Product Quality and Environmental Standards:
The Effect of an International Environmental Agreement
on Tropical Timber Trade

Andrea Leiter-Scheiring
(with Stefan Borsky and Michael Pfaffermayr)
University of Innsbruck

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Research question

- Harmonization of (environmental) standard can be seen as improvement in product quality.
- Does a voluntary commitment to an environmental production standard influence the pattern of international trade flows?

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- Influence of the International Tropical Timber Agreement (ITTA) on international trade in tropical timber?
  - Influence of product quality (ITTA standard) on (i) the exporters' decision to serve a foreign market and (ii) the volume of TT traded?
  - How do these potential effects vary across specific country characteristics (e.g., economic development)?

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Contribution

- Examining influence of voluntary unilateral (product) standards on international trade patterns.
- Distinguishing between baseline product quality effect and the environmental standard/agreement effect.
- Comparative static analysis:
  - ITTA's trade impact on extensive and intensive margin?
  - Differential impact of ITTA on international vs. domestic trade?

The International Tropical Timber Agreement (ITTA)

- ITTA entered into force in 1986.

- Original agreement renegotiated twice, in 1994 and 2006.

- Primary objective: protection of natural tropical forests from destruction, degradation and excision.

- Further objectives: promoting trade in high quality, sustainably produced TT.

- 1994 ITTA includes 'ITTO Objective 2000' and Bali Partnership Fund

- Harmonization of environmental standards in TT production due to implementation of
  - forest certification schemes,
  - criteria and indicators for sustainable management,
  - transparent harvesting data of tropical wood,
  - financial assistance for the implementation of sustainable TT management.

- 1994 ITTA was signed by 65 member countries whereof the producing member countries possess about 80 % of the world's tropical forests.

Related literature

- Standards & trade patterns:
  Swann et al. (1996), Moenius (2004), Maertens & Swinnen (2009),
  Maskus et al. (2013)
- Distributional consequences of agreements/standards: Chen et al. (2008),
  Disdier et al. (2008), Shepherd & Wilson (2013), Disdier et al. (2014)
- Product quality & international trade
  Linder (1961), Hallak (2010)
- International trade literature:
  Anderson & van Wincoop (2003), Anderson & Yotov (2010)

Theoretical model

- Partial equilibrium monopolistic competition model

- Demand of country j for country i's tropical wood exports, x_{ij}, is derived from CES utility function

$$x_{ij} = \frac{\left(\frac{p_i \tau_{ij}}{\theta_i^{\gamma_j}}\right)^{-\sigma}}{\sum_{h=1}^{J}\left(\frac{p_h \tau_{hj}}{\theta_h^{\gamma_j}}\right)^{1-\sigma}} \phi Y_j.$$

with

- mill price p_i,

- elasticity of substitution $\sigma > 1$,

- iceberg-type transportation costs $\tau > 1$,

- income share ϕY_j spent on TT,

- quality indicator for production $\theta_i = e^{\kappa D_i} e^{\alpha q_i}$,

- j's consumer preferences for quality $\gamma_j = \delta D_j + \beta y_j$.

Theoretical model

- Taking logs of quality parameters leads to

$$\gamma_j \ln \theta_i = \delta\kappa D_j D_i + \beta\kappa D_i y_j + \delta\alpha D_j q_i + \beta\alpha y_j q_i.$$

with D_j, D_i, y_j, q_i, indicating the importer's and exporter's ITTA status, the wealth of consumers, and timber quality, respectively.

- $\rightarrow$ Trading partners' ITTA status and their economic and resource endowments influence quality demand and supply.

- Four different combinations of ITTA standard effects on TT trade:

$$\ln(\theta_i^{\gamma_j}) = \alpha\beta q_i y_j \qquad\qquad\qquad \text{if } D_i = 0 \text{ and } D_j = 0$$
$$\ln(\theta_i^{\gamma_j}) = \alpha\beta q_i y_j + \alpha\delta D_j q_i \qquad\qquad \text{if } D_i = 0 \text{ and } D_j = 1$$
$$\ln(\theta_i^{\gamma_j}) = \alpha\beta q_i y_j + \beta\kappa D_i y_j \qquad\qquad \text{if } D_i = 1 \text{ and } D_j = 0$$
$$\ln(\theta_i^{\gamma_j}) = \alpha\beta q_i y_j + \alpha\delta D_j q_i + \beta\kappa D_i y_j + \delta\kappa D_j D_i \quad \text{if } D_i = 1 \text{ and } D_j = 1$$

