Trade Clubs and International Environmental Agreements: The Basel Convention

George Deltas[1] and Prakrati Thakur[2]

[1]Department of Economics, University of Illinois at Urbana-Champaign
[2]Department of Economics, Rensselaer Polytechnic Institute

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Multilateral Agreement Free Riding

Multilateral environmental agreements

- address externalities
- provide public goods

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$\Rightarrow$ Equilibrium membership in agreements very small.

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- Exclusionary restrictions
  - Members exclude non-members from certain transactions
  - Climate Club (Nordhaus), trade clubs

Exclusionary Restrictions

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Issue: When members are few, trade clubs are isolating the members!!

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As membership increases, it is eventually more costly to stay out.

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We investigate these questions in the context of the Basel Convention.

We hope to inform the broader question of

- whether clubs work as intended, and
- how well they do so, compared to alternatives.

The Basel Convention

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Background in Brief:

By 1980, much developed world toxic waste was dumped in Africa.

This led to public outcry.

In response, guidelines developed by the UN Environment Programme, resulting to the Basel Convention.

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  - Trade under equivalent side agreements is allowed.

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Non-hazardous waste is traded outside the Convention strictures.

Spillover effects on that trade may exist.

The Basel Convention in Numbers

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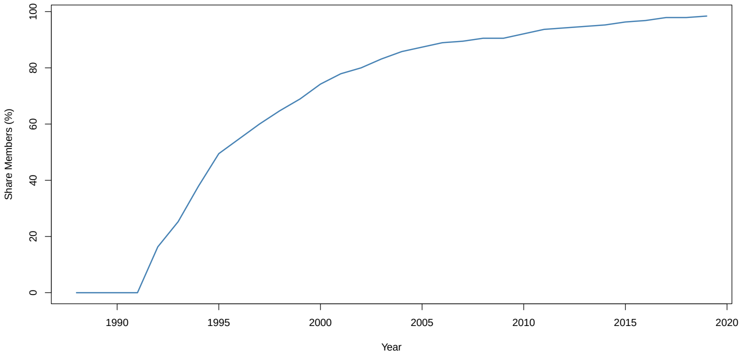
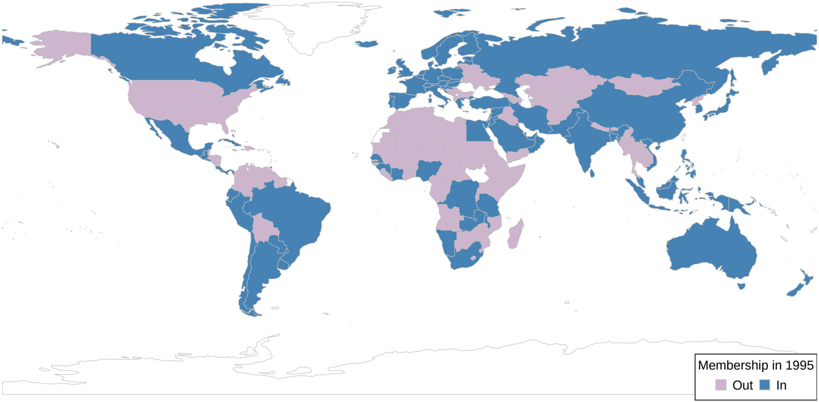
By 2020, almost every country has ratified it.

