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

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Context

- FTAs can lead to price distortions and allocative inefficiency
- RoOs define the local content requirements to prove origin for preferential access (prevent trade deflection)
- The associated cumulation system allows materials in another country to be considered as originating to fulfill the RoOs
- Limited analysis on their effects because RoOs are heterogenous and difficult to quantity
- Recent work by Conconi et al (2018) shows that ROOs affected NAFTA member and non-member countries sourcing decision

Hence, do sourcing decisions established under FTAs change following the expansion of a cumulation zone or the establishment of a custom union? And if so, how?

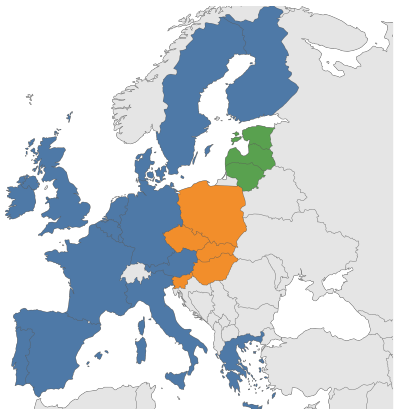
Insights on whether sunk costs are difficult to foregone and hence, sourcing choices are persistent.

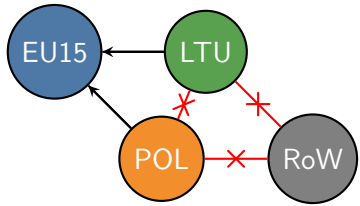
Our contribution

- Study the effects of **different cumulation systems of RoO on sourcing decisions**. Empirical analysis on EU PECS (diagonal cumulation) and 2004 EU enlargement.
- Create a **new database on European RoO at HS6 level** by codifying the legal text of EU FTAs and developing a measure of the restrictiveness of RoO on sourcing decisions for vertically related goods.
- Provide **consistent estimate of the elasticities** of EU-RoO on the demand for intermediate inputs using two episodes and different robustness checks.

Bilateral Cumulation

- In the early 90s, FTAs btw EU and CEECs eliminated tariffs
- However, this not implemented in a continent-wide free trade area.
- Instead, there were bilateral agreements with RoO: i.e. CEFTA and BAFTA.

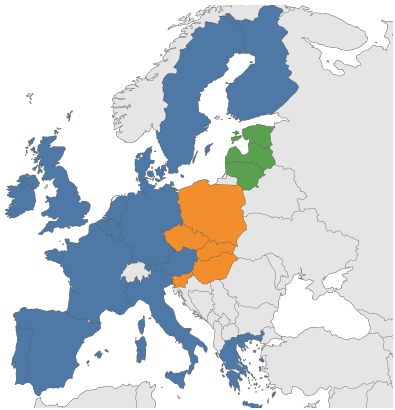


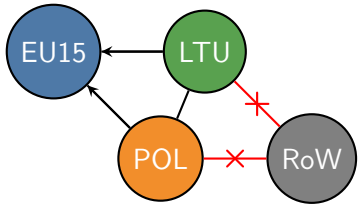


Originating input from POL is NOT considered to be originating input in LTU.

Diagonal Cumulation

- In 1997 PECS was established: CEECs could cumulate stages of production to obtain preferential access to EU15.





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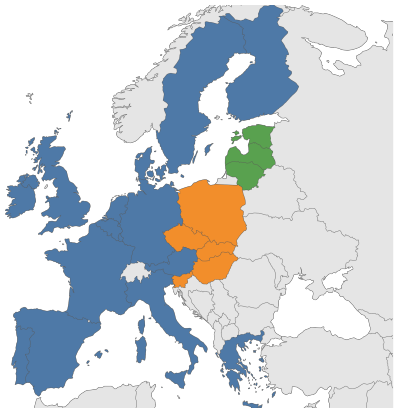
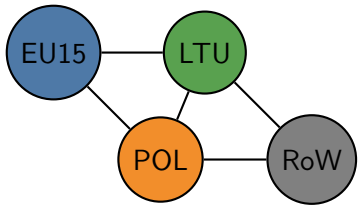
Full Cumulation

- In the 2004, CEECs countries joined the EU Customs Union
- permitted full cumulation and eliminated the use of RoO among members





RoOs are eliminated, free movements of goods within the EU.

