we interpret these coefficients jointly. In the Spokes versus RoW comparison, Panel (a), a positive change in the preferential margin between the two periods—such as an increase in the post-PECS margin or a decrease in the pre-PECS margin—is associated with a rise in intermediate imports from Spokes relative to RoW. Although the model does not explicitly isolate the role of preferential margins, this relationship can be explained by recognizing that when intermediate imports comply with RoO, they enable final goods to gain preferential access to the EU market. As this preferential access strengthens over time, it encourages exports to the EU and, indirectly, leads to higher imports from Spokes that facilitate cumulation. However, the effect of preferential margins is not significant in the Spokes versus EU comparison, Panel

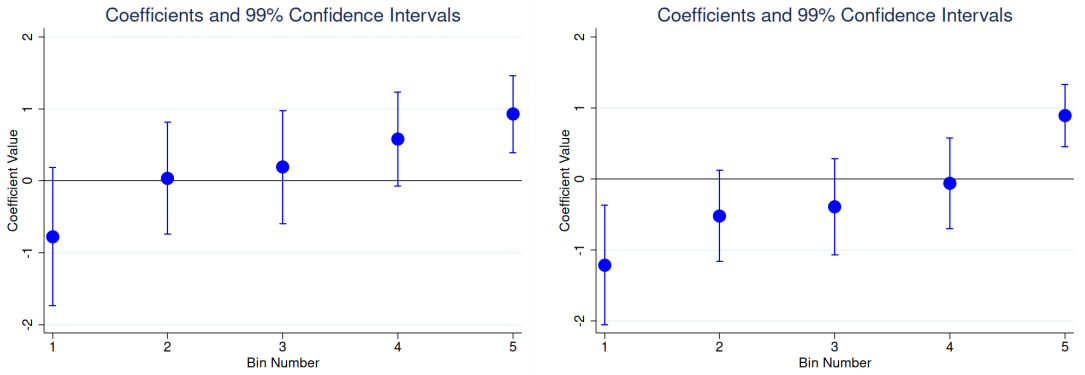
(b). This could be due to the fact that stronger incentives to export to the EU also lead to an increase in imports from the EU, which offsets the channel discussed earlier.

Table 6. PECS Change in Imports, Spokes vs. RoW and Spokes vs. EU15

Dependent Variable:	$\Delta\log\left(\frac{X_{SPjk}}{X_{RoWjk}}\right)$			Dependent Variable:	$\Delta\log\left(\frac{X_{SPjk}}{X_{EUjk}}\right)$		
	Panel (a)				Panel (b)		
	(1)	(2)	(3)		(4)	(5)	(6)
$\log r_{SPk}^{PRE-PECS}$	-0.531	-1.220**	-1.057**	$\log r_{SPk}^{PRE-PECS}$	-1.415***	-1.386***	-1.335***
	(0.430)	(0.514)	(0.537)		(0.263)	(0.312)	(0.321)
$\Delta\log\left(\frac{\tau_{SPjk}}{\tau_{RoWjk}}\right)$	-2.219**	-2.084**	-1.711*	$\Delta\log\left(\frac{\tau_{SPjk}}{\tau_{EUjk}}\right)$	-2.319***	-2.305***	-2.359***
	(0.895)	(0.889)	(0.905)		(0.780)	(0.785)	(0.789)
$\Delta\log r_{RoWjk}$	1.283**	1.166**	1.424***				
	(0.525)	(0.525)	(0.552)				
$\log r_{SPk}^{PRE-PECS} \times m_{jEUk}^{PRE-PECS}$	0.118***	0.252***	0.203***	$\log r_{SPk}^{PRE-PECS} \times m_{jEUk}^{PRE-PECS}$	0.229***	0.222***	0.209***
	(0.034)	(0.062)	(0.067)		(0.025)	(0.048)	(0.052)
$m_{jEUk}^{PRE-PECS}$		-0.066***	-0.119***	$m_{jEUk}^{PRE-PECS}$		0.004	-0.003
		(0.024)	(0.031)			(0.021)	(0.023)
m_{jEUk}^{PECS}			0.073**	m_{jEUk}^{PECS}			0.013
			(0.029)				(0.020)
Observations	39,364	39,364	39,364	Observations	9,386	9,386	9,386
R-squared	0.075	0.076	0.077	R-squared	0.073	0.073	0.073
Importer FE	Yes	Yes	Yes	Importer FE	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Exporter FE	Yes	Yes	Yes

Notes: OLS estimation. Changes refer to the period 1995–2002. In Panel (a), the dependent variable is the difference between changes in log imports of intermediate k from the other Spoke countries and the RoW. In Panel (b), the dependent variable represents changes in log imports of intermediate goods of each Spoke country from the other Spokes compared to the change of imports from the EU15. $\Delta\log\tau_{ijk}/\tau_{i'jk}$ represents the change in tariffs applied by a Spoke country to imports from Spokes (i) compared to country i' (either RoW or the EU). $\log r_k^{PRE-PECS} = \log(1 + \text{EU-RoO}_k/100)$ represents the pre-PECS RoO applied to inputs from Spokes, while $\Delta\log r_{RoWjk}$ captures the change in RoO criteria due to PECS revisions, applied to inputs from RoW. The preferential margin accounting for vertical linkages is represented by $m_{jEUk}^{PRE-PECS}$ before PECS and m_{jEUk}^{PECS} after PECS, with calculations based on data availability as detailed in Section 4.3. Importing countries include the Czech Republic, Estonia, Hungary, Lithuania, Latvia, and Poland. Cluster standard errors at the (HS6-importer) level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Fig. 4. PECS and RoO-elasticity: Bins on the preferential margin



(a) SP-ROW, PECS (b) SP-EU15, PECS

Source: Authors' computation using EU-RoO measures.

EU Enlargement. We now turn our attention to the role of the preferential margin in the context of EU enlargement. Table 7 presents results comparing two groups: RoW versus Spokes in Panel (a), and RoW versus EU15 in Panel (b).

The results in Panel (a) reaffirm the initial findings regarding the effects of RoO on intermediate imports from other Spokes relative to the RoW, even after accounting for preferential margins. When post enlargement preferential margins are considered, column (3), the interaction between the RoO restrictiveness and the preferential margin, $\log r_{RoWk}^{PECS} \times m_{jEUk}^{PECS}$, is positive and significant. This suggests that intermediates that faced high RoO restrictions during PECS and were associated with significant preferential margins to the EU, benefited more from the removal of RoO. Panel (a) of Figure 5 visually illustrates the impact of RoO across different bins of preferential margins, and provides a possible explanation for the limited precision in identifying the effects of the interaction term in columns (1) to (3). The elasticity of RoO does not increase monotonically with the preferential margin; instead, it is high at very low preferential margins (bin 1), and only increases across subsequent margin bins. This pattern may reflect a selection effect relevant to the EU Enlargement phase, where low preferential margins are often associated with products less focused on promoting regional integration. Consequently, the trade promotion resulting from EU enlargement, combined with higher RoO, may favor international sources over regional ones for such products. Additionally, Figure 5 corroborates evidence from Figure 3, showing that the removal of RoO significantly affects supply chains primarily for products with high preferential margins (bin 5). This underscores that RoO liberalization plays a relevant role in shaping sourcing decisions, particularly in sectors where final good producers were previously constrained by RoO compliance to access substantial preferential benefits.

We now shift our focus to the change in imports from RoW relative to the EU15, as presented in Panel (b) of Table 7. The interaction between the EU-RoO measure and the preferential margin, $\log r_{RoWk}^{PECS} \times m_{jEUk}^{PECS}$, is negative. This suggests that for intermediates with positive preferential margins in 2002, the effect of eliminating the RoO is diminished. These results are visualized in Figure 5, Panel (b), where we plot the elasticity of RoO across different bins of preferential margins for the comparison RoW relative to the EU15. At all levels of preferential margin, the effect of RoO is positive, but the relationship is relatively flat across

bins, except for the first one, where the effect is notably higher. As noted in the previous paragraph, this may reflect a selection effect, where small preferential margins are typically associated with products that are less oriented toward regional integration, and therefore less exposed to the trade promotion effects resulting from the EU Enlargement.