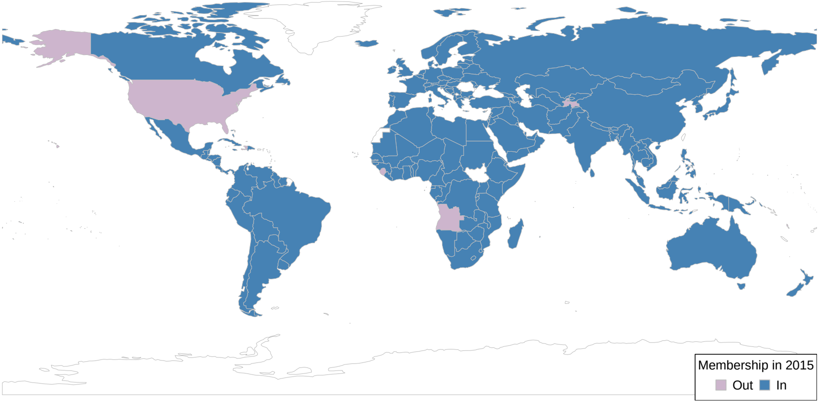


The Basel Convention in Maps: 1995



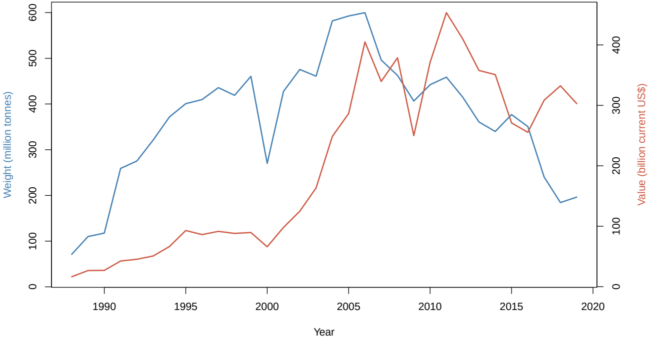
Note: The map does not reflect side agreements.

The Basel Convention in Maps: 2015



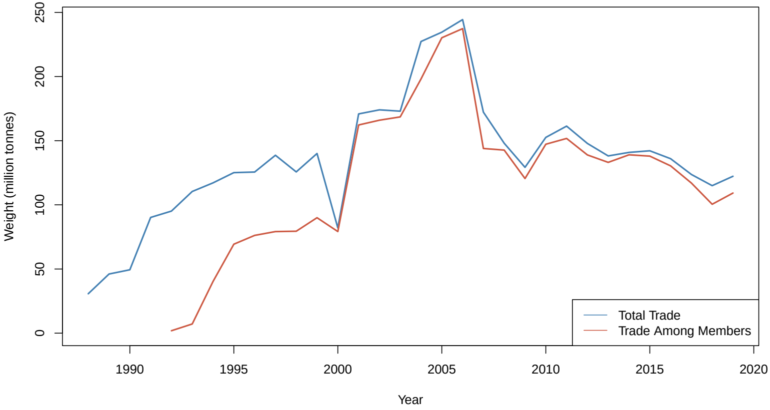
Note: The map does not reflect side agreements.
US not ratified, but signed many equivalent bilateral agreements.

Waste Trade in Figures: Volume and Value



Value is in current USD

Waste Trade Volume in Figures: by Treaty Coverage



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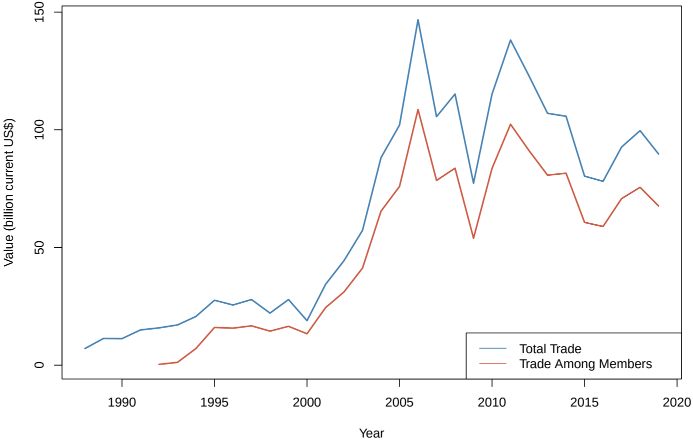

Other Relevant Data

Exporter and importer country characteristics:

- Data on income and income per capita from the World Development Indicators database for the years 1988-2019.
- Environmental Performance Index provides time-series on 32 different indicators.
- Participation in other agreements, not related to waste.

We also control for trends in global trade by using total trade flows.

Membership and Waste Trade Flows

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- Few countries are members ⇒ joining can suppress a country's overall trade.
  It can only trade hazardous waste with a few other countries.
- Most countries are members ⇒ joining may not even suppress a country's trade.
  It will now open up new markets and foreclose only a few.

Therefore, "treatment" effects are variable.

We do some reduced form regressions first, followed by some choice-based (demand style) analysis.

