

# *Reputation Spillovers and International Exchange*

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**Views expressed are those of the authors and do not necessarily reflect those of the Federal Reserve Board of Governors or the Federal Reserve Bank of San Francisco**

“ ... poll after poll shows deep distrust among America’s traditional allies, distrust that makes cooperation on everything from nuclear proliferation to trade far harder.”

-- Economist, 9/2/2006

# 1. Introduction

Countries, like people, interact on different dimensions

1. Economic

2. Political

3. Strategic

Non-economic partnerships often take place in context of international institutions

1. Security alliances (e.g., NATO)
2. International organizations (IAEA)
3. International Environmental arrangements (IEAs)  
(Montreal Protocol, Kyoto Protocol)

This paper asks whether participation in non-economic partnerships enhances international economic relations, using the example of IEAs.

1. Answer is positive.

2. Reason is that there are costs of participation from international partnerships, but also benefits

3. Direct benefits: water cleaner, borders safer, etc.

4. Indirect benefits:

a. Countries become tied into “web” of international relationships

b. Deviating in one arena may adversely affect activities in another

c. Spillovers may allow relationships infeasible based only on direct costs and benefits.

*So there may be an economic cost of unilateralism!*

## 5. Reputation spillovers [Cole and Kehoe (1997)]

- a. Policymakers across countries have different discount rates
- b. More patient governments choose to join more IEAs
- c. IEA participation choice sends credible signal about discount rate, which affects countries borrowing capacity
- d. Affect is *unilateral*, in sense that it increases borrowing capacity from *any* country

## 6. Bilateral spillovers

- a. IEA membership may confer punishment power to joint members
- b. We therefore consider the possibility of *bilateral* spillovers, where the value of one relationship can provide support to another
- c. Extended model allows economic interaction to be a function of *joint* participation in IEAs



## 7. Empirics

a. These two models are nested

b. Test whether unilateral participation matters, and whether bilateral participation matters in terms of predicting bilateral capital flows and trade volumes.

c. Using gravity specification, find positive impact of both unilateral and bilateral engagement in IEAs on bilateral cross-holdings of assets

d. Data supports model with both unilateral reputation and some sort of bilateral punishment

## 2. Previous Literature

a. Bulow and Rogoff (1989): Can't sustain reputation-based sovereign credit relationship

b. Series of papers by Cole and Kehoe (1995, 1997, 1998)

1. Bulow-Rogoff problem: Borrower receives only *transient* benefits from relationship with creditors.

2. At some finite point in time, cost of debt service exceeds discounted value of consumption smoothing

3. Reputation spillovers: Desire to maintain other relationships with creditors nations may support debt relationship, provided that these other relationships are *enduring*.

c. Two types of spillover models

1. Pure reputation model

- a. Borrower reveals true discount rate in IEA membership decision
- b. Result affects credit constraint faced by borrower

2. Punishment model [Cole and Kehoe (1997) ]:

- a. Spillover in sense that bilateral punishments through mutual IEA memberships potentially support credit relationships

d. Literature on International Environmental Agreements

1. Rich literature on voluntary self-enforcing IEAs

2. Ability of IEAs to credibly increase pollution abatement is limited [Barrett (1994), Carraro and Siniscalco (1998)]

a. Intuition is that amount of credible abatement one can achieve is limited by marginal IEA member

b. Most abatement in smaller, more homogeneous groups

c. But this group may choose similar levels unilaterally

3. We respect these constraints in our model, where country characteristics (govt. discount rate) determines IEA membership

### 3. Theoretical Framework

#### a. Pure Reputation model

1. 2 countries, and infinite number of periods  
 $t = 0, 1, \dots, \infty$ .
2. Decisions made by country government, which maximizes utility of representative consumer, in terms of its discount rate
3. Utility linear in consumption, so country  $i$  maximizes

$$U_t^i = \sum_{j=t}^{\infty} (\beta^i)^j c_t^i \quad (1)$$

4. For simplicity, drop  $i$  and work in terms of a representative country
  
5. International environmental agreements
  - a.  $J$  categories of environmental issues, numbered  $j = 1, \dots, J$ .
  - b. Each category covered by an abatement treaty
    - c. Treaty requires each member to contribute fixed amount of consumption good,  $e$ , in each period, then yields a benefit  $y_j$ , in each of the following periods  $t > 0$ .