Notice that in all specifications, an increase in the preferential margin over the two periods, i.e. a larger m_{jEUk}^{EU-ENL} for a given m_{jEUk}^{PECS}, leads to a decrease in imports from RoW relative to the other Spokes (columns 1 to 3) and relative to EU (column 4 to 6).

Table 7. EU Enlarg. Change in Imports, RoW vs. Spokes and RoW vs. EU15

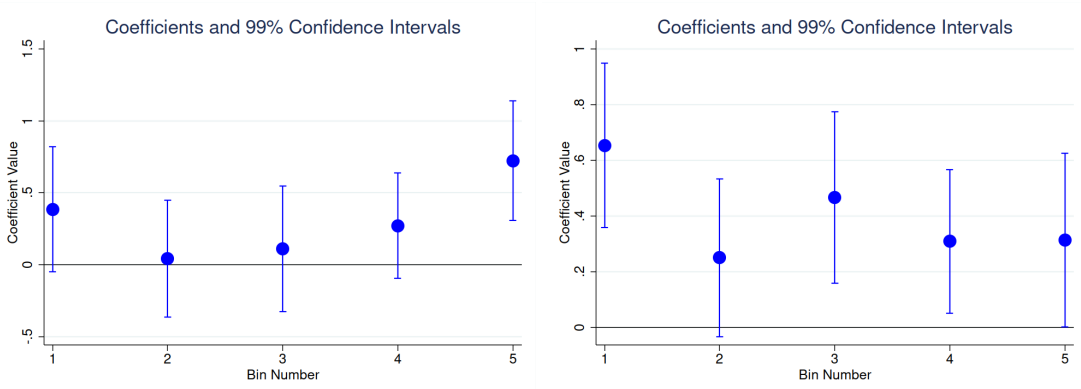
Dependent Variable:	$\Delta\log\left(\frac{X_{RoWjk}}{X_{SPjk}}\right)$			Dependent Variable:	$\Delta\log\left(\frac{X_{RoWjk}}{X_{EUjk}}\right)$		
	Panel (a)				Panel (b)		
	(1)	(2)	(3)		(4)	(5)	(6)
$\log r_{RoWk}^{PECS}$	0.770***	0.595***	0.230	$\log r_{RoWk}^{PECS}$	0.979***	0.908***	0.657***
	(0.150)	(0.197)	(0.206)		(0.109)	(0.139)	(0.140)
$\Delta\log\left(\frac{\tau_{RoWjk}}{\tau_{SPjk}}\right)$	-1.904***	-1.895***	-1.930***	$\Delta\log\left(\frac{\tau_{RoWjk}}{\tau_{EUjk}}\right)$	-1.028***	-1.026***	-1.087***
	(0.437)	(0.437)	(0.417)		(0.248)	(0.248)	(0.234)
$\log r_{RoWk}^{PECS} \times m_{jEUk}^{PECS}$	0.001	0.037	0.052*	$\log r_{RoWk}^{PECS} \times m_{jEUk}^{PECS}$	-0.069***	-0.055***	-0.047**
	(0.012)	(0.029)	(0.030)		(0.009)	(0.021)	(0.021)
m_{jEUk}^{PECS}		-0.018	0.010	m_{jEUk}^{PECS}		-0.007	0.017
		(0.013)	(0.014)			(0.009)	(0.010)
m_{jEUk}^{EU-ENL}			-0.036***	m_{jEUk}^{EU-ENL}			-0.029***
			(0.005)				(0.004)
Observations	160,260	160,260	160,260	Observations	169,516	169,516	169,516
R-squared	0.058	0.058	0.060	R-squared	0.074	0.074	0.075
Importer FE	Yes	Yes	Yes	Importer FE	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Exporter FE	Yes	Yes	Yes

Notes: OLS estimation. Changes refer to the period 2002-2006. In Panel (a) the dependent variable is the difference between changes in log imports of intermediate k from the RoW and the other Spoke countries. In Panel (b) the dependent variable represents changes in log imports of intermediate goods of each Spoke country from the RoW compared to the change of imports from the EU15. $\Delta \log \tau_{ijk}/\tau_{i'jk}$ represents the change in tariffs applied by a Spoke country to imports from RoW (i) compared to country i' (either other Spokes or the EU). $\log r_k^{PECS} = log(1 + \text{EU-RoO}_k/100)$ represents the PECS RoO applied to inputs from RoW before the EU Enlargement. The preferential margin accounting for vertical linkages is represented by m_{jEUk}^{PECS} in 2002, while m_{jEUk}^{EU-ENL} denotes the preferential margin in 2006, based on data availability as discussed in Section 4.3. Importing countries include the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Slovak Republic, and Slovenia. Cluster standard errors at the (HS6-importer) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

7 Robustness and Sensitivity Analysis

In this section, we conduct robustness checks to assess the external validity of our results and address potential limitations in the analysis. We begin by modifying the sourcing countries in two ways: first, by replacing Spoke imports with domestic trade, and second, imports from

Fig. 5. RoO-elasticity for different Bins on the preferential margin



(a) RoW-SP, EU enlargement (b) RoW-EU, EU enlargement

Source: Authors' computation using EU-RoO measures.

other PECS countries (not among CEECs), specifically EFTA countries and Turkey. We then consider the implications of China's accession to the WTO in 2001, account for additional trade barriers such as quotas, and relax assumptions about sectoral trends.

Domestic Trade. Following the 2004 EU enlargement, Spoke countries experienced significant investments and technological advancements, boosting domestic production. To evaluate whether the impact of RoO liberalization promoted global rather than regional supply chains—while accounting for domestic sourcing within the regional context—we use data from the Granular Trade and Production Activities (GRANTPA) database (Bradley et al., 2024).[34]

Our analysis is restricted to the EU Enlargement episode due to data constraints, with 2001 being the first year when data for the Spoke countries are available. Additionally, many products lack complete data due to reporting limitations and classification differences. We address these limitations in two ways. First, we focus on products that have both domestic and trade data available in the pre-enlargement period (either 2001 or 2002) and the post-enlargement period (either 2006 or 2007). This approach ensures that we are comparing consistent data across time and reduces potential bias from missing observations. Second, we adopt a less restrictive method for handling missing values by including products that have domestic data across both periods and imputing zeros for missing import values, as trade data are generally more reliable.

[34]This dataset provides detailed export and domestic trade information at the product level for EU countries, although the classification of production data is coarser, covering approximately 3,000 products.

This method allows us to retain a larger sample size while acknowledging and adjusting for the limitations in the data.

To assess whether RoO liberalization encouraged international sourcing over domestic sourcing—such as Poland shifting from domestic markets to international suppliers—we use this alternative dataset to replicate the estimations in Table 3, comparing imports from the RoW with regional sourcing. Table 19 confirms that RoO liberalization significantly increased sourcing from the RoW, fostering global supply chains over regional ones. This conclusion remains robust whether regional sourcing is defined to include both Spoke imports and domestic sourcing (with elasticities comparable to those in Table 3) or focuses exclusively on domestic sourcing. Interestingly, estimates based solely on domestic sourcing exhibit larger elasticities, suggesting that transitioning from domestic producers to international suppliers may be relatively easier. This could be due to lower customization requirements or reduced sunk costs compared to shifting from one Spoke country to another.

EFTA and Turkey. To further assess the external validity of our analysis, we replace the group of Spokes' exporting countries with EFTA countries (Iceland, Liechtenstein, and Norway) and Turkey, since they were also part of PECS during the period under consideration. Specifically, since 1994, EFTA members had full cumulation with the EU as part of the European Economic Area (EEA) agreement. For all EFTA countries, PECS led to diagonal cumulation with CEECs and Baltic countries. In 1999 the PECS system was also widened to industrial products originating in Turkey. Note that these countries were previously excluded from RoW exporting countries because they belong to the cumulation zone.