Annex II of the Treaty 1994 with BAFTA countries

ANNEX II

LIST OF WORKING OR PROCESSING REQUIRED TO BE CARRIED OUT ON NON-ORIGINATING MATERIALS IN ORDER THAT THE PRODUCT MANUFACTURED CAN OBTAIN ORIGINATING STATUS

The products mentioned in the list may not all be covered by the Agreement. It is therefore necessary to consult the other parts of the Agreement

HS heading No	Description of product	Working or processing carried out on non-originating materials that confers originating status		
(1)	(2)	(3)	or	(4)
Chapter 1	Live animals	All the animals of Chapter 1 used must be wholly obtained		
Chapter 2	Meat and edible meat offal	Manufacture in which all the materials of Chapters 1 and 2 used must be wholly obtained		
Chapter 3	Fish and crustaceans, molluscs and other aquatic invertebrates	Manufacture in which all the materials of Chapter 3 used must be wholly obtained		
ex Chapter 4	Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included; except for:	Manufacture in which all the materials of Chapter 4 used must be wholly obtained		
0403	Buttermilk, curdled milk and cream, yoghurt, kephir and other fermented or acidified milk and cream, whether or not concentrated or containing added sugar or other sweetening matter or flavour or containing added fruit, nuts or cocoa	Manufacture in which: — all the materials of Chapter 4 used must be wholly obtained; — any fruit juice (except those of pineapple, lime or grapefruit) of heading No 2009 used must already be originating; — the value of any materials of Chapter 17 used does not exceed 30 % of the ex-works price of the product		
ex Chapter 5	Products of animal origin, not elsewhere specified or included; except for:	Manufacture in which all the materials of Chapter 5 used must be wholly obtained		
ex 0502	Prepared pigs', hogs' or boars' bristles and hair	Cleaning, disinfecting, sorting and straightening of bristles and hair		

Annex II of the Treaty 1994 with CEFTA countries

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ex 0502	Prepared pigs', hogs' or boars' bristles and hair

	materials of Chapter 3 used must be wholly obtained
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Annex II of the Treaty 1997 with PECS countries

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Codification and Classification of RoO

1. Rules are assigned to the final good at the HS6 level.

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Codification and Classification of RoO

1. Rules are assigned to the final good at the HS6 level.
2. Rules are classified into 5 classes

Table: Taxonomy of 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

Codification and Classification of RoO

1. Rules are assigned to the final good at the HS6 level.
2. Rules are classified into 5 classes
3. The set of potentially restricted HS6 products are identified for each rule as well as the corresponding Value Requirement

Table: Assignment to Inputs and Value Requirement by Rule Class

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

Measure of restrictiveness of RoO

- Not all inputs k actually enters in the production of a product f
- The EU-RoO measure takes into account Input-Output linkages:

$$\text{EU-RoO}_k = \sum_f \left(\text{VR}_{fk} \frac{dr_{fk}}{\sum_f dr_{fk}} \right) \quad (1)$$

where

- dr_{fk} refers to the direct requirement coefficient
- VR_{fk} valued requirement that restricts the use of input k for producing f

Note that $0\% \geq \text{EU-RoO}_k \geq 100\%$

To avoid endogeneity, we follow Rajan and Zingales (1998) and take IO table from the US at HS6 that refers to the initial period 1997.

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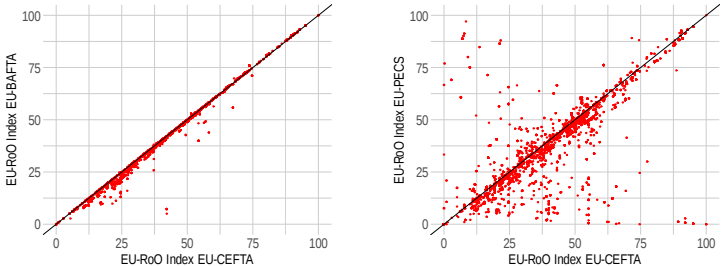
Summary stat on EU-RoO

