Economic Inquiry

ECONOMIC DETERMINANTS OF THE *TIMING* OF PREFERENTIAL TRADE AGREEMENT FORMATIONS AND ENLARGEMENTS

JEFFREY H. BERGSTRAND, PETER EGGER and MARIO LARCH*

Preferential trade agreements (PTAs) have proliferated over the past 60 years. While a small number of recent studies have examined empirically the economic determinants of the likelihood of a pair of countries having a PTA, this study explains empirically the timing of all PTA formations and enlargements from 1950 through 2006 using duration analysis. Our main and novel goal is to predict (in- and out-of-sample) a substantive share of these 1,560 PTA events using a parsimonious model with mainly economic variables, taking selection dynamics into account. Our analysis reveals that we can predict correctly in-sample the actual year of entry into force for 26% of the 1,560 bilateral PTA formations/enlargements in the period 1950–2006 among 10,518 pairings of 146 countries using only a few economic and political variables. Moreover, we can predict correctly in-sample 57% of these PTA events within a 10-year window leading up to the event using this model. The model also performs well out-of-sample for the near term (82%), but not if the out-of-sample period is very long. We conclude with an evaluation of the model's ability to predict the timing of the North American Free Trade Agreement, the European Union's formation and enlargements, and the model's ten most likely post-2006 PTA events. (*JEL* F14, F15)

I. INTRODUCTION

One of the most notable economic events since World War II is the proliferation of preferential trade agreements (PTAs), including free trade agreements (FTAs) and customs unions (CUs). The study of such agreements has followed fundamentally two paths, one normative and one positive. The normative path is whether or not PTAs are welfare-improving (see Bagwell and Staiger 1997, 2005; Bond, Riezman, and Syropoulos 2004). A full survey of this literature is beyond the scope of this paper, but see Baldwin (2007) for an excellent survey.

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ABBREVIATIONS

AFTZ: African Free Trade Zone
BB: Baier and Bergstrand (2004)
COMESA: Common Market for Eastern and Southern Africa
CUs: Customs Unions
CUSFTA: Canada–United States Free Trade Agreement
EAC: East African Community
ECCAS: Economic Community of Central African States
EEC: European Economic Community
EL: Egger and Larch (2008)
EU: European Union
FTAs: Free Trade Agreements
GATT: General Agreement on Tariffs and Trade
GDPs: Gross Domestic Products
MTN: Multilateral Trade Negotiation
NAFTA: North American Free Trade Agreement
PTAs: Preferential Trade Agreements
ROW: Rest of the World
SADC: Southern African Development Community
WTO: World Trade Organization

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The second path, which is "positive," examines what factors explain and predict which pairs of countries *have* PTAs. Building on the work of Krugman (1991a, 1991b) and Frankel (1997), Baier and Bergstrand (2004), or BB, introduced asymmetric absolute and relative factor endowments into a Krugman-type increasing-returns/monopolistic-competition model to show theoretically that the net utility gains from a bilateral PTA depend on two countries' economic sizes and their economic similarity, bilateral distance, and relative factor endowments. Using a single cross-section for 1996, BB employed a probit analysis to show that these economic factors that tend to improve on net a country-pair's utility from a PTA also tend to increase the pair's probability of having a PTA. Egger and Larch (2008), Chen and Joshi (2010), and Baldwin and Jaimovich (2012) confirmed BB's findings and showed that additional variables—such as pre-existing PTAs—also tend to increase the likelihood of a pair of countries having an agreement.[1]

Despite the proliferation of PTAs over the past 60 years, there is still considerable scope for further formations or enlargements of PTAs. Governments' policy makers have long been looking for a "road map" to guide them toward selection of PTA partners for enlarging existing arrangements or forming new ones; limited resources and political obstacles have inevitably constrained governments to sequencing such formations and enlargements rather than pursuing them simultaneously. Ideally, such a road map should be consistent with improving the net economic welfare of members. This study attempts to explain and predict (in-sample) the actual *timing* of formations and enlargements of *all PTAs* among 10,518 pairings of 146 countries for 57 years from 1950 through 2006 based upon a parsimonious structure inspired by a simple economic model. Moreover, to gauge the potential usefulness of this exercise for future formations and enlargements, we also show how our approach predicts PTA events well *out-of-sample*, based primarily on economic considerations. The results suggest that most PTA formations and enlargements are influenced by factors that tend to increase pairs' economic welfare.

In econometrics, the analysis of the time elapsed until a certain event occurs is referred to as duration analysis. Duration analysis has its origin in survival analysis, which refers to the survival time of a subject in a particular state. In our context, this refers to the survival of a country-pair in the state of "No-PTA." Central to such analyses is the hazard rate, which in our context emphasizes the conditional probability of a country-pair leaving the state of No-PTA *conditional upon* having been in this state for a particular duration. The latter emphasizes the inherently dynamic nature of duration analysis, cf., Abbring and van den Berg (2002), de Ree and Nillesen (2009), and Wooldridge (2010). So, the key difference of this paper from the existing literature is predicting the *specific year* of a PTA formation/enlargement event (or a window of years leading up to the event), in-sample and out-of-sample, using a parsimonious econometric model motivated by economic and political variables.[2]

In this paper, we first address how one might interpret the decision of a pair of countries to form/enlarge a PTA in some year *conditional upon* not having had a PTA until that year. This discussion informs us about the determinants of the "hazard rate" (without economic covariates), which is the probability of a country-pair leaving the No-PTA state in a year conditional upon having been without a PTA up until that year. Classic distributions determining hazard rates include the Weibull and log-logistic distributions, which yield that such hazard rates are functions of time trends. However, a simple time trend in the absence of economic covariates can explain only 11% of the variation in the PTA events. Second, most economic duration analyses are concerned with the influence of time-invariant or time-varying economic covariates that "shift" the hazard rate in any year. Drawing upon the recent literature on economic determinants of PTAs noted above, we motivate the inclusion of several economic and political covariates that likely influence the probability of two countries forming/enlarging a PTA in any particular year, conditional upon not having a PTA until that year. These covariates include

1. Egger and Larch (2008) and Baldwin and Jaimovich (2012) examined the influence on the probabilities of PTAs of existing nearby agreements in a previous period using spatial econometrics, providing broad empirical support for potential trade diversion inducing nonmembers to either join existing PTAs (supporting Baldwin's domino theory) or form new ones. A similar analysis motivated by network formation was undertaken by Chen and Joshi (2010). However, these studies did not examine the effects of existing PTAs on the *timing* of new PTAs and enlargements, which we examine.

2. Baldwin and Jaimovich (2012) used duration analysis in one robustness analysis of their model. Liu (2008, 2010) used a duration analysis, but excluded interdependence controls. Also, neither of these studies focused on the role of time and all of them omitted in-sample and out-of-sample predictions.

three measures of *geography*, four measures of *economic size and relative factor endowments*, four measures of the influences of *other PTAs*, and six *political variables*. These covariates have an explanatory power of up to 44% when measured by the pseudo-R^2 (up to 49% including fixed effects). They predict (in-sample) up to 57% of the 1,560 bilateral PTA events in the period 1950–2006 among the 10,518 pairings of 146 countries within a 10-year window leading up to the date of entry (up to 72% when including fixed effects). The same models predict up to 26% (39% with country-pair fixed effects) of the PTA events in the very year they occurred.[3]

Third, our model also performs well out-of-sample. Taking only the periods up through 2000 for the estimation, the model predicts up to *66%* of the 284 PTAs concluded from 2001 through 2006 in the year the PTAs were concluded, and up to *82%* in a 5-year window up until the actual formation of the PTAs. The out-of-sample predictions are worse when only the years up through 1989 were used for estimation and the out-of-sample period was quite long (1990–2006), but then the regressions are informed by only 523 PTA events that happened prior to 1990. We close the study with an evaluation of the influence of multilateralism on PTA timing and of the successfulness of the model for predicting in particular the Canada–United States Free Trade Agreement (CUSFTA), the North American Free Trade Agreement (NAFTA), the formation of the original European Economic Community (EEC) and subsequent enlargements, and the model's most likely PTA events in the post-sample period of 2007–2013.

The remainder of the paper is organized as follows. Section II motivates the use of an econometric duration model to analyze the timing of PTA (formation/enlargement) "events." Section III motivates the time-invariant and time-varying economic, political, and historical determinants of the hazard rate. Section IV describes the data. Section V provides the empirical results. Section VI provides the predictive analysis. Section VII concludes.

3. As will be discussed later, the potential number of observations is 599,526, given the number of country-pairs and years. However, we construct our sample such that—once a country-pair forms a PTA in a particular year—subsequent years are excluded. For instance, Germany and France entered (into force) the European Economic Community in 1958; consequently, years 1959–2006 are excluded for Germany–France. This reduces our number of observations from 599,526 to 463,289. Subsequent data constraints will reduce it further for some empirical specifications.

II. MOTIVATION FOR A DURATION ANALYSIS OF TIME-TO-PTA

A. Analyzing PTA Status versus Timing of PTAs

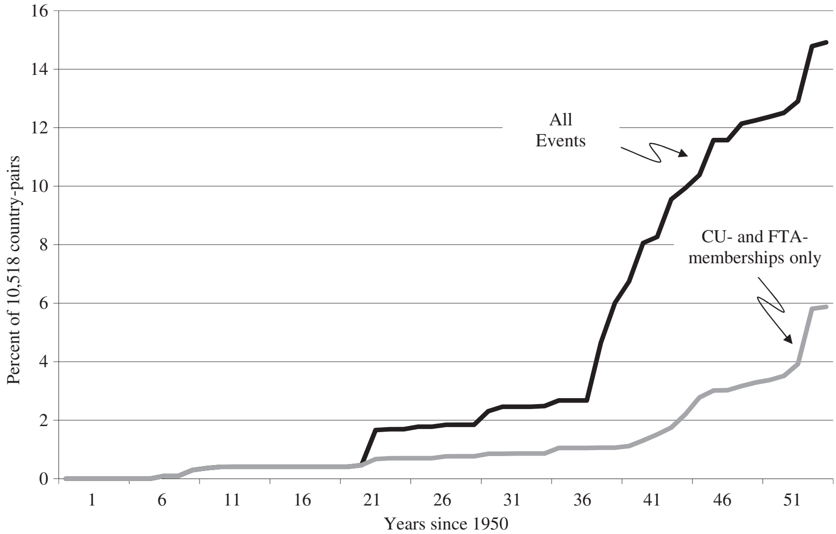
Figure 1 illustrates the years in which PTA events occurred, summarizing the (cumulative) number of bilateral trade agreement "membership events" for all years from 1950 through 2006 in which some new "membership" occurred (either a new agreement or an enlargement), according to information mainly provided by the World Trade Organization (WTO).[4] The WTO categorization (labeled there regional trade agreements, or RTAs) includes two-way preferential agreements, FTAs in goods, FTAs in services, and CUs.[5] We focus on memberships at the country-pair level and avoid redundant observations by counting events such as the membership of France and (West) Germany in the original EEC as a single new membership "event" (instead of two events) and the enlargement of the original EEC to include the United Kingdom as five new membership events instead of ten events.[6] Accordingly, the events should not be interpreted as just new PTAs that have been formed, since we also count as new memberships ones that are brought about through enlargements of existing PTAs. In this study, we do not separate our empirical sample into "new

4. The cumulative number of all PTA events corresponds to the number of country-pairs in the sample which liberalized trade preferentially since 1950. We had to amend the data to capture agreements not included in the WTO data base. For instance, most of the members of the former communist bloc were engaged in agreements outside the WTO (or, prior to the foundation of the WTO, the General Agreement on Tariffs and Trade, GATT). Note that an event requires that explanatory variables employed in the subsequent empirical analysis are not missing for a country-pair. Accordingly, the memberships associated with this figure are the same ones used in estimation later. Figure 1 presents these cumulative events as a percentage of 10,518 country-pairs covered.

5. Higher levels of economic integration, such as common markets and economic unions, are also included; for instance, Germany and France—members of the Eurozone—are considered in the WTO listing as a customs union (CU). One-way preferential trade agreements, such as Generalized System of Preferences (GSP) agreements, are excluded.

6. For instance, the 10 events in 1958 correspond to the formation of the EEC in that year. The corresponding number of memberships is 10, because Belgium and Luxembourg are counted as a single country (as often done in economic studies), so that there are 5 founding members and the number of unique dyads is $5(5 - 1)/2$.

FIGURE 1
Years to Event for Different Groups for the Years 1950–2006



PTAs" versus "enlarged PTAs." We also show in Figure 1 the subset of PTA events that include only FTAs and CUs.

The figure suggests that there have been years with strong and weak membership activity over time. The number of all PTA membership "events" concluded since 1950 rose to 1,560 until the end of 2006, that is, 14.83% of the 10,518 country-pairs and 0.34% of the 463,289 total observations in the panel, recalling that a time-series for a country-pair ends in 2006 if no PTA is formed *or* in the year a PTA enters into force (see footnote 3). From these data, we can create a variable representing the "Time-to-PTA event," as done in duration analysis. Our focus will then be to find the economic, political, and historical determinants that explain the "Time-to-PTA event," meaning the *timing* of the formation of a new agreement or an enlargement of an existing PTA agreement.[7]

Our goal in this paper is to predict the duration (in years) before a country-pair entered a PTA (through formation or enlargement) using a duration model with a parsimonious set of time-invariant and time-varying variables. This contrasts with the goal of BB, Magee (2003), Egger and Larch (2008, henceforth EL), Chen and Joshi (2010), and Baldwin and Jaimovich (2012) who focused on explaining which country-pairs *had* a PTA in a given year. The econometric framework employed there was the qualitative choice model of McFadden (1975, 1976). In BB, the probability of a PTA was linked heuristically to an underlying latent variable, denoted ΔU_{ij} here. In that study's context, ΔU_{ij} represented the difference in utility levels from an action (formation of a PTA), where

$$\Delta U_{ij} = \mathbf{x}_{ij}\beta + e_{ij}, \quad (1)$$

and $\mathbf{x}_{ij}$ denoted a vector of explanatory variables (economic characteristics) of country-pair ij including a constant, β was a vector of parameters, and error term e_{ij} was assumed to be independent of $\mathbf{x}_{ij}$ and to have a standard normal distribution. In the context of BB's model, $\Delta U_{ij} = min(\Delta U_i, \Delta U_j)$, where ΔU_i (ΔU_j) denoted the change in utility for the representative consumer in i (j); both countries' representative consumers needed to benefit from a PTA for their governments to form one.[8] The

7. Figure 1 illustrates three apparent "waves of regionalism" since 1950. The first wave (beginning in 1958) was initiated by the formation of the European Economic Community (EEC) and then the European Free Trade Agreement (EFTA). The second wave (beginning in 1973) included several enlargements of the EEC and the introduction of several new PTAs. The third wave (beginning in 1989) included the formations of the Canada–United States FTA, NAFTA, MERCOSUR, and numerous bilateral agreements.

8. Side (or compensation) payments were ruled out.

latent variable ΔU_{ij} was assumed to generate the binary indicator variable of PTA membership, PTA_{ij}, which was unity if two countries had a PTA and zero otherwise. The response probability for a PTA, P, was then:

$$(2)\quad P\left(PTA_{ij} = 1\right) = P\left(\Delta U_{ij} > 0\right) = G\left(\mathbf{x}_{ij}\beta\right),$$

where $G(\cdot)$ was the standard normal cumulative distribution function, which ensured that $P(PTA_{ij} = 1)$ was between 0 and 1. This literature has assumed that $P(PTA_{ij} = 1) > 0.5$ "indicated" $\Delta U_{ij} > 0$ and $P(PTA_{ij} = 1) \leq 0.5$ indicated $\Delta U_{ij} \leq 0$.

Rather than focusing on the static explanation of PTAs in a cross-section of data in a given year, this paper aims at examining the determinants of the *timing* of PTA events using duration analysis. Duration models fall within the class of limited dependent variable models in general and censored regression models in particular (cf., Wooldridge 2010). Duration analysis has been used increasingly in the economics literature since 1980. The most common application is in labor economics evaluating empirically the determinants of the length of a spell of unemployment of an individual, cf., Heckman and Singer (1984) and Kiefer (1988). There is only a small number of studies which have applied this framework in international trade.[9]

For the research question of this paper, two issues have to be addressed. First, we have to rationalize an empirical model of timing of PTAs in the *absence* of time-invariant and time-varying economic covariates. Second, we have to allude to how the hazard rate interacts with fundamental economic variables that are known to *shift* a country-pair's probability of forming an agreement at any point in time. We address these issues separately below.[10]

B. Economic Motivation for a Discrete-Time Duration Model

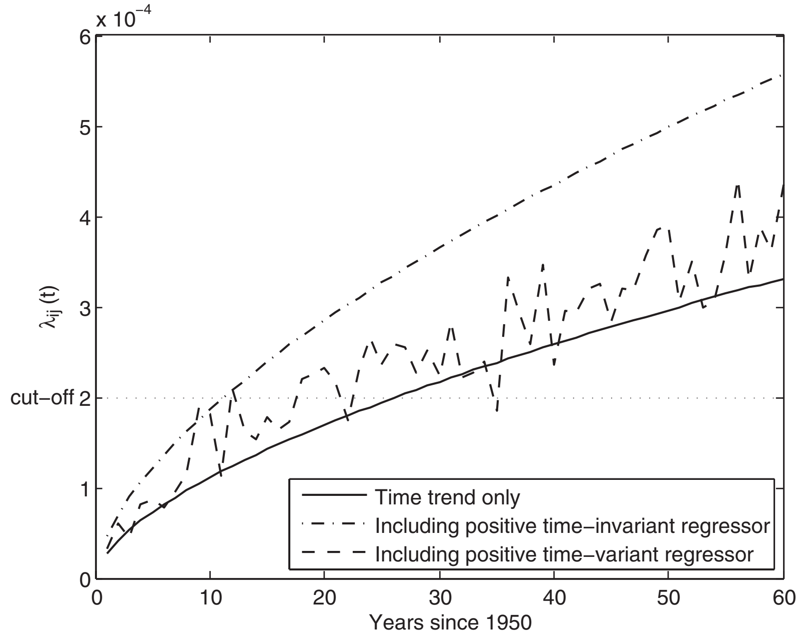
In this section, we discuss a simple economic motivation for a discrete-time duration model for analyzing time-to-PTA events. Suppose that, at the country-pair ij level in any year t, each of two governments choose between two states, entering a bilateral PTA or not. The decision of interest is the duration of years T_{ij} after which governments i and j will adopt a bilateral PTA. Data on elapsed time since some fixed year until the inception of a PTA are only available by year. Hence, we cannot portray time-to-PTA events by a continuous process econometrically, but need to resort to a discrete-time representation.

In the No-PTA state and year t, assume the governments of i and j receive utility $U_{ij}'(t)$ associated with bilateral trade flows. These governments may receive the possibility in any year t to form a PTA. From that, they would realize cum-PTA utility (associated with cum-PTA trade flows) drawn from a continuous distribution with density $f(U_{ij}(t))$ at a constant rate g in every year t. The probability of realizing the benefits $U_{ij}(t)$ from concluding a PTA (and the associated trade flows) after T years is gT. Suppose that the possibility to conclude PTAs is drawn independently of $f(U_{ij}(t))$, and governments know the density function $f(\cdot)$ but not the utility $U_{ij}(t)$ from a given PTA. Moreover, suppose for simplicity that reservation utility $U_{ij}'(t)$ from staying outside of a PTA is independent of the change in trade flows induced by the conclusion of the PTA, while the change in utility through PTA formation is a function of the change in trade flows but not of the functional form $f(\cdot)$. Upon receiving the possibility to conclude a PTA at random intervals, governments then decide about when to form a PTA. The decision about when to enter a PTA will depend on the comparison of the expected gains from PTA membership as captured by $U_{ij}(t)$ with

9. Joyce (2005) and Conway (2007) studied determinants of the lengths of spells of IMF programs. Besedes (2008), Besedes and Prusa (2006a,2006b), Fugazza and Molina (2009), Nitsch (2009), and Hess and Persson (2010) all have studied the determinants of bilateral trade-flow durations. Only two other studies have examined determinants of the timing of PTA events, namely Liu (2008, 2010). However, Liu (2008) focused on the marginal effects of political economy determinants of PTA timings (specifically, income-inequality's interactive effects with relative capital-labor endowment ratios) to test a "median-voter" model of PTA timing versus a "lobbying" model. That study's finding in favor of the median-voter model provides support for our economic determinants of the timing of PTA approach and our alternative focus on domino effects, competitive liberalization, and PTA interdependence. Liu (2010) extends Liu (2008) by testing competing predictions of the median voter model versus the lobbying model. However, Liu (2008, 2010) omitted controls for "interdependence," did not provide any predicted probabilities of time-to-PTA events, and did not provide any out-of-sample predictions, all of which are goals of the present paper.

10. The vast number of pairs of countries that form PTAs in our sample (1,560 events) do so permanently; our sample includes only 48 events of pairs ending agreements. By contrast, the labor economics duration literature on unemployment spells and the international economics literature on IMF program spells deal with macroeconomic policies/environments, where entering and exiting spells of unemployment or programs, respectively, is frequent. Due to the insignificant number of PTA exits, we do not address the latter events in this study.

FIGURE 2
Illustration of Hazard Rate as a Function of Time



the reservation gains captured by $U_{ij}'(t)$. Accordingly, the probability that a PTA is acceptable can be written as:

$$(3) \qquad P_{ij}(t) = \int_{U_{ij}'(t)}^{\infty} f\left(U_{ij}(t)\right) dU_{ij}(t).$$

Country-pair ij's transition rate from No-PTA to PTA in year t is reflected in the product of the constant rate at which PTAs become possible in any year (g) and the probability that they are acceptable in year t, $P_{ij}(t)$. This transition rate is the probability of leaving the No-PTA state in t given that governments i and j did not conclude a PTA until then, and it may be referred to as the hazard rate for the distribution of duration until PTA formation:

$$(4) \qquad \lambda_{ij}(t) = P\left(T_{ij} = t | T_{ij} \geq t\right) = gP_{ij}(t),$$

where T_{ij} is the survival time out of PTA status of country-pair ij.

There are several possible distributions for modeling the hazard rate, $\lambda_{ij}(t)$. For a discrete-time multivariate model as the one proposed here, the complementary log-log distribution is a common choice (see Jenkins 1995, 2005). In comparison to other distributions, this specification has the advantage of allowing for time-varying covariates—an essential element of our study discussed in the next section. Figure 1 suggests that, apart from the covariates in vector $\mathbf{x}_{ijt}$, we may want to allow for a general time trend in a specification of time-to-PTA events. The latter can be easily done with the complementary log-log distribution when specifying $\lambda_{ij}(t)$ as:

$$(5) \qquad \lambda_{ij}(t) = 1 - \exp\left[-\exp\left(\mathbf{x}_{ijt}\beta + \gamma_t\right)\right],$$

where $\mathbf{x}_{ijt}\beta = \beta_0 + \beta_1 x_{1,ijt} + \beta_2 x_{2,ijt} + \ldots + \beta_K x_{K,ijt}$ and γ_t captures the general time trend.

We model the general time trend as $\gamma_t = r\ln(t)$, which implies that the shape of the hazard monotonically increases if $r > 0$, decreases if $r < 0$, or is constant if $r = 0$ (see Jenkins 2005). If concluding PTAs becomes generally easier as time marches on, we would expect $r > 0$.

Figure 2 illustrates the relationship between the hazard rate and time t with a complementary log-log distribution function. The slope of the hazard rate depends on the coefficient of the general time trend r as well as the explanatory variables. Consistent with estimates reported later on for the data underlying this study, we assume that $r = 0.61$ in Figure 2.[11] If other

11. This result is consistent with a time trend parameter of 0.61 in Specification 2 in Table 3 below.

explanatory variables do not matter and the hazard rate $\lambda_{ij}(t)$ of leaving the initial No-PTA state increases with larger t, we obtain a functional relationship as shown by the continuous concave locus labeled "Time trend only" in Figure 2 with $\lambda_{ij}(t) = 1 - \exp[-\exp(0.61 \ln(t))]$. One may think of many factors underlying a rising hazard rate with time per se. For instance, falling tariffs due to multilateral trade liberalization under the General Agreement on Tariffs and Trade (GATT) or WTO may have had an influence; in fact, we examine this later empirically in Section VI. Alternatively, generally declining political costs of political and economic cooperation after World War II could be mentioned here.

Beyond a trend (and multilateralism's possible effect), the timing of PTAs is likely influenced by economic, historical, and political factors. Clearly, variables that have been found to increase the probability of concluding a PTA in previous research will lead to a reduction of the time-to-PTA events with processes as specified in Equations (3) and (5). The reason is that everything that influences the net utility gain of country-pair ij from participating in a PTA in any year t will also raise the hazard rate $\lambda_{ij}(t)$. Hence, obvious candidate variables in $\mathbf{x}_{ijt}$ to predict (in- and out-of-sample) a substantive share of the 1,560 PTA events underlying Figure 1 are the determinants of PTA memberships in a cross-section of data in BB. For instance, having a common land border (a time-invariant variable) or two countries being jointly economically larger (a time-variant variable) are strong partial predictors of PTA membership in a cross-section. Either of these factors raises the probability that a PTA is acceptable, $P_{ij}(t)$, *ceteris paribus*. Hence, either of these factors should raise the hazard rate $\lambda_{ij}(t)$. However, time-invariant and time-variant elements in $\mathbf{x}_{ijt}$ affect the hazard rate in functionally different ways. This is illustrated by the two broken loci in Figure 2. For the locus labeled "Including positive time-invariant regressor," we added 0.52 to the time trend so that $\lambda_{ij}(t) = 1 - \exp[-\exp(0.52 + 0.61 \ln(t))]$.[12] For the locus labeled "Including positive time-variant regressor," we added $0.10\varepsilon_{ijt}$ to the time trend, where ε_{ijt} is drawn randomly from a normal distribution with mean and standard deviation of one. Then, $\lambda_{ij}(t) = 1 - \exp[-\exp(0.13\varepsilon_{ijt} + 0.61 \ln(t))]$.[13] As can be seen from Figure 2, there is a tendency for both time-invariant and time-variant shifters of $P_{ij}(t)$ to raise the hazard rate. However, time-variant shifters of $P_{ij}(t)$ render the hazard rate a potentially *non-monotonic* function of time, which is not the case for time-invariant shifters.

III. FACTORS SHIFTING THE PROBABILITIES OF PTAs

A. Economic Factors

The purpose of this section is to identify economic variables that potentially "shift" the hazard rate, $\lambda_{ij}(t)$, in any year t, thus increasing or decreasing the likelihood that a PTA occurs *sooner*.[14] In the spirit of the *extant* literature, we consider determinants of the probability of PTAs suggested in recent studies by BB, EL, and Baldwin and Jaimovich (2012), as such variables are expected to alter in any period t the latent variable $U_{ij}(t)$ defined earlier.[15]

Notice that the time-to-PTA-event structure addressed in the previous section makes both the theoretical and the empirical approach in this paper fundamentally different from the ones in BB, EL, Chen and Joshi (2010), and Baldwin and Jaimovich (2012). These papers provided only a static motivation for PTA formation. Hence, conditional on observable (economic and/or political) time-specific and time-invariant determinants, PTA membership was explained in the cross-section pertaining to a specific time period. However, duration, time-to-event, or survival models as the one outlined in the previous section are inherently dynamic, since the selection into PTA membership changes conditional on the time elapsed (see Wooldridge 2010, chapter 22, Section IV.B for a discussion of the dynamic nature of duration models). However, the present approach shares with the earlier work that there are time-specific fundamental

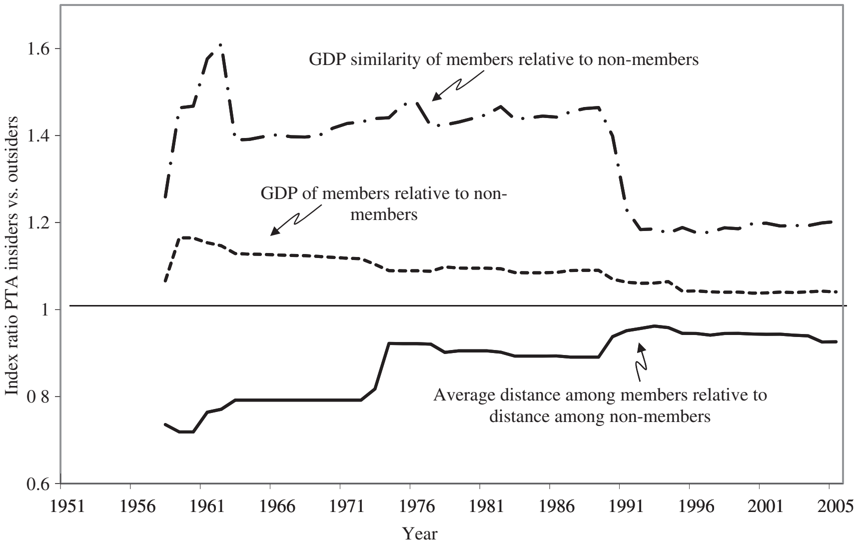
12. A parameter on common borders of 0.52 is also consistent with Specification 2 in Table 3 below.

13. A parameter of 0.13 is, for example, consistent with the coefficient on two countries' joint economic size in Specification 2 in Table 3 below. However, we do not draw ε_{ijt} from a normal distribution with mean and variance as of two countries' joint economic size for reasons of illustration.

14. In short, period t economic variables influence $P_{ij}(t)$ in the equation $\lambda_{ij}(t) = gP_{ij}(t)$, because $P_{ij}(t)$ is a function of period t utility, $U_{ij}(t)$.

15. We provide in an online Theoretical Supplement (Appendix S1) a one-sector Krugman-type general equilibrium model to account for sequencing of PTA events to motivate all the economic factors below (except relative factor endowments).

FIGURE 3
Characteristics of RTA Insiders versus Outsiders for the Years 1950–2006



(economic, political and/or historical) drivers of PTA formation that are at play and inform the otherwise dynamic process.

Figure 3 illustrates the interplay between dynamic model aspects and shifters of the probability of becoming a PTA member. It takes the information associated with Figure 1 and combines the Time-to-PTA event data with three particular economic characteristics associated with the members of PTAs *relative to* those of nonmembers. One economic characteristic is the "proximity" of PTA members relative to nonmembers. We measure this using the average distance between the economic centers of members of PTAs relative to the average distance between economic centers of nonmembers. A second economic characteristic is the average economic size of PTA members relative to that of nonmembers; economic size is measured using countries' gross domestic products (GDPs). The third economic characteristic is the average difference between country-pairs' GDPs for PTA members relative to that of nonmembers.

Figure 3 illustrates several profoundly systematic relationships between distance, economic size, economic similarity, and the timing of PTA events.[16] The bottom line indicates two phenomena. The earliest PTA events (1958–1961) were between members whose average distance between members relative to nonmembers was the *smallest*. As time passed, the average distance between members relative to nonmembers rose systematically. This line suggests that PTAs formed or enlarged *sooner* among closer countries. The middle line indicates two phenomena related to economic size and PTA-event timing. The earliest PTA events were also between countries whose average economic size was the *largest* relative to nonmembers. Then, as time passed, the average relative economic size of members declined. This line suggests that PTAs formed or enlarged *sooner* among economically larger countries. The top line indicates two phenomena related to economic size similarity and PTA-event timing. The earliest PTA events were also among countries with very similar GDP sizes. As time passed, the degree of size similarity declined in general. This line suggests that PTAs formed or enlarged *sooner* among countries with more similar economic sizes.

BB provided theoretical motivations for the relationships between a country-pair's bilateral proximity, remoteness, economic size, economic similarity, and relative factor endowments for influencing the probability of a PTA, based upon a Krugman-type model of trade. Two countries' governments want to liberalize their bilateral

16. "Similarity" is measured (as traditionally) using the product of country *i*'s share of both countries' real GDPs with country *j*'s share.

trade through a PTA if they are less distant from each other but more distant from the rest of the world (ROW), if they are larger but more similarly sized economically, and have sufficiently different relative factor endowments.

Drawing on the domino theory in Baldwin (1995), EL enriched the BB framework by examining the role of other country-pairs' PTAs for influencing the likelihood of a PTA of a given country-pair. EL showed that, given a PTA forms, outsiders will lose in utility due to trade diversion. This creates, under some conditions, an incentive for them to join an existing PTA, or under alternative conditions form a new PTA. We introduce four new variables inspired by EL's approach to capture the influences of existing agreements on new or enlarged PTAs. First, we include the log distance of a pair of countries to the "nearest PTA" (DISTPTA). Intuitively, the closer are two countries to an existing PTA, the greater is the trade diversion they have incurred from that PTA. This implies a greater economic incentive to form/enlarge a PTA because of the potentially offsetting trade creation. Hence, DISTPTA is expected to be negatively related to the hazard rate. Second, a country-pair's utility is influenced by the "degree of regionalism" (or "competitive liberalization") in the ROW. The greater the number of PTAs in the ROW, the more trade diversion and loss of utility a country-pair experiences. We include a variable measuring the "degree of regionalism" in the ROW for every pair which is a spatially weighted average of all the PTAs that countries i and j face in ROW, denoted WPTA. WPTA is expected to be positively related to the hazard rate. Third, the variable DISTPTA influences—in the terminology of Baldwin (1995)—the "demand for membership" of outsiders into an existing PTA or a new PTA. However, in Baldwin (1995), the "supply of membership" was purposely assumed to be infinitely elastic. In reality, PTA membership is also constrained potentially by existing members; that is, supply of membership may have finite elasticity. In a theoretical model, we are able to show that the likelihood of a PTA between a country-pair may at first increase with the number of members in the "nearest PTA" but eventually may be constrained by the number of members in it, as some members of the existing agreement suffer sufficient trade diversion from other existing members as a result of a potential new entrant that these "marginally worse-off" members prevent entry. This suggests a quadratic relationship between the number of members in the nearest PTA and the hazard rate. We capture this new influence with a variable NPTA (and its squared value, SQNPTA), which is the actual number of members of the nearest existing PTA (and the square of that number). We expect NPTA (SQNPTA) to be positively (negatively) related to the hazard rate. These four variables, alongside the seven variables motivated by BB, suggest 11 economic covariates to be included in our duration analysis.[17]

B. *Political and Historical Factors*

In reality, political and historical factors matter. We employ several other control variables as shifters of the hazard rate as had been used in earlier work. The Polity 2 index is a well-known measure of political freedom in a country; we employ DPolity2 as a measure of the disparity in this index between country-pairs. We expect that a wider difference in two countries' degrees of political freedom will tend to reduce the likelihood of PTA formation. In an alternative specification, we also consider measures of differences of *sub-indices* of the Polity index: differences in political regimes of two countries (democracy and autocracy scores, DDEMOC and DAUTOC, respectively), differences in the party competition in the parliament (DPARCOMP) and in the political competition in government (DPOLCOMP). Earlier work has provided evidence that PTAs are less likely to form between countries with dissimilar political systems.

We also consider historical factors that have surfaced in the literature as determinants of PTAs. There are two variables related to the length and recency of wars between two countries (CUMDURAT and DIFFYEAR, respectively). The length of wars between a country-pair (CUMDURAT) is likely to have a negative effect on the hazard rate, but the number of years since the last war (DIFFYEAR) is likely to have a positive effect on the hazard rate. Earlier work

17. As noted earlier, all of these economic variables (with the exception of relative factor endowments) are shown to influence the sequencing of PTA events in our theoretical model in the Online Theoretical Supplement. Note that DISTPTA, WPTA, NPTA and SQNPTA all account for various channels through which other PTAs influence the formation of subsequent PTAs (i.e., interdependence). Other papers that have distinguished sources of interdependence include Chen and Joshi (2010), Baldwin and Jaimovich (2012), and Baier, Bergstrand, and Mariutto (2014); the latter paper details distinctions among these three papers and EL. Also, Deltas, Desmet, and Facchini (2012) provide evidence of the effects of the nature of PTA interdependencies on bilateral trade flows.

has provided evidence that PTAs are less likely to form between countries that have had long war history and recent wars (see Egger, Egger, and Greenaway 2008, and EL).

IV. DATA

A. Data on PTAs and Associated Variables

The data set for the timing-of-PTA events was compiled for the period 1950–2006 using information from notifications to the WTO, the CIA *World Fact Book*, and individual web pages of countries.

The information on the timing of PTA membership of country-pair *ij* at time *t* (the dependent variable) as well as on four explanatory variables—$\text{WPTA}_{ij,t-5}$ (the inverse-distance-weighted PTA membership of other pairs than *ij* at time $t-5$), $\text{DISTPTA}_{ij,t-5}$ (the minimum distance of *i* and *j* to a PTA at time $t-5$) and $\text{NPTA}_{ij,t-5}$ as well as $\text{SQNPTA}_{ij,t-5}$ (the number of members in the nearest PTA to *ij* at time $t-5$ and its squared value)—are based on the information on all PTAs notified to the WTO in conjunction with information on the geographic location of countries *i* and *j* (see also EL).

B. Data on Geography and Associated Variables

Geographic information is based on the CIA *World Fact Book*. Beyond $\text{WPTA}_{ij,t-5}$ and $\text{DISTPTA}_{ij,t-5}$, such information is used to construct three time-invariant, geographical variables which are supposed to capture whether two countries are "natural" trading partners or not. DIST_{ij} is the (natural) logarithm of the great circle distance between the capitals of countries *i* and *j* (based on the great circle distance between their economic centers), BORDER_{ij} indicates whether two countries share a common land border (=1) or not (=0), and REMOTE_{ij} measures a country-pairs' remoteness from the ROW. The latter variable is the interaction of an indicator variable of 1 (0) for two countries on the same (on a different) continent, DCONT_{ij}, and a measure of "remoteness":

$$(6)\quad \text{REMOTE}_{ij} = \text{DCONT}_{ij} \times \frac{1}{2}\left[log\left(\sum_{k=1,k\neq j}^{N}\left(\text{Distance}_{ik}/(N-1)\right)\right) + log\left(\sum_{k=1,k\neq i}^{N}\left(\text{Distance}_{jk}/(N-1)\right)\right)\right].$$

C. Data on Country Size, Relative Factor Endowments, and Associated Variables

Countries' economic sizes are measured using real GDPs from Maddison (2003). $\text{GDPSUM}_{ij,t}$ is the log of the sum of two countries' real GDPs. $\text{GDPSIM}_{ij,t}$ is the log of the similarity of two countries' RGDPs, where "similarity" is measured (as traditionally) using the product of country *i*'s share of both countries' real GDPs with country *j*'s share. In order to generate variables which run up through 2006, we extrapolate the information on real GDPs from Maddison with the one on real GDPs from the World Development Indicators (2009).

Apart from GDPs, we use data from Maddison (2003) on population to construct absolute differences between two countries' log real per-capita income and its squared value, PCYDIFFA and SQPCYDIFF. As with real GDP, we extrapolate the information on population from Maddison (2003) with the one from the World Development Indicators (2009) to obtain data series that run up through 2006.

D. Data on Political and Historical Variables

We employ seven different covariates that relate to political and historical conflict factors driving PTA formation and membership. The two historical conflict variables capture the war history between two countries. DIFFYEAR measures the period elapsed since two countries *i* and *j* last saw a period of war, and CUMDURAT measures the cumulative number of days of war since 1945 (the data source is the International Institute for Strategic Studies' Armed Conflict Database, https://acd.iiss.org/). Other political variables are based on Marshall, Gurr, and Jaggers' (2013) Polity IV database, and all measure absolute differences in political characteristics between two countries *i* and *j* at time *t*. DPolity2 is an overall index of differences in political freedom. A higher Polity2 index means more political freedom, and a larger value of DPolity2 measures a bigger discrepancy in such freedom among two countries. As an alternative to DPolity2, we employ four sub-indices thereof which are again formulated as absolute differences in the scores of *i* and *j* at *t*: two countries' democracy and autocracy scores (DDEMOC, DAUTOC); the political party competition in parliament score (DPARCOMP); and the political competition in government score (DPOLCOMP).

Descriptive statistics for all variables are provided in Table 1. It is important to note that the

TABLE 1
Descriptive Statistics

Variable	Obs	Mean	SD	Minimum	Maximum
Dep. var.	463,289	0.02	0.15	0	1
TIME	463,289	2.96	0.94	0.00	4.04
PTA	463,289	0.00	0.06	0	1
YEAR	463,289	1979.04	16.65	1950	2006
Geography					
DIST	463,289	8.71	0.73	4.09	9.89
BORDER	463,289	0.02	0.13	0.00	1.00
REMOTE	463,289	1.91	3.59	0.00	9.70
Size and relative factor endowments					
GDPSUM	463,289	11.16	1.67	4.74	16.63
GDPSIM	463,289	−1.97	1.37	−9.92	−0.69
PCYDIFF	463,289	−1.25	0.89	−4.66	0.00
SQPCYDIFF	463,289	−2.36	2.90	−21.69	0.00
PTA determinants					
DISTPTA	463,289	3.44	1.81	0.17	15.21
WPTA	463,289	0.05	0.06	0.00	0.43
NPTA	463,289	10.80	3.97	7.19	18.90
SQNPTA	463,289	132.34	100.16	51.70	357.27
Historical					
DIFFYEAR	463,289	0.13	2.17	0	107
CUMDURAT	463,289	5.96	172.33	0	15, 389
Political					
DPolity2	335,450	8.12	6.49	0	20
DDEMOC	340,726	10.65	21.94	0	98
DAUTOC	340,726	10.06	21.93	0	98
DPARCOMP	340,726	8.06	22.03	0	93
DPOLCOMP	340,726	10.30	22.28	0	98
Multilateralism					
WTO Members	165,962	103.98	31.02	34	147
MTN Round	172,974	0.59	0.49	0	1
Dispute 3rd	165,962	0.39	0.49	0	1
Loss 3rd	152,011	0.26	0.44	0	1

sample size falls by about 28% from 463,289 to 335,450 (or 340,726) once we include political variables. Consequently, pseudo-R^2 values will not be directly comparable for specifications due to the sample differences. Hence, we will report results with and without the political variables.[18]

Table 2 provides a list of the 146 countries included in the sample, together with each country's number of PTA partners. It is interesting to note that several countries in Latin America—notably, Chile and Mexico—have pursued a large number of bilateral PTA agreements. By contrast, the United States has only five PTA partners; however, one reason for the low number of the United States' PTAs is the cut-off of the sample in 2006.

V. EMPIRICAL RESULTS

We discuss the main empirical results as follows. First, we discuss the empirical results for a time trend only and then include the geographic controls, economic controls, and other PTA "interdependence" determinants. Next, we address the sensitivity of the results by adding the historical and political variables. We then account for unobserved heterogeneity using fixed effects for all the specifications.

Table 3 provides the results from estimating the determinants of the instantaneous probability of leaving the initial state (No-PTA) in the interval $[t, t+dt)$ given survival up until time T (i.e., the hazard rate), based upon Equation (5). Specification 1 provides the results of estimating the hazard rate on the time trend alone. We find evidence of positive duration dependence. In the absence of economic, historical, and political covariates, this result suggests that the longer a country-pair has had no PTA, the higher the probability in any period t that it will enter a PTA. This could be attributable to the trend effects of "multilateralism" (which we address later) or even trend movements in economic, political or historical variables. The very low R^2 for this variable suggests there is room to improve explanation of the

18. The last four variables in Table 1 (multilateralism variables) will be discussed later in Section VI; they are included here for convenience.

TABLE 2
Countries and Numbers of PTAs per Country, 1950–2006

Country	Number	Country	Number	Country	Number
Afghanistan	9	Guatemala	0	Paraguay	19
Albania	7	Guinea	0	People's Rep. of China	13
Algeria	38	Guinea-Bissau	44	Peru	42
Angola	16	Haiti	2	Philippines	45
Argentina	40	Honduras	0	Poland	31
Armenia	11	Hong Kong	0	Portugal	32
Australia	3	Hungary	26	Qatar	5
Austria	27	India	41	Republic of Korea	44
Azerbaijan	15	Indonesia	41	Republic of Moldova	17
Bahrain	5	Iran	46	Republic of the Congo	5
Bangladesh	45	Iraq	38	Romania	54
Belarus	10	Ireland	27	Russia	9
Belgium	23	Israel	30	Rwanda	15
Benin	44	Italy	28	São Tomé and Príncipe	0
Bolivia	40	Jamaica	2	Saudi Arabia	5
Bosnia-Herzegovina	5	Japan	2	Senegal	7
Brazil	42	Jordan	11	Sierra Leone	0
Bulgaria	28	Kazakhstan	15	Singapore	46
Burkina Faso	7	Kenya	15	Slovakia	28
Burundi	15	Kuwait	5	Slovenia	31
Cambodia	9	Kyrgyzstan	15	Somalia	0
Cameroun	43	Laos	13	South Africa	5
Canada	4	Latvia	29	Spain	26
Cape Verde	0	Lebanon	0	Sri Lanka	41
Central African Rep.	5	Liberia	0	Sudan	49
Chad	5	Libya	49	Sweden	34
Chile	68	Lithuania	29	Switzerland	35
Colombia	40	Macedonia	12	Syria	0
Comoros	15	Madagascar	15	Tadjikistan	15
Costa Rica	1	Malawi	16	Tanzania	50
Côte d'Ivoire	7	Malaysia	41	Thailand	42
Croatia	18	Mali	7	The Gambia	0
Cuba	7	Mauritania	0	Togo	7
Czech Republic	22	Mauritius	16	Trinidad and Tobago	40
Denmark	25	Mexico	53	Tunisia	44
Djibouti	15	Mongolia	7	Turkey	31
Dominican Republic	0	Morocco	46	Turkmenistan	15
Ecuador	40	Mozambique	50	Uganda	15
Egypt	70	Myanmar	41	Ukraine	9
El Salvador	2	Nepal	4	United Arab Emirates	5
Equatorial Guinea	5	Netherlands	32	United Kingdom	26
Estonia	26	New Zealand	2	United States	5
Finland	29	Nicaragua	38	Uruguay	19
France	26	Niger	7	Uzbekistan	15
Gabon	5	Nigeria	38	Venezuela	40
Georgia	11	Norway	35	Vietnam	48
Germany	25	Oman	5	Yemen	0
Ghana	38	Pakistan	50	Zambia	15
Greece	26	Panama	1		

determinants of the timing of PTA events, which we now examine.

We next turn to Specifications 2 through 4 in Table 3 including the geographic, economic, historical, and political variables. An important result to especially note in Specifications 2 through 4 is the substantive change in the coefficient estimate for "Time-to-PTA event" (i.e., the time elapsed since 1950) and its z-statistic as compared to Specification 1. This indicates that time *per se* (reflecting the dynamic mechanism behind PTA formation and enlargement) is implicitly picking up the effect of time-varying covariates in Specification 1.

Specifications 2 through 4 confirm our expectation about the relationship between geography and the hazard rate suggested by our earlier discussion (and the underlying theoretical framework). A lower distance (DIST) between two countries i and j, sharing a common land border (BORDER), and a larger distance from the ROW (REMOTE) raise the likelihood for a

TABLE 3
Economic Determinants of Hazard Rates for Country-Pairs[a]

Explanatory Variables	Theory	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5	Spec. 6	Spec. 7
Time-to-PTA event	+	2.05***	0.61***	0.53***	0.54***	1.74***	1.57***	1.71***
		(74.56)	(33.53)	(27.75)	(28.90)	(33.14)	(28.01)	(30.11)
Geography								
DIST	−		−0.15***	−0.16***	−0.16***	−0.25***	−0.25***	−0.27***
			(−8.66)	(−8.64)	(−8.79)	(−13.92)	(−13.32)	(−14.44)
BORDER	+		0.52***	0.53***	0.51***	0.49***	0.49***	0.44***
			(6.99)	(6.69)	(6.50)	(6.42)	(6.03)	(5.48)
REMOTE	+		0.01**	0.004	0.01**	12.92***	11.83***	10.42***
			(2.07)	(0.99)	(2.29)	(12.15)	(10.22)	(9.02)
Size and relative factor endowments								
GDPSUM	+		0.13***	0.15***	0.10***	2.16***	2.24***	2.31***
			(17.12)	(17.60)	(12.14)	(58.86)	(56.70)	(57.89)
GDPSIM	+		0.16***	0.18***	0.14***	0.80***	0.81***	0.77***
			(18.36)	(17.32)	(14.22)	(32.09)	(30.51)	(28.06)
PCYDIFF	+		0.26***	0.27***	0.28***	0.40***	0.38***	0.40***
			(7.44)	(7.34)	(7.92)	(8.24)	(7.43)	(7.73)
SQPCYDIFF	−		−0.08***	−0.08***	−0.08***	−0.14***	−0.12***	−0.11***
			(−7.50)	(−7.64)	(−7.40)	(−9.79)	(−8.25)	(−7.72)
PTA determinants								
DISTPTA	−		−0.17***	−0.15***	−0.17***	−0.67***	−0.65***	−0.72***
			(−13.81)	(−11.78)	(−13.84)	(−22.35)	(−20.72)	(−23.13)
WPTA	+		5.25***	5.66***	5.39***	14.68***	14.91***	14.40***
			(42.00)	(42.52)	(41.08)	(71.48)	(68.58)	(66.37)
NPTA	+		0.41***	0.27***	0.34***	−0.16***	−0.20***	−0.24***
			(10.40)	(6.55)	(8.41)	(−3.30)	(−3.85)	(−4.72)
SQNPTA	−		−0.004***	0.00	−0.002	0.003*	0.004**	0.005***
			(−2.71)	(0.26)	(−1.46)	(1.83)	(2.32)	(2.83)
Political and historical								
DPolity2	−			−0.01***			−0.03***	
				(−7.51)			(−11.90)	
DDEMOC	−				0.032***			0.07***
					(6.38)			(11.11)
DAUTOC	−				−0.03***			−0.06***
					(−6.47)			(−8.40)
DPARCOMP	−				0.05***			0.10***
					(9.25)			(14.08)
DPOLCOMP	−				−0.06***			−0.12***
					(−7.71)			(−14.73)
DIFFYEAR	+			−0.002	−0.001		0.001	0.003
				(−0.60)	(−0.33)		(0.18)	(0.46)
CUMDURAT	−			−0.00	−0.00		0.00***	0.00**
				(−0.62)	(−0.67)		(2.60)	(2.40)
Constant		−10.82***	−10.51***	−9.33***	−9.21***	−1.56	1.75	1.66
		(−106.25)	(−34.54)	(−28.55)	(−28.52)	(−1.44)	(1.54)	(1.48)
Pseudo-R^2		0.11	0.27	0.24	0.23	0.38	0.35	0.36
Number of observations		463,289	463,289	335,450	340,726	463,289	335,450	340,726
Log-likelihood (model)		−44,840	−36,521	−32,939	−34,151	−31,019	−27,978	−28,813

Notes: There are 463,289 observations, 10,518 country-pairs and 1,560 events in specifications (1), (2), and (5); 335,450 observations, 9,920 country-pairs, and 1,511 events in specifications (3) and (6); and 340,726 observations, 9,925 country-pairs, and 1,516 events in specifications (4) and (7). The likelihood value of the constant only model is −50,207. The p value of the likelihood ratio statistics on the model is 0.

[a]z-statistics in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

pair *ij* to form or join the same PTA sooner. Specifications 2–4 also confirm that countries with larger and more similar economic sizes (GDPSUM and GDPSIM, respectively) appear to have larger gains from forming a PTA or joining the same PTA sooner. With regard to relative factor endowments proxied by PCYDIFF, larger relative factor endowment differences tend to enhance the likelihood of a PTA forming or enlarging sooner. Moreover, the negative coefficient estimate for SQPCYDIFF implies that this effect diminishes with the degree of per capita income differences, similar to results in BB.

Moreover, the results of Specifications 2 through 4 in Table 3 suggest that "existing PTAs," or "interdependence" in EL's terms (or "contagion" in terms of Baldwin and Jaimovich 2012), plays an influential role in the timing of PTA events. In line with expectations, the farther a country-pair is from its nearest other PTA (i.e., the larger is DISTPTA) the smaller are the potential gains from a PTA between two countries that is concluded sooner rather than later. The results also confirm that the probability of forming/enlarging a PTA earlier in time rises with the "degree of regionalism (or competitive liberalization)" in the ROW at that time, measured by WPTA. Specifications 2 through 4 also add the number of members in the nearest PTA of the pair linearly and quadratically (NPTA, SQNPTA). Consistent with our theoretical conjectures, we find a positive effect for the linear term of the number of members in the nearest PTA and a negative one for the quadratic term in the duration analysis.[19]

Specifications 3 and 4 also control for political and historical factors determining the hazard rate, beyond the geography, economic, and interdependence fundamentals. In both specifications, we control for the period elapsed since two countries *i* and *j* last saw a period of war (DIFFYEAR), and for the cumulative number of days of war since 1945 (CUMDURAT). In both specifications DIFFYEAR and CMDURAT are not significantly different from zero. However, we note, in particular, that the variable DIFFYEAR is highly collinear with the variable "Time-to-PTA event." Specification 3 includes one compact measure of the absolute difference in political freedom between two countries, captured by the difference in Polity IV scores (DPolity2). This measure is higher the larger is the average difference in two countries' political freedom. The results suggest that countries with more similar political systems and degrees of freedom tend to enter PTAs earlier than others. In contrast, Specification 4 use sub-indices behind the Polity IV index and condition on absolute differences of two countries' democracy and autocracy scores (DDEMOC, DAUTOC), as well as for the absolute differences in political party competition in parliament (DPARCOMP) and the political competition in government (DPOLCOMP). This specification suggests that the political variables are all relevant. Countries with different degrees of democracy (autocracy) tend to enter PTAs earlier (later) than ones with similar degrees. A greater similarity (dissimilarity) in party competition in parliament (political competition in government) tends to lead to an earlier entry in PTAs. In comparing pseudo-R^2 values, please note, as Table 1 suggests, that due to data constraints the sample sizes differ somewhat across specifications, with Specifications 3 and 4 having smaller sample sizes. Also, the sample size is about 5,000 observations larger when the Polity IV sub-indices are used in Specification 4, rather than the summary measure in Specification 3.

Specifications 5 through 7 add parameterized pairwise fixed effects to Specifications 2 through 4, respectively. The purpose is to see whether the results in Specifications 2 through 4 are biased by unobserved heterogeneity. The range of possible omitted variables is vast. In order to allow for a set of unobserved effects which may be correlated with $\mathbf{x}_{ij}(t)$, we consider introducing fixed country-pair effects. However, the introduction of fixed effects in a non-linear function is not a trivial endeavor, since the number of incidental parameters is increasing with sample size. Chamberlain (1980) shows that, for a fixed time dimension, maximum likelihood estimates of β will be inconsistent as the number of cross-sectional observations goes to infinity. Chamberlain (1980) provides an approach that eliminates the incidental parameters problem. Essentially, the unobserved effects can be eliminated by an appropriate differencing transformation. Chamberlain (1980) suggests including averages of all time-varying explanatory variables along with the original variables in the empirical models (see also Wooldridge 2010).

Specifications 5 through 7 report the results using the Chamberlain-Wooldridge-type model. For brevity, we do not report coefficient estimates

19. In the context of the "domino theory" in Baldwin (1995), an increase in the number of members of the nearest PTA causes a rise in demand for membership of non-members in this agreement, tending to increase the hazard rate for *ij*. However, Baldwin's domino theory assumes an infinitely elastic supply of membership by a PTA. As the number of members of a PTA increases, there are incumbent members whose utility falls when a new member is added, especially the members of the PTA most distant from the core. Every time a new member is added, the utility from the PTA of the (marginal) "worse-off" member declines. It can be shown in our simple Krugman-like model (in the Theoretical Supplement) that at some point the marginal worse-off member's utility declines from new members, dampening the average utility gain of members in the PTA. This finite-elasticity-of-membership supply implies theoretically a quadratic relationship between the number of members of the nearest PTA (*NPTA*) and the hazard rate for pair *ij*. See our Theoretical Supplement for an illustration of this argument.

for fixed effects; moreover, recall that DIST and BORDER are time-invariant (and so are not demeaned). First, unsurprisingly the pseudo-R^2's increase, from 23–27% to 35–38%. Second, Specifications 5–7 reveal that most of the coefficient estimates maintain the same qualitative effects as found in the previous specification. In particular, PTA economic determinants DIST, BORDER, REMOTE, GDPSUM, GDPSIM, PCYDIFF, SQPCYDIFF, DISTPTA, and WPTA all retain their expected coefficient signs and their coefficient estimates are statistically significant. However, NPTA and SQNPTA change signs unexpectedly; this could be attributable to multicollinearity. Third, the large change in quantitative values of the coefficient estimates should not come as a surprise. The new coefficient estimates are based upon only time variation of the variables; the coefficient estimates for DIST and BORDER are unchanged because only those two variables are not time-demeaned.[20]

In qualitative terms, virtually all of the coefficient estimates of the political and historical variables are unaffected, though most change in quantitative terms because of the time-demeaning nature of the fixed effects. Note that DIFFYEAR's coefficient estimate turns positive when including the fixed effects in Specification 7 (compare Specifications 4 and 7), but remains economically and statistically insignificant. Also, CUMDURAT turns statistically significant; however, the coefficient estimates are not economically different from zero.[21] However, we need to bear in mind that CUMDURAT is relatively time-invariant and the difference in the parameter on it from Specifications 3 and 4 to 6 and 7, respectively, may flow from multicollinearity with the pairwise fixed effects. Even though the pseudo-R^2 of the models rises if we add fixed effects, Specifications 2 through 4 appear to work reasonably well (when remembering the large amount of zeros in the dependent variable). Moreover, two advantages of Specifications 2 through 4 relative to 5 through 7 are that: (1) fixed effects cannot be estimated precisely in duration models, and (2) they are unknown whenever predictions are supposed to be made out-of-sample (i.e., high-level assumptions have to be made regarding their changes).

20. For instance, typical gravity equations of international trade have similar differences for GDP variables' coefficient estimates if variables are time-demeaned.

21. A possible reason for this positive correlation might be that countries with a higher probability of war (a longer war history) have higher opportunity costs from a war the larger are the trade gains, making PTA formation more likely (see Martin, Mayer, and Thoenig 2012).

VI. PREDICTIVE ANALYSIS

In this section, we examine the ability of the model to predict the actual *year* of the formation (or enlargement) of a PTA between each pair of countries, as well as for various "windows" leading up to PTA events. The section has four parts. The first part addresses the in-sample and out-of-sample predictive power of the model using the main specifications presented in Section V. The second part evaluates the predictive power of the model after accounting for multilateralism, but using a much smaller sample (due to data availability of multilateralism variables). The third part examines the predictive power of the model for the time-to-PTA events of the CUSFTA, the NAFTA, and the European Community's formation and subsequent enlargements. The fourth part examines whether the model's ten most likely time-to-PTA events in the post-sample period (2007–2013) have actually occurred as predicted.

A. Predicting the Actual Years of PTA Formation or Enlargements

In this section, we examine the predicted timings—in particular, even the predicted *year*—of *all PTA events*. Because predicting the specific year is a demanding objective, we also consider predicting an event within time "windows" of up to 10 years prior to the event. It is important to again contrast our duration analysis with previous analyses predicting the existence of a PTA in a given year. In the latter studies, predictions can occur in the years prior to the PTA's entry into force, in the year of the PTA's entry into force, or in the years following the PTA's entry into force. By contrast, our analysis can only predict the *actual year* of the PTA's entry into force, or a designated window leading up to that year. Hence, predictions from our analysis cannot be compared to previous non-duration-analysis-based predictions.

Table 4 provides a summary of the accuracy for predicting the timing of each bilateral PTA event using Specifications 1 through 7 from Table 3. It is important to note that our *preferred* specifications for predicting events are Specifications 2 through 4 for the reasons mentioned at the end of the previous subsection. In order to map the continuous linear index

TABLE 4

Predicting the Timing of the PTA Events Covered[a]

Predicted Events	Specification 1		Specification 2		Specification 3		Specification 4		Specification 5		Specification 6		Specification 7	
	Number	% of all PTA Events	Number	% of all PTA Events	Number	% of all PTA Events	Number	% of all PTA Events	Number	% of all PTA Events	Number	% of all PTA Events	Number	% of all PTA Events
Base case														
Total number PTA events	1,560	100	1,560	100	1,560	100	1,560	100	1,560	100	1,560	100	1,560	100
In the same year as the event occurred	209	13	320	21	402	26	379	24	551	35	616	39	601	39
In the same year as the event occurred or up to 1 year prior to that	353	23	384	25	468	30	434	28	651	42	713	46	690	44
In the same year as the event occurred or up to 2 years prior to that	431	28	416	27	517	33	477	31	744	48	818	52	783	50
In the same year as the event occurred or up to 3 years prior to that	531	34	541	35	635	41	600	38	840	54	901	58	868	56
In the same year as the event occurred or up to 4 years prior to that	546	35	551	35	646	41	616	39	900	58	950	61	924	59
In the same year as the event occurred or up to 5 years prior to that	678	43	640	41	710	46	679	44	971	62	991	64	968	62
In the same year as the event occurred or up to 10 years prior to that	853	55	752	48	891	57	857	55	1,121	72	1,084	69	1,076	69
Predictions using data from 1970 onwards only														
Total number PTA events	1,517	100	1,517	100	1,517	100	1,517	100	1,517	100	1,517	100	1,517	100
In the same year as the event occurred	209	14	337	22	408	27	373	25	742	49	769	51	731	48
In the same year as the event occurred or up to 1 year prior to that	353	23	394	26	477	31	435	29	855	56	883	58	843	56
In the same year as the event occurred or up to 2 years prior to that	431	28	424	28	526	35	478	32	916	60	940	62	912	60
In the same year as the event occurred or up to 3 years prior to that	531	35	550	36	643	42	607	40	995	66	1,033	68	997	66
In the same year as the event occurred or up to 4 years prior to that	546	36	569	38	655	43	625	41	1,021	67	1,067	70	1,060	70
In the same year as the event occurred or up to 5 years prior to that	678	45	647	43	731	48	692	46	1,062	70	1,111	73	1,106	73
In the same year as the event occurred or up to 10 years prior to that	853	56	762	50	918	61	871	57	1,102	73	1,156	76	1,168	77
Regression only run on data up to 2000 and out-of-sample predictions for 2001 to 2006														
Total number PTA events	284	100	284	100	284	100	284	100	284	100	284	100	284	100
In the same year as the event occurred	9	3	175	62	188	66	178	63	97	34	122	43	131	46
In the same year as the event occurred or up to 1 year prior to that	15	5	183	64	196	69	185	65	98	35	123	43	132	46

TABLE 4
Continued

Predicted Events	Specification 1 Number	Specification 1 % of all PTA Events	Specification 2 Number	Specification 2 % of all PTA Events	Specification 3 Number	Specification 3 % of all PTA Events	Specification 4 Number	Specification 4 % of all PTA Events	Specification 5 Number	Specification 5 % of all PTA Events	Specification 6 Number	Specification 6 % of all PTA Events	Specification 7 Number	Specification 7 % of all PTA Events
In the same year as the event occurred or up to 2 years prior to that	42	15	194	68	208	73	198	70	106	37	131	46	140	49
In the same year as the event occurred or up to 3 years prior to that	95	33	207	73	222	78	217	76	107	38	132	46	141	50
In the same year as the event occurred or up to 4 years prior to that	109	38	217	76	232	82	227	80	108	38	133	47	142	50
In the same year as the event occurred or up to 5 years prior to that	112	39	218	77	232	82	228	80	108	38	133	47	142	50
Regression only run on data up to 1989 and out-of-sample predictions for 1990 to 2006														
Total number PTA events	1,037	100	1,037	100	1,037	100	1,037	100	1,037	100	1,037	100	1,037	100
In the same year as the event occurred	144	14	231	22	244	24	251	24	282	27	314	30	302	29
In the same year as the event occurred or up to 1 year prior to that	222	21	263	25	277	27	274	26	317	31	343	33	331	32
In the same year as the event occurred or up to 2 years prior to that	322	31	316	30	333	32	328	32	337	32	361	35	347	33
In the same year as the event occurred or up to 3 years prior to that	337	32	331	32	349	34	342	33	338	33	361	35	347	33
In the same year as the event occurred or up to 4 years prior to that	469	45	346	33	366	35	355	34	338	33	361	35	347	33
In the same year as the event occurred or up to 5 years prior to that	474	46	346	33	366	35	355	34	338	33	361	35	347	33
In the same year as the event occurred or up to 10 years prior to that	653	63	346	33	366	35	355	34	338	33	361	35	347	33

[a]Underlying cut-off values minimize a quadratic loss function of predicting binary events by the complementary log-log model. For the base case, the cut-off for specification 1 is 0.038, for specifications 2, 3, and 4 it is 0.009, for specification 5 it is 0.023, for specifications 6 it is 0.035, and for specification 7 it is 0.033. For the predictions using data from 1970 onwards only, the cut-off for specification 1 is 0.039, the cut-off for specification 2 is 0.011, for specifications 3 and 4 it is 0.01, for specification 5 it is 0.054, for specification 6 it is 0.056, and for specification 7 it is 0.051. For the predictions using data up to 2000, the cut-off for specification 1 is 0.006, for specifications 2 and 3 it is 0.011, for specification 4 it is 0.009, for specification 5 it is 0.09, for specification 6 it is 0.08, and for specification 7 it is 0.086. For the predictions using data up to 1989, the cut-off for specification 1 is 0.002, for specifications 2 and 3 it is 0.014, for specification 4 it is 0.016, for specification 5 it is 0.041, for specification 6 it is 0.056, and for specification 7 it is 0.063.

behind the hazard rate or the hazard rate itself into discrete event predictions, we must utilize a cut-off probability. Various methods to select endogenously the cut-off exist, including Sensitivity-Specificity analysis (see Baier, Bergstrand, and Mariutto 2014) or a quadratic loss function akin to Matthew's Correlation Coefficient (see Bergstrand and Egger 2013). In the latter approach used here, the cut-off probability which distinguishes zeros from ones for the predicted PTA indicator is chosen so as to minimize the associated loss function which trades off correct and incorrect unitary and zero predictions (notice that the cut-off probability will not be at 50%, since the PTA indicator data in panel form contain numerous zeros relative to the ones).

Table 4 is organized horizontally in seven blocs (referring to Specifications 1 through 7) and vertically in four blocs. The bloc at the top represents the base case directly associated with Specifications 1–7 as reported in Table 3. The other three blocs are based on parameter estimates akin but not identical to the ones in Table 3 (we suppress presenting these parameter estimates for the sake of brevity). The results from the second bloc are based on Specifications 1–7 from Table 3 that are rerun only using data from 1970 (rather than from 1950) onwards. This set of results tells us how much of the explanatory and predictive power is due to letting the process run from a time period which is relatively distant in time from most of the PTA events in the data. The third bloc of results runs Specifications 1–7 using data from 1950 to only 2000 (rather than 2006), but predicting events *out-of-sample* for the years 2001–2006. The last bloc of results runs Specifications 1–7 using data from 1950 to only 1989 (rather than 2006), but predicting events *out-of-sample* for the years 1990 through 2006. The last two blocs are meant to assess generally the out-of-sample prediction quality of the models near-term versus long-term, respectively.

With regard to the benchmark model predictions at the top of Table 4, we see that Specifications 1–4 predict various percentages of all 1,560 events covered within the year or up to ten years prior to the event. About 13–26% of the events are predicted within the same year that they had occurred. Among the four specifications, Specification 3 performs relatively best. It predicts 26% of the events within the same year that the actual PTA membership occurred, 30% in the same year or up to 1 year prior to actual PTA membership, and 33% within the same year or up to 2 years prior to actual PTA membership, respectively. In comparison, Specification 1 only predicts 13% of the events within the same year that the actual PTA membership occurred, 23% in the same year or up to 1 year prior to actual PTA membership, and 28% within the same year or up to 2 years prior to PTA membership, respectively.

Not surprisingly, Specifications 5 to 7, which include parameterized fixed country-pair effects, perform even better in predicting PTA membership events. These specifications predict 69–72% of the events within 10 years prior to actual PTA membership. Among those, Specification 5 works best for the 10-year window and Specification 6 works best for a window of up to 3 years, explaining 39% of the events within the same year that the actual PTA membership occurred, 46% in the same year or up to 1 year prior to actual PTA membership, and 52% within the same year or up to 2 years prior to the actual event. In the subsequent discussion, we mainly focus on Specifications 2 to 4 since they will turn out to outperform Specifications 5 to 7 in terms of *out-of-sample* predictions and also exclude fixed effects (which complicates out-of-sample predicting).

In the second vertical bloc, using data from 1970 rather than from 1950 onwards leads to a better predictive performance for all specifications. This is intuitive, since the density of PTA events is relatively much higher during the more recent decades of the data than in the first ones. However, there is not a material difference in predictive power between the two blocs.

With regard to out-of-sample predictions of PTA events in the third bloc, Specification 3 tends to work best. Note that in the third bloc we only forecast events in the 6 years after the end of the estimation sample in 2000 (2001 through 2006) and we forecast the years with relatively many PTA events. We predict 66% of the events within the same year that the actual PTA membership occurred, 69% in the same year or up to 1 year prior to actual PTA membership, 73% of all 284 events within the same year or up to 2 years prior to the actual event, and 82% of all 284 actual PTA events in 2001–2006 within up to 5 years prior to their occurrence. This near-term out-of-sample performance of Specification 3 dominates the predictions of Specification 1, which uses only the time trend. No other study has provided out-of-sample predictions of PTA timings. These results suggest a strong predictive power of our model relative to the simple time trend *near term*.

However, a different outcome results for long-term forecasting of PTA events, shown in the fourth vertical bloc. Estimating the models from 1950 through 1989 and then predicting all events that had occurred between 1990 and 2006, Specification 3 predicts only 24% of the events within the same year that the actual PTA membership occurred, 27% in the same year or up to 1 year prior to actual PTA membership, and 35% within the same year or up to 10 years prior to the actual event. Not surprisingly, the previous vertical bloc in Table 4 shows a much better performance of Specification 3 to predict PTA events than in the last vertical bloc. The reasons are that, in contrast to the fourth bloc, in the third bloc we only forecast events in the 6 years after the end of the estimation sample in 2000 (2001 through 2006) and we forecast the years with relatively many PTA events. Although the predictive power is lower than previously, note that our model still outperforms out-of-sample the model with only a time trend (Specification 1) when forecasting the specific year of the event or a window up to 3 years preceding the event. Yet, for windows of up to 4, 5, or 10 years prior to the event, the model with only a time trend has better predictive power. Note, however, that the model itself is only estimated using data through 1989, and consequently includes only one-third of the events as in the entire sample (523 events for the fourth bloc versus 1,276 events for the third bloc).[22]

In sum, even relatively parsimonious specifications without fixed effects perform quite well in predicting PTA events in- *or* out-of-sample, as long as the estimates are based on data with a sufficient number of PTA events *and* if the out-of-sample forecast period is not too long.

22. Note that with out-of-sample predictions a decision has to be made with regard to the values assumed for covariates determining the time-to-PTA events. Moreover, with parameterized fixed country-pair effects, one has to decide whether to keep those effects fixed outside of the sample period and, if not, how to adjust them. In Table 4, we use the covariates as they are observed even outside of the sample period. However, it should be noted that keeping them fixed at the end of the estimation sample period does not have a substantive impact on the predictions. The reason appears to be that the covariates determine well the cross-sectional variation in hazard-rate base levels, and the time trend predicts well the cross-sectional heterogeneity in the timing-to-PTA events relative to the end of the sample period. For instance, let us compare the results for a model that is the same as Specification 3 in Table 4 for the out-of-sample predictions from 1990 to 2006 for the PTA events in those years, but keeping the covariates constant at their 1989 levels and only letting time change. In this setting, the specification predicts up to 43% (47%) of the 1,037 PTA events between 1990 and 2006 in the same year or up to 5 (10) years prior to the actual events. The corresponding number in Table 4, where the covariates change as observed in the out-of-sample period, is 35% (35%) for the same precision window.

B. *Robustness to Multilateralism's Effects*

As mentioned earlier, the time trend in the econometric model could likely capture overall trends in multilateral liberalization. The influence of multilateralism on PTA formation in terms of empirical work started with Mansfield and Reinhardt (2003). The focus of that study—and subsequent empirical studies—has been on four variables related to the influence of multilateralism potentially explaining PTA formations. Baldwin and Jaimovich (2012) incorporated these four variables in their predictions of PTAs. Gradeva and Jaimovich (2014) reexamined the original Mansfield and Reinhardt (2003) findings, focusing largely on the robustness of the original four Mansfield-Reinhardt multilateralism variables.

The first of the four variables is WTOMEMBERS, the number of contracting parties to the GATT/WTO (in the previous period). The argument is that an increasing number of parties reduces each party's leverage over the progress and path of multilateral liberalization, making it more difficult to conclude such rounds. Country-pairs may provide an alternative means for countries to pursue trade liberalization to avoid adverse implications of slow multilateral liberalization, that is, more PTAs. Hence, WTOMEMBERS is expected to have a positive impact on the hazard rate of PTA events.

The second variable is MTNROUND, a dummy variable indicating if a GATT or WTO multilateral trade negotiation (MTN) round is in place in the current year (1), or not (0). The expected sign on this variable is ambiguous due to two alternative views. One view is that countries' governments may believe they can increase their bargaining power in a current MTN round if they form PTAs; this suggests a positive impact of MTNROUND on the hazard rate. A second view is that PTAs and multilateral liberalizations are complements, cf., Freund (2000). Hence, if a MTN round has been completed (hence, the dummy is zero), the likelihood of a PTA is higher; this suggests a negative impact of MTNROUND on the hazard rate. Baldwin and Jaimovich (2012) found a negative but statistically insignificant effect of MTNROUND on the probability of a PTA. However, Gradeva and Jaimovich (2014) found a negative and statistically significant effect, if the sample was constrained to 1980–2007. Moreover, Fugazza and Robert-Nicoud (2011) show that the frequency in which the United States grants immediate duty-free access to PTA partners is larger for goods in which multilateral tariffs have had the largest cuts. Based on these various considerations, we expect a negative coefficient estimate.

The third variable is DISPUTE3rdPARTY, a dummy variable indicating if either *i* or *j* is a complainant or defendant in a new GATT/WTO dispute with a third party in the previous year (1), or not (0). The argument is that a country that has entered a dispute with a third party may have an incentive to form a PTA to gain leverage in the dispute. Hence, DISPUTE3rdPARTY is likely to have a positive impact on the hazard rate.

The fourth variable is LOST3rdPARTY, a dummy variable indicating if either *i* or *j* lost a GATT/WTO dispute with a third party 3 years prior (1), or not (0). The argument is that a country that recently lost a dispute is at risk for securing market access through the multilateral system. This may encourage incentives to form PTAs. Hence, LOST3rdPARTY is likely to be positively related to the hazard rate.

Consequently, we re-estimated our models above to add these four multilateralism variables to see if our results change materially, both in terms of model explanatory power as well as predictive power. However, we note one important restriction associated with this robustness analysis, and therefore present the associated results separately. Due to data availability, the overlap in data on the multilateralism variables from Gradeva and Jaimovich (2014) and our data set is narrow. As noted above, in our Specifications (3) and (4) without fixed effects ((6) and (7) with fixed effects), the sample size is either 335,450 observations (for Specifications (3) and (6)) or 340,726 observations (for Specifications (4) and (7)). Adding the multilateralism variables reduces our sample size to only 141,096 or 141,523 observations, respectively. The reason is that the data set in Gradeva and Jaimovich (2014) has considerably fewer observations than ours in the first 30 years of their sample (1948–1978). Thus, while we consider it worthwhile to see the sensitivity of the earlier regression results and predictions to including multilateralism variables, the results are *not directly comparable* due to the difference in samples.

Table 5 provides the empirical results for Specifications (3), (4), (6), and (7) now including the multilateralism variables; these are labeled accordingly Specifications (3A), (4A), (6A), and (7A), respectively. Several points are worth noting; for brevity we compare first Specification (3) in Table 3 to Specification (3A) in Table 5. First, the coefficient estimates for the four multilateralism variables are all statistically significant. Moreover, three of the four coefficient estimates' signs are as expected; only LOST3rdPARTY has a coefficient estimate sign different from the expectation. Second, we note that the coefficient estimate for the time trend now becomes trivially small, though still statistically significant. This result is consistent with our earlier conjecture that the time trend may be reflecting overall trends in multilateral trade liberalization. Third, despite the presence of the multilateralism variables causing the time trend's effect to become trivially small, their presence has little effect on the other variables' coefficient estimates in Specification (3). The coefficient estimates for the three geography and the four economic size and similarity and relative factor endowments variables are qualitatively the same. However, coefficient estimates for DISTPTA, NPTA, and SQNTA change sign. Yet, one must keep in mind that the sample is considerably different from that in the main empirical specifications, which could also explain the changes. Fourth, the changes just discussed largely carry over to the other specification comparisons, and so for brevity are not discussed.

Table 6 provides the predictions for Specifications (3A), (4A), (6A), and (7A), similar to those for comparable specifications in Table 4. The main point to note is that for Specifications (3A) and (4A) the predictive power of the model is enhanced somewhat using specifications incorporating the multilateralism variables. However, once again a caveat for any comparison is the different samples used, and hence the results are effectively not comparable. For Table 6, the results are influenced by a shorter sample for a period with a higher density of PTAs and that consequently influences the predictive power of the model.

C. Predictions of CUSFTA, NAFTA, and the European Union's Formation and Enlargements

Two of the most well-known PTAs are the NAFTA—following in the footsteps of the CUSFTA—and the European Union (EU), which began as the EEC in 1958. Since we have data going back to 1950, it would be useful to know how well our model, in retrospect, predicted the timing of these events. As apparent by now, our model explains and predicts bilateral events. So an additional evaluation of the successfulness of the model is determining the

TABLE 5
Multilateralism Determinants of Hazard Rates for Country-Pairs[a]

Explanatory variables	Theory	Spec. 3A	Spec. 4A	Spec. 6A	Spec. 7A
Time-to-PTA event	+	−0.08***	−0.09***	−1.30***	−1.26***
		(−2.70)	(−2.84)	(−9.19)	(−8.99)
Geography					
DIST	−	−0.06***	−0.07***	−0.11***	−0.11***
		(−2.60)	(−2.73)	(−4.19)	(−4.23)
BORDER	+	0.64***	0.62***	0.65***	0.60***
		(5.51)	(5.42)	(5.51)	(5.10)
REMOTE	+	0.03***	0.03***	3.38**	3.78**
		(5.30)	(5.66)	(2.21)	(2.48)
Size and relative factor endowments					
GDPSUM	+	0.06***	0.05***	0.93***	0.84***
		(4.93)	(3.79)	(13.57)	(12.05)
GDPSIM	+	0.09***	0.08***	0.64***	0.55***
		(6.34)	(5.47)	(11.28)	(9.66)
PCYDIFF	+	0.17***	0.20***	0.15**	0.18***
		(3.71)	(4.41)	(2.14)	(2.67)
SQPCYDIFF	−	−0.05***	−0.07***	−0.02	−0.04**
		(−3.41)	(−4.97)	(−0.89)	(−1.98)
PTA determinants					
DISTPTA	−	0.14***	0.15***	0.17***	0.19***
		(10.71)	(11.03)	(4.35)	(4.99)
WPTA	+	2.68***	2.64***	10.33***	10.24***
		(15.95)	(15.84)	(32.99)	(32.86)
NPTA	+	−8.00***	−8.10***	−5.85***	−5.94***
		(−56.04)	(−56.80)	(−40.03)	(−40.60)
SQNPTA	−	0.23***	0.23***	0.14***	0.15***
		(52.47)	(53.25)	(31.84)	(32.37)
Political and historical					
DPolity2	−	−0.003		−0.02***	
		(−1.11)		(−5.42)	
DDEMOC	−		−0.01*		0.003
			(−1.88)		(0.37)
DAUTOC	−		0.04***		−0.003
			(4.70)		(−0.26)
DPARCOMP	−		0.006		0.05***
			(0.78)		(5.89)
DPOLCOMP	−		−0.03***		−0.06***
			(−3.80)		(−5.69)
DIFFYEAR	+	−0.008*	−0.007*	0.002	0.003
		(−1.78)	(−1.72)	(0.15)	(0.24)
CUMDURAT	−	−0.00*	−0.00*	−0.00	−0.00
		(−1.75)	(−1.75)	(−0.11)	(−0.05)
Multilateralism					
WTO Members	+	0.43***	0.44***	0.43***	0.43***
		(70.78)	(71.38)	(65.86)	(66.27)
MTN Round	−	−1.14***	−1.17***	−0.72***	−0.75***
		(−11.75)	(−12.11)	(−7.28)	(−7.64)
Dispute 3rd Party	+	0.19***	0.21***	0.15***	0.15***
		(5.51)	(6.30)	(3.71)	(3.82)
Lost 3rd Party	+	−0.17***	−0.18***	−0.19***	−0.21***
		(−4.87)	(−5.11)	(−4.11)	(−4.70)
Constant		7.58***	8.01***	62.57***	62.45***
		(14.68)	(15.57)	(40.78)	(40.64)
Pseudo-R^2		0.44	0.44	0.49	0.49
Number of observations		141,096	141,523	141,096	141,523
Log-likelihood (model)		−14,730	−14,816	−13,427	−13,536

[a]z-statistics in parentheses. There are 141,096 observations, 6,625 country-pairs and 894 events in specification (3A) and (6A), and 141,523 observations, 6,625 country-pairs and 894 events in specifications (4A) and (7A).

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 6
Predicting the Timing of the PTA Events Covered with Multilateralism[a]

Predicted Events	Specification 3A		Specification 4A		Specification 6A		Specification 7A	
	Number	% of all PTA Events	Number	% of all PTA Events	Number	% of all PTA Events	Number	% of all PTA Events
Base case								
Total number PTA events	1,560	100	1,560	100	1,560	100	1,560	100
In the same year as the event occurred	702	45	706	45	856	55	845	54
In the same year as the event occurred or up to 1 year prior to that	715	46	720	46	880	56	870	56
In the same year as the event occurred or up to 2 years prior to that	757	49	748	48	932	60	926	59
In the same year as the event occurred or up to 3 years prior to that	802	51	800	51	953	61	965	62
In the same year as the event occurred or up to 4 years prior to that	823	53	807	52	959	61	981	63
In the same year as the event occurred or up to 5 years prior to that	901	58	902	58	975	63	999	64
In the same year as the event occurred or up to 10 years prior to that	995	64	1,022	66	999	64	1,047	67
Predictions using data from 1970 onwards only								
Total number PTA events	1,517	100	1,517	100	1,517	100	1,517	100
In the same year as the event occurred	746	49	746	49	843	56	838	55
In the same year as the event occurred or up to 1 year prior to that	761	50	759	50	872	57	865	57
In the same year as the event occurred or up to 2 years prior to that	781	51	779	51	887	58	879	58
In the same year as the event occurred or up to 3 years prior to that	825	54	823	54	948	62	937	62
In the same year as the event occurred or up to 4 years prior to that	857	56	855	56	1,068	70	1,065	70
In the same year as the event occurred or up to 5 years prior to that	905	60	903	60	1,092	72	1,086	72
In the same year as the event occurred or up to 10 years prior to that	993	65	991	65	1,129	74	1,124	74
Regression only run on data up to 2000 and out-of-sample predictions for 2001 to 2006								
Total number PTA events	284	100	284	100	284	100	284	100
In the same year as the event occurred	153	54	45	16	87	31	58	20
In the same year as the event occurred or up to 1 year prior to that	171	60	60	21	90	32	64	23
In the same year as the event occurred or up to 2 years prior to that	213	75	96	34	100	35	88	31
In the same year as the event occurred or up to 3 years prior to that	257	90	276	97	102	36	121	43
In the same year as the event occurred or up to 4 years prior to that	258	91	279	98	103	36	122	43
In the same year as the event occurred or up to 5 years prior to that	260	92	282	99	103	36	122	43
Regression only run on data up to 1989 and out-of-sample predictions for 1990 to 2006								
Total number PTA events	1,037	100	1,037	100	1,037	100	1,037	100
In the same year as the event occurred	498	48	482	46	509	49	520	50
In the same year as the event occurred or up to 1 year prior to that	512	49	504	49	526	51	554	53
In the same year as the event occurred or up to 2 years prior to that	538	52	532	51	529	51	583	56
In the same year as the event occurred or up to 3 years prior to that	539	52	573	55	531	51	624	60
In the same year as the event occurred or up to 4 years prior to that	539	52	579	56	531	51	667	64
In the same year as the event occurred or up to 5 years prior to that	539	52	628	61	531	51	716	69
In the same year as the event occurred or up to 10 years prior to that	539	52	731	70	531	51	780	75

[a]Underlying cut-off values minimize a quadratic loss function of predicting binary events by the complementary log-log model. For the base case, the cut-off value for specification 3A is 0.002, for specification 4A it is 0.001, for specification 6A it is 0.051, and for specification 7A it is 0.033. For the predictions using data from 1970 onwards only, the cut-off for specifications 3A and 4A is 0.001, and for specifications 6A and 7A it is 0.01. For the predictions using data up to 2000, the cut-off for specification 3A is 0.016, for specification 4A it is 0.001, for specification 6A it is 0.097, and for specification 7A it is 0.015. For the predictions using data up to 1989, the cut-off for specification 3A is 0.013, for specification 4A it is 0.001, for specification 6A it is 0.066, and for specification 7A it is 0.004.

clustering of the bilateral events around the plurilateral events.

We divide our analysis here into three parts. First, we examine the prediction of the original CUSFTA, which began in 1989. This constitutes the prediction of one (bilateral) event. Second, we examine the prediction of NAFTA in 1994. In this case, we are predicting two events: a Mexico-Canada event and a Mexico–U.S. event. Third, we examine the predictions associated with the formation of the EU and its subsequent enlargements. Thus, the first 10 events are the bilateral pairings among Belgium (which, for data reasons, includes Luxembourg; see earlier), the Netherlands, Germany, France, and Italy, which comprise the original EEC membership. We will then discuss the predictive power of the model for each of the seven subsequent enlargements of the EU.[23]

Table 7 will be helpful in organizing the discussion. First, we discuss CUSFTA. While CUSFTA officially began in 1989, it is important to note that the foundation for CUSFTA was in the Canadian–United States Automobile Trade Agreement, which was signed in 1965 to facilitate free Canadian–U.S. trade in autos and auto parts. Going further back historically, during the Great Depression of the 1930s following the isolationism of the world economy with rampant tariff escalation, Canada and the United States started reducing tariffs under a bilateral agreement. However, the post-World War II environment of multilateral liberalization dominated the 1950s, 1960s, and 1970s, so that little attention was given in Canada and the United States to a bilateral free trade agreement. The imbalance in macroeconomic policies of the 1980s along with expansion of the EEC provided impetus so that CUSFTA discussions began in 1985 and concluded with CUSFTA entering into force in 1989. Our model predicted CUSFTA in 1976, which we note is halfway between the start of the Canada–U.S. Auto Pact and CUSFTA's year of entry into force.

Second, we discuss NAFTA. Just as the path to NAFTA began with CUSFTA, the path to NAFTA started earlier between Mexico and the United States than between Mexico and Canada. The 1980s saw structural economic reforms beginning in Mexico. In 1985, the United States signed with Mexico the Understanding on Subsidies and Countervailing Duties, a substitute for Mexican participation in the subsidies code of the GATT. In 1987, Mexico and the United States signed the Framework of Principles and Procedures for Consultation Regarding Trade and Investment Relations, which established an agenda for bilateral trade and investment negotiations. In 1989, the two countries signed an Understanding Regarding Trade and Investment Facilitation Talks. Thus, while Mexican–U.S.

TABLE 7
Prediction of CUSFTA, NAFTA, and EU Formation and Enlargements

Country	Predictions	Actual Formation
CUSFTA		
Canada–United States	1/1 from 1976 to 1989	1989
NAFTA		
Canada–United States–Mexico	1/2 from 1978 to 1993	
	2/2 in 1994	1994
EU		
EU foundation	4/10 from 1950 to 1957	
	6/10 in 1958	1958
First EU enlargement	3/15 from 1950 to 1972	
	5/15 in 1973	1973
Second EU enlargement	1/8 from 1950 to 1977	
	8/8 from 1978 onwards	1981
Third EU enlargement	2/18 from 1950 to 1960	
	4/18 from 1961 to 1972	
	5/18 from 1973 to 1977	
	18/18 from 1978 onwards	1986
Fourth EU enlargement	3/33 from 1950 to 1959	
	4/33 in 1960	
	10/33 in 1961	
	13/33 from 1962 to 1975	
	14/33 in 1976	
	15/33 in 1977	
	30/33 in 1978	
	31/33 in 1979	
	32/33 in 1980	
	31/33 in 1981	
	32/33 in 1982	
	33/33 from 1983 onwards	1995
Fifth EU enlargement	54/112 in 1990	
Note:	108/112 in 1991	
We do not have data for Cyprus and Malta and many data are missing before 1990.	103/112 in 1992 105/112 in 1993 112/112 from 1994 onwards	2004
Sixth EU enlargement	26/36 in 1990	
Note:	35/36 in 1991	
Data are missing for Czech	27/36 in 1992	
Republic, Hungary, Poland, and	32/36 in 1993	
Slovakia	36/36 from 1994 onwards	2007
Seventh EU enlargement	23/23 from 1990 onwards	2013

23. For all these predictions, we used Specification 4 from Table 3; similar results were obtained using Specification 3.

bilateral liberalization initiatives lagged behind Canadian-U.S. initiatives, the former started as early as 1985. In Table 7, the 1/2 (meaning "1 out of 2") refers to Mexico–United States; our model predicts the Mexican–U.S. PTA starting as early as 1978. By contrast, Canadian–Mexican agreements arose more slowly, with ten minor accords signed in 1990. Our model predicted the Canadian–Mexican PTA in 1994—the year it actually went into force. Moreover, it is interesting to note that the year that the model predicted *both* a Mexican–U.S. PTA and a Mexican–Canadian PTA was 1994 (i.e., 2/2 in 1994 in Table 7), the year NAFTA actually began.

Our third part—which is more extensive than the first two parts combined—is an analysis of the (in-sample) predictive ability of the model for the formation of the EU (termed in 1958 the EEC) and its seven subsequent enlargements.[24] Table 7 reports comprehensively the predictions of the model (in column 2) and the actual formation years (in column 3). A detailed analysis of *every row* is beyond the scope of this paper due to the eight rounds of activity; however, we will summarize the key implications using the last row of data for each of the eight rounds (the formation and seven enlargements). We begin with the formation of the EU; the Treaty of Rome went into effect in 1958. As noted above, Belgium represents Belgium and Luxembourg; hence, we have five original EEC countries and ten non-direction country-pairs (10 = [5 x 4]/2). As shown in Table 7, our model predicts *six of the ten* original EU country-pairs in 1958, the *actual* year of entry into force. Based upon economic size, proximity, political similarity, and the interdependence variables in our model, it is likely that the other four pairs would have been predicted for later years, but the data set's construction precludes that as discussed earlier. It is also possible that our historical conflict variables' influence contributed to predicting the other four country-pairs PTA events later.

We now discuss each of the seven enlargements. The first enlargement in 1973 added Denmark, Ireland, and the United Kingdom. Five of the 15 bilateral events were predicted in 1973. Likely because of (West) Germany's economic size, three of these five pairs were Germany with the three new EU partners. Once again, based upon economic size, proximity, political similarity, and the interdependence variables in our model, it is likely that the other ten pairs would have been predicted for later years, but the data set's construction precludes that. Also, it is possible again that our historical conflict variables' influence contributed to predicting the other ten country-pairs PTA events later. The second enlargement in 1981 added Greece. The model predicted all eight country-pair events for Greece with the other eight members starting in 1978, only 3 years prior to the events. The third enlargement added Spain and Portugal in 1986. Although a few of these 18 (18 = 9 x 2) bilateral events were predicted in earlier years, all 18 bilateral events were predicted beginning in 1978, 8 years prior to the event. The fourth enlargement added three new members—Austria, Finland, and Sweden—in 1995. As shown in Table 7, all 33 PTA events ($33 = 11 \times 3$) were predicted beginning in 1983 about 12 years before the events.

The fifth and sixth enlargements were all quite large in terms of numbers of new members. Actually, ten new members joined the EU in 2004. However, due to data constraints, our model was only able to make predictions for eight of these new members: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia. With 14 countries in our model as of the fourth enlargement in 1995, this allows 112 predictions ($112 = 14 \times 8$). Our model predicted all 112 events starting in 1994, about 10 years prior to the 2004 enlargement. Year 2007 saw the sixth enlargement by adding Bulgaria and Romania. These 36 PTA events were predicted starting in 1994 also, about 13 years prior to their inclusion. The seventh enlargement in 2013 to add Croatia was predicted in 1990.

Although the precise timing of the bilateral PTA events *by actual year* is difficult, we note two important results. First, not only the formation of the EU—but also *five of the seven* enlargements—were predicted within a 10-year window of the actual events (as summarized above). The fifth and seventh enlargements were predicted 12–13 years before the events occurred. It is feasible that politics played an influential role in the actual timing of the events. A second interesting result is the *sequencing* of the enlargements. The second enlargement was predicted no later than the third enlargement. The third enlargement was predicted before the fourth enlargement. The fourth enlargement was predicted before the fifth enlargement. The fifth enlargement was predicted no later than the six

24. The name of the EU has evolved over time. For tractability, we will use EU for the original EEC as well as for subsequent names.

TABLE 8
Ten Highest Predictions for 2007–2013

Country Pair	Probability	Predictions for Year	Actual	Details
China–Pakistan	0.840	2011	2007	China–Pakistan FTA implemented
Egypt–South Africa	0.754	2011	Proposed in 2008	Oct 2008 and June 2011 Summits; Proposed African Free Trade Zone (AFTZ) expected to be operational in 2018
Australia–Egypt	0.724	2011	None	No agreement yet under consideration
Libya–Chad	0.705	2009	Proposed in 1998	Community of Sahel-Saharan States (CEN-SAD); Founding members; Goal is to create an economic union; Not yet an effective free trade agreement
Italy–South Korea	0.701	2011	2011	EU–South Korea FTA implemented
Pakistan–Saudi Arabia	0.688	2011	None	No agreement yet under consideration
Spain–South Korea	0.673	2011	2011	EU–South Korea FTA implemented
Italy–Pakistan	0.657	2010	Proposed in 2009	EU–Pakistan 5-year Engagement Plan instituted in 2009 to develop GSP treatment into a FTA
United Arab Emirates–Pakistan	0.645	2011	None	No agreement yet under consideration
Egypt–Gabon	0.644	2011	Proposed in 2012	Proposed extension of proposed AFTZ to include Economic Community of Central African States (ECCAS)

enlargement. Thus, the model generally explains well the sequencing of the EU's enlargements.

While the discussion above has focused on in-sample predictions of particular PTA events that occurred during the sample, it would be interesting to see whether the model—based upon data from 1950 to 2006—predicts the most likely post-2006 *out-of-sample* PTA events. This is the subject of the next section.

D. Evaluating Realizations of the Model's Ten Most Likely Post-Sample Time-to-PTA Events

The main sample of the paper spanned the period 1950–2006. In this section, we consider the predictive analysis of the model for the post-2006 period—2007–2013—using actual values of right-hand-side variables. In particular, we focus on the *ten most likely* PTA events predicted post-sample by the model, comparing their predicted year of PTA formation with the *actual status* of PTA formation—either entered into force, proposed, or not yet considered.

Table 8 will be helpful in organizing the discussion. The first column of Table 8 lists the country-pairs for which a PTA was most likely to be formed in the post-sample period 2007–2013, ranked by highest to lowest probabilities.[25] The second column lists the probability associated with the PTA event. The third column lists the year predicted for the event. The fourth column specifies a year associated with an entry-into-force of an agreement, a year associated with a significant development in a proposed agreement, or the reporting of no PTA or proposed PTA.

For these ten most likely PTA events, seven of the ten pairs have PTAs entered into force or proposed; there is no reported activity for only three of the most likely events. The last column of Table 8 provides details about pairs with proposed agreements or actual PTA formations. We discuss the ten pairs in three groupings: implemented agreements, proposed agreements, and absence of agreements. First, three of the ten country-pairs with post-sample predicted PTA events formed PTAs in the post-sample period. The China–Pakistan PTA went into force in 2007, and was predicted by the model for 2011. The EU formed a PTA with South Korea in 2011. Italy and Spain were both predicted by the model to form PTAs with South Korea in 2011.

The second group of country-pairs is those with predicted PTAs but only a proposal is in place, not an actual agreement. There are four country-pairs in this group. First, Egypt and

25. Predictions were enabled by use of actual values of countries' GDPs and other time-varying right-hand-side variables for the period 2007–2013 using Specification 3; similar results were obtained using Specification 4.

South Africa had a probability of 0.705 of forming a PTA in 2011. In an October 2008 summit followed by another June 2011 summit, the African Free Trade Zone (AFTZ) was proposed. Comprised of 26 countries that span three major existing PTAs—the East African Community (EAC), the Southern African Development Community (SADC), and the Common Market for Eastern and Southern Africa (COMESA)—the AFTZ would create a free trade area that goes from Cairo to Cape Town. Interestingly, the AFTZ would actually implement the dream of Cecil Rhodes in the 1890s of free trade spanning Egypt to South Africa. The AFTZ is expected to be operational in 2018 and progress suggests this is feasible. Second, we have the special case of Libya and Chad. The model predicted a PTA in 2009. The table lists that the two countries were both founding members of the Community of Sahel-Saharan States (CEN-SAD) in 1998, which exists and has a goal of becoming an economic union. However, most observers consider that the FTA signed has not been "effective." Consequently, we consider the 1998 CES-SAD agreement as a proposed agreement. Third, our model predicted an Italy–Pakistan PTA in 2010. The EU instituted in 2009 a 5-year Engagement Plan to extend its current one-way GSP treatment to Pakistan to an FTA. Fourth, our model predicted an Egypt–Gabon PTA in 2011. There was a proposal in 2012 that the AFTZ, proposed during October 2008 and June 2011 summits, be extended from the EAC, SADC, and COMESA to include the Economic Community of Central African States (ECCAS), which would then unite Egypt and Gabon in a PTA.

The third group of country-pairs is those with no planned or existing PTA. This group includes Australia–Egypt, Pakistan–Saudi Arabia, and Pakistan–United Arab Emirates.

VII. CONCLUSION

Despite the proliferation of PTAs in the last 60 years, there have been only 1,560 bilateral formations/enlargements among 10,518 pairings of 146 countries from 1950 to 2006. We used an econometric duration analysis to determine the economic, political, and historical factors explaining the instantaneous probability at a particular year of leaving the initial state of "No-PTA" to form or enter a PTA (given survival of the state No-PTA up until that period). We found that geography, economic size and similarity, relative factor endowments, interdependence (or contagion) in PTA formation, and political and historical factors had statistically significant effects on the timing of country-pairs' PTA "events." Moreover, the coefficient estimates for the variables are consistent with relationships suggested by an underlying theoretical model, suggesting the PTA events are occurring sooner when the net welfare gains for the countries' consumers are higher.

When estimating a specification on all 1,560 PTAs over the period 1950 through 2006, the preferred parsimonious specification (without fixed effects) explains 26%, 46%, and 57% of the PTA events within 1, 5, and 10 years, respectively, up until the actual occurrence of those PTAs within the sample and estimation period. Estimating such a specification for the years 1950 through 2000, the model explains out-of-sample 66% of the events within the same year that the actual PTA membership occurred in 2001 through 2006, 69% in the same year or up to 1 year prior to actual PTA membership, and 82% within 10 years up until the actual occurrence of all 284 PTAs. The model largely explains in-sample the formations of the Canadian–U.S. FTA, NAFTA, and the EU's formation and subsequent enlargements. Moreover, for seven of the ten most likely post-2006 out-of-sample PTA events, either a PTA formed during the period 2007–2013 or one has been proposed.

The results suggest not only that the path of regionalism over time in terms of country-pairs has been one consistent with welfare-maximizing behavior of countries' governments, but that there is a feasible "road map" for policy makers for the evolution of PTAs in the world economy. While most observers might agree that overall multilateral liberalization would be the most preferred policy for the world economy in principle, in the absence of such progress the path of regionalism has likely been a beneficial one.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Theoretical supplement