THE IMPORTANCE OF TRADE FOR THE RATIFICATION OF THE 1992 CLIMATE CHANGE CONVENTION

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ABSTRACT

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The focus in this paper is the issue of "political drag" in environmental policy making. Do countries delay the ratification of international environmental agreements and the associated abatement efforts, for international "competitiveness" reasons? We study the determination of the propensity of countries to participate in global environmental policy making by ratifying the Framework Convention for Climate Change (FCCC).

We found mixed evidence that trade mattered for the ratification of the FCCC. Whereas total exports have a positive impact on the speed of ratification, the opposite is true of total imports. More aggregate measures of trade openness indicate no effect of international trade flows on the probability of ratifying the FCCC, i.e., we find no evidence of "political drag" in the ratification process due to international trade. Other findings were that the conditional probability of signing the FCCC was positively related to total CO_2 emissions and the presence of civil liberties.

Key words: race to the bottom, political drag, international environmental agreement, democracy, carbon dioxide

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NON-TECHNICAL SUMMARY

The focus in this paper is the issue of "political drag," or "race to the bottom," in environmental policy making. We study the determination of the propensity of countries to participate in global environmental policy making by ratifying the Framework Convention for Climate Change (FCCC). Do countries delay the ratification of international environmental agreements and the associated abatement efforts for international "competitiveness" reasons? We argue that countries that speedily ratify an environmental treaty have a more intense preference for the provisions it contains.

We found mixed evidence that trade mattered for the ratification of the FCCC. Whereas total exports have a positive impact on the speed of ratification, the opposite is true of total imports. More aggregate measures of trade openness indicate no effect of international trade flows on the probability of ratifying the FCCC, i.e., we find no evidence of "political drag" in the ratification process due to international trade. Moreover, the effects of these trade variables disappear when they are scaled by variables capturing size or total wealth, such as GDP.

Other findings were that the conditional probability of signing the FCCC was positively related to total CO_2 emissions and the presence of civil liberties. The latter finding is highly significant and robust and is consistent with earlier research that found that democratic freedoms raised the probability of signing the Montreal Protocol. The finding for CO_2 emissions indicates that large, heavily polluting countries were under great political pressure, either internally or externally, to ratify the FCCC.

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1. Introduction

The *United Nations Framework Convention on Climate Change* (FCCC) was made available for signature at the *Earth Summit* held at Rio de Janeiro in June 1992. It entered into force in March 1994 after fifty countries had ratified the Convention.[1] The *Summit* was a response to the growing weight of scientific evidence that the Earth may be affected by climate change in the coming decades.[2]

As a framework treaty, the FCCC sets out principles as well as general commitments to adopt national programs for mitigating climate change and promote the conservation of greenhouse gas "sinks," such as forests. The FCCC differentiates between developing countries and former Eastern Bloc countries and OECD countries (the latter two groups are referred to as Annex One countries). By ratifying the Convention, the latter two groups committed themselves to "aim" to reduce emissions individually or jointly to their 1990 levels by the year 2000. Developing countries have no significant commitments under the FCCC, but are responsible for cooperation and promotion of the diffusion of technologies and practices that restrict emissions, i.e., there is a "common but differentiated responsibility" of nations in confronting the global environmental problem. The OECD countries were obliged to make financial resources and abatement technologies available to developing countries in order to meet these obligations. According to Chayes and Chayes (1991), the majority of international environmental agreements are complied with by ratifying countries. Although no nation can be forced to strictly adhere to the conditions stipulated in any international environmental agreement, Carraro and Siniscalco (1992) and Barrett

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[1] The *date of signature* is defined as the date when a state expresses its consent to be bound by a treaty (subject to its ratification). The *date of ratification* is the date when a state's legislature formally consents to be bound by a treaty. The agreement only enters into force for the countries that ratify the agreement.

[2] Expected effects are an increase in malaria, a rise in sea levels that could displace millions of people, and significant changes in ecosystems such as deforestation and degradation of coral reefs. Economic costs have been estimated to lie between 1 and 1.5 percent of GDP for industrialized countries and up to 9 percent for developing countries [Cline (1992), Frankhauser (1995), Tol (1995)]. The earth's temperature could increase by 1.5 to 6.5 degrees Fahrenheit and sea levels rise by between 6 to 37 inches by the year 2100. Fossil fuel combustion is the most important reason for the increase in greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), chloro-fluorocarbons (CFC's), nitrous oxide (N_2O), ozone (O_3), and water vapor. Only vapor concentrations are not directly affected by human activities.

(1994) argue that due to their voluntary nature, that such agreements are self-enforcing.[3]

As suggested by the quotations that open this section, we are interested in *when* countries signed the FCCC, rather than whether they signed. In a departure from the existing related literature, we focus on the delay in the ratification of an environmental treaty, i.e., the duration of time it takes for countries to formally take action.[4] We argue that countries that speedily ratify an environmental treaty have a more intense preference for the provisions it contains. Thus, in our context the date of eventual ratification proxies the relative intensity of preference for the provisions of the FCCC. A shorter delay in ratifying implies that a country sees the provisions in its immediate national self-interest. In Barrett's (1990) terminology, signatories (and ratifiers, in our view) act as "abatement leaders" and the others as "abatement followers." Ratification delay data of the type we use in this paper are informative about the characteristics of "leaders" and "followers" (i.e., given that abatement takes place subsequent to ratification of the agreement). A characterization of these countries may facilitate an improvement in the design of future international environmental agreements (IEA's).

Working with ratification or delay times not only avoids the problem of choosing an arbitrary cutoff date to investigate determinants of treaty ratification, but also adds to our knowledge of the political process underlying treaty ratification. Those countries that delay their ratification of a treaty do so, either because they perceive the treaty provisions as too costly and severe or, lacking net benefits (or that it may be strategically worthwhile to "hold-out," in which case they risk non-implementation of the agreement).

Global environmental policy carried out by international treaties suffer from at least two drawbacks. First, since participation is voluntary for each sovereign state, both in the ratification and the compliance stages, an international environmental agreement is based on a consensus of all participants and must be self-enforcing. According to Sand (1991), agreed upon environmental standards tend to result in the lowest common denominator. Barrett (1994) and Murdoch and Sandler (1997) argue that the Montreal Protocol merely codified CFC reductions that the countries would have undertaken in the absence of any agreement. Second, ratification of an international environmental treaty by parliament results in a time lag, delaying the implementation of the provisions of the treaty. In addition, the stipulation that multilateral agreements be ratified by a certain number of countries further slows implementation.[5] While this condition is aimed at avoiding any free-riding by potential non-ratifiers, it delays the

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[3] Although they have not been used the Montreal Protocol has provisions for the use of trade sanctions.