Reduced Form Regressions

Introduce framework via log-linear model:

$$\ln(TF_{ijt}) = \alpha(R_t) + \beta_1(R_t)\,\mathrm{One}_{ijt} + \beta_2(R_t)\,\mathrm{Both}_{ijt} + \gamma_1 \mathbf{Z_{it}} + \gamma_2 \mathbf{Z_{jt}} + \delta \mathbf{Z_t} + \mu_{ij} + \epsilon_{ijt}$$

where

R_t = fraction of countries (or waste trade) in Basel Agreement

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$\alpha(R_t) = \alpha_c + \alpha_R R_t$

$\beta_1(R_t) = \beta_{1c} + \beta_{1R} R_t$

$\beta_2(R_t) = \beta_{2c} + \beta_{2R} R_t$

One_{ijt} = indicator for only one of trade partners being Basel member

Both_{ijt} = indicator for both partners being in Basel or equivalent

$\boldsymbol{Zs}$ = country and year control variables.

Reduced Form Regressions (cont.)

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Use Poisson functional form.

$$TF_{ijt} = e^{\alpha_p(R_t)+\beta_1(R_t)\,\mathrm{One}_{ijt}+\beta_2(R_t)\,\mathrm{Both}_{ijt}+\boldsymbol{\gamma_1}\mathbf{Z_{it}}+\boldsymbol{\gamma_2}\mathbf{Z_{jt}}+\boldsymbol{\delta}\mathbf{Z_t}+\mu_{ij}}\eta_{ijt}$$

Estimate using GMM

$$TF_{ijt} = e^{\alpha_p(R_t)+\beta_1(R_t)\,\mathrm{One}_{ijt}+\beta_2(R_t)\,\mathrm{Both}_{ijt}+\boldsymbol{\gamma_1}\mathbf{Z_{it}}+\boldsymbol{\gamma_2}\mathbf{Z_{jt}}+\boldsymbol{\delta}\mathbf{Z_t}+\mu_{ij}} + \epsilon_{\eta_{ijt}}$$

Results: Reduced Form Regressions (PPML)

	Dependent Variable					
Variables	Trade Volume			Trade Value		
One	0.807	2.799	1.091	-0.637	-7.632	-0.384
	(0.193)	(3.133)	(0.185)	(0.224)	(3.563)	(0.321)
Both	-2.796	-14.51	-1.124	-3.080	-11.91	-0.931
	(0.525)	(1.919)	(0.549)	(0.441)	(2.996)	(0.443)
Fraction in Basel	1.185	-6.297	2.124	0.002	-4.270	-0.710
initial trade weighted	(0.437)	(2.349)	(0.571)	(0.730)	(3.544)	(0.312)
Fraction in Basel × One	-2.986	-5.714	-4.040	- 0.443	8.212.	-0.507
	(0.611)	(4.286)	(0.484)	(0.914)	(4.505)	(0.650)
Fraction in Basel × Both	3.830	18.23	0.850	3.528	13.92	1.417
initial trade weighted	(0.823)	(2.609)	(0.820)	(0.938)	(3.737)	(0.684))
ln(Exporter's EPI)		1.031			0.048	
		(0.724)			(0.601)	
ln(Importer's EPI)		-1.813			-2.706	
		(0.769)			(0.512)	
Exporter-Importer FEs	Y	Y	Y	Y	Y	Y
Side Agreements Included	N	N	Y	N	N	Y
pseudo R-squared	0.868	0.882	0.868	0.931	0.938	0.930

Other vars: export/import PCI/GDP, global trade, linear trend. Count-based fraction, quadratic trends, and arcsinh results similar. Obs 428,151 (343,422 with EPI).

Effects of Accession to the Treaty on Waste Flows

Consider a non-member i with flows TF_{ijt}^{ob} with another non-member j.

What would these have been if country i where a member?

$$TF_{ijt}^{cfB1} = \exp\left\{\alpha_{pR}(\text{PrcntBasel}_t^{cf} - \text{PrcntBasel}_t^{ob}) + \beta_{1c} + \beta_{1R}\text{PrcntBasel}_t^{ob}\right\} \times TF_{ijt}^{ob}$$

where ^{ob} and ^{cf} denote observed and counterfactual values.