Figure: Comparison of EU-RoO measures across trade agreements



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

1. high degree of similarity across pre-PECS trade agreements
2. small changes in product rules introduced with PECS

[Descriptives by sectors] [Validation of the index]

Identification Strategy (1/3)

- Empirical specification derived from multi-industry version of EK 2002 from CDK 2011
- We take perspective of final producers in country j (CEEC PECS country) that export under preferential access
- We take the ratio of importer j's (one PECS country) intermediate imports from an exporter which is a cumulation member i versus i' (either RoW or EU15).
- We look at changes in two time periods (from bilateral to diagonal (PECS) cumulation- and from diagonal to full cumulation)

Identification Strategy: From Bilateral to Diagonal (2/3)

Difference in Δ% of imports in intermediate of a PECS CEECs from another PECS CEECs versus ROW or EU15 between 2002 and 1995

- $t-1$ refers to bilateral cumulation
- t refers to diagonal cumulation

$$\Delta \log \left(\frac{X_{ijt}}{X_{i'jt}} \right) = \Delta \log \delta_{ikt} - \Delta \log \delta_{i'kt} - \theta \Delta \log \frac{\tau_{ijk}}{\tau_{i'jk}} + \theta\rho \log r_{ijkt-1} + \theta\rho \log \frac{r_{i'jkt}}{r_{i'jkt-1}}$$

1.a Evolution of technology in PECS exporter i

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1.a Evolution of technology in PECS exporter i
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3. The intensity of RoO towards PECS in bilateral cumulation

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1.b Evolution of technology in non-CEEC exporter i' (RoW or EU 15)
2. Change in relative tariffs
3. The intensity of RoO towards PECS in bilateral cumulation
4. Change in Intensity of RoOs for RoW **(= 0 for i' ∈ EU15)**

Identification Strategy: From Bilateral to Diagonal (3/3)

Difference in Δ% of imports in intermediate of a PECS CEECs from BAFTA or CEFTA versus ROW or EU15 between 2002 and 1995

$$\Delta \log \left(\frac{X_{ijt}}{X_{i'jt}} \right) = \Delta \log \delta_{ikt} - \Delta \log \delta_{i'kt} - \theta \Delta \log \frac{\tau_{ijk}}{\tau_{i'jk}} + \theta\rho \log r_{ijkt-1} + \theta\rho \log \frac{r_{i'jkt}}{r_{i'jkt-1}}$$

1.a $\delta_{ik} \longrightarrow \delta_i$ and $\delta_{i'k} \longrightarrow \delta_{RoW}$

Conconi et al. (2018): technology in *HS*6 evolves in a similar way across countries

Identification Strategy: From Bilateral to Diagonal (3/3)

Difference in Δ% of imports in intermediate of a PECS CEECs from BAFTA or CEFTA versus ROW or EU15 between 2002 and 1995

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2. TRAINS database

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3. $\log r_{ijkt-1}$ is $\log(1 + \text{EU-RoO}^{PRE-PECS}/100)$

- when j in BAFTA, computed on 1994 EU-BAFTA Agr.
- when j in CEFTA, computed on 1994 EU-CEFTA Agr.

Identification Strategy: From Bilateral to Diagonal (3/3)

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- when j in CEFTA, computed on 1994 EU-CEFTA Agr.

4. $\Delta \log \frac{r_{i'jkt}}{r_{i'jkt-1}}$

change in EU-RoO not due to change in cumulation systems but to variation in the intensity of RoO vs RoW (= 0 for i' ∈ EU15)

Results: from Bilateral to Diagonal cumulation

Table: PECS and change in imports, CEEC PECS vs. RoW

DEP. VAR.	$\Delta \log \left(\frac{X_{SPjk}}{X_{RoWjk}} \right)$		$\Delta \log \left(\frac{X_{SPjk}}{X_{EUjk}} \right)$	
	(1)	(2)	(3)	(4)
$\log r_{SPjk}^{PRE-PECS}$	0.511***	0.299*	0.437***	0.716***
	(0.141)	(0.170)	(0.149)	(0.158)
$\Delta \log \tau_{jk}$		-4.830***		-0.985*
		(0.723)		(0.428)
$\Delta \log r_{RoWjk}$		-0.455		
		(0.297)		
Observations	101,234	77,686	16,224	10,169
R-squared	0.055	0.069	0.070	0.075
Exporter FE	Yes	Yes	Yes	Yes