Empirical Specification

Econometric specification is based on two equations

- Nominal value of TT exports from i to j, X_{ij}, if $V_{ij} = 1$, 0 otherwise:

$$\ln X_{ij} = (1-\sigma)\ln\tau_{ij} + (\sigma-1)\gamma_j\ln\theta_i + (\sigma-1)\ln(P_j) + (1-\sigma)\ln(p_i) + \ln(\phi Y_j)$$

with $P_j = \left(\sum_{h=1}^{J}\left(\frac{p_h\tau_{hj}}{\theta_h^{\gamma_j}}\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$

- Propensity of exporter i to serve import market j, V_{ij}^*:

$$\begin{aligned} V_{ij}^* &= (1-\sigma)\tau_{ij} + (\sigma-1)\gamma_j\ln\theta_i + (\sigma-1)\ln(P_j) + (1-\sigma)\ln(p_i) \\ &+ \ln(\phi Y_j) - \ln(f_{ij}) - \ln\sigma \end{aligned}$$

- Estimation: Heckman-sample selection model (Heckman 1976) with exporter, importer and product fixed effects.

Comparative static analysis

Quantifying impact of ITTA standard on extensive and intensive margin of TT trade:

- Comparison of predicted expected export flows in the baseline scenario with counterfactual world assuming no ITTA

- Decomposing expected aggregated export volume (Yen and Rosinski 2008) into extensive and intensive margin:

$$\Delta_{ij} = \frac{E[e^{x_{ij}}]}{E[e^{x_{ij}^C}]} - 1$$

$$= \frac{E[e^{x_{ij}}|V_{ij}^{*C} > 0]P(V_{ij}^{*C} > 0) - E[e^{x_{ij}^C}|V_{ij}^{*C} > 0]P(V_{ij}^{*C} > 0)}{E[e^{x_{ij}^C}|V_{ij}^{*C} > 0]P(V_{ij}^{*C} > 0)}$$

(intensive margin at constant probability to export)

$$+ \frac{E[e^{x_{ij}}|V_{ij}^* > 0]P(V_{ij}^* > 0) - E[e^{x_{ij}}|V_{ij}^{*C} > 0]P(V_{ij}^{*C} > 0)}{E[e^{x_{ij}^C}|V_{ij}^{*C} > 0]P(V_{ij}^{*C} > 0)}$$

(extensive margin at constant positive export flows)

The data

Dependent variable
- Log of import flows (import value in 1000 USD) in TT

Explanatory variables
- Distance measures (geographical distance, common language, colonial links, contiguity)
- Trading partners' ITTA status and interaction with their economic and resource endowments
- Religion, RTA (exclusion restrictions)
- Exporter, importer, product fixed effects

Final data set
- Time coverage: average over 13 years (1996-2008)
- 132 (71) importing (exporting) countries (non tropical exporters were excluded)
- 37,204 observations; 12 % positive trade flows (N = 4,321)

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Descriptive statistics

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Table: Trade flows in TT in % of import value

Exporter	Importer						Total
	(1)	(2)	(3)	(4)	(5)	(6)	
TT, overall import value: 3,480 mill. USD							
(1) Africa	1.90	6.17	0.05	14.33	1.06	0.05	23.55
(2) Asia	1.49	48.07	0.70	8.86	8.33	0.13	67.56
(3) Australia	0.01	0.14	0.02	0.05	0.08	–	0.30
(4) Europe	–	–	–	–	–	–	–
(5) North America	0.01	0.54	0.00	0.17	0.45	0.01	1.17
(6) South America	0.06	1.49	0.05	2.11	3.04	0.66	7.41
Total	3.48	56.40	0.80	25.52	12.95	0.84	100.00

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Notes: Figures are based on the aggregate bilateral trade flows for the product classes 4403, 4407, 4408 and 4412. '–' indicates that no bilateral trade flows occurred between these country groups; '0.00' means that bilateral trade is of minor value (smaller than a one-hundredth of a percent).