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Trade with member j' would lead to counterfactual flows of

$$TF_{ij't}^{cfB2} = \exp\left\{\alpha_{pR}(\text{PrcntBasel}_t^{cf} - \text{PrcntBasel}_t^{ob})\right\}$$
$$\times \exp\left\{\beta_{2c} + \beta_{2R}\text{PrcntBasel}_t^{cf} - \beta_{1c} - \beta_{1R}\text{PrcntBasel}_t^{ob}\right\} \times TF_{ij't}^{ob}.$$

Effects of Accession to the Treaty on Waste Flows

Consider a non-member i with flows TF^{ob}_{ijt} with another non-member j.

What would these have been if country i where a member?

$$TF^{cfB1}_{ijt} = \exp\left\{\alpha_{pR}(\text{PrcntBasel}^{cf}_t - \text{PrcntBasel}^{ob}_t) + \beta_{1c} + \beta_{1R}\text{PrcntBasel}^{ob}_t\right\} \times TF^{ob}_{ijt}$$

where ^{ob} and ^{cf} denote observed and counterfactual values.

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Then, the total trade effect of non-member joining the agreement is

$$\Delta TTF^B_i = \sum_j \left[BM_j\left(TF^{cfB2}_{ijt} - TF^{ob}_{ijt}\right) + (1 - BM_j)\left(TF^{cfB1}_{ijt} - TF^{ob}_{ijt}\right)\right]$$

Results: Effects of Accession to the Treaty on Waste Flows

Based on PPML **trade value** parameter estimates.
– Averages of 9 specifications
– Plotted for relevant range (over 50% membership)

Percent in Basel	Joining Country's effect on trade with a non-member	Joining Country's effect on trade with Member	Country's trade incentive to Join
50%	-62.0%	-22.6%	-42.3%
60%	-62.7%	-1.7%.	-26.1%
70%	-62.0%	29.9%	2.3%
80%	-59.0%	82.5%	54.2%
90%	-51.7%	182.2%	158.8%

Note: Incentive to join is based on unweighted fraction of countries that are cartel members.

A Choice Based Quasi-Structural Trade Analysis

Choice of destination by domestic waste generator, p_i, based on

$$U_{p_i jt} = a_i + b_1 X1_j + b_2 X2_{jt} + b_3 X3_t + \tilde{\xi}_{ij} + \varepsilon_{p_i j}$$

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Share of waste shipped from country i to country j is

$$s_{ijt} = \frac{\exp\left\{a_i + b_1 X1_j + b_2 X2_{jt} + b_3 X3_t + \tilde{\xi}_{ij}\right\}}{\exp\left\{b_4 X4_{it} + \tilde{\xi}_{i0}\right\} + \sum_k \exp\left\{a_i + b_1 X1_k + b_2 X2_{kt} + b_3 X3_t + \tilde{\xi}_{ik}\right\}}$$

Share that is disposed domestically by

$$s_{i0t} = \frac{\exp\left\{b_4 X4_{it} + \tilde{\xi}_{i0}\right\}}{\exp\left\{b_4 X4_{it} + \tilde{\xi}_{i0}\right\} + \sum_k \exp\left\{a_i + b_1 X1_k + b_2 X2_{kt} + b_3 X3_t + \tilde{\xi}_{ik}\right\}}$$

A Choice Based Quasi-Structural Trade Analysis (cont.)

Performing standard transformations we get

$$\ln(s_{ijt}) - \ln(s_{i0t}) = a_i + b_1 X1_j + b_2 X2_{jt} + b_3 X3_t - b_4 X4_{it} + \xi_{ij}$$

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We observe volumes traded, and not shares.

To implement this, we need to know total volume of tradable waste available in a country.

Denote this by $\mathcal{M}_{it}$.

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Denote this by $\mathcal{M}_{it}$.

Then, adding a subtracting $\ln(\mathcal{M}_{it})$ on the LHS yields

$$\ln(s_{ijt}\mathcal{M}_{it}) - \ln(s_{i0t}\mathcal{M}_{it}) = a_i + b_1 X1_j + b_2 X2_{jt} + b_3 X3_t - b_4 X4_{it} + \xi_{ij}$$

A Choice Based Quasi-Structural Trade Analysis (cont.)