Notes: OLS estimation. Changes refer to the period 2002-1995. Cluster standard errors at the (HS6-importer) in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Identification Strategy: From Diagonal to Full

Difference in Δ% of imports in intermediate of a PECS CEECs from Row versus imports from another PECS CEECs or EU15 between 2006 and 2002

- $t-1$ refers to diagonal cumulation
- t refers to full cumulation

$$\Delta \log \left(\frac{X_{i'jt}}{X_{ijt}} \right) = \Delta \log \delta_{ik't} - \Delta \log \delta_{ikt} - \theta \Delta \log \frac{\tau_{i'jk}}{\tau_{ijk}} + \theta\rho \log r_{i'jkt-1}$$

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Intensity of RoO towards ROW in diagonal cumulation

Results: from Diagonal to Full cumulation

Table: Change in imports, RoW vs. Spokes and RoW vs. EU

DEP. VARIABLE	$\Delta \log \left(\frac{X_{RoWjk}}{X_{SPjk}} \right)$		$\Delta \log \left(\frac{X_{RoWjk}}{X_{EUjk}} \right)$	
	(1)	(2)	(3)	(4)
$\log r^{PECS}_{RoWjk}$	0.653***	0.515***	0.324***	0.330***
	(0.106)	(0.108)	(0.078)	(0.075)
$\Delta \log \tau_{jk}$		-1.613***		-4.522***
		(0.494)		(0.178)
Observations	192,560	166,302	214,894	199,055
R-squared	0.027	0.033	0.030	0.053
Exporter FE	Yes	Yes	Yes	Yes

Notes: Changes refers to the period 2002-2006. OLS Estimation. Cluster standard errors at the (HS6-importer). *** p<0.01, ** p<0.05, * p<0.1.

Quantification of the effect of cumulation for product with $\bar{r}$

- Bilateral to Diagonal:
  - Δ% Imp from PECS - Δ% Imp from Row $\approx$ 13.5 p.p.
  - PECS vs EU15 $\approx$ +30 p.p.
- Diagonal to full:
  - RoW vs PECS $\approx$ +22 p.p.
  - RoW vs EU15 $\approx$ +14 p.p.

Validity and Robustness

- Test for pre-trends [More]
- Include exporter-sector (ISIC) FEs [More]
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Summary

Do sourcing decisions established under FTAs change following the expansion of a cumulation zone or the establishment of the custom union?

- EU PECS– led to regionalization of supply chains
- EU enlargement –led to globalization of supply chains
- We estimate consistent elasticity of RoO between 0.3-0.7%

Appendix I

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

SECTOR	(EU-BAFTA)	EU-RoO$_k$ (EU-CEFTA)	(EU-PECS)
Animal Products	53.83	53.83	64.32
	(32.93)	(32.92)	(27.34)
Chemicals	21.62	23.85	20.38
	(12.65)	(12.50)	(12.06)
Foodstuffs	45.64	45.73	16.49
	(24.25)	(24.18)	(19.71)
Footwear/Headgear	26.64	26.69	26.31
	(25.67)	(25.71)	(25.47)
Machinery/Electrical	49.98	50.47	43.40
	(17.63)	(17.26)	(17.11)
Metals	44.12	44.30	41.87
	(11.03)	(11.05)	(11.12)
Mineral Products	23.87	27.51	23.78
	(16.54)	(15.77)	(16.67)
Miscellaneous	41.88	42.37	39.69
	(14.02)	(14.13)	(13.38)
Plastic/Rubbers	39.09	39.70	36.54
	(9.45)	(9.57)	(10.62)
Raw Hides,Skins,Leathers	38.54	38.27	33.94
	(19.15)	(18.94)	(20.33)
Stone/Glass	38.92	39.45	42.77
	(15.31)	(14.87)	(16.45)
Textiles	73.70	73.35	70.94
	(15.12)	(14.98)	(15.78)
Transportation	47.79	48.00	44.60
	(16.83)	(16.68)	(17.11)
Vegetables	34.04	34.27	27.85
	(18.44)	(18.32)	(19.24)
Wood Products	34.31	35.00	32.65
	(12.60)	(12.51)	(12.43)
Total	44.3	44.9	42.6
	(23.0)	(22.4)	(23.2)