[4] Fredriksson and Gaston (1999a) investigate the implication of some alternative cutoff dates using logit estimation.

[5] See Black *et al.* (1993) for a discussion of the impact of the minimum participation requirement for a Climate Change agreement.

desired outcome to the time until the "slowest truck in the convoy" reaches its destination.[6]

Sand (1991) sees time lags and treaty ratification as one of the most serious drawbacks of the treaty approach to global environmental policy-making. Therefore, the question arises as to whether the traditional approach to multilateral agreements constitutes an effective way of undertaking international environmental policy. Since the target of the FCCC was to stabilize greenhouse gases within eight years, the exhibited ratification speed may have been important for the failure of many ratifiers to live up to the agreement.[7] Moreover, it is possible that countries behaved strategically looking ahead to Kyoto.[8] The negotiations on global warming issues are clearly an ongoing process. The Kyoto meeting held in December 1997 was decided upon less than three years subsequent to Rio. The timing of this process, with new rounds of negotiation occurring at such short time intervals, may have been an important reason for countries to have delayed their ratification and for the perceived subsequent failure of the FCCC.

Unfortunately, slow ratification by major emitters and competitors is likely to either dampen the enthusiasm of others to ratify the agreement, or alternatively, to reduce the interest in adhering to commitments made. The FCCC is a prime example of the voluntary provision of a public good. There is scope for free-riding both in the ratification and the implementation stages. A better understanding of the underlying behavior of countries in this process is important for the appropriate design of global policies. Hopefully, this paper represents a step forward in our understanding of why ratifying countries deviated from the FCCC agreement.

As well as its unique focus on delays in the ratification of an international environmental agreement, the paper contributes to the policy debate and the literature in several ways. We are particularly interested in the impact of the degree of openness to international trade on the ratification process. Trade-related issues arose during the Protocol negotiations when it became apparent that some countries considered that future mitigation measures could have strong trade impacts [see Assunção (1997)]. Based on the experience with the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) and the Montreal Protocol, some countries believed that trade restrictions might be used, both to limit emissions and to induce

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[6] A United Nations Institute for Training and Research (UNITAR) study, cited by Sand (1991), found that patterns of "drag" in treaty acceptance postponed the date of effectiveness by between two to twelve years after formal agreements had been made (the average was about five years).

[7] The *Law of the Sea* only entered into force after more than twelve years.

[8] Schelling's (1960) conjecture states that an international negotiator may point to a hawkish domestic legislature to extract greater concessions from the foreign country. For example, Denmark obtained considerable concessions in the 1992 renegotiation of the Maastricht Treaty after an initial ratification failure [Iida (1996)]. It could thus be possible to gain from a slow ratification of the FCCC in order to obtain a better bargaining position in Kyoto. If a legislature is too "hawkish," the negotiator's threat to the foreign country becomes non-credible, and the Schelling conjecture does not hold [Milner and Rosendorff (1997)].

non-compliant parties to participate in the new Protocol. Profitable trading relationships between nations therefore have important implications for a country's willingness to take up the obligations under the FCCC.

Increased exposure to international markets may yield a "race to the bottom," or "political drag" in the enactment of environmental regulations [see Esty (1996), Esty and Geradin (1997), Stewart (1993)]. Consequently, countries may delay the ratification of international environmental agreements and the associated abatement efforts, for international "competitiveness" reasons.

In the next section, we describe the legislative delay time data. To our knowledge, this is one of the first papers that uses data on the FCCC. Section 3 describes our key hypotheses, and section 4 presents results from a proportional hazards regression model. Section 5 provides some concluding observations. A description of the empirical methodology and technical details are left for the Appendix.

2. The Data on Legislative Delay

The few empirical studies that have preceded ours on the determinants of signing environmental treaties have investigated the signatories and non-signatories at a particular point in time. Since the date of ratification is a continuous variable, this introduces an inevitable degree of arbitrariness in the choice of a cut-off date for an investigation. It also reduces the political environmental treaty ratification decision to a dichotomous choice. In contrast, we focus on delay times to ratification of the FCCC.

The FCCC was made available for ratification on June 4th, 1992. The date of ratification by the countries is recorded by the Convention. By definition, "left-censoring" is not a problem. That is, we know the date when the FCCC was made available for ratification by all countries. However, some spells are incomplete since some countries have not ratified the FCCC. That is, some of the data are "right-censored." This requires the use of special empirical techniques that have been developed to handle duration data. At the commencement date of the Kyoto meeting, December 1st, 1997, twenty-one countries had still not ratified the convention.

The total sample size consists of 184 countries. The main part of the data are for countries that were members of the United Nations (UN) as of June 1992. For countries that came into existence after June 1992, we compute the delay time from the date of that country's admission into the UN.[9]

Figure 1 plots the (non-parametric) estimates of the survival distribution function for the delay time data. This survivor function specifies the probability that the delay time will exceed a certain number of days. The average delay time for the countries that ratified the FCCC is 810 days, while the median spell length is 728 days

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[9] Specifically, we make such calculations for the Czech Republic, Eritrea, Georgia, and Macedonia.

(indicating skewness in the delay time distribution). The quartiles of the delay time distribution are 375, 810, and 978 days. That is, more than a year had passed by the time a quarter of the countries had ratified and well over two years had elapsed before half the countries had done so.