Observe that $s_{i0t} = 1 - \sum_j s_{ijt}$ and that $TF_{ijt} = s_{ijt}\mathcal{M}_{it}$. Then:

$$\ln(TF_{ijt}) - \ln(\mathcal{M}_{it} - \sum_j TF_{ijt}) = a_i + b_1 X1_j + b_2 X2_{jt} + b_3 X3_t - b_4 X4_{it} + \xi_{ij}$$

Assume that $\mathcal{M}_{it}$ is a factor λ times municipal waste, W_{it}.

Because of re-exports,

$$\mathcal{M}_{it} = \lambda W_{it} + \sum_j TF_{jit}$$

A Choice Based Quasi-Structural Trade Analysis (cont.)

Substituting yields the equation

$$\ln(TF_{ijt}) - \ln(\lambda W_{it} + \sum_j TF_{jit} - \sum_j TF_{ijt}) = a_i + b_1 X1_j + b_2 X2_{jt} + b_3 X3_t - b_4 X4_{it} + \xi_{ij}$$

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Because of zeros in the annual bilateral flows, we estimate the parameter vector via PPML.

The estimable equation is

$$TF_{ijt} = \exp(a_i + b_1 X1_j + b_2 X2_{jt} + b_3 X3_t - b_4 X4_{it} + \ln(\lambda W_{it} + \sum_j TF_{jit} - \sum_j TF_{ijt})) + \epsilon_{\xi_{ij}}$$

Estimated for weight data, because λ is calibrated from quantity information.

Results: Choice Based Model

We set $\lambda = 20$, based on industry sources.

Variables	Preference parameters			
One	-1.036	-1.115	-1.832	-1.955
	(0.344)	(0.365)	(0.581)	(0.646)
Both	0.0934	-0.110	-1.174	-1.452
including side agreements	(0.210)	(0.226)	(0.371)	(0.395)
$\log(Exporter's\ EPI)$			-0.369	0.365
			(0.721)	(0.748)
$\log(Importer's\ EPI)$			-2.120	-1.472
			(0.787)	(0.759)
Trend	linear	quadratic	linear	quadratic
Exporter/Importer FEs	Y	Y	Y	Y
pseudo R-sq.	0.8597	0.8614	0.8755	0.8779
Observations	420,656	420,656	337,633	337,633

Other variables: exporter/importer GDP/capita, total global trade, importer's GDP.

Other specifications: Including exporter's GDP, and/or ignoring bilateral agreements.

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  - Per capita income
- Secular trends in preferences and payoffs

Duration Analysis

Estimate time to accession:

$$\ln(T_i^*) = a + b\tilde{E}_i + c\tilde{H}_i + d\Delta\tilde{T}TF_i^B + e_i$$

where

T_i^* is the time country joined.

$\tilde{E}_i$ average value (until 1999) for environmental index

$\tilde{H}_i$ average value (until 1999) of economic development

$\Delta\tilde{T}TF_i^B$ average value (until 1999) of trade effect divided by GDP

Taking constant values of RHS variables not very appealing.

Time varying duration models are somewhat cumbersome

Annual Choice for Treaty Accession

Alternative:

Estimate an unbalanced panel discrete choice model

Accession is an absorbing state: the country leaves the sample

$$y_{it}^{*} = a + bE_{i,t} + cH_{i,t} + d\Delta TTF_{i,t}^{B} + z_1 t + z_2 t^2 + e_{i,t}$$

where

y_{it}^{*} is an unobserved latent variable, with accession when $y_{it}^{*} > 0$.

Duration dependence is added explicitly through a trend (and trend squared)

Results: Time to Entry

	Weibull (hazard parameters)		Probit (entry index)	
variable	value	weight	value	weight
GDP per capita	0.032	0.032	-0.014	-0.014
(in '000 USD)	(0.008)	(0.008)	(0.013)	(0.012)
EPI	-0.013	-0.012	0.010	0.009
	(0.003)	(0.003)	(0.006)	(0.006)
IEA memberships	-1.166	-1.209	1.714	1.669
	(0.189)	(0.191)	(0.310)	(0.302)
HDI	-1.054	-1.112	0.654	0.751
	(0.606)	(0.616)	(1.014)	(1.011)
Trade Effect	-0.0054	-0.0507	0.0056	0.142
	(0.0029)	(0.0330)	(0.0031)	(0.067)
Year	–	–	-0.108	0.074
			(0.050)	(0.053)
Year squared	–	–	-0.0026	-0.0016
			(0.0013)	(0.0014)
ln(p)	0.584	0.581	–	–
	(0.061)	(0.0615)		

Variations: Dropping the quadratic trend term and/or dropping GDP per capita.