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

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Validation of the EU-RoO Index

- EU-RoO measure is compared with Cadot's index, which represents complexity and restrictiveness of RoO in NAFTA and EU.
- Cadot's index ranges from 1 to 7 (most restrictive), accounting for the number and level of restrictions.[1]
- However, Cadot's index doesn't account for how final goods affect different input groups.
- To make EU-RoO measure comparable, an average at the final goods level is calculated.[2]
- Result: EU-RoO measure correlates positively and significantly with Cadot's index (Kendall's rank correlation test p-value < 0.001).

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Pre-Trends

Table: Pre-Trends for the Case of Hungary

Dep Var:	Imports from Spoke vs. RoW		Imports from Spoke vs. EU15		Imports from RoW vs. EU15	
	(1)	(2)	(3)	(4)	(5)	(6)
Subsample$_{1992-1993}$						
$\log r^{PRE-PECS}_{SPjk}$	0.147	-0.001	-0.085	-0.128	-0.020	0.107
	(0.336)	(0.570)	(0.229)	(0.474)	(0.157)	(0.157)
$\Delta \log \tau_{ii'jk}$		0.681		-0.867		0.040
		(1.711)		(3.096)		(0.490)
Observations	16,264	6,664	4,447	958	16,215	14,951
R-squared	0.268	0.339	0.000	0.000	0.353	0.367
Subsample$_{1994-1996}$						
$\log r^{PRE-PECS}_{SPjk}$	-0.019	-0.502	0.003	0.195	-0.048	0.039
	(0.257)	(0.306)	(0.264)	(0.524)	(0.176)	(0.174)
$\Delta \log \tau_{ii'jk}$		-0.652		-2.911		-3.416***
		(1.301)		(1.887)		(0.692)
Observations	17,140	11,470	4,447	1,945	17,061	15,929
R-squared	0.051	0.069	0.000	0.002	0.071	0.081
Subsample$_{1995-2002}$						
$\log r^{PRE-PECS}_{SPjk}$	1.291***	1.189***	0.249*	0.505***	-0.133	-0.284**
	(0.257)	(0.306)	(0.136)	(0.141)	(0.176)	(0.174)
$\Delta \log \tau_{ii'jk}$	-6.085***	-6.042***		-3.416***		-1.699***
	(1.344)	(1.345)		(0.428)		(0.437)
$\Delta \log r_{RoWjk}$		-0.307				
		(0.526)				
Observations	17,247	17,247	19,050	11,767	110,840	96,352
R-squared	0.070	0.070	0.000	0.001	0.087	0.091

Notes: OLS estimation using only Hungary as importing country with respect to our three groups of sourcing countries.

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Table: PECS and change in imports, EFTA and Turkey vs RoW and vs EU

DEP. VAR:	$\Delta \log \left(\frac{X_{ETjk}}{X_{RoWjk}} \right)$		DEP. VAR:	$\Delta \log \left(\frac{X_{ETjk}}{X_{EUjk}} \right)$	
Products:	All	Industrial		All	Industrial
	(1)	(2)		(3)	(4)
$\log r_{ETjk}^{PRE-PECS}$	0.799***	1.284***	$\log r_{ETjk}^{PRE-PECS}$	1.214***	1.303***
	(0.196)	(0.171)		(0.168)	(0.189)
$\Delta \tau_{jk}$	-6.145***	-5.324***	$\Delta \tau_{jk}$	-3.767***	-3.951***
	(1.133)	(1.898)		(0.885)	(1.077)
$\Delta \log r_{RoWjk}$	0.376	-0.088			
	(0.408)	(0.965)			
Obs.	63,182	28,926	Obs.	7,735	7,277
R-squared	0.063	0.074	R-squared	0.008	0.008
Exporter FE	Yes	Yes	Exporter FE	Yes	Yes

Notes: OLS estimation. Cluster standard errors at the (HS6-importer). * p<0.01, ** p<0.05, * p<0.1.