d. Number treaties such that  $y_j \geq y_{j+1}$  and assume that  $y_j$  is a continuous twice-differentiable function that satisfies  $y_j' < 0$ ,  $y_j'' > 0$ , and  $\lim_{j \rightarrow \infty} y_j = 0$ .

e. Country then chooses a marginal treaty  $j$ , and joins treaties 1 through  $j$ , and doesn't join the rest

## 5. Economic interactions are bilateral

a. Countries trade with each other, experiencing gains from trade that are facilitated by trade credit

$T_t^k = T(\eta_t^k, d_t^k)$ ,  $T' \geq 0$ ,  $T'' \leq 0$  in both arguments

b.  $\eta_t^k$  represents vector of other characteristics (we later associate with standard gravity equation).

c.  $d_t^k$  payment due in period  $t$  on trade credit extended in period  $t-1$  from country  $k$  to country  $i$



## 6. Timing of model

- a. Country chooses  $j^*$ , number of treaties to join
- b. Country makes compliance decision
- c. Representative creditor chooses  $d_t^k$
- d. Country makes default decision and consumes, subject to any penalties for shirking on IEAs or on debt obligations

7. Solve model backwards, beginning with default decision.

8. Consumption in a period  $t > 0$  satisfies

$$(c_t | t > 0) = x + \sum_{k=1}^K \left[ T(\eta_t^k, d_t^k) - \tilde{d}_t^k \right] + \sum_{j=1}^{j^*} \tilde{y}_j$$

where  $\tilde{y}_j$  is payoff from treaty  $j$  ( $y_j - e$  under compliance, and  $-\phi$  under non-compliance)

9. Comparison of utility under debt service and default yields an equilibrium credit ceiling

$$d_t^k \leq \beta T(\eta_t^k, d_t^k)$$

10. We solve model under separating equilibrium, and then derive conditions to rule out pooling in appendix

- a. First show that gains from joining an extra union are decreasing in  $j^*$
- b. Then show country would not join union  $j^*+1$

11. Credit ceiling is then a function of perception of discount rate

**PROPOSITION 1:** Under a separating equilibrium,  $d^k$  is increasing in  $j^*$ .

12. Intuition: Joining more IEAs sends credible signal under a separating equilibrium that eases credit constraint

## b. Bilateral penalties

1. Assume that if a country defaults, it is punished bilaterally by creditor
2. Reduces gains from mutual IEAs by some constant  $\gamma < 1$ , so that gains from being in treaty  $j$  are equal to

$$(1 - \gamma)(y_j - e)$$

3. Define  $m^k$  as the highest-numbered treaty which contains both countries  $i$  and  $k$ . Credit constraint now satisfies

$$d_t^k \leq \frac{e}{y_{j^*}} \left[ T(\eta_t^k, d_t^k) + \varphi \gamma \sum_{z=1}^{j^*} (y_z - e) \right]$$

where  $\varphi$  is an indicator variable that takes value 1 if  $z \leq m^k$ , and value 0 otherwise.

**PROPOSITION 2:** Under a separating equilibrium, and given the bilateral treaty-based default penalty  $\gamma$ ,  $d_t^k$  is increasing in  $j^*$ . Moreover,  $d_t^k$  is also increasing in  $m^k$ .