Tables 20 and 21 present the results using only EFTA countries and Turkey as Spoke exporting countries, replacing then X_{SPjk} with X_{ETjk}. Specifically, Tables 20 and 21 replicate Table 6. The coefficient of $r_{ETk}^{PRE-PECS}$ and its interaction with the preferential margin remain positive. Additionally, we conducted a separate analysis for industrial goods, which were explicitly included in the Turkey-EU agreement, unlike agricultural goods. The results for industrial products align with our previous estimates, exhibiting higher elasticities. This supports the notion that industrial goods are typically integrated into global supply chains, where firms actively seek cost-efficient alternatives.

China in WTO. The implementation of the PECS in 1997 and the European Enlargement in 2004 marked significant shifts in EU trade policies. However, these were not the only major events shaping trade within the EU during that period. Specifically, China's accession to the WTO could have provided additional motivation for EU policymakers to relax RoO. If this were the case, including China among our group of RoW countries could distort our estimated coefficient for RoO. To address this concern, we exclude China from the RoW countries in our analysis. Table 22 replicates the most comprehensive specifications with RoW as the comparison group, as presented in Tables 2, 3, 6, and 7, but with China excluded from the RoW group. The estimates remain nearly identical to those that include China, suggesting that our results are not driven by changes in EU-China trade relations.

Preferential Tariff Quotas Tariff quotas were used substantially by the EU in the 1990s to control the import of sensitive products, particularly to protect the agricultural sector. Preferential quotas were often granted as part of EU FTAs to secure licenses for partner countries. The EU indeed granted preferential quotas to the Spokes countries. Note that this system was to be gradually phased out in the EU market around the same time that the relaxation of RoO under PECS was occurring. In particular, all quotas were phased out by 2002.[35] To avoid confounding the effects of the easing of these trade restrictions, Table 23 presents two checks. First, we exclude all agricultural products, which correspond to those with HS2 Chapters up to 24. Second, we compute, for each intermediate product, the share of its final goods that are covered by preferential quotas to our Spoke countries, and we exclude intermediate inputs where more than 1% of their value enters into final goods with a quota. This step results in excluding around 25% of our estimating sample. The results are consistent with our previous estimates, showing higher elasticities. This is in line with the larger substitution effects observed for industrial products in Table 20.

Sectoral Trends. To address the assumption discussed in Section 5.1.1 that technological trends evolve similarly across products within exporting countries, we perform robustness checks by incorporating exporter-sector fixed effects in Table 24. We define sectors using the

[35]Data on products subject to preferential tariff quota are obtained from the TRAINS WITS raw database.

three-digit BEC (Broad Economic Categories) classification, which categorizes goods based on their economic characteristics and intended use.[36] This approach enables us to test the stability of our results by relaxing the assumption of static comparative advantages—that is, allowing sectoral trends to differ within countries—while maintaining sufficient variation in the EU-RoO across products within each sector. Table 24 replicates the most comprehensive specifications from Tables 2, 3, 6, and 7, now incorporating exporter-sector fixed effects. The estimates remain consistent with our previous findings, exhibiting similar magnitudes, which suggests that differences in sectoral trends across exporters do not bias our results.

8 Conclusion

Preferential trade agreements have boomed in recent years. At the heart of FTAs there are RoO, and their corresponding cumulation rules. By determining the origin of a product, RoO defines whether a good qualifies for preferential access. Cumulation of origin rules defines whether a firm can use imported intermediate goods from a non-partner country without losing the preferential access to the FTA.

Unlike existing empirical studies that primarily examine the initial implementation of FTAs and their RoO, this paper leverages the European context to assess the impact of subsequent reductions in RoO restrictiveness. We focus on two key reforms: the 1997 Pan-European Cumulation System, which introduced diagonal cumulation of RoO, and the 2004 EU enlargement, which eliminated RoO for Central and Eastern European Countries joining the EU Customs Union. We develop a theoretical framework capturing how import shares respond to RoO restrictiveness, influenced by both the level of RoO and preferential margins for final goods. Employing a novel measure of RoO at the intermediate level—derived from textual analysis of EU-FTA agreements—we empirically assess the implications of reduced RoO restrictiveness across HS6 intermediates from various origin groups. Guided by theoretical gravity equations, we estimate that a 1% larger value requirement correlates with a 0.4% to 0.7% increase in intermediate imports from countries where restrictions are lifted.

[36]The BEC classification identifies approximately 30 product categories, allowing exporter-product trends to vary across sectoral classes such as "Transport Equipment for Industrial Purposes" and "Processed Industrial Supplies," among others.

Our findings indicate that these increases are relevant for intermediates used in final goods with higher preferential margins, reflecting a non-linear relationship between RoO restrictiveness and sourcing decisions. The reforms initiated by the PECS and the subsequent EU enlargement prompted firms to reassess their sourcing strategies—initially reinforcing regional production structures and later facilitating integration into global supply chains. This dynamic restructuring underscores the significant role that cumulation systems and preferential margins play in shaping global trade configurations.

The implications of our findings are significant for trade policy design. Increased flexibility in RoO can drive transformative changes in supply chains and potentially enhance allocative efficiency. As policymakers continue to negotiate and refine trade agreements, understanding these dynamic effects is crucial for fostering efficient global value chains. Future studies could extend our analysis to quantify the effects of RoO liberalization on other economic outcomes, such as prices and employment, following methodologies similar to those employed by Head et al. (2024). Such extensions would provide a more comprehensive understanding of the broader economic impacts of RoO policies and inform the ongoing evolution of international trade strategies.

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Supplementary Online Appendix

Appendix A provides additional details on our data. Appendix B provides additional details on the costruction of our EU-RoO Index. Appendix C discusses the preparation of tariff data used.

A Additional Tables on Sample Selection

Table 8 categorizes the importer and exporter countries by groups. The Slovak Republic and Slovenia are excluded from our sample of importing countries for the PECS episode due to missing tariff data prior to 1997 but are included as importers in the EU enlargement episode (and excluded in robustness checks upon request). Additionally, for the PECS episode, Spokes exporters refer to spokes from other FTAs, specifically BAFTA countries for CEFTA and vice versa.

Table 9 instead reports the list of Rest of the World countries that are included in our analysis as exporters. These countries had no FTAs with any of the Spoke countries or with the EU, and therefore no FTAs were inherited by the Spokes with these RoW countries upon EU enlargement.

Table 8. List of importers and exporter countries by groups

Spokes Importing	Spokes Exporting	EFTA Countries	EU15
Czech Republic	Czech Republic	Iceland	Austria
Estonia	Estonia	Norway	Belgium
Hungary	Hungary	Switzerland	Denmark
Latvia	Latvia		France
Lithuania	Lithuania		Finland
Poland	Poland		Germany
Slovak Republic*	Slovenia		Greece
Slovenia*	Slovakia		Ireland
	Turkey		Italy
	EFTA		Luxembourg
			Netherlands
			Portugal
			Sweden
			Spain
			United Kingdom

Notes: The Slovak Republic and Slovenia are excluded from our sample of importing countries for the PECS episode due to missing tariff data before 1997. However, they are included as importers in the EU enlargement episode (and excluded in robustness checks).