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Controlling for Sectoral-Exporter FE

Table: PECS and change in imports, Controlling for Sectoral-Exporter FE

DEP. VAR:	$\Delta \log \left(\frac{X_{SPjk}}{X_{RoWjk}} \right)$			$\Delta \log \left(\frac{X_{SPjk}}{X_{EUjk}} \right)$
$\Delta \log \left(\frac{X_{RoWjk}}{X_{EUjk}} \right)$				
	(1)	(2)	(4)	(5)
$\log r_{jk}^{PRE-PECS}$	0.752***	0.676**	0.178	
	(0.258)	(0.278)	(0.259)	
$\Delta \log r_{jk}$		-0.334		0.105
		(0.364)		(0.267)
$\Delta \log \tau_{jk}$	-4.192***	-4.231***	-0.662	-2.349***
	(0.718)	(0.720)	(0.574)	(0.431)
Observations	76,463	76,463	10,169	95,097
R-squared	0.153	0.153	0.037	0.178
Exp.$\times$ Sec. FE	Yes	Yes	Yes	Yes

Notes: This Table presents PECS results for the different comparison groups controlling for sector-exporter FE. Importing countries include: Czech Republic, Estonia, Hungary, Lithuania, Latvia, and Poland. Cluster standard errors at the (HS6-importer). * p<0.01, ** p<0.05, * p<0.1. OLS estimation.

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Controlling for Sectoral-Exporter FE

Table: EU Integration, controlling for Sectoral-Exporter FE

DEP. VAR:	$\Delta \log \left(\frac{X_{SPjk}}{X_{RoWjk}} \right)$	$\Delta \log \left(\frac{X_{RoWjk}}{X_{EUjk}} \right)$
	(1)	(2)
$\log r_{jk}^{PECS}$	-0.444***	0.583***
	(0.173)	(0.117)
$\Delta \log \tau_{jk}$	-0.955***	-4.775***
	(0.253)	(0.182)
Observations	164,791	197,512
R-squared	0.089	0.109
Exp.$\times$ Sec. FE	Yes	Yes

Notes: This Table presents results for the EU enlargement controlling for sector-exporter FE. Importing countries include: Czech Republic, Estonia, Hungary, Lithuania, Latvia, and Poland. Cluster standard errors at the (HS6-importer). * p<0.01, ** p<0.05, * p<0.1. OLS estimation.

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Preferential Agreements

Table: Preferential agreements providing for diagonal cumulation

	Czech Rep.	Estonia	Hungary	Latvia	Lithuania	Poland	Slovakia	Slovenia
EU	97	97	97	97	97	97	96	97
Czech Republic	—	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 Republic	97	96	97	97	97	97	—	97
Slovenia	97	96	97	97	97	97	97	—

Notes: Table 9 reports the Commission notice (2002/C 100/05) concerning preferential agreements providing for diagonal cumulation of origin between the EU Community and our Spoke countries. Note that Slovakia and Slovenia are not included in our sample of importing countries because of missing tariffs.

Data and Sample Selection

- Analysis Period: Introduction of PECS and EU Integration (1995, 2002, 2006).
- Importers: BAFTA and CEFTA members (except Romania, Bulgaria, Slovak Republic, and Slovenia).
- Exporters: Non-participating (RoW), EU15, and PECS countries.
- Data Aggregation: Different for RoW and Spoke to highlight third-country vs. cumulation zone effects.
- Data Sources: Trade - WITS (1995, 2002, 2006); Tariffs - UNCTAD TRAINS.
- Tariff Change Computation: Based on preferential and MFN tariffs.

Identification Strategy

- **Difference in Δ% imports (2002-1995)**

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

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

- **Difference in Δ% imports (2006-2002)**

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

4. $$\Delta \log\left(\frac{X_{RoWjk}}{X_{EUjk}}\right) = \delta_{SP} + \delta_{RoW} + \beta_1 \Delta \log\left(\frac{\tau_{RoWjk}}{\tau_{EUjk}}\right) + \beta_2 \log r_{RoWjk}^{PECS} + \epsilon_{RoW,EU,jk},$$