5. Both models predict that exchange of trade credit will be increasing in number of treaties ( $j^*$ ).
6. Proposition 2 adds prediction that exchange of trade credit will be increasing in number of jointly-held treaties ( $m^k$ )
7. Models are therefore nested and we can test both hypotheses

## 4. Empirics

### a. Key predictions of model:

1. Non-economic commitments (here using IEA as example) have positive effect on ability to conduct international exchange

2. Bilateral non-economic interactions may also matter

a. Level of unilateral IEA participation not a sufficient statistic

b. Number of common IEAs may also matter

c. Take these predictions to data in a nested gravity specification

## b. Gravity specification

$$\begin{aligned}\ln(A_{ij}) = & \beta_1 \ln(D_{ij}) + \beta_{2i} \ln(Y_i) + \beta_{2j} \ln(Y_j) + \beta_{3i} \ln(Pop_i) + \beta_{3j} \ln(Pop_j) \\ & + \beta_4 RTA_{ij} + \beta_5 CU_{ij} + \beta_6 Lang_{ij} + \beta_{7i} \ln(Area_i) + \beta_{7j} \ln(Area_j) + \beta_8 Cont_{ij} \\ & + \beta_{8i} Landl_i + \beta_{8j} Landl_j + \beta_{9i} Island_i + \beta_{9j} Island_j + \beta_{10} ComCol_{ij} \\ & + \gamma_1 IEA_i + \gamma_2 IEA_{ij} + \beta_{11} IEA_j + \varepsilon_{ij}\end{aligned}$$

Coefficients of interest are  $\{\gamma\}$ , where  $\gamma_1$  represents effect of participation by  $i$  in IEAs, and  $\gamma_2$  represents effect of *joint* participation by  $i$  and  $j$  in IEAs

## Condition for usual gravity variables:

- $A_{ij}$  denotes asset cross-holdings held in host country  $i$  and sourced from  $j$ , measured in (millions of ) dollars,
- $D_{ij}$  is the distance between  $i$  and  $j$ ,
- $Y_i$  is real GDP of  $i$ ,
- $Pop_i$  is population of  $i$ ,
- $RTA_{ij}$  is a binary variable which is unity if  $i$  and  $j$  belong to the same regional trade agreement and zero otherwise,
- $CU_{ij}$  is a binary variable which is unity if  $i$  and  $j$  use the same currency at time  $t$ ,
- $Lang_{ij}$  is a binary variable which is unity if  $i$  and  $j$  have a common language,
- $Area_i$  is the total area of  $i$ ,
- $Cont_{ij}$  is a binary variable which is unity if  $i$  and  $j$  share a land border,
- $Landl_i$  is a binary variable which is unity if country  $i$  is land-locked,
- $Island_i$  is a binary variable which is unity if country  $i$  is an island nation,
- $Comcol_{ij}$  is a binary variable which is unity if  $i$  and  $j$  were ever colonies after 1945 with the same colonizer,
- $IEA_i$  is the number of environmental treaties that  $i$  has ratified at  $t$ ,
- $IEA_{ij}$  is the number of environmental treaties that  $i$  and  $j$  have both ratified at  $t$ ,
- $\beta$  is a vector of nuisance coefficients, and
- $\varepsilon_{ij}$  represents the other influences on bilateral credit, assumed to be well behaved.



## c. Data

1. Use *Coordinated Portfolio Investment Survey* (CPIS) for asset cross-holdings, 2001, 2002, 2003 (IMF)
  - a. 68 source, 221 host countries
2. We consider asset holdings a good measure of economic exchange, but less precise for trade credit
  - a. To check sensitivity, also use trade flows, with export and import data from IMF *Direction of Trade* (DoT)
3. Population, GDP from *World Development Indicators* (WDI)
4. Others from CIA's *World Factbook*, WTO, etc.