Table 9. List of Rest of the World countries

Afghanistan	Albania	Algeria	Angola
Argentina	Armenia	Australia	Azerbaijan
Bangladesh	Belarus	Belize	Benin
Bhutan	Bolivia	Botswana	Brazil
Brunei Darussalam	Burkina Faso	Burundi	Cabo Verde
Cameroon	Canada	Central African Republic	Chile
China	Colombia	Congo, Rep.	Costa Rica
Côte d'Ivoire	Croatia	Cuba	Djibouti
Dominican Republic	Ecuador	Egypt, Arab Rep.	El Salvador
Equatorial Guinea	Eritrea	Eswatini	Ethiopia
French Guiana	Gabon	Gambia, The	Georgia
Ghana	Guatemala	Guinea	Guinea-Bissau
Haiti	Honduras	Hong Kong SAR, China	India
Indonesia	Iran, Islamic Rep.	Iraq	Jamaica
Japan	Jordan	Kazakhstan	Kenya
Korea	Korea, Rep.	Kuwait	Kyrgyzstan
Lao	Lebanon	Lesotho	Liberia
Libya	Macao	Madagascar	Malawi
Malaysia	Mali	Malta	Mauritania
Mauritius	Mongolia	Morocco	Mozambique
Myanmar	Namibia	Nauru	Nepal
New Zealand	Nicaragua	Niger	Nigeria
Oman	Pakistan	Panama	Papua New Guinea
Paraguay	Peru	Philippines	Qatar
Réunion	Rwanda	Saudi Arabia	Senegal
Serbia-Montenegro	Sierra Leone	Singapore	Somalia
Sri Lanka	Tajikistan	Tanzania	Thailand
Togo	Tonga	Trinidad and Tobago	Turkmenistan
Uganda	Ukraine	United Arab Emirates	United States
Uruguay	Uzbekistan	Vanuatu	Venezuela, RB
Vietnam	Yemen, Rep.	Zambia	Zimbabwe

Notes: List of countries classified as Rest of the World (RoW) in our analysis. These countries had no FTAs with any of the Spoke countries or with the EU, and therefore no FTAs were inherited by the Spokes with these RoW countries upon EU enlargement.

Table 10. Preferential agreements allowing for diagonal cumulation

	Czech Rep.	Estonia	Hungary	Latvia	Lithuania	Poland	Slovak Rep.	Slovenia
EU	97	97	97	97	97	97	96	97
Czech Rep.	—	97	97	97	97	97	97	97
Estonia	97	—	99	97	97	97	96	97
Hungary	97	99	—	00	00	97	97	97
Latvia	97	97	00	—	97	98	96	96
Lithuania	97	97	00	97	—	98	97	97
Poland	97	99	97	98	98	—	97	97
Slovak Rep.	97	96	97	97	97	97	—	97
Slovenia	97	96	97	97	97	97	97	—

Source: Commission notice (2002/C 100/05) regarding preferential agreements that allow for diagonal cumulation of origin between the EU Community and the Spoke countries in our study.

B Construction of the EU-RoO Index

Data Source The legal texts analyzed include the 1994 Trade Agreements with Hungary (CEFTA) and Lithuania (BAFTA), as well as the 1997 PECS Agreement with the Czech Republic. These agreements were chosen because, although BAFTA and CEFTA members individually signed FTAs with the European Community in 1994, the RoO within these agreements are consistent across all BAFTA and CEFTA participants. Similarly, the RoO in the 1997 PECS Agreements, which were also signed individually, are uniform across all PECS members. The pre-PECS Treaties referenced in our analysis can be accessed on the Eur-Lex website here and here. The PECS Treaty with the Czech Republic is available here. The rules are detailed in Annex II of each treaty, with Annex I providing clarifications on their interpretation.

Codification Process. Whenever possible, rules are codified at the HS6 level. When rules apply to broader categories (HS2 or HS4), they are extended to all relevant HS6 products within those categories. In some cases, only textual descriptions are available without corresponding HS6 codes. To address this, we employ a word matching technique to classify these textual descriptions into appropriate HS6 categories. The word matching is conducted between the HS6 product descriptions in both the HS classification and the CN European Classification, and the corresponding product descriptions in the treaty, allowing the recovery of the appropriate HS6 codes. This matching process is carried out using the FuzzyWuzzy Library in Python, which involves tokenization, adjusting capitalization, and removing punctuation to ensure accurate string matches. Manual checks are performed in instances where multiple HS6 categories could potentially match.

Classification and Sub-classification of Rules. The rules of origin are organized into five main categories, each further subdivided based on the specific restrictions they impose. For

instance, within the “Change in Tariff Classification" category, the rules are broken down into sub-categories such as “Change in Chapter" and "Change in Heading." The classification process employs regular expressions to identify and group these patterns within the text. Table 11 provides examples of the text patterns used for classification.

Each main category is divided into sub-categories based on the type and scope of the restriction. A single rule can fall into multiple categories. For example, a rule might require both a Change in Heading and set a minimum Regional Value Content for the materials used. An example from the PECS Treaty illustrates this: a sub-heading for the product “ex 2008" requires that “all materials used are classified within a heading other than that of the product" (CTC), and also that “the value of any materials of Chapter 17 used does not exceed 30% of the ex-works price of the product" (Regional Value Content). Table 12 shows the frequency of these rules across the three Trade Agreements analyzed. This classification is essential for assigning the correct value requirements and understanding the restrictions imposed by each rule.

Table 11. Taxonomy of RoO rules and examples of text used to identify them

Class	Sub-Class	Text Pattern in Annex II
Regional Value Content	Value Material Used (VMU)	Manufacture in which the value of all the materials used does not exceed X% of the ex-works price of the product
	Value Material of the Heading (VMH)	Manufacture in which materials from the same heading can be used provided their value does not exceed X%
	Value Material of Other Heading (VMOH)	Materials which are classified in heading N. Y may be used provided their value does not exceed X%
	Value Material Originating (VMNOM)	Manufacture in which the value of non-originating materials used does not exceed the value of the orig. materials
Change in Tariff Class.	Change in Chapter (CC)	Any heading except those of Chapter Y might be used
	Change in Heading (CH)	All the materials used are classified in a heading other than that of the product
	Change in Subheading (CS)	Manufacture from materials of any heading, including other materials of heading N. Y
	Heading Exception (HE)	Manufacture from materials of any heading except prepared or preserved vegetables of heading N. Y
Technical Requirement		Manufacture from materials of heading N. Y
Wholly obtained		Manufacture in which all the materials used must already be originating
No Rule		Manufacture from materials of any heading

Notes: Taxonomy of RoO taken from FTA treaties . RoO are text strings indicating the processing required on non-originating materials in order that the product realized receive originating status. This text information is then used to classify RoO. X and Y are numeric elements, the first refers to the value content while the second to HS categories.

Table 12. Frequencies of Rules by Classes

Rule Type	EU-BAFTA	EU-CEFTA	EU-PECS
VMU	588	592	2132
Technical Requirement	1178	1268	1135
CH	51	51	897
Wholly Obtained	166	159	447
CH, VMU	180	180	164
Technical Requirement, VMC	114	114	77
VMH	63	63	66
Wholly Obtained, VMC	2	2	61
Technical Requirement, CH, VMH	0	0	60
NO_rule	114	114	52
CH, VMC	40	40	51
CH, VMH	656	586	26
Wholly Obtained, CH	0	0	18
Technical Requirement, CH	20	20	18
HE	44	28	14
Wholly Obtained, VMU	0	0	13
CH, VMH, VMOH, VMU	14	14	12
Technical Requirement, VMOH	1	1	11
VMOH	18	18	8
Wholly Obtained, HE, VMOH	0	0	8
VMC	57	57	7
CS, VMS	5	5	7
CS	16	16	6
CC	0	0	5
Wholly Obtained, HE, VMC	0	0	3
Technical Requirement , CH, VMC	0	0	2
CH, VMH, VMOH	0	0	2
Technical Requirement , VMU	1	1	1
Wholly Obtained, Technical Requirement, VMC	2	2	0
CH, VMOH	2	2	0
CS, VMH	21	21	0
VMH, VMOH	39	39	0
VMH, VMU	563	555	0
VMU, VMC	60	60	0
VMOH, VMU	105	105	0
VMH, VMOH, VMU	11	11	0
CH, VMH, VMU	0	8	0

Notes: Number of HS6 covered by Rule Type in the three differents Trade Agreements analyside: EU-BAFTA, EU-CEFTA, EU-PECS. For the legend, refer to Table 11

Identification of Restricted Products. To identify the HS6 products that may be restricted by each rule, we analyze the textual information contained in each RoO. This process is straightforward for most sub-classes. For instance, the Value of Material Used class potentially restricts the use of all HS6 products. In contrast, rules under the Value Material of Other Heading class limit the use of only certain headings specified in the text (as shown in Table 11). In this case, local searches for numeric sequences are conducted, and external dictionaries, such as WITS, are used to translate textual descriptions into HS codes.[37] These local searches

[37]The dictionary is available at the link here.

focus on the areas surrounding specific keywords, such as “of the Chapter" or “of the Heading," ensuring that all relevant products are accurately identified and included in the index calculation. Additionally, since Technical Requirements typically mandate that the producer complete the entire production process, we assume they can potentially restrict all HS6 products.