Table: Largest importers and exporters of TT (ranked by aggregated value imported[a])

Importers		Exporters	
of tropical timber trade (codes 4403, 4407, 4408, 4412)			
Japan	1062	India	1121
United States	361	Malaysia	919
China	272	Gabon	310
Republic of Korea	235	Cameroon	260
Italy	142	China	186
France	142	Brazil	135
Germany	103	Cote d'Ivoire	134
India	102	Ghana	83
Netherlands	94	Ecuador	31
Belgium	92	Peru	30

Notes: [a] Sum of TT trade (in million US$).

Descriptive statistics

Table: Trade flows in TT in % of import value

Exporter	Importer		
	(1)	(2)	Total
TT, overall import value: 3,480 mill. USD			
(1) no ITTA	0.86	1.63	2.50
(2) ITTA	10.10	87.41	97.51
Total	10.96	89.04	100.00

Notes: Figures are based on the aggregate bilateral trade flows for the product classes 4403, 4407, 4408 and 4412.

Estimation results

Table: Trade flows in TT – estimation results

	Heckman, two-step exogenous ITTA				Heckman, restricted restricted model	
	Selection		*Outcome*		*Outcome*	
$D_i D_j$	0.037	(0.582)	0.494***	(3.102)	0.325***	(3.130)
$D_i GDP_j$	0.055***	(2.598)	0.093*	(1.774)	0.141***	(3.760)
$D_j QUAL_i$	0.117***	(3.499)	0.126	(1.460)	0.206***	(3.347)
Linder term	0.105***	(9.522)	0.112***	(3.854)	0.089***	(3.916)
Ln(Distance)	−0.788***	(-30.774)	−1.188***	(-13.106)	−1.183***	(-14.515)
Contiguity	0.467***	(5.986)	0.245	(1.446)	0.238	(1.554)
Com Language	0.270***	(6.098)	0.288***	(2.783)	0.282***	(2.957)
Com Colonizer	0.315***	(5.524)	0.328**	(2.282)	0.332**	(2.457)
Colony	0.287***	(2.661)	0.459**	(2.210)	0.465**	(2.521)
RTA	0.098**	(2.160)				
Religion	0.014	(0.205)				
Mills ratio			1.619***	(10.270)	1.619***	(11.139)
Exporter FE, χ^2	3342.23***		630.43***		–	
Importer FE, χ^2	2686.36***		1076.18***		–	
Product FE, χ^2	1040.03***		205.26***		–	
Observations	37204		4321		4321	

Robustness checks

- **Endogeneity of the ITTA accession**
  - **Contiguity sig positive, $D_j QUAL_i$ insig**

- Estimates based on recent years (2004-2008)
  - 9.3 % non-zero trade flows; $D_j QUAL_i$ insig in selection eq

- Different proxies for wood quality
  - Proxies: GDP/capita (technological dimension), degree of corruption and level of property rights (institutional dimension)
  - Selection eq: $D_i D_j$ sig positive; $D_j QUAL_i$ insig; Linder term sig negative or insig

- Semi-parametric estimation
  - 1st stage probit using semi-parametric SNP estimator (De Luca 2008)
  - Outcome equation using two-step semi-parametric series estimator (Newey 2009)
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Counterfactual Analysis

Table: Changes (in %) in intensive/extensive margin

Exporter	Decomposition	Importer			
		Non-ITTA		ITTA	
		poor	rich	poor	rich
		Total	**0.00**	**0.00**	**115.77**	**179.94**
	Low Quality	Int margin	0.00	0.00	89.75	106.82
		Ext margin	0.00	0.00	26.02	73.12
non-ITTA		**Total**	**0.00**	**0.00**	**173.32**	**196.34**
	High Quality	Int margin	0.00	0.00	165.60	162.14
		Ext margin	0.00	0.00	7.73	34.20
		Total	**84.67**	**141.28**	**591.30**	**830.85**
	Low Quality	Int margin	82.20	138.05	574.89	817.84
		Ext margin	2.47	3.23	16.41	13.02
ITTA		**Total**	**101.40**	**150.39**	**775.45**	**1042.07**
	High Quality	Int margin	92.02	148.06	723.74	970.32
		Ext margin	9.38	2.33	51.71	71.76

Notes: Partial equilibrium effects of ITTA membership on tropical timber trade. Figures represent weighted average changes in % in extensive and intensive margin if no trading partner were an ITTA member (counterfactual world) compared to the observed status were some countries are (not) ITTA signatories.