Figure 1: Survival Function Estimates

```
SDF  |
     |
 1.0 +  A+
     |    ++++
S    |      +A
u    |       ++
r    |        ++
v    |         ++
i    |          A
v 0.8 +         ++
a    |          ++
l    |           ++
     |            A
D    |            +
i    |             +
s    |             ++
t 0.6 +             +
r    |              +
i    |              A
b    |              +
u    |               +
t    |               ++
i    |                +
o 0.4 +               +
n    |                A
     |                ++
F    |                 ++
u    |                 ++
n    |                  A+
c    |                   ++
t 0.2 +                   ++
i    |                    +A+++
o    |                       +++A++++++A
n    |
     |
     |
 0.0 +
     |
     --+------+------+------+------+------+------+------+------+------+------+-
       0     200    400    600    800   1000   1200   1400   1600   1800   2000
                                 Ratification Delay (days)
```
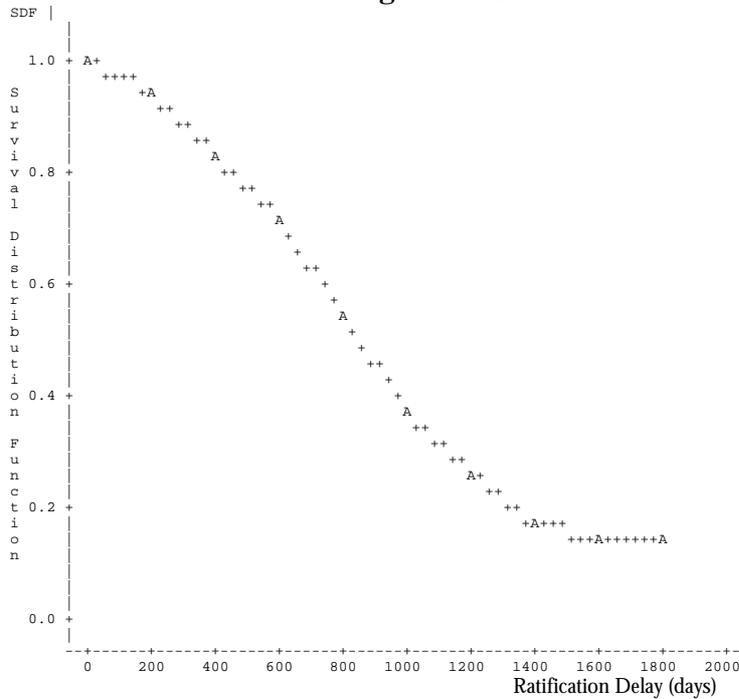
Figure 2 plots non-parametric estimates of the hazard function. The hazard rate is the rate at which countries will ratify the FCCC at any particular date (i.e., conditional on them not having ratified up until that point in time). The single-peakedness indicates an initially increasing hazard or positive duration dependence and then a decreasing hazard or negative duration dependence. (The peak is at 98 countries, above the critical number of 50 countries required for ratification.) Negative duration dependence indicates that the longer a country has not ratified the FCCC, the less likely it is to do so. This latter fact points to the importance of early ratification.

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Figure 2: Hazard Function Estimates

```
Hazard |
  0.0023 +
         |
         |                              A
         |                             ++
  0.0020 +                            +  +
         |                            +  +
         |                           +    +
         |                          +      +
         |                         +        +
  0.0018 +                        +          +
         |                       +            +
         |                      +          A+
         |                     +          +++
H 0.0015 +                    +         +A
a        |                   +           +
z        |                  A             +
a        |                  +              +
r        |                 +               +
d 0.0013 +                +                 +
         |               +                   +
F        |              +                     A
u        |             +                       +
n        |            +                         +
c 0.0010 +           +                           +
t        |          +                             +
i        |          +                              +
o        |         +                                +
n        |        +                                  +
  0.0008 +       +A                                   +
         |      +++                                    +
         |     A+                                       +
         |     +                                         +
  0.0005 +    +                                           +
         |   +                                             +
         |   +                                              +
         |  +                                                A
  0.0003 + +
         | +
         |A
         |
  0.0000 +
         |
          ------+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-
              0    200   400   600   800  1000  1200  1400  1600  1800  2000
                                   Ratification Delay (days)
```
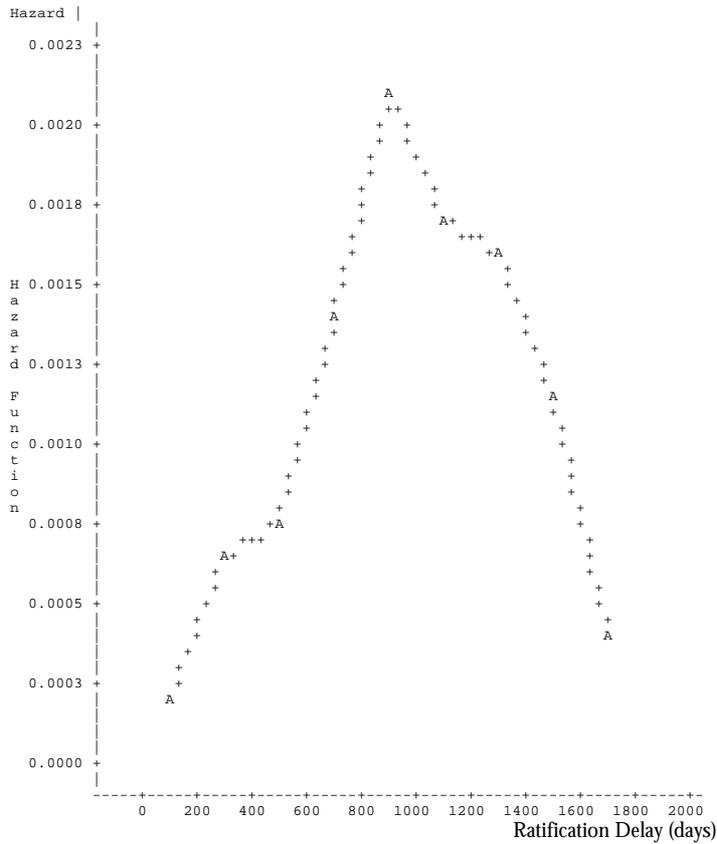
Table 1 provides a breakdown by broad country "type," i.e., OECD and former Eastern Bloc, and developing country. Despite the concessions granted, it is evident that developing countries tend to have longer delay times.[10] This suggests the importance of a variety of country characteristics as determinants of the ratification of international environmental agreement. We turn to this issue in the next section.

Table 1: Descriptive statistics for legislative delay times

Countries	Complete	Mean	Std Dev	Median	Incomplete
All	163	810	396	728	21
Developing country	130	849	402	914	19
OECD/Former Eastern Bloc	33	656	336	630	2

Source: Data on ratification dates are from the UNFCCC official web site http://www.infccc.de/

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[10] See the discussion in the next section on the effect of side-payments, e.g., in the form of technology transfers [see also Hoel and Schneider (1997)].

3. The Determinants of Legislative Delay

The descriptive information is illuminating, but additional insights are gained from an analysis of probabilistic models that estimate the effects of various factors on ratification delay times. To deal with the censored nature of the data, we use the proportional hazards regression model [Cox (1972)]. Further details of the estimation and specification tests are left for the Appendix.

We link the delay time data with data on characteristics of the countries that are drawn from a number of different sources. All the data are publicly available. See table 2. Missing observations for some of the key explanatory variables reduce the sample size to 114 countries. The column containing correlations in table 2 provides some preliminary insights on some of the hypothesized relationships in this section.

Table 2: Descriptive statistics for covariate analysis

Variable	Label	N	Mean	Std Dev	Minm	Maxm	$r^{\dagger}$	Sources
DELAY	Ratification delay, days after June 4, 1992	104	795.12	385.57	92.00	1959.00	.	a
ANNEX1	OECD/Former Eastern Bloc	114	0.23	0.42	0.00	1.00	-.28***	b
TROPICS	Tropics	114	0.61	0.49	0.00	1.00	.15	c
CAPRCORN	South of Tropic of Capricorn	114	0.05	0.22	0.00	1.00	.04	c
AREA	Total area, '000 sq km	114	877.71	1869.07	0.63	9976.14	-.42***	cia
COASTLIN	Coastline, '000 km	114	5.68	23.78	0.00	243.79	-.30***	cia
POPN	Population, 1994, mill.	114	43.64	142.87	0.21	1190.43	-.23**	cia
LIFEEXP	Life expectancy, years	114	64.01	11.82	37.46	79.31	-.18*	cia
EXPORTS	Exports 1992, bill. ($US)	114	26.00	65.56	0.04	449.00	-.35***	cia
IMPORTS	Imports 1992, bill. ($US)	114	27.62	70.50	0.13	582.00	-.34***	cia
NPCAPITA	National product pre capita, 1993 ($US)	114	6091.75	6500.01	500.00	24700.00	-.27***	cia
SACHSIDX	Sachs-Warner trade openness index	104	0.37	0.48	0.00	1.00	-.12	sachs
NOTFREE	Gastil civil rights index	114	4.26	2.04	1.00	7.00	.37***	scully
SOCIALIST	Gastil economic system index	114	3.79	2.33	1.00	9.00	.15	scully
GDPPER	GDP growth, 1983-93, %	114	2.48	3.00	-14.90	8.90	-.11	wri table 7.1
CO2TOTAL	Total CO2 Emissions, 1992 (mill. tons)	114	143.84	532.68	0.02	4881.35	-.39***	wri table 14.1
OILRES	Crude oil recoverable reserves (bill. tons)	65	2.00	5.44	0.00	35.62	.11	wri table 12.3
SCOALRES	Soft coal recoverable reserves (bill. tons)	37	8.41	24.40	0.00	134.06	-.54***	wri table 12.3
HCOALRES	Hard coal recoverable reserves (bill. tons)	46	8.43	22.41	0.00	106.50	-.40***	wri table 12.3
OPEC	OPEC member country	114	0.09	0.28	0.00	1.00	.13	d

Notes:

a. Data are from UNFCCC official web site (http://www.unfccc.de/). Sample consists of 114 countriesof which 10 are non-ratifiers.

b. Dummy variable = 1, if country a member of OECD or former Eastern bloc.

c. Latitude calculated from geographic center of country.

d. OPEC country = 1.

cia: Data from *The World Fact Book, 1996* (U. S. Central Intelligence Agency).

scully: Data from Scully (1992), Appendix table 5.2, pp.132-9.

sachs: Data calculated from Sachs and Warner (1995). Open = 1.

wri: Data from *World Resources: A Guide to the Global Environment, 1996-7*, World Resources Institute, various tables.

† Correlation with Log of Delay time. Statistically significant at 1%(***); 5%(**), 10%(*) level. N = 104.

The major focus of this paper is the association between trade relations and environmental policy making. Esty (1996) and Esty and Geradin (1997) discuss the issue of "political drag" in environmental policy making. Interpreted in our context, they have the following concern: Do countries delay the ratification of IEA's and the associated abatement efforts, for international "competitiveness" reasons?[11]

Fredriksson (1999a) argues that in countries with a comparative advantage in pollution intensive industries, the political pressures on environmental policy from both industry and environmental lobby groups will increase, and the final effect on policy depends on the relative shifts in lobby group pressures.

Barrett (1997) studies the important relationship between trade and IEA's. He shows that if trade sanctions are a credible threat, full cooperation on global environmental policy can be sustained when a minimum participation requirement is used. He also argues that in the absence of trade sanctions, the environment is not protected at the Pareto efficient level.

Moreover, analogous to Fernandez' (1997) reasoning concerning regional trade areas, the commitment to environmental cooperation may work as a signaling device. That is, it signals that a country's industries are competitive, that the investment climate is attractive, and that future political relationships with other nations will remain healthy. All these factors stimulate investment and are therefore likely to make ratification of the FCCC more attractive.

Trade has been seen as a civilizing force for centuries [see Hirschman (1982) and Schiff and Winters (1997)].[12] Chan (1984) argues that the level of conflict between any two nations diminishes if they are democratic. Polachek (1992, 1997) explains this result by the effect of democracy on trade. International trade between democracies is greater than between other countries. Trade also has a negative effect on the level of conflict and a positive effect on bilateral cooperation.

Hoel and Schneider (1997) argue that governments may ratify an IEA for fear of exclusion from future trade agreements. The costs of non-ratification, as well as of deviating after having ratified, are likely to be increasing in the total trade flows and openness of a country and in the number of trading partners. Hoel and Schneider (1997) argue that low income countries have little to lose by not joining an IEA because they have small non-environmental costs (such as a loss of reputation). Whereas exporters are likely to be concerned about both their reputation and abatement costs, import-competing sectors may care primarily about their costs, and thus trade may cause industries to take different lobbying stances on the FCCC.

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[11] See also Fredriksson and Gaston (1999b) for an analysis of the "race to the bottom" hypothesis incorporating political economy pressures.

[12] This paragraph draws on Schiff and Winters (1997).

In the area of international trade negotiations, and in the political game between superpowers, *reciprocity* is often invoked as the correct standard of behavior producing cooperation among states [Keohane (1986)]. Obligations are important and imply that agents behave in a generally acceptable fashion. The concept appears to apply to IEA's, such as the FCCC, as well as to trade agreements.

The sum of these arguments imply that nations which are relatively reliant on trade interact with other nations more frequently and exchange ideas more freely, and may therefore behave in a different way than autarkies. While the global benefits of ratification are commonly shared, the costs of non-ratification are likely to vary with each country's reliance on trade. Per se, the effect of openness is ambiguous. For example, it should also be noted that openness is also likely to affect compliance costs of an IEA as well as the trade-related costs associated with ratifying an IEA. However, conditional on compliance with IEA's, we hypothesize that EXPORTS are likely to be positively correlated with reputation costs and lead to shorter delay times and a higher hazard rate. However, greater total IMPORTS increase the inflow of foreign influences and ideas, as well as the amount of technology transfers and foreign competition.

We also include other controls and variables thought to be important determinants of the ratification of IEA's. First, the financial situation of the country is likely to play a role. Countries that are growing relatively quickly, for instance, may find it less costly on the margin to ratify an IEA than countries that grow more slowly. Slow income growth, which is associated with a growing unemployment problem, is often cited as the reason for resistance to entering into an IEA. Hence, higher percentage growth in income (GDPPER) is likely to be associated with shorter delay times and a higher hazard rate. Also, we use GDP per capita, NPCAPITA, as suggested by Congleton (1992). Murdoch and Sandler (1997) found a linear relationship between GNP and emission cutbacks which they interpreted as evidence in favor of the theory of the voluntary provision of public goods. To the extent that environmental quality is a normal good, NPCAPITA is likely to yield shorter delay times and a higher hazard rate [Bergstrom *et al.* (1986)].

Second, countries that emit more greenhouse gases and are more reliant on energy-intensive production may be more hesitant about ratification of the FCCC because their input costs are likely to rise relatively more. On the other hand, in a model with identical countries, Barrett (1994) finds that the greater is the ratio of the slope of each country's marginal abatement cost curve to the slope of the global marginal benefit function, the fewer are the number of countries that sign an IEA. If higher emissions imply a lower slope of the marginal abatement cost curve, then ratification of an IEA is more likely. Countries that emit more pollutants are also likely to be under greater international pressure to ratify an IEA, and the reputational effects of non-ratification are likely to be greater. A country's reputation may also affect international negotiations on other important issues, such as trade policy. We use CO2TOTAL as an indicator for greenhouse gas emissions.

Third, Congleton (1992) presents a theory which shows that autocratic countries select less stringent environmental regulations. He argues that dictators tend to have shorter time horizons and should be less likely, or take longer, to ratify an IEA, since the benefits of doing so are likely to accrue after they have left office, whereas the costs are incurred earlier.[13] The same argument implies a longer time before the FCCC is ratified. In addition, if more undemocratic governments do have a higher turnover, they are more likely to be out of office at the time of ratification. For reasons other than the purported shorter tenure of dictatorships, Olson (1993) argues that dictators wish to maximize tax revenues and thus oppose any policies that would reduce revenue, e.g., those that result from increased abatement expenditures. Fredriksson (1997) argues that more democratic countries (in the sense that they put a greater emphasis on social welfare relative to lobbying activities) chose local environmental policies that are closer to being welfare-maximizing.[14] Consequently, democratic countries may therefore also be more likely to speedily ratify global environmental policies.

If a change in government or particular political group in favor has occurred from the time of the negotiations, the preferences of the legislative body have changed and thus a rapid ratification may be less likely. Iida (1996) argues that ratification failures are more likely when negotiators are uncertain about their constituency's preferences. We assert that a greater degree of representative democracy may be expected to yield better information about domestic legislative behavior. Furthermore, great internal divisions imply that legislatures are less likely to ratify international environmental agreements, although this can to some degree also be used by negotiators to extract concessions [see Milner and Rosendorff (1997)].

It is also possible that the ratification of IEA's serves as a commitment to the idea of democracy. By participation in international agreements, countries can show that they fulfill the requirements for participation in various forms of cooperation [Fernandez (1997)].[15]

Following previous authors [e.g., Congleton (1992)], we use Gastil's indices of civil liberties and political freedoms (NOTFREE) as well as an index of the type of economic system that a country has (SOCIALIST). Higher values of NOTFREE index *fewer* civil liberties; higher values of SOCIALIST index a greater degree of government control of property and less market-oriented or more socialistic economic systems [see Scully (1992)].

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[13] Dictatorships face an inherent uncertainty regarding the time of succession [Olson (1993)].

[14] Fredriksson (1999b) performs a similar analysis of governments decision to site hazardous waste facilities
   in federal systems.

[15] Fernandez (1997) argues that by entering into regional trade agreements countries can show a commitment to democracy, e.g., the entry of Greece, Portugal, and Spain to the European Union, the signing by the countries of Central and Eastern Europe of the Europe Agreements (which are meant to lead to eventual accession), and possibly the creation of MERCOSUR.

Fourth, the population size (POPN) may influence the ratification date because a country with a small population may stand to gain more from an IEA than a large country. This is because in the negotiation process a small concession by a large country may imply a substantial gain for a small country [see Chen (1997)]. It may be easier for a small country to free-ride, however, since the effect on global pollution is lower. Alternatively, Congleton (1992) used POPN to proxy for a country's labor force. Hence, the extent to which this is correlated with worker concerns about unemployment is likely to delay ratification.

A country's resource base is positively related to personal income and negatively related to the marginal cost of environmental regulations (and therefore, positively correlated with the equilibrium stringency of environmental policies). We use land area (AREA) as a proxy for resource base (which is also correlated with fossil fuels). Available data for recoverable oil and coal reserves are poor, due to the large number of missing observations. However, we estimate some models with the reduced sample and also estimate models with an OPEC country dummy.

Next, the time horizon has implications for the costs and benefits derived from the reduction of emissions. Nordhaus (1991) argues that whereas the costs of environmental regulations are incurred immediately, the rewards of regulation are repaid only later. We use life expectancy at birth (LIFEEXP) as a proxy for the planning horizon.

Flooding is expected to increase as a result of global warming. We use total COASTLINE as a measure of the propensity for floods. Moreover, desertification and increased frequency of malaria are expected results of increased temperature. We use distance from the equator as measured by two dummies (TROPICS, CAPRICORN).

Finally, developing countries have no significant obligations under the FCCC. This is likely to reduce the costs of ratifying the agreement. We capture this effect by the ANNEX1, which takes a value of one for OECD and former Eastern Bloc countries. Preliminary evidence for this hypothesis is not supported by comparisons across the rows of table 1 and by the negative correlation in the penultimate column of table 2. This is, however, consistent with Hoel and Schneider (1997) who argue that the availability of side-payments, such as technology transfers, provided that a country does not commit itself to cooperation, may actually reduce the incentive to participate in IEA's.

4. The Results

Main findings: Table 3 contains the estimation results. Column (1) presents estimates of the main model specification. The findings reveal that the hazard rate, the conditional probability of ratifying the FCCC, is positively correlated with EXPORTS, GDPPER, CO2TOTAL, AREA, and ANNEX1 and negatively correlated with IMPORTS and NOTFREE.

Table 3: Estimates of Proportional Hazards Model:
Effects of Trade Measures

Variable	(1) Full	(2) No trade	(3) Scaled trade	(4) Openness	(5) Sachs-Warner
AREA(*10^3)	0.152*	0.147	0.139	0.143	0.153
	(0.086)	(0.091)	(0.090)	(0.091)	(0.095)
POPN(*10^2)	0.015	0.056	0.050	0.049	0.035
	(0.115)	(0.101)	(0.102)	(0.102)	(0.104)
EXPORTS	0.010**	.	1.319	.	.
	(0.005)		(1.038)		
IMPORTS	-0.012**	.	-1.616	.	.
	(0.006)		(1.150)		
OPENNESS	.	.	.	-0.165	-0.067
				(0.279)	(0.285)
NOTFREE	-0.275***	-0.243***	-0.275***	-0.240***	-0.222***
	(0.080)	(0.078)	(0.082)	(0.078)	(0.087)
SOCIALIST	0.041	0.050	0.061	0.054	0.043
	(0.055)	(0.055)	(0.055)	(0.055)	(0.057)
GDPPER	0.070*	0.069*	0.083*	0.073*	0.050
	(0.041)	(0.041)	(0.043)	(0.042)	(0.042)
CO2TOTAL(*10^2)	0.106*	0.071**	0.069**	0.071**	0.067*
	(0.057)	(0.035)	(0.035)	(0.035)	(0.036)
ANNEX1	0.776*	0.597	0.618	0.605	0.518
	(0.402)	(0.391)	(0.388)	(0.388)	(0.392)
TROPICS	0.004	0.071	0.029	0.097	-0.060
	(0.357)	(0.356)	(0.359)	(0.358)	(0.369)
CAPRCORN	0.127	0.238	0.216	0.252	0.140
	(0.518)	(0.518)	(0.516)	(0.518)	(0.542)
COASTLIN	0.007	0.009	0.009	0.009	0.009
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
LIFEEXP	-0.016	-0.013	-0.013	-0.010	-0.010
	(0.014)	(0.013)	(0.015)	(0.015)	(0.015)
N	114	114	114	114	104
-2 LOG L	749.783	755.266	753.227	754.886	683.115
Likelihood ratio	56.961	51.477	53.517	51.858	44.708
Score	111.695	106.381	106.916	106.381	96.695
Wald	62.301	54.664	55.687	54.810	48.397

Notes:
i. Standard errors in parentheses. Statistically significant at 1%(***); 5%(**), 10%(*) level;
ii. Column (3): Exports and Imports are scaled by domestic consumption (GDP + Imports - Exports); Column (4): Openness index calculated as (Exports + Imports)/GDP; Column (5): Sachs and Warner (1995) Openness index.

The coefficient for EXPORTS indicates that large exporting countries were more likely to ratify the FCCC quickly. Exporters appear to take reputational effects into consideration, possibly because of fears of consumer boycotts or repercussions in other international forums, such as the World Trade Organisation. Moreover, they are likely to be more exposed and more receptive to ideas in the area of environmental policy and are therefore more open to cooperation as predicted by Polachek (1992, 1997). To the extent that faster ratification mirrors a greater preference for increased abatement efforts and stringent regulations, the finding provides no support for the "political drag" or "race to the bottom" effects induced by freer trade. On the other hand, the negative sign for IMPORTS is suggestive of a "political drag" or "race to the bottom." Large importing countries have been hesitant to ratify the FCCC, perhaps out of fear of loss of "competitiveness."[16] This indicates that lobbying by import-competing industries may have been successful in stalling the ratification process. Evidently, the inflow of novel ideas about environmental policies from abroad through imported goods and services has been minimal. The findings for trade are subjected to further scrutiny below.

The finding for CO2TOTAL indicates that countries generating greater *total* pollution had shorter ratification delay times. This suggests that large polluting countries were under great political pressure, either internally or externally, to ratify the FCCC. Reputational considerations or marginal abatement costs thus appear to be playing an important role.

The positive coefficient for GDPPER suggests that fast-growing countries perceive relatively greater benefits, or lower costs, from the ratification of the FCCC than slower-growing ones. The latter group of countries is more likely to be concerned with high unemployment and to have fewer funds available for environmental protection. We also studied the effect of per capita income. We estimated several models. All models excluded POPN, as population appears in the denominator of NPCAPITA. In many models, GDPPER was deleted. In addition, some of the other size-related variables were rotated out of the some of the models. To the extent that total CO_2 emissions are positively correlated with a country's wealth, some models were also estimated without CO2TOTAL. In *all* cases, the income per capita variable *never* achieved significance (at the 10 percent level). Hence, our discussion in this section relates to the preferred model specification, which includes GDPPER, reported in column (1) of table 3.

The group identity variable (ANNEX1) had a significant and positive impact on the ratification speed. It lends some support to the theory by Hoel and Schneider (1997) that the availability of technology transfers to developing countries does not

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[16] It should be noted that much of the literature has found insignificant results or small effects for the effects of environmental regulations on international trade patterns (see Jaffe *et al.* (1995) for a survey). However, Lucas *et al.* (1992) and Low and Yeats (1992) find evidence of the relocation of polluting industries from OECD countries to developing countries.

necessarily increase the incentive to cooperate. Since developing countries had no binding commitments under the FCCC, the ratification decision may best be viewed as having a low priority by their legislatures or other decision-making bodies.

Robustness of the findings: Unfortunately, there is some sensitivity in some of the parameter estimates. Alternative model specifications were also estimated because of a suspected multicollinearity problem between some of the variables (e.g., the correlation of the size variables is quite high for our sample).[17] In some model specifications, many of the effects identified above, in connection with the results reported in column (1), generally have weak statistical significance. Across all the specifications that were estimated, the signs of significant coefficients were generally robust. In particular, NOTFREE – Gastil's civil liberties index – is always associated with a significantly lower hazard across *all* model specifications that were estimated, i.e., greater civil liberties result in more rapid ratification. Using the point estimate in column (1), the marginal effect of a unit increase in NOTFREE on the hazard rate is -24 percent.[18]

Benedick (1991) argues that the experience with the CFC negotiations shows the importance of political leadership and resistance to lobby groups interested in impeding the legislative process. More democratic countries may also be less likely to use tardy ratification as a tool in the next negotiation round. The result underscores the importance of political and institutional factors for the ratification of IEA's.

Apart from NOTFREE, the only other variable that consistently retained both its coefficient sign and statistical significance across all the model specifications that were estimated was CO2TOTAL. However, this variable is likely to be correlated with economic size and wealth. Scaling this variable by a size variable such as POPN yields a statistically insignificant coefficient estimate. That is, CO_2 emissions *per capita* have an insignificant effect on ratification delay. Therefore, the most conservative conclusion that can be drawn is that larger, wealthier countries, which have greater pollution levels, were more likely to ratify the FCCC at any point in time.

Variables that capture endowments (such as AREA and POPN) or vulnerability to global warming (COASTLINE) generally appear to be less important, although AREA and COASTLINE are significant at the 10 percent significance level in column (4) with the expected signs. AREA is a proxy for resource abundance, i.e. the marginal cost of environmental regulations (which is falling in the available resources), and this has some influence on countries' behavior, which was also reported by Congleton (1992).[19] The risk of flooding (COASTLINE) does seem to have some effect, maybe

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[17] For example, the simple correlation between AREA and POPN is 0.54.

[18] For any independent variable X_i, the marginal effect is calculated as [exp(b_i) - 1]*100.

[19] We also estimated hazard models that included an OPEC dummy, as well as models that included measures of total oil and coal reserves. None of these variables proved to be significant at the 10 percent level. In models using coal and oil reserves measures, this could be due to missing

because of pressure from local insurance companies. This is not a robust finding, however. Finally, the type of economic system (SOCIALIST), location (TROPICS, CAPRICORN), and planning horizon (LIFEEXP) have no significant effects.

A detailed examination of trade variables: One of our key interests is the effects of trade and trade-related variables on the ratification of the FCCC. The remaining columns of table 3 present the estimation results for different measures of trade and trade openness. Column (2) reports the results from a model specification without any trade-related variables, which once again highlights the importance of NOTFREE and CO2TOTAL. Also, note that omission of total trade flows, which are positively correlated with a country's size, does not increase the significance levels or change the coefficient signs of the size variables such as AREA and POPN. Column (3) scales imports and exports by domestic consumption (i.e., GDP plus imports minus exports). These measures therefore capture some notion of the importance of imports and exports in the domestic economies of each country by scaling trade flows using market size. The findings now reveal that the hazard rate is unaffected by either import penetration or scaled exports. Thus, as above, the economic size of a country appears to be the overriding consideration.[20]

Columns (4) and (5) use two different measures of countries' outward orientation or trade openness. We use the ratio of total trade (imports plus exports) scaled by total output, as well as the measure of trade openness developed by Sachs and Warner (1995).[21] In both model specifications, the results indicate that only NOTFREE and CO2TOTAL are significant. The signs of the other covariates are also stable, albeit insignificant.

Overall, while there is some evidence that trade may well matter for the passage of the FCCC, specifically total exports and imports, we find no conclusive evidence for either the "race to the bottom" or the "race to the top" hypothesis. In addition, since the coefficients of the two trade measures are approximately equal in absolute value, multilateral trade liberalization is unlikely to have a significant impact on the speed of ratification. This is evidenced by the insignificant coefficients for openness and Sachs-Warner in columns (4) and (5) of table 3. The findings can possibly be explained by the offsetting behavior of import and export industry lobby groups in the legislative process. We note that the evidence on the importance of trade variables is far from conclusive and indicates the need for both further empirical investigation and,

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observations, however (see table 2). In most cases, the sample size was so dramatically reduced, that the results were uninformative.

[20] It is also the case that the coefficients on EXPORTS and IMPORTS each lose their statistical significance, when either of them are omitted. They are highly correlated with each other and highly correlated with the other size variables. The authors are grateful to Alan Winters for this observation.

[21] The Sachs-Warner openness dummy is based on five criteria. A country is classified as *closed* if it fulfills any of them: average tariff level, quota coverage, black market premiums, the existence of export marketing boards, and the presence of a socialist regime. *Open* countries have a value of one.

in our opinion, greater effort directed at theoretically modeling the precise avenues through which international trade and environmental policy interact with one another.

There are (at least) two possible interpretations of the estimated effects of trade related variables on the ratification of the FCCC. The conservative statistical conclusion is that the economic size of countries is of overriding importance and that trade, or trade openness, has had no effect on the speed of the ratification of the FCCC. A more controversial conclusion is that large exporting countries were quicker to ratify the agreement because of reputational concerns. On the other hand, large importing countries were guilty of dragging their heels with regards to ratification of the agreement. This may have been due to competitiveness pressures and lobbying by import-competing industries.

Our findings may have implications for the ratification of future IEA's as follows. If we take the conservative high road (i.e., that trade is irrelevant), then trade sanctions against non-ratifiers will have no effect on the speed of ratification. In fact, linking trade sanctions and the ratification of IEA's is likely to be counterproductive. Such measures will likely result in social welfare losses and have no great impact on when ratification of IEA's is achieved.

Alternatively, if one takes the view that trade does matter, then the threat of trade sanctions may reinforce the reputational concerns for exporters. In other words, trade sanctions are a credible threat for exporters and may expedite the ratification process. On the other hand, the large importing countries are the laggards in the ratification process and sanctions imposed by those countries that are more likely to ratify (i.e., the exporters with reputational concerns), would not be a credible threat. Even if sanctions are credible, then under the interpretation that international competitiveness concerns slow the ratification process, the use of measures that sanction exports to these countries would further mitigate these competitiveness concerns and not serve to accelerate the ratification process. This is an area where much work remains to be done.

5. Conclusion

This paper represents a unique study of the United Nations Framework Convention on Climate Change (FCCC). In particular, the study looked at the determinants of the delay in ratification of the FCCC. The legislative delays in ratifying the agreement were instrumental in preventing the timely entry of the FCCC into force. Consequently, this may have had important implications for the overall lack of success of the agreement. The deadline for reductions was 8 years after the Rio Earth Summit. The credibility of this agreement hinged on its *early* entry into force. By examining when countries ratified the FCCC, our approach enabled us to identify the intensity of each country's preference to ratify, or not to ratify, the FCCC. We consequently identified the characteristics of the "leaders" and the "followers" involved in the process of negotiations on the global warming issue.

Among the more interesting findings were that the conditional probability of signing the FCCC was positively related to total CO_2 emissions and the presence of civil liberties. The latter finding is highly significant and robust and is consistent with earlier research that found that democratic freedoms raised the probability of signing the Montreal Protocol. Assuming increased levels of democracy over time, existing forecasts of future emissions may overestimate future CO_2 levels. Future research on the ratification of global international environmental agreements should explicitly consider the political and democratic status of countries at any point in time. If countries are converging in their degree of democracy, ratification delay may also converge. Interestingly, converging income levels would not yield this effect. The finding for CO_2 emissions indicates that large, heavily polluting countries were under great political pressure, either internally or externally, to ratify the FCCC. This also indicates that the speed of ratification is indeed viewed as important.

Finally, we found mixed evidence that trade mattered for the ratification of the FCCC. Whereas total exports has a positive impact on the speed of ratification, the opposite is true of total imports. Not surprisingly then, more aggregate measures of trade openness indicate no effect of international trade flows on the probability of ratifying the FCCC, i.e., we find no evidence of "political drag" in the ratification process due to international trade. Moreover, the effects of these trade variables disappear when they are scaled by variables capturing size or total wealth, such as GDP. The economic size of countries also seems to be an extremely important determinant of the decision about *when* to ratify an international environmental agreement.

Naturally, there are strategic issues involved since the CO_2 negotiations are an ongoing process. This game merits further analysis in our opinion. We consider that our findings may be important for projections of the future increase of greenhouse gases under various scenarios. If democracy spreads further among nations, future abatement efforts may prove to be more successful than are currently predicted. The diffusion of democratic ideas are thus an important consideration in the continuing attempts to reduce global greenhouse emissions.

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Appendix

The essential ideas of a survival model are sketched briefly here. See Kiefer (1988) or Lancaster (1992) for more detailed treatments. The conditional hazard rate is modelled as

$$l(t|X) = l_0(t)\exp^{Xb}. \qquad (A.1)$$

$l(t|X)$ is the rate at which countries will ratify the FCCC at any particular date, given that they have not ratified up until that point in time. Equation (A.1) specifies the hazard rate as the product of two components: a function of spell length (i.e., delay time), $l_0(t)$ or baseline hazard, and a function of the observable country characteristics, which are denoted by the vector X. The Cox nonparametric estimation method enables us to estimate b without having to make a distributional assumption about $l_0(t)$. A central objective of this paper is to obtain unbiased estimates of the vector b.

For those readers used to thinking in terms of standard regression analysis, it is helpful to interpret the estimates of the elements of b as being negatively related to the respective element in the b vector estimated by an OLS regression of X on log delay time. For example, if a variable X_j has a coefficient $\hat{b}_j > 0$ in equation (A.1), this implies that the effect of X_j on the hazard rate is positive, i.e., that the country characteristic X_j is associated with a *higher* hazard or greater conditional probability of exiting (i.e., ratifying the FCCC). Alternatively, it implies that the variable X_j is associated with a *shorter* delay in the ratification of the FCCC. Note that such direct comparisons and interpretations of coefficients are only meaningful if the data are not heavily censored (see Kiefer, 1988, p.665).

More formally, the *hazard rate l(t)* is the probability of exiting a state in the time interval $[t, t+h]$, conditional on having arrived at t in that state, and is defined as

$$l(t)h = \lim_{h \to 0} \Pr\left(t \le T < t+h \mid T \ge t\right), \qquad (A.2)$$

where the random variable T is the length of the duration in the state. Assuming T has a distribution function $F(t) = \Pr(T < t)$, with density $f(t)$, then

$$l(t) = f(t)/(1 - F(t)) = f(t)/S(t), \qquad (A.3)$$

where $S(t) = \Pr(T \ge t)$ is the survivor function, i.e., the probability of "surviving" at least until t. The density of completed spells can be found from Eqn.(A.3), i.e., $f(t) = S(t)l(t)$. In addition, note that

$$d \ln S(t)/dt = -f(t)/S(t) = -l(t), \qquad (A.4)$$

hence, from Eqns.(A.3) and (A.4), the survivor function is

$$S(t) = \exp\left\{-\int_0^t l(s)ds\right\}. \qquad (A.5)$$

Thus, the density of completed spells can be computed from the *integrated hazard* rate function. For our purposes, note that "survival" means that the country has still not ratified the FCCC and that a "hazard" occurs when the country ratifies the FCCC.

Also note that the time variable "t " is not calendar time but rather the delay time, which is measured in days.

To model the effect of covariates on delay times, the hazard rate can be written as a conditional function of country characteristics, which we denote by the vector X. The most widely-used specification of the conditional hazard rate is the *proportional hazards* model,

$$\lambda(t\,|\,X) = \lambda_0(t)f(X) . \tag{A.6}$$

Eqn.(A.6) specifies the hazard rate as the product of two components: a function of spell length, $\lambda_0(t)$ or *baseline hazard*, and a function of the observables, $f(X)$. Letting $f(X) = \exp(X'b)$, and taking logs, Eqn.(A.6) gives:

$$\ln \lambda(t\,|\,X) = \ln \lambda_0(t) + X'b . \tag{A.7}$$

Note that

$$\partial \ln \lambda(t\,|\,X) \big/ \partial X_j = b_j , \tag{A.8}$$

so that $\hat{b}_j$ gives an estimate of the effect of explanatory variable X_j on the conditional probability of ratifying the FCCC.

One approach to estimating Eqn.(A.7) is to assume a parametric form for $\lambda_0(t)$ and maximize the likelihood function constructed from the implied distribution of spell lengths. The Cox nonparametric estimation technique provides an alternative method for estimating b without risking the specification bias that may arise if an incorrect distribution is assumed for $\lambda_0(t)$ [Cox (1972)]. The basic idea of the Cox technique is that even in the absence of a functional form assumption for the baseline hazard, information about b is present in the ranking of the data by spell lengths. If countries with a high value of a certain characteristic X_j, for example, have shorter delay times than countries with a low value of characteristic X_j, the hazard rate is then positively correlated with X_j, and the Cox estimation technique assigns a positive value to b_j. The usual method of estimation of the Cox model is *partial likelihood*, and is dealt with in many econometrics texts [e.g., Lancaster (1992)].