Table 13. Assignment to Inputs and Value Requirement by Rule Class

Class	Sub-Class	Restricted HS	Value Requirement
Regional Value Content	Value Material Used	All HS6	100-X%
	Value Material of the Heading	All HS6 in the HS4 of the rule	100-X%
	Value Material of Other Heading	All HS6 in the HS4 specified (Y)	100-X%
	Value Material Originating	All HS6	50%
Change in Tariff Class.	Change of Chapter	All HS6 in the Chapter specified (Y)	100%
	Change of Heading	All HS6 in the HS4 of the rule	100%
	Change of Subheading	The HS6 of the rule	100%
	Heading Exception	All HS6 in the HS4 specified	100%
Technical Requirement		All HS6	100%
Wholly obtained		All HS6 (unless specified)	100%
No Rule		All HS6	0%

Notes: Map between RoO classes and HS input and value restrictions. The X% value represents the content requirement for each rule within the "Regional Value Content" class, as outlined in Table 11. Y denotes one or more HS products (at the Chapter, HS4, or HS6 level) and is used to specify inputs in rules for classes such as Change of Tariff Classification, as shown in Table 11.

Assignment of Value Requirement. The assignment of Value Requirements to each rule is based on the nature of the restriction and is detailed in Table 13. For Regional Value Content rules, the Value Requirement is the minimum value-added content within the FTA. For Change in Tariff Classification and Wholly Obtained rules, the restriction is based on the extent of transformation required within the FTA. For example, if the rule of origin calls for a Change of Chapter, this implies that all intermediates which belong to the same Chapter as the final product and originate from outside the FTA cannot be used. We therefore assign a 100% restriction to the intermediates belonging to the same Chapter. Similarly, if the rule of origin requires a Change in Heading, all the inputs' values belonging to the subheadings (HS6) in the same heading (HS4) as the final product must originate entirely from the FTA. Also in this case, as shown in Table 13, we assign a 100%. Let's consider our previous example for the product “ex 2008" in the PECS Treaty. A sub-heading of this product requires that “all the materials used are classified within a heading other than that of the product", which is a CTC, to which we assign a 100% restriction. Then, another sub-heading states “the value of any materials of Chapter 17 used does not exceed 30% of the ex-works price of the product," which is a Regional Value content, to which we assign a 30% restriction.

Technical requirements impose the highest restrictions, as they often require the entire production process to occur within the FTA.[38] These value requirements are then integrated into the final product's value through the use of an Input-Output (IO) matrix.

[38]In a robustness test, we verify if our results are stable to other possible choices in treating these types of goods.

C Preparation of Tariff Data

Table 14 presents the availability of raw data from WITS on Most Favored Nation (MFN) tariffs and Preferential Tariffs (PRF) by importer. Specifically, it lists tariffs availability for each of the three periods in our analysis: pre-PECS, post-PECS, and post-EU enlargement. The table uses the earliest available year closest to 1995 and the most recent available year closest to 2002 when data for these years is otherwise missing. In 2006, all tariffs for our Spokes countries align with those of the EU, meaning both MFN and PRF data are available for all countries in that year.

Table 14. Raw Tariff Data Sources Availability from WITS

	MFN Data			**PRF Data**		
Country	pre-PECS	post-PECS	EU-Enl.	pre-PECS	post-PECS	EU-Enl.
Czech Republic	1996	2002	2006	-		2006
Estonia	1995	2002	2006	-	-	2006
Poland	1996	2001	2006	1996	2001	2006
Hungary	1996	2002	2006	-	1997	2006
European Union	1996	2002	2006	1996[39],1997[40]	2002	2006
Lithuania	1995	2002	2006	1995	2002	2006
Latvia	1996	2001	2006	-	-	2006
Slovenia	-	2002	2006	-	2002	2006
Slovak Republic	-	2002	2006	-	-	2006

Notes: Data availability from WITS on MFN and PRF by importer for the three periods in our analysis: pre-PECS, post-PECS, and post-EU enlargement. The table reports the earliest available year closest to 1995 and the most recent available year closest to 2002 when data for these years is otherwise missing.

Although MFN data is available for most Spokes countries during the pre-PECS period (except for the Slovak Republic and Slovenia), PRF data is largely missing despite the existence of several bilateral and regional FTAs between Spokes countries and the EU. To address this gap, we have created a new database that includes the missing information on Preferential Tariffs across Spokes countries and with the EU, using the available treaties which we describe in Tables 15 and 16 of Sections C.1 and C.2.

For the EU, data on MFN tariffs and preferential tariffs to CEFTA members is available from 1996, while the earliest year for preferential tariffs to BAFTA countries is 1997. These data can be used for the pre-PECS period since tariffs were fully liberalized at the signing of the agreements in 1994 and 1995 and remained constant, except for agricultural products, which had a phase-out agreement. We took these phase-outs into consideration by using the Annexes of the Agreements and adjusting the reductions to reflect the tariff levels applied in 1996. In the following sections we described the construction of the tariffs database used in our estimation.

C.1 Treaties and Annexes for Imports from Spokes

In this section we discuss how we fill the missing preferential tariff information concerning Spokes' imports from other Spokes (for all three periods).[41]

Industrial Products. Preferential tariff information for industrial products across all periods was manually compiled using various treaties. For bilateral relations within CEFTA members, we used the CEFTA Agreement and its annexes available here. Similarly, for bilateral relations within BAFTA members, we used the BAFTA agreement available in GPTAD. For all other bilateral relationships, we used information from GPTAD. Generally, agreements either set preferential tariffs to zero or maintain them at a certain MFN level, with exceptions listed in the annexes. The agreed preferential tariff levels were codified and assigned to the corresponding products as outlined in the agreements, with the exception of those listed in the annexes. For these products, we adhered to the provisions detailed in the annexes.

Agricultural Products. Given the reading of the available treaties, we have assigned to all agricultural products the MFN tariff for 1995. While, for 2002, we used information from bilateral treaties using GPTAD, as reported in Table 15.

Table 15. FTA Treaties between Spokes Countries

Treaties	HUN	CZE	SVN	SVK	LTU	LVA	EST
POL	CEFTA Agr. 01/92	CEFTA Agr. 01/92	CEFTA Enlarg., 01/96	CEFTA Agr. 01/92	Bilateral FTA, 03/97	Bilateral FTA, 01/99	Not available
HUN	-	CEFTA Agr. 01/92	CEFTA Enlarg., 01/96	CEFTA Agr. 01/92	Bilateral FTA, 01/00	Bilateral FTA, 03/00	Bilateral FTA, 01/98
CZE		-	CEFTA Enlarg., 01/96	CEFTA Agr. 01/92	Bilateral FTA, 01/97	Bilateral FTA, 01/96	Bilateral FTA, 07/96
SVN			-	CEFTA Agr. 01/92	Bilateral FTA, 01/97	Bilateral FTA, 01/96	Bilateral FTA, 01/97
SVK				-	Bilateral FTA, 01/97	Bilateral FTA, 01/1997	Bilateral FTA, 07/96
LTU					-	BAFTA Pref from 1994	BAFTA Pref from 1994
LVA						-	BAFTA Pref from 1994

Notes: FTA treaties active between pairs of Spokes before the EU enlargement. Available from GPTAD.