## 5. Data on Environmental Treaties

a. Data set is Environmental Treaties and Resource Indicators (ENTRI)

b. Contains country-by-country participation for up to 464 treaties

- Act regarding Navigation and Economic Cooperation between the States of the Niger Basin
- Vienna Convention on the Law of Treaties
- Convention on the International Trade in Endangered Species of Wild Flora and Fauna)
- Kyoto Protocol to the United Nations Framework Convention on Climate Change

c. Provides data on treaties that are 1. signed, 2. in force, or 3. denounced.

d. Only a small number of denounced treaties; almost 100 countries have not denounced any

e. Unilateral regressor  $IEA_i$ , is number of agreements either signed or in force (no weighting)

f. Bilateral regressor  $IEA_{ij}$ , is number of agreements either signed or in force by both countries

## 6. Instrumental Variables

- a. We are relatively unconcerned about simultaneity
  - 1. Key variables (unilateral and joint IEA participation) are plausibly exogenous
  - 2. Contrasts with defense or economic alliances which are sometimes explicitly linked to economic interactions
  - 3. Still, we estimate specification with OLS and IV using heteroskedasticity-corrected standard errors
- b. Use IV primarily to address measurement error

c. Two instruments:

1. Country's "polity" score, from polity IV data set
  - a. Available for 161 countries through 2003
  - b. Measures extent of democracy
  - c. Believe countries with higher scores will be likely to have longer time horizons and join more IEAs
  
2. "Environmental Sustainability Index" from Yale
  - a. Measures overall national progress towards environmental sustainability
  - b. Available for 145 countries for 2001 and 2002
  - c. High: Finland, Norway, Canada; Low: Haiti, Saudi Arabia, Burundi
  - d. Use 3 most plausible components: Environmental systems, environmental stress, and human vulnerability to the environment

**Table A2: Descriptive Statistics**

|   | <b>Obs.</b> | <b>Mean</b> | <b>Std. Dev.</b> | <b>Min</b> | <b>Max</b> |
|---|-------------|-------------|------------------|------------|------------|
| <b>Log Assets</b>                       | 9,396       | -3.33       | 6.62             | -9.21      | 13.20      |
| <b>Log Trade</b>                        | 11,031      | 2.41        | 3.53             | -6.40      | 12.85      |
| <b># Environmental Treaties, Joint</b>  | 14,960      | 38.47       | 32.53            | 0          | 232        |
| <b># Environmental Treaties, Host</b>   | 13,403      | 78.08       | 50.09            | 1          | 278        |
| <b># Environmental Treaties, Source</b> | 13,420      | 125.4       | 60.75            | 1          | 278        |
| <b>Log Distance</b>                     | 14,960      | 7.91        | .75              | 3.18       | 9.27       |
| <b>Log Host Real GDP</b>                | 10,242      | 17.37       | 2.09             | 12.85      | 23.03      |
| <b>Log Source Real GDP</b>              | 11,710      | 18.90       | 1.72             | 13.27      | 23.03      |
| <b>Log Host Population</b>              | 11,862      | 8.56        | 2.08             | 3.00       | 14.06      |
| <b>Log Source Population</b>            | 12,200      | 9.19        | 1.97             | 4.15       | 12.57      |
| <b>Regional Trade Agreement</b>         | 14,960      | .106        | .31              | 0          | 1          |
| <b>Currency Union</b>                   | 14,960      | .014        | .12              | 0          | 1          |
| <b>Common Language</b>                  | 14,960      | .19         | .39              | 0          | 1          |
| <b>Log Host Area</b>                    | 14,960      | 10.63       | 3.20             | .69        | 16.65      |
| <b>Log Source Area</b>                  | 14,960      | 11.11       | 3.20             | 3.04       | 16.65      |
| <b>Common Land Border</b>               | 14,960      | .01         | .12              | 0          | 1          |
| <b>Host Landlocked</b>                  | 14,960      | .17         | .37              | 0          | 1          |
| <b>Source Landlocked</b>                | 14,960      | .08         | .28              | 0          | 1          |
| <b>Host Island Nation</b>               | 14,960      | .21         | .41              | 0          | 1          |
| <b>Source Island Nation</b>             | 14,960      | .20         | .40              | 0          | 1          |
| <b>Common Colonizer</b>                 | 14,960      | .07         | .26              | 0          | 1          |
| <b>Host Polity</b>                      | 10,487      | 3.21        | 6.64             | -10        | 10         |
| <b>Source Polity</b>                    | 11,660      | 7.68        | 4.42             | -7         | 10         |
| <b>Product, Host and Source Polity</b>  | 8,162       | 24.47       | 60.52            | -100       | 100        |
| <b>Host ESI</b>                         | 9,605       | 49.45       | 9.02             | 23.9       | 73.9       |
| <b>Source ESI</b>                       | 11,220      | 54.36       | 9.08             | 35         | 73.9       |
| <b>Product, Host and Source ESI</b>     | 7,191       | 2687.2      | 666.7            | 836.5      | 5394.7     |