Counterfactual Analysis
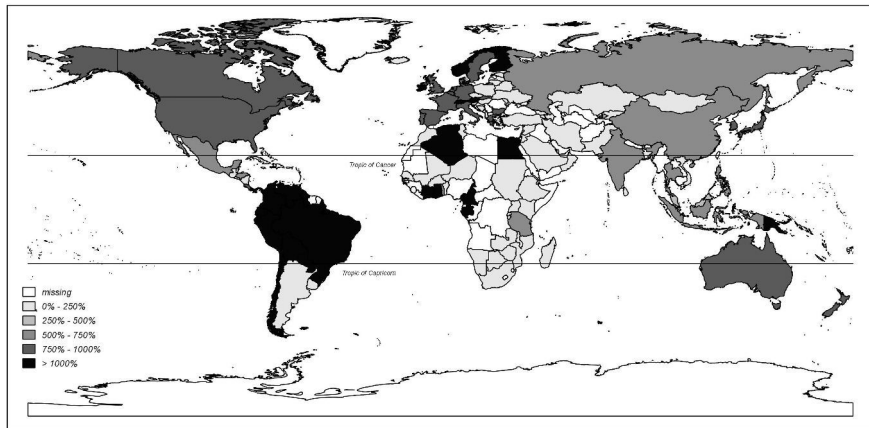
Figure: Total change in trade volume (import markets)
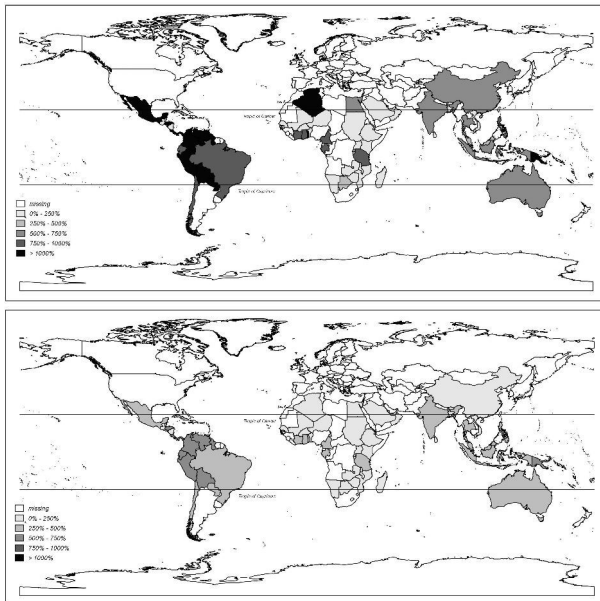
Figure: Total change in export trade volume into (a) Northern and (b) Southern import markets

Table: Counterfactual analysis – ϕ-ness of trade

	Product Standard Effect $(D_i = 1, D_j = 0)$		**Environm. Preference Effect** $(D_i = 0, D_j = 1)$	
	Poor Imp.	Rich Imp.	Poor Imp.	Rich Imp.
Median values				
Low Quality	34.07	5.97	74.44	25.91
High Quality	47.05	44.43	301.60	175.30
Mean values				
Low Quality	64.07	64.41	153.78	121.05
High Quality	93.93	80.10	532.54	329.91

Notes: Figures represent changes of international trade flows relative to domestic trade flows when ITTA is in force compared to the relative changes where no ITTA exists, i.e., ϕ_{ij}/ϕ_{ij}^c. The importer is classified as poor (rich) whenever its 2012 Gross National Income (GNI) is below (above) USD 12,615 (Source: World Bank classification of countries). Exporters with an annual precipitation below (above) 1000 mm are defined as low (high) timber quality countries.

Conclusion

- **Effect of ITTA on international trade patterns in TT?**
- Monopolistic competition setting; gravity equation including baseline quality and sustainable TT production indicators.
- Findings based on Heckman two-step estimation & counterfactual analysis:
  - Strong increase in TT trade if exporter's supply of TT quality matches importer's preference for TT quality.
  - Increasing trade intensity if both trading partners agreed on ITTA standard.
  - Given that the trading partner is an ITTA signatory, trade in TT is the higher the higher the importer's economic (exporter's timber) endowment.
  - Increase in TT trade due to ITTA is higher in rich importer markets than poorer importer markets.
  - ITTA especially benefits exporters producing qualitative timber and serving rich importer markets.
  - Compliance with ITTA favors international trade compared to domestic trade.

Thank you!

e-mail: andrea.leiter-scheiring@uibk.ac.at