C.2 Treaties and Annexes for Spokes' Imports from EU15

To fill information about preferential tariff pre PECS, we used the information in the treaties available from EUR-Lex as listed in Table 16.

Industrial Products. For industrial products, all preferential tariffs are set to zeros, with some exceptions listed in Annexes for Lithuania and Latvia. These exceptions have been taken into consideration.

Agricultural Products. Following the treaties and annexes, for pre-PECS we assigned to all agricultural products, the MFN tariff. Instead, we give a zero tariff to Estonia and CZE. Differently, for post-PECS, we assume that tariffs on agricultural products are the same among BAFTA importing from the EU (here we applied Lithuania's tariffs to Estonia and Latvia); and

[41] Notice that there is no available treaty between Poland and Estonia. Thus, we keep the MFN tariff information available from raw data in WITS.

the same across CEFTA importing from EU (we applied Poland's tariffs to Hungary and CZE). This assumption is justified by the fact that by 2002 tariffs with respect to EU products should be harmonized across respective FTA.

Table 16. FTA treaty identifiers between the EU and Spokes Countries

Partner	Treaty Identifier
POL	Bilateral FTA 1993 L348 EUR-Lex
HUN	Bilateral FTA 1993 L347 EUR-Lex
CZE	Bilateral FTA 1994 L360 EUR-Lex
SVN	Bilateral FTA 01/1997
SVK	Bilateral FTA 07/1996
LTU	Bilateral FTA 1994 L375 EUR-Lex
LVA	Bilateral FTA 1994 L374 EUR-Lex
EST	Bilateral FTA 1994 L373 EUR-Lex

Notes: FTA between the EU and the Spokes used to recover PRF tariffs for the pre-PECS period. For the Slovak Republic (SVK) and Slovenia (SVN), no treaties were used for the pre-PECS phase as MFN tariffs were also unavailable.

C.3 Treaties and Annexes for EU Preferential Margin

To calculate preferential tariffs from the EU on imports from our Spokes and determine the preferential margin m_{jk}, we referenced treaties listed in Table 16. Since 1995, the EU has applied zero duty on industrial imports from CEFTA and BAFTA partners; therefore, missing 2002 values for industrial products were set to zero. For agricultural products, exceptions in the annexes were addressed by applying an adjustment factor based on the MFN tariff phase-out ratio. Specific tariffs, mostly in agriculture and largely unchanged during this period, were converted to ad valorem equivalents using UNCTAD 1 methodology, based on import values, to calculate the EU-preferential margin accurately.

To address remaining gaps in the relationships described in Sections C.1, C.2, and C.3, we implemented the following adjustments. First, if a PRF tariff was missing in the post-PECS period but available in pre-PECS, we used the pre-PECS data. Second, in instances where the preferential margin was negative, we retained the data as missing; this affected only 5% of cases and likely reflects data entry errors. For example, Slovenia's preferential tariff is reported as 106.5% while the MFN is 20%, indicating a probable misreport, in which case we assigned a zero. Third, when treaties specified zero tariffs on all industrial products without exceptions, we assigned a 0% preferential tariff to industrial products with missing data.

C.4 Summary Statistics

We here report summary statistics for the tariffs used. Table 17 shows average applied Spokes' import tariff to the group of exporters across product groups and across the three periods considered. The data highlights significant tariff reductions over time, particularly in industrial

goods, aligning with trade liberalization trends in the region. Table 18 presents EU-applied tariffs and the relative preferential margins over three periods. The table shows a progressive increase in the preferential margin over time, reaching a maximum in the EU enlargement phase, underscoring the EU's growing trade integration and preferential access granted to partner countries.

Table 17. Average Import Tariffs for Spokes countries

Importer Group	**Spokes**			**RoW**			**EU-15**		
Time Period	1	2	3	1	2	3	1	2	3
Animal Products	20.12	4.75	0	18.92	18.88	2.07	18.17	4.47	0
Chemicals	2.37	0.09	0	3.49	2.84	0.84	1.90	0.18	0
Foodstuffs	24.96	5.51	0	25.01	25.24	3.89	18.68	4.11	0
Footwear/Headgear	5.70	0.31	0	9.17	5.84	2.00	4.62	0.53	0
Machinery/Electrical	2.90	0.08	0	4.18	3.32	0.31	1.65	0.14	0
Metals	2.76	0.14	0	4.10	3.57	0.45	2.37	0.27	0
Mineral Products	0.81	0.02	0	1.22	1.06	0.03	0.50	0.05	0
Miscellaneous	3.31	0.08	0	4.78	3.85	0.43	2.42	0.16	0
Plastic/Rubbers	2.97	0.11	0	4.16	3.14	0.89	2.52	0.21	0
Raw Hides Skins Leathers	4.76	0.04	0	6.61	4.10	0.51	3.71	0.31	0
Stone/Glass	3.70	0.16	0	5.42	4.87	0.56	2.20	0.11	0
Textiles	5.86	0.49	0	8.38	5.98	2.74	5.21	0.66	0
Transportation	3.73	0.45	0	5.17	4.38	0.90	2.33	0.75	0
Vegetables	14.55	2.34	0	12.28	13.23	1.70	13.01	0.83	0
Wood Products	2.73	0.20	0	3.85	2.96	0.21	2.20	0.16	0
Average	5.50	0.69	0	6.68	5.77	1.13	4.47	0.62	0

Notes: Data sources include TRAINS from WITS, supplemented with information from FTA treaties as outlined in Section C.1. Impot Tariffs refer to those imposed by Spokes on imports from the respective groups (e.g., other Spokes, EU15 and RoW) . Time Periods 1, 2, and 3 correspond to pre-PECS (before 1997), post-PECS (2002), and post-EU Enlargement (2006), respectively.

Table 18. EU Applied Tariff and Preferential Margin Towards Spokes

	Pre-PECS (Time 1)		Post-PECS (Time 2)		Post EU-Enl. (Time 3)	
Variable	Appl. Tariff	Prf. Margin	Appl. Tariff	Prf. Margin	Appl. Tariff	Prf. Margin
CZE	3.26	3.99	2.08	3.96	0.00	5.97
EST	3.06	4.20	2.05	4.03	0.00	5.97
HUN	3.21	4.05	1.89	4.20	0.00	5.97
LTU	3.11	4.15	2.18	3.94	0.00	5.97
LVA	3.04	4.22	2.13	3.94	0.00	5.97
POL	3.15	4.11	1.86	4.20	0.00	5.97
SVK	.	.	2.16	3.88	0.00	5.97
SVN	.	.	2.22	3.85	0.00	5.97
Total	3.14	4.12	2.07	4.00	0.00	5.97

Notes: Data sources include the TRAINS database from WITS, supplemented with information extracted from FTA treaties as detailed in Section C.1. EU applied tariffs refer to the tariffs imposed by the EU on imports originating from Spoke countries. The EU preferential margin is defined as the difference between the Most Favored Nation (MFN) tariffs and Preferential (PRF) tariffs. The three time periods considered are as follows: Period 1 (pre-PECS, before 1997), Period 2 (post-PECS, 2002), and Period 3 (post-EU Enlargement, 2006).

D Additional Robustness

The following tables present additional robustness checks that we conducted in Section 7.