Data averaged over 2001-03.

**Table A3: Bivariate Correlations**

|  | <b>Log Assets</b> | <b>Log Trade</b> | <b># Joint Env. Trts</b> | <b># Host Env. Tr.</b> |
|--|-------------------|------------------|--------------------------|------------------------|
| <b>Log Trade</b>                       | .71               |                  |                          |                        |
| <b># Environmental Treaties, Joint</b> | .70               | .65              |                          |                        |
| <b># Environmental Treaties, Host</b>  | .63               | .57              | .78                      |                        |
| <b>Host Polity</b>                     | .48               | .31              | .49                      | .56                    |
| <b>Product, Host and Source Polity</b> | .47               | .30              | .52                      | .49                    |
| <b>Host ESI</b>                        | .33               | .17              | .36                      | .40                    |
| <b>Product, Host and Source ESI</b>    | .23               | .01              | .30                      | .29                    |

**4,636 observations**

**Table 1: OLS Results**

|  |  |                                |                                |                                |
|--|--|--------------------------------|--------------------------------|--------------------------------|
| <b># Environmental Treaties, Host</b>  |  | <b>.024**</b><br><b>(.001)</b> |                                | <b>.013**</b><br><b>(.002)</b> |
| <b># Environmental Treaties, Joint</b> |  |                                | <b>.048**</b><br><b>(.003)</b> | <b>.032**</b><br><b>(.004)</b> |



Table 1 (continued)

|   |                  |                  |                  |                  |
|---|------------------|------------------|------------------|------------------|
| <b>Log Distance</b>                         | -1.07**<br>(.08) | -.85**<br>(.09)  | -.49**<br>(.09)  | -.59**<br>(.09)  |
| <b>Log Host<br/>Real GDP</b>                | 3.51**<br>(.05)  | 2.83**<br>(.07)  | 2.95**<br>(.06)  | 2.76**<br>(.07)  |
| <b>Log Source<br/>Real GDP</b>              | 2.73**<br>(.09)  | 2.33**<br>(.12)  | 2.14**<br>(.10)  | 2.26**<br>(.12)  |
| <b>Log Host<br/>Population</b>              | -2.27**<br>(.07) | -1.72**<br>(.08) | -1.84**<br>(.08) | -1.67**<br>(.08) |
| <b>Log Source<br/>Population</b>            | -2.12**<br>(.10) | -1.79**<br>(.12) | -1.53**<br>(.11) | -1.67**<br>(.12) |
| <b>Regional Trade<br/>Agreement</b>         | 1.13**<br>(.16)  | 1.20**<br>(.16)  | .69**<br>(.16)   | .89**<br>(.16)   |
| <b>Currency Union</b>                       | 3.17**<br>(.21)  | 1.77**<br>(.24)  | .83**<br>(.25)   | .90**<br>(.26)   |
| <b>Common Language</b>                      | 1.83**<br>(.16)  | 2.06**<br>(.16)  | 1.97**<br>(.16)  | 2.00**<br>(.16)  |
| <b>Log Host Area</b>                        | .13**<br>(.04)   | .01<br>(.04)     | -.00<br>(.04)    | -.03<br>(.04)    |
| <b>Log Source Area</b>                      | -.26**<br>(.03)  | -.28**<br>(.03)  | -.44**<br>(.03)  | -.36**<br>(.04)  |
| <b>Common Land<br/>Border</b>               | .97**<br>(.36)   | .87*<br>(.38)    | .56<br>(.39)     | .61<br>(.39)     |
| <b>Host<br/>Landlocked</b>                  | -.56**<br>(.14)  | -.48**<br>(.14)  | -.29*<br>(.14)   | -.36*<br>(.14)   |
| <b>Source Landlocked</b>                    | .35*<br>(.18)    | .43*<br>(.18)    | .28<br>(.18)     | .38*<br>(.18)    |
| <b>Host Island<br/>Nation</b>               | .61**<br>(.18)   | .57**<br>(.18)   | .31**<br>(.17)   | .38*<br>(.18)    |
| <b>Source Island Nation</b>                 | 1.37**<br>(.17)  | 1.43**<br>(.17)  | 1.27**<br>(.17)  | 1.33**<br>(.17)  |
| <b>Common Colonizer</b>                     | 1.00**<br>(.41)  | 1.81**<br>(.40)  | 1.37**<br>(.39)  | 1.66**<br>(.40)  |
| <b># Environmental<br/>Treaties, Source</b> |                  | .009**<br>(.001) |                  | .003<br>(.001)   |
| <b>Observations</b>                         | 6432             | 6354             | 6432             | 6354             |
| <b>R<sup>2</sup></b>                        | .61              | .63              | .63              | .63              |
| <b>Root MSE</b>                             | 4.227            | 4.131            | 4.116            | 4.111            |