Other specifications: Exponential and Generalized gamma duration models.

A Structural Model of Treaty Participation

Annual payoff from being a Basel member:

$$\pi_{i,t}^{IN}(\mathbf{M}_t) = g(t|E_{i,t}, H_{i,t}) + \chi \frac{TF_{i,t}^{IN}}{GDP_{i,t}}$$

where

$$\bar{g}(t|E_{i,t}, H_{i,t}) = \rho_o + \rho_E E_{i,t} + \rho_H H_{i,t} + \rho_{t1} t + \rho_{t2} t^2 + \tilde{\rho}_i + \nu_{i,t}$$

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Annual payoff from not being a member

$$\pi_{i,t}^{OUT}(\mathbf{M}_t) = \chi \frac{TF_{i,t}^{OUT}}{GDP_{i,t}}$$

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5. (current version) There is perfect foresight about
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   - accession decisions of all countries
6. No further decisions made after the end of our sample.
   (current version) World ends at T (next: T repeats for ever).

Decision Payoffs

Country $i's$ payoff from joining in year τ_i

$$V^{IN}_{i,\tau_i}(\mathbf{G}_{\tau_i}, \mathbf{M}^{-i}_{\tau_i})) = \sum_{t=\tau_i}^{T} \delta^{t-\tau_i} g(\tau_i | E_{i,\tau_i}, H_{i,\tau_i}) + \delta^{t-\tau_i} \chi E \left[\frac{TF^{IN}_{i,t}(\mathbf{M}^{-i}_t)}{GDP_{i,t}} \right]$$

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Country $i's$ payoff from staying out in year τ_i

$$V^{OUT}_{i,\tau_i}(\mathbf{G}_{\tau_i}, \mathbf{M}^{-i}_{\tau_i})) = \chi \frac{TF^{OUT}_{i,\tau_i}(\mathbf{M}^{-i}_{\tau_i})}{GDP_{i,\tau_i}} + \delta E \left[V(\mathbf{G}_{\tau_i}, \mathbf{M}^{-i}_{\tau_i+1}) \right]$$

where $V(\mathbf{G}_{\tau_i}, \mathbf{M}^{-i}_{\tau_i+1})$ = payoff from optimal future decisions, evaluated at current preferences.

Results: Net Participation Payoffs

	Net payoff from joining the Convention			
variable	value	weight	value	weight
GDP per capita	-0.02	-0.02	-0.04	-0.03
(in '000 USD)	(0.01)	(0.01)	(0.02)	(0.02)
EPI	0.012	0.011	0.015	0.004
	(0.005)	(0.004)	(0.009)	(0.008)
IEA memberships	1.191	1.176	2.178	1.866
	(0.217)	(0.220)	(0.463)	(0.342)
HDI	0.940	1.011	3.649	3.111
	(0.751)	(0.650)	(1.371)	(1.488)
Trade Effect	0.018	0.224	0.029	0.242
	(0.004)	(0.064)	(0.006)	(0.070)
Year	-0.079	-0.060	0.018	0.139
	(0.043)	(0.043)	(0.065)	(0.068)
Year squared	0.001	0.001	-0.002	-0.005
	(0.001)	(0.001)	(0.002)	(0.002)
ρ	–	–	1.173	1.296
log likelihood	-310.117	-316.410	-274.856	-280.329

Variations: Dropping the quadratic trend term or the linear trend term.

Where to From Here?

Incorporate uncertainty in the structural model.

Assess the ability of the model to replicate the observed accession pattern in replication exercises.

Use the parameters of the structural model to estimate counterfactual exercises.

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What if countries strengthened restrictions, fully banning any waste trade between members and non-members.

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In the choice-based model, eliminate non-members as a choice (equivalent to setting $\beta_1 = \infty$).

Counterfactual Exercises (cont.)

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