Table 19. EU Enlargement and change in imports, RoW vs. Spokes and domestic sources

SAMPLE	More Restrictive Treatment of Missing Values				Less Restrictive Treatment of Missing Values			
	Panel (a)				Panel (b)			
Dependent Variable:	Change in (log) Imports from: RoW vs Spks+Dom		RoW vs DOM		Change in (log) Imports from RoW vs Spks+Dom		RoW vs DOM	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\log r^{PECS}_{RoWk}$	0.581	0.895**	2.262*	2.489*	0.665	1.116**	2.758**	3.119**
	(0.428)	(0.454)	(1.287)	(1.322)	(0.489)	(0.517)	(1.202)	(1.254)
$\Delta\log\left(\frac{\tau_{RoWjk}}{\tau_{SPjk}}\right)$		-6.961***				-8.472***		
		(2.122)				(2.131)		
$\Delta\log\left(\tau_{RoWjk}\right)$				-6.927**				-6.191**
				(3.320)				(2.707)
Observations	11,755	11,564	11,755	11,564	21,849	21,457	21,849	21,457
R-squared	0.039	0.042	0.087	0.091	0.150	0.154	0.141	0.145
Importer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS estimation. Changes refer to the period 2002-2006. Data from the Granular Trade and Production Activities (GRANTPA) database (Bradley et al., 2024). The more restrictive approach includes only products with complete domestic and trade data in both pre- and post-enlargement periods, while the less restrictive approach allows a larger sample by imputing zeros for missing trade values. In columns (1), (2), (5) and (6) the dependent variable is the difference in log changes of intermediate imports from the RoW versus other Spoke countries and domestic sourcing. In columns (3), (4), (7) and (8) the dependent variable is the difference between changes in log imports of intermediate k from the RoW versus domestic sourcing. $\Delta \log \tau_{ijk}/\tau_{i'jk}$ denotes the change in tariffs applied by a Spoke country on imports from country i versus i'. Note that τ_{SPjk} is 1 in both period and therefore column (4) and (8) include $\Delta \log \tau_{RoWjk}$. $\log r_k^{PECS} = log(1 + \text{EU-RoO}_k/100)$ represents the PECS RoO applied to inputs from RoW. Importing countries include the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia and Slovak Republic. Cluster standard errors at the (HS6-importer) in parentheses. *** p<0.01, ** p<0.05, * p<0.1..

Table 20. PECS and change in imports, EFTA and Turkey vs. RoW

Dependent Variable:	$\Delta\log\left(\frac{X_{ETjk}}{X_{RoWjk}}\right)$					
Products:	All	Industrial	All	Industrial	All	Industrial
	(1)	(2)	(3)	(4)	(5)	(6)
$\log r_{ETk}^{PRE-PECS}$	1.083***	1.544***	0.322	-0.183	0.422	-0.100
	(0.171)	(0.269)	(0.318)	(0.508)	(0.328)	(0.520)
$\Delta\log\left(\frac{\tau_{ETjk}}{\tau_{RoWjk}}\right)$	-2.397**	-6.861***	-2.595**	-6.883***	-2.782**	-6.853***
	(1.170)	(2.074)	(1.168)	(2.056)	(1.162)	(2.051)
$\Delta\log r_{RoWk}$	0.513	1.546**	0.472	1.191*	0.669	1.262*
	(0.431)	(0.694)	(0.436)	(0.717)	(0.438)	(0.710)
$\log r_{ETk}^{PRE-PECS} \times m_{jEUk}^{PRE-PECS}$			0.091**	0.255***	0.027	0.206**
			(0.045)	(0.076)	(0.050)	(0.088)
$m_{jEUk}^{PRE-PECS}$			0.015	0.029	-0.046*	0.015
			(0.020)	(0.029)	(0.025)	(0.031)
m_{jEUk}^{PECS}					0.083***	0.035
					(0.019)	(0.030)
Observations	68,802	30,063	68,802	30,063	68,802	30,063
R-squared	0.062	0.078	0.064	0.083	0.065	0.083
Importer FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS estimation. Changes refer to the period 1995-2002. The dependent variable represents changes in log imports of intermediate k of each Spoke country from EFTA countries and Turkey compared to the change of imports from the RoW. $\Delta\log\tau_{ETjk}/\tau_{RoWjk}$ denotes the change in tariffs applied by a Spoke country on imports from EFTA versus the EU15. $\log r_k^{PRE-PECS} = log(1+\text{EU-RoO}_k/100)$ represents the RoO applied to inputs from EFTA before PECS. $m_{jEUk}^{PRE-PECS}$ refers to preferential margin before PECS, while m_{jEUk}^{PECS} denotes the preferential margin after PECS, based on data availability as discussed in Section 4.3. Importing countries include: the Czech Republic, Estonia, Hungary, Lithuania, Latvia, and Poland. Cluster standard errors at the (HS6-importer). * p<0.01, ** p<0.05, * p<0.1.

Table 21. PECS and change in imports, EFTA and Turkey vs. EU15

Dependent Variable:	$\Delta\log\left(\frac{X_{ETjk}}{X_{EU15jk}}\right)$					
Products:	All	Industrial	All	Industrial	All	Industrial
	(1)	(2)	(3)	(4)	(5)	(6)
$\log r_{ETk}^{PRE-PECS}$	1.494***	1.629***	0.349	0.600	0.355	0.575
	(0.144)	(0.221)	(0.280)	(0.439)	(0.282)	(0.441)
$\Delta\log\left(\frac{\tau_{ETjk}}{\tau_{EUjk}}\right)$	-0.458	2.300*	-1.018**	1.387	-1.178**	1.401
	(0.500)	(1.214)	(0.499)	(1.216)	(0.502)	(1.215)
$\log r_{ETk}^{PRE-PECS} \times m_{jEUk}^{PRE-PECS}$			0.157***	0.111*	0.126***	0.138*
			(0.044)	(0.066)	(0.046)	(0.072)
$m_{jEUk}^{PRE-PECS}$			0.001	0.051*	-0.024	0.059**
			(0.020)	(0.027)	(0.023)	(0.030)
m_{jEUk}^{PECS}					0.042**	-0.021
					(0.016)	(0.024)
Observations	13,741	7,072	13,741	7,072	13,741	7,072
R-squared	0.024	0.026	0.027	0.030	0.028	0.030
Exporter FE	Yes	Yes	Yes	Yes	Yes	Yes
Importer FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: OLS estimation. Changes refer to the period 1995–2002. The dependent variable represents the difference between the log change in Spoke countries' imports of intermediate good j from EFTA and Turkey and the corresponding change from the EU15. $\Delta\log\tau_{ETjk}/\tau_{EUjk}$ denotes the change in tariffs applied by a Spoke country on imports from EFTA versus the EU15. $\log r_k^{PRE-PECS} = \log(1+\text{EU-RoO}_k/100)$ represents the RoO applied to inputs from EFTA before PECS. $m_{jEUk}^{PRE-PECS}$ refers to the preferential margin before PECS, and m_{jEUk}^{PECS} to the one after. Cluster standard errors at the (HS6-importer) level. * p<0.1, ** p<0.05, *** p<0.01.

Table 22. Exclusion of China from RoW exporters

Dependent Variable	Panel (a) PECS, Change in (log) Imports from: Sp. (i) vs RoW (i')		Dependent Variable	Panel (b) EU Enl., Change in (log) Imports from: RoW (i) vs. Sp (i')		RoW (i) vs. EU15 (i')	
	(1)	(2)		(3)	(4)	(5)	(6)
$\log r_{SPk}^{PRE-PECS}$	0.543**	-1.021*	$\log r_{RoWk}^{PECS}$	0.753***	0.117	0.377***	0.568***
	(0.244)	(0.553)		(0.107)	(0.211)	(0.081)	(0.141)
$\Delta \log r_{RoWjk}$	1.541***	1.486***					
	(0.535)	(0.564)					
$\Delta \log \left(\frac{\tau_{SPjk}}{\tau_{RoWjk}}\right)$	-2.904***	-1.724*	$\Delta \log \left(\frac{\tau_{RoWjk}}{\tau_{SPjk}}\right)$	-1.873***	-1.946***	-1.491***	-1.401***
	(0.906)	(0.951)		(0.435)	(0.418)	(0.243)	(0.234)
$\log r_{SPk}^{PRE-PECS} \times m_{jEUk}^{PRE-PECS}$		0.203***	$\log r_{SPk}^{PECS} \times m_{jEUk}^{PECS}$		0.064**		-0.034
		(0.069)			(0.031)		(0.021)
Observations	35,778	35,778	Observations	143,910	143,910	149,475	149,475
R-squared	0.057	0.060	R-squared	0.047	0.049	0.074	0.075
Importer FE	Yes	Yes	Importer FE	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Exporter FE	Yes	Yes	Yes	Yes
Controls for margin	No	Yes	Controls for margin	No	Yes	No	Yes

Notes: OLS estimation. Changes refer to the period 1995–2002 in Panel (a), and to 2002–2006 in Panel (b). The dependent variable represents changes in log imports of intermediate k of each Spoke country from i compared to the change of imports from i'. $\Delta \log \tau_{ijk}/\tau_{i'jk}$ represents the change in tariffs applied by a Spoke country to imports from country i versus i'. The variable $\log r_{SPk}^{PRE-PECS} = \log(1 + \text{EU-RoO}_k/100)$ represents the pre-PECS RoO applied to inputs from Spokes, while $\Delta \log r_{RoWjk}$ captures the change in RoO criteria due to PECS revisions, applied to inputs from RoW. The variable $\log r_{RoWk}^{PECS}$ denotes the PECS EU RoO that applies to inputs from RoW. For Panel (a), importing countries are the Czech Republic, Estonia, Hungary, Lithuania, Latvia, and Poland, while Panel (b) also includes the Slovak Republic and Slovenia. Cluster standard errors at the (HS6-importer) level. * p<0.1, ** p<0.05, *** p<0.01.

Table 23. Exclusion of products covered by preferential tariff quotas

SAMPLE	All HS6 except Agricultural				SAMPLE	All HS6 with ≤1% Value in Finals with Quotas			
Dependent Variable	PECS Change in (log) Imports from: Sp. (i) vs RoW (i')		Sp. (i) vs EU15 (i')		Dependent Variable	PECS Change in (log) Imports from: Sp. (i) vs RoW (i')		Sp. (i) vs EU15 (i')	
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
$\log r_{SPk}^{PRE-PECS}$	0.573**	-1.072*	0.605***	-1.396***	$\log r_{SPk}^{PRE-PECS}$	1.320***	0.091	0.753***	-1.494***
	(0.264)	(0.577)	(0.181)	(0.382)		(0.287)	(0.679)	(0.208)	(0.453)
$\Delta \log r_{RoWjk}$	1.896***	1.476**			$\Delta \log r_{RoWjk}$	2.743***	2.462***		
	(0.568)	(0.577)				(0.585)	(0.617)		
$\Delta \log \left(\frac{\tau_{ijk}}{\tau_{i'jk}}\right)$	-3.464***	-2.644**	-4.719***	-3.374***	$\Delta \log \left(\frac{\tau_{ijk}}{\tau_{i'jk}}\right)$	-2.504**	-1.343	-5.193***	-3.486***
	(1.078)	(1.153)	(0.929)	(0.937)		(1.084)	(1.184)	(1.032)	(1.040)
$\log r_{i'k}^{PRE-PECS} \times m_{jEUk}^{PRE-PECS}$		0.235***		0.219***	$\log r_{i'k}^{PRE-PECS} \times m_{jEUk}^{PECS}$		0.141*		0.226***
		(0.067)		(0.059)			(0.075)		(0.066)
Margin Adv.$_{jk}$		-0.075***		0.009			-0.017		0.023
		(0.026)		(0.027)			(0.029)		(0.031)
Observations	37,019	37,019	8,446	8,446	Observations	29,587	29,587	6,704	6,704
R-squared	0.079	0.081	0.065	0.074	R-squared	0.078	0.080	0.077	0.090
Importer FE	Yes	Yes	Yes	Yes	Importer FE	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes	Exporter FE	Yes	Yes	Yes	Yes
Controls for margin	No	Yes	No	Yes	Controls for margin	No	Yes	No	Yes

Notes: OLS estimation. Changes refer to the period 1995–2002. Agricultural products are defined as HS2 Chapters 1–24. The value of an intermediate in final goods subject to quotas is calculated as the weighted average of the intermediate's value contribution across all final goods covered by preferential license quotas to Spoke countries. The dependent variable represents changes in log imports of intermediate k of each Spoke country from i compared to the change of imports from i'. $\Delta \log(\tau_{ijk}/\tau_{i'jk})$ represents the change in tariffs applied by a Spoke country to imports from country i versus i'. The variable $\log r_{SPk}^{PRE-PECS} = \log(1 + \text{EU-RoO}_k/100)$ represents the pre-PECS RoO applied to inputs from Spokes, while $\Delta \log r_{RoWjk}$ captures the change in RoO criteria due to PECS revisions, applied to inputs from RoW. The variable $\log r_{RoWk}^{PECS} = \log(1 + \text{EU-RoO}_k/100)$ denotes the PECS EU RoO that applies to inputs from RoW. Importing countries are the Czech Republic, Estonia, Hungary, Lithuania, Latvia, and Poland. Cluster standard errors at the (HS6-importer) level. * p<0.1, ** p<0.05, *** p<0.01.

Table 24. Control for exporter specific sectoral trends

Dependent Variable	Panel (a) PECS, Change in (log) Imports from				Dependent Variable	Panel (b) EU Enl., Change in (log) Imports from			
	Sp. (i) vs RoW (i')		Sp. (i) vs EU15 (i')			RoW (i) vs. Sp (i')		RoW (i) vs. EU15 (i')	
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
$\log r_{SPk}^{PRE-PECS}$	0.475*	-0.740	0.338*	-1.458***	$\log r_{RoWk}^{PECS}$	0.575***	0.454***	0.268***	0.649***
	(0.250)	(0.514)	(0.188)	(0.315)		(0.105)	(0.157)	(0.071)	(0.104)
$\Delta \log r_{RoWjk}$	0.851*	0.643							
	(0.516)	(0.521)							
$\Delta \log \left(\frac{\tau_{ijk}}{\tau_{i'jk}}\right)$	-2.983***	-2.688***	-3.725***	-3.343***	$\Delta \log \left(\frac{\tau_{ijk}}{\tau_{i'jk}}\right)$	-1.495***	-1.541***	-1.176***	-1.054***
	(0.872)	(0.872)	(0.915)	(0.914)		(0.408)	(0.416)	(0.230)	(0.233)
$\log r_{SPk}^{PRE-PECS} \times m_{jEUk}^{PRE-PECS}$		0.193***		0.226***	$\log r_{RoWk}^{PECS} \times m_{jEUk}^{PECS}$		0.014		-0.046***
		(0.061)		(0.032)			(0.014)		(0.010)
Observations	39,084	39,084	9,007	9,007	Observations	160,028	160,028	166,882	166,882
R-squared	0.121	0.123	0.198	0.203	R-squared	0.078	0.078	0.110	0.111
Importer FE	Yes	Yes	Yes	Yes	Importer FE	Yes	Yes	Yes	Yes
Exp×Sec FE	Yes	Yes	Yes	Yes	Exp×Sec FE	Yes	Yes	Yes	Yes
Controls for margin	No	Yes	No	Yes	Controls for margin	No	Yes	No	Yes

Notes: OLS estimation. Changes refer to the period 1995–2002 in Panel (a), and to 2002–2006 in Panel (b). Sectors are defined using BEC classification at 3 digits. The dependent variable represents changes in log imports of intermediate k of each Spoke country from i compared to the change of imports from i'. $\Delta \log \tau_{ijk}/\tau_{i'jk}$ represents the change in tariffs applied by a Spoke country to imports from country i versus i'. The variable $\log r_{SPk}^{PRE-PECS} = \log(1 + \text{EU-RoO}_k/100)$ represents the pre-PECS RoO applied to inputs from Spokes, while $\Delta \log r_{RoWjk}$ captures the change in RoO criteria due to PECS revisions, applied to inputs from RoW. The variable $\log r_{RoWk}^{PECS}$ denotes the PECS EU RoO that applies to inputs from RoW. For Panel (a), importing countries are the Czech Republic, Estonia, Hungary, Lithuania, Latvia, and Poland, while Panel (b) also includes the Slovak Republic and Slovenia. Cluster standard errors at the (HS6-importer) level. * p<0.1, ** p<0.05, *** p<0.01.