#### d. OLS Results

1. Both unilateral and bilateral IEA participation enter significantly positively

2. Using model with both unilateral and joint IEA participation, find that jointly joining an additional treaty raises cross-holdings of assets by a plausible 0.03%

a. Moving from 25<sup>th</sup> percentile to 75<sup>th</sup> percentile in joint membership would raise cross-holdings by 1.5%

3. Similarly, a one standard deviation increase in unilateral participation raises cross-holdings by 0.65%

4. Default gravity variables work well

- a. Variables tend to enter as expected
- b. Respectable R-squared without environmental agreements of 0.61

5. Consider results supportive of small but significant positive effect of IEA membership on economic exchange

6. Significant entry of bilateral variable suggests some role for bilateral punishment

**Table 2: IV Results**

|  |                          |                          |                          |
|--|--------------------------|--------------------------|--------------------------|
| <b># Environmental Treaties, Host</b>  | <b>.113**<br/>(.007)</b> |                          | <b>.077**<br/>(.013)</b> |
| <b># Environmental Treaties, Joint</b> |                          | <b>.176**<br/>(.011)</b> | <b>.057**<br/>(.022)</b> |

Table 2 (continued)

|   |                  |                  |                  |
|---|------------------|------------------|------------------|
| <b>Log Distance</b>                         | -.02<br>(.18)    | .98**<br>(.18)   | .28<br>(.24)     |
| <b>Log Host<br/>Real GDP</b>                | .12<br>(.22)     | 1.10**<br>(.16)  | .40<br>(.21)     |
| <b>Log Source<br/>Real GDP</b>              | -.25<br>(.78)    | .61**<br>(.18)   | .25<br>(.73)     |
| <b>Log Host<br/>Population</b>              | .07<br>(.17)     | -.60**<br>(.13)  | -.12<br>(.16)    |
| <b>Log Source<br/>Population</b>            | .34<br>(.60)     | .10<br>(.18)     | .10<br>(.57)     |
| <b>Regional Trade<br/>Agreement</b>         | 1.85**<br>(.22)  | -.04<br>(.22)    | 1.24**<br>(.30)  |
| <b>Currency Union</b>                       | -3.15**<br>(.64) | -4.91**<br>(.70) | -3.73**<br>(.73) |
| <b>Common Language</b>                      | 3.09**<br>(.29)  | 2.13**<br>(.21)  | 2.74**<br>(.27)  |
| <b>Log Host Area</b>                        | .34**<br>(.07)   | .06<br>(.05)     | .26**<br>(.07)   |
| <b>Log Source Area</b>                      | .07<br>(.10)     | -.33**<br>(.06)  | -.08<br>(.09)    |
| <b>Common Land<br/>Border</b>               | .28<br>(.65)     | -1.13<br>(.62)   | -.19<br>(.65)    |
| <b>Host<br/>Landlocked</b>                  | .06<br>(.20)     | .42*<br>(.18)    | .18<br>(.19)     |
| <b>Source Landlocked</b>                    | 1.09**<br>(.38)  | .79**<br>(.26)   | .91*<br>(.36)    |
| <b>Host Island<br/>Nation</b>               | 1.10**<br>(.35)  | -.35<br>(.31)    | .65<br>(.38)     |
| <b>Source Island Nation</b>                 | 1.79**<br>(.49)  | .18<br>(.27)     | 1.16**<br>(.44)  |
| <b>Common Colonizer</b>                     | 6.22<br>(.88)    | 4.53**<br>(.80)  | 5.66**<br>(.82)  |
| <b># Environmental<br/>Treaties, Source</b> | .060**<br>(.012) |                  | .037**<br>(.011) |
