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The Hazard of War: Reassessing the Evidence for the Democratic Peace*

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In this article, we re-examine the statistical evidence for the democratic peace at the dyadic level. We also investigate the seeming paradox that democracies are engaged in war as often as autocracies at the nation level. From the extensive literature on democracy and peace we have selected as our point of departure two influential contributions (one by Stuart Bremer, the other by Zeev Maoz & Bruce Russett), both of which analyse the relationship between democracy and peace at the dyadic level. Several problematic aspects of these analyses are addressed; in particular, problems concerning dependence between observational units caused by continuing war and peace, and by diffusion effects. We show that the increasing number of countries in the international system causes their assumption of a stationary probability of war at the dyadic level to be violated. It is argued that these problems cannot be solved adequately within the traditional dyad-year framework. Instead, it is proposed to model observations on the interstate dyad as a process in continuous time using Cox regression. An extensive model is developed that controls for contiguity, power status, alliances, stability, diffusion of war, and recurrence effects. A concept of *relevance* is introduced to account for the dependence of the dyadic probability of war on the size of the international system. The democratic peace is supported in our basic model. In a refined model, we find that the tendency of democracies to join each other in wars is much more marked than their avoidance of mutual fighting. This explains why democracies are as war-prone as autocracies.

1. *The 'Democratic Peace'*

The statistical evidence for the *democratic peace* – the hypothesis that interstate dyads (i.e. pairs of states) consisting of two democracies are almost never at war – is re-examined. The hypothesis is often attributed to Kant's *Zum Ewigen Frieden* (Doyle, 1986). It is supported by a large number of empirical studies (see Gleditsch & Hegre, 1997 for a recent overview), and has been championed as 'as close as anything we have to an empirical law in international relations' (Levy, 1988, p. 662).

However, there is a caveat: at the nation level, empirical studies indicate that democracies are engaged in war as frequently as autocracies. This has the important implication that politically mixed dyads, i.e. dyads consisting of one democracy and one autocracy, must have a higher probability of war than double autocratic dyads. The latter observation is theoretically troubling for the 'democratic peace'. For instance, Maoz & Russett (1993, p. 625) assume that the norms of behaviour that characterize relations between democracies will be dominated by the autocracies' norms for international behaviour in relations between a democracy and an autocracy. From this we would expect that politically mixed dyads will have *the same* probability of war as autocratic dyads, not a higher probability.

An explanation of the paradox is suggested

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by Gleditsch & Hegre (1997, p. 294), who observe that democracies rarely start wars, but they join wars much more frequently than autocracies. The two world wars and the 1991 Gulf War are examples of several democracies joining an alliance against a smaller number of autocracies after the fighting has started.

Even though the democratic peace has been assessed in a large number of studies, both empirically and theoretically, it remains controversial. Some of its antagonists claim that the empirical support for the democratic peace is inconclusive because of the inadequacy of the statistical methods used to test it.[1] However, we think the situation can be improved by careful statistical modelling.

2. *Empirical Studies of the Democratic Peace Hypothesis*

As our starting-point, we have selected two influential articles from the extensive literature on democracy and peace: Bremer (1992a) and Maoz & Russett (1993). 'Dangerous Dyads' by Bremer is a pioneering work presenting several major improvements compared to the previous literature. Bremer stressed the interstate *dyad* as the appropriate unit of analysis, in contrast to such earlier works as those of Small & Singer (1976), Chan (1984) and Weede (1984). Bremer used the full spatial and temporal domain of the Correlates of War (COW) project from 1816 and forwards, and recognized the need for multivariate analysis. Several scholars have since taken a similar approach, notably Maoz & Russett (1993), Barbieri (1996), and Oneal et al. (1996). Although their specific choice of statistical model differ (e.g. Bremer uses a Poisson model, whereas Maoz & Russett use logistic regression), the basic idea is the same: the dyad-year is the observational unit and the response variable (conflict status) is related to a set of explanatory variables through a regression model. All these authors find clear empirical support for the democratic peace hypothesis. In the following we refer to this as the *dyad-year* tradition.

3. *Methodological Problems with the Dyad-Year Tradition*

Spiro (1994) has claimed that the empirical evidence for the democratic peace is insignificant: the low nominal p-values reported in the literature are biased downwards because the models require that the dyad-years constitute independent observations, whereas they are actually highly dependent. In this section we scrutinize the methodological shortcomings of the dyad-year tradition, and point at specific improvements, some of which can be handled within the dyad-year framework itself, whereas others transcend it.

The interstate dyad is the most elementary unit that can have war as a characteristic. Any interstate war (in the sense of the COW project) that involves more than two nations can be seen as a more or less complex cluster of interstate dyad wars, possibly with causal relationships between them. In what follows, we define 'dyad war' as any pair of states that fight on opposite sides in an interstate war – whether the two are the only participants or take part in a wider war. For example, the war between Poland and Germany and the Japanese-US war are two of the many dyad wars that together form World War II.

3.1 *Dependency between Units and Inconsistent Censoring*

In the dyad-year tradition, the basic idea is to count the number of dyad-years in war and peace. It is assumed that all dyad-years are independent (when we condition on the explanatory variables). If this is tenable, the war status of the dyad-years are conditionally independent random variables. Bremer points out two problems with this assumption. Firstly, when a dyad is at war for more than one year, the counts of 'war' in the subsequent years are dependent on the first. Secondly, once an interstate war has started, other states may join it. Hence one dyad war can cause other dyad wars, and the latter will be dependent on the first.

At this point, Bremer and Maoz & Russett diverge. Bremer chooses to remove all the subsequent dyad wars (the 'joiners') from the data set and to count only the initiating dyad war, relying on Small & Singer's coding of whether countries are joining a war or are starting a new war. Furthermore, if a dyad war continues over several years, only the first year is counted, and subsequent dyad-years at war are removed from the data set. By these criteria, World War II is reduced to a single war dyad: Poland-Germany in 1939. In statistical terms, this is a deliberate censoring. Apart from trying to reduce the problem of dependence, Bremer sets forth a second rationale for this censoring: 'the question of why wars begin is fundamentally different from the questions of why wars grow in size, duration, and severity' (p. 320) and his concern in 'Dangerous Dyads' is with the first matter only.

The estimation of the statistical models of dyad war consists essentially in comparing the features of the dyads that did experience war (in a given year) with the dyads that – ex ante – could have experienced war (in that year); we will refer to the latter set of dyads as the *risk set*. When Bremer discusses the problem of dependent dyads, his concern is restricted to the class of dyad wars. But the problem of dependence concerns the other dyads in the risk set as well.

To see this, we first note that the risk set consists of two types: dyads that risk *starting* (an independent) war, and dyads that risk *joining* an existing interstate war. In Bremer's approach, the latter dyads have zero probability of being counted as 'war' and hence should not contribute to the estimation of the model; they are not a part of the *actual* risk set. Therefore, to be consistent, not only dyads actually joining a war but also dyads that *risk* joining a war should be removed. To take one example: Assume that a new dyad war breaks out. During the following years the original dyad war may have been joined by other dyad wars that, when taken together, form a single interstate war. The latter dyad wars will be censored because they are considered to be dependent on the first (e.g. all dyad wars in World War II except Poland-Germany). There could also be dyads that did not erupt in war (e.g. United Kingdom-Sweden) but, which, if they had done so, would have been censored. Accordingly, they are not a part of the *actual* risk set and should be removed. One may argue that after the outbreak of the Poland-Germany war and until the end of World War II, no dyad was at risk of starting an independent war and hence that the risk set was empty in this period. In practice it will be difficult, or even impossible, to determine ex ante whether a (potential) dyad war would be dependent on ongoing wars. And even ex post, for actual war outbreaks, the censoring criteria may be more or less arbitrary – for instance, what are the *general criteria* for reducing the Japan-US war to the Poland-Germany war during World War II?

Not only will an ongoing war lead to dependent counts of 'war', but a continuing peace will lead to dependent counts of 'peace' as well. If we are to censor continuing wars, why should we not censor continuing peace? Maoz & Russett (1993, p. 631), are aware of this problem, and choose to count *all* dyad-years at war, even if the responses are clearly dependent. They realize that the root of the problem is that the 'true' model is one of dependent response, no matter whether that response is 'war' or 'peace'. It is difficult to assess how this dependence will bias the estimates, but it will certainly lead to deflated p-values when testing statistical hypothesis. This situation is similar to distributing a questionnaire to a sample of N individuals *twice* and treating the responses as coming from $2N$ different individuals. Our answer to these problems is to model war origination and war-joining *simultaneously* – as causally related events in a statistical event history model.

The problems with the dyad-year tradition fundamentally derive from statistical dependence: a war in one dyad may alter the probability of war in other dyads. To some extent these problems can be handled within the framework of the dyad-year approach. One option is to include explanatory variables containing information about ongoing wars. In general, we may condition on all relevant historical information, i.e. information known prior to year t, and this would fit naturally into the dyad-year framework. This is also recognized by Beck & Tucker (1996), who propose modelling the probability of outbreak of war as a function of the duration of peace. They also address the problem of cross-sectional dependencies between units. Contrary to their suggestion, we do not consider these dependencies as due to latent variables. Instead, we propose a model where inter-dyad dependencies are a part of the statistical model itself and are treated as *diffusion of war* effects.

If two wars are dependent and start in the same year (as when the United Kingdom declared war on Germany two days after Hitler's attack on Poland in September 1939), their dependence is a greater problem to the dyad-year approach. Since the start and end of wars are identified by date in the Correlates of War data, we suggest using a continuous time model. Of course, all time measures are discrete, but with a finer scale a continuous time model becomes more realistic. In 'continuous' time, the history contains all information up until *day t*. We will then be able to observe the succession of war outbreaks accurately and the problem of dependence through causality can be more adequately accounted for.[2] In the case of Britain's war with Germany, it will be possible to have explanatory variables that record that another dyad war was going on, and that Britain was directly affected by it through its defence pact with Poland.

In a continuous time model, the dyadic observations at t could become *conditionally* independent – and thus amenable to statistical analysis – and still remain highly interrelated (through dependence on a common history). Furthermore, information about ongoing wars as well as other circumstantial evidence relevant for classifying a war as starting or joining can be incorporated into the empirical model. This obviates the need to classify a dyad war as one type or the other a priori.

Some of the time-dependent variables are measured by year. In these cases, we follow common practice in event history analysis and treat them as step functions, i.e. constant through the year. This does not invalidate our argument for a continuous time model. The reason is that, by using a coarser grid, with for example the year as (a discrete) time unit, we are unable to make use of relevant information. On the other hand, when treating variables observed annually as constant through the year, no information is lost; the available information may just be less than desirable.

3.2 *Untenable Assumptions of Stationarity*

Our final criticism of the dyad-year tradition relates to the assumption of *stationarity:* for a dyad with a set of explanatory variables at fixed values, the probability of war is assumed not to depend on *time*. Bremer (1992b) criticizes this assumption in the context of joining a war: the relation between the probability of war and the explanatory variables may change over time due to time-dependent unobserved (latent) variables. These variables may reflect what we could loosely term 'the general degree of tension' in the international system. A negative trend in the probability of war has been posited for example by Rosecrance (1986) and Mueller (1989). Another, and fundamentally different, reason why the assumption of stationarity should be abandoned is the increase in the size of the international system of states (from 32 in 1840 to 182 by 1992). As shown in Gleditsch & Hegre (1997, pp. 298–300), this does indeed have stochastic consequences: Let N be the number of states in the international system. Since each state enters N-1 dyads, the number of interstate exposures for a given state increases by N. If the war probabilities in each dyad-year are constant, the probability of war on the nation level approaches one as N increases.[3] The important implication for statistical modelling is that probabilities at the *dyadic level* must depend on the size of the system. Failure to incorporate an explicit system dependence yields estimated probabilities of war at the nation level that become absurd when N increases. Furthermore, there is a high risk of spurious correlation if we should include explanatory variables that are correlated with the (unmodelled) time-trend. Note that regime type *could* be such a variable, since the fraction of double democracy dyads has increased over time (see Gleditsch & Hegre, 1997, Figure 3, p. 305) and hence will be correlated with the trend. We may wonder, then, whether the significant negative relationship between double democracy dyads and war reported in the literature is a substantial finding or merely an artifact of the double democracy variable being a proxy for a general negative trend in dyadic war probabilities.

From a priori considerations most dyads have very low or zero probability of war and it is plausible to assume that the emergence of a new independent state will affect only a few 'relevant' states, rather than all existing ones. We do not know of any general criteria for sorting out zero-risk dyads, but it is easy to find criteria which sort out dyads with low risk – or *low-relevance dyads* as we will call them. Maoz & Russett (1993) apply such low-relevance criteria in their analysis when they exclude what they call 'politically irrelevant' dyads. This exclusion can, however, be justified only if 'irrelevant' dyads have a negligible probability of war. Unfortunately, this is far from being the case: In excluding three-quarters of the dyad-years Maoz & Russett lose as many as one-quarter of the conflicts.[4] In this article we refine the approach of Maoz & Russett in several ways. In particular, we do not exclude the 'irrelevant' dyads but instead treat them as a separate class of *low-relevance dyads*, where each member has a non-stationary probability of war depending on the size of the international system. Thorough discussion and the motivation for these concepts are deferred to Section 5.

4. *An Alternative Model*

We have demonstrated that even the most solid contributions to the empirical literature on the outbreak of war suffer from serious inadequacies and inconsistencies. We have also suggested some essential features of an 'ideal' model: (i) observations on dyads should be recorded on the finest possible time-scale to keep track of the succession of events, (ii) the war probabilities of low-relevance dyads should depend on the number of states in the international system, and (iii) the model should allow for non-stationarity due to changes in latent variables at the system level. In Sections 5 and 6 we formulate a Cox regression model that addresses these three concerns. In this section we present the general idea of Cox regression, and relate the parameters of the model to logistic regression to facilitate comparison with the existing literature.[5]

In Cox regression the dependent variable is the transition between 'states of nature' – the transition from peace to war (or vice versa) being of this type. A central concept is the *hazard function*, $\lambda(t)$, which is closely related to the concept of transition probability: $\lambda(t)\Delta t$ is approximately the probability of a transition in the 'small' time interval $(t, t + \Delta t)$ *given* that the subject under study is at risk of transition at t. In our case, the subjects under study are all the different interstate dyads and t is calendar time. We study the transition from peace to war and a dyad that risks transition has a non-zero probability of war, i.e. it is a system member[6] and not already at war. The main idea of Cox regression is the assumption that the hazard of war $\lambda_d(t)$ for dyad d can be factorized into a parametric function of (time-dependent) variables and a non-para-metric function of time itself (the baseline hazard):

$$(1) \quad \lambda_d(t) = \alpha(t) \exp\left(\sum_{j=1}^{p} \beta_j X_j^d(t)\right)$$

In (1), $\alpha(t)$ is the baseline hazard: an arbitrary function reflecting unobserved variables at the system level. $X_j^d(t)$ is a (possibly time-dependent) explanatory variable for dyad d; β_j is the corresponding regression coefficient; and p is the number of explanatory variables. All legitimate explanatory variables are known prior to t – they must be a part of the history up until immediately before t.

Estimating this model involves (i) estimation of the regression coefficients $\beta = (\beta, \ldots, \beta_p)'$ and (ii) estimation of the baseline hazard of war $\alpha(t)$. These two tasks are quite different, since the latter is an unknown function – not a parameter. However, for the specific purpose of inference about the democratic peace, we are mainly interested in the 'structural' parameters β. Inferences about β can efficiently be made by conditioning on the time-points of outbreaks of war, $\{t_1, \ldots t_n\}$. This means that we can consider $\{t_1, \ldots t_n\}$ as fixed rather than stochastic, without losing any information about the structural parameters.

Given that there is an outbreak of dyad war at time t_w, the probability that this war outbreak will happen in dyad d is:

$$(2) \quad \Pr(\text{war in dyad } d \backslash \text{a war breaks out at } t_w) = \frac{\exp\left(\sum_{j=1}^{p} (\beta_j X_j^k(t_w)\right)}{\sum_{i \in Rt_w} \exp\left(\sum_{j=1}^{p} \beta_j X_j^i(t_w)\right)}$$

where Rt_w is the *risk set* at t_w: the set of dyads at peace immediately before t_w. The parameters can be interpreted in terms of a *relative* probability of war: Assume that dyads i and j have the same values on all explanatory variables, except for $X_k(t)$. Then, from (1), the ratio between the hazard of war of dyad i and dyad j becomes

$$(3) \quad \frac{\lambda_i(t)}{\lambda_j(t)} = \exp(\beta_k(X_k^i(t) - X_k^j(t))).$$

Hence we have

$$\ln \frac{\lambda_i(t)}{\lambda_j(t)} = \beta_k(X_k^i(t) - X_k^j(t)).$$

We may therefore interpret the parameter β_k

as follows: β_k is the log of the relative risk between two dyads which are identical, except for the variable $X_k(t)$, which differs by one unit. This interpretation may be compared to the interpretation of the parameters in the logistic model. Let $p^i(t)$ be the probability of war in year t assigned by the logistic model for dyad i:

$$p^i(t) = \frac{1}{1 + \exp(-\tilde{\beta}_0 - \sum_{j=1}^{p} \tilde{\beta}_j X_j^i(t))}$$

Then, for the two dyads of the previous example, it follows by a standard deduction that

$$\ln\left(\frac{p^i(t)}{p^j(t)} \times \frac{1-p^j(t)}{1-p^i(t)}\right) = \tilde{\beta}_k$$

i.e., $\tilde{\beta}_k$ is the *log-odds ratio* between dyad i and j – not the log-relative risk. However, the probabilities of war $p^i(t)$ and $p^j(t)$ are typically both very small. Hence the term $\frac{1-p^j(t)}{1-p^i(t)} \approx 1$ and the log-relative risk are almost identical to the log-odds ratio. The conclusion is that, for rare events like war, the parameters of the Cox model and the logistic model have almost identical interpretations.

To perform an analysis with this model, we need a data-file constructed in the following way: For each t_w – i.e. each day a dyad war breaks out somewhere – we take a 'snapshot' of the international system; we note for all dyads that are system members and not already at war, the values of the explanatory variables on that particular day. As seen from expression (2), the dyad that *did* erupt in war at t_w is compared to all dyads that were at risk of doing so. Thus, all information for the time *between* different t_w's is ignored. From the combined information about all war outbreaks during 150 years of history, we can estimate β and hence the relative hazard (3).

5. *High-Relevance and Low-Relevance Dyads*

Maoz & Russett (1992, 1993) distinguish between 'politically relevant' and 'politically irrelevant' dyads. We prefer to use the terms high-relevance and low-relevance dyads. The aim of the classification is to sort out a set of dyads with no observed intra-dyad relationship. In particular, the number of high-relevance dyads for each state should be fairly stable over time.

We have argued (in Section 3.2) that the probability of war for the group of low-relevance dyads should be modelled as a decreasing function of the size of the system. This is mainly derived from the inadequacy of our explanatory variables to automatically sort out dyads with zero (or negligible) probability of war. If this were possible, the high-relevance/low-relevance classification would be superfluous; all information about relevance would be contained in the explanatory variables and no additional classification would be required. In particular, an increasing share of the dyads would have explanatory variables implying zero (or negligible) probability of war when the number of states increases. Modelling war probabilities of low-relevance dyads as a decreasing function of system size is only a 'second best' solution to the non-stationarity problem. Before discussing our exact operationalization of 'relevance', we will motivate the concept further by a more formal argument.

Let a be a state, N_t the number of states in the international system at time t, and m_{at} the number of states 'politically relevant' to a at t. Finally, assume for a moment that all explanatory variables are identical for all low-relevance dyads, with corresponding hazard function equal to $\tilde{\lambda}(t)$. Then, from (1), the probability $p_a(t)$ (at the nation level) that state a will become at war in *at least* one low-relevance dyad is:

$$p_a(t) = 1 - (1 - \tilde{\lambda}(t))^