| <b>Observations</b>                         | 4430             | 4430             | 4430             |
| <b>R<sup>2</sup></b>                        | .40              | .55              | .50              |
| <b>Root MSE</b>                             | 5.288            | 4.552            | 4.822            |

## e. IV Results

1. Both coefficients remain positive and significant
2. Consistent with attenuation or simultaneity bias, IV-estimated coefficients are even larger
3. Effect of joint participation doubles and effect of unilateral participation almost quadruples!

## f. Sensitivity analysis

1. Estimate as a pooled panel, rather than taking average
2. Substitute the three most plausible components of ESI for portmanteau approach (Environmental Systems, Environmental Stress, and Human Vulnerability)
3. Replace ESI as IV with # of environmental treaties in CIA *World Factbook*
4. In all cases, both variables of interest enter positively and significantly
5. Use bilateral trade as regressand, and condition for regional effects
6. In these cases, unilateral coefficient is positive and significant, but bilateral variable enters insignificantly

**Table 3: Sensitivity Analysis**

|  | <b># Environmental<br/>Treaties, Host</b> | <b># Environmental<br/>Treaties, Joint</b> |
|--|---|--|
| OLS, Annual<br>Panel with year<br>effects    | .006**<br>(.002)                          | .042**<br>(.003)                           |
| IV, Annual Panel<br>with year effects        | .062**<br>(.011)                          | .065**<br>(.018)                           |
| IV, Polity and 3<br>ESI components as<br>IVs | .028**<br>(.006)                          | .094**<br>(.013)                           |
| IV, CIA Treaties<br>as IVs                   | .018**<br>(.002)                          | .028**<br>(.006)                           |
| IV, Polity as IV                             | -.008<br>(.022)                           | .167**<br>(.039)                           |
| IV, ESI as IV                                | .021<br>(.067)                            | .143<br>(.122)                             |
| Bilateral Goods<br>Trade, OLS                | .005**<br>(.001)                          | -.001<br>(.001)                            |
| IV, with regional<br>dummies                 | .080**<br>(.013)                          | .024<br>(.023)                             |
| IV, without Africa                           | .083**<br>(.016)                          | .038<br>(.028)                             |
| IV, without Latins<br>and Caribbean          | .075**<br>(.013)                          | .043<br>(.023)                             |
| IV, without Asians                           | .093**<br>(.013)                          | .031<br>(.021)                             |



## 5. Conclusion and caveats

- a. Results demonstrate link between environmental engagement and international exchange of assets
- b. Effect of joint participation suggests a punishment role
- c. Sensitivity analysis confirmed unilateral effect, although bilateral results indicated some sensitivity
- d. Suggests that there are economic costs to “going it alone” above benefits and costs of treaty (Ex. Kyoto)
- e. One caveat is that punishment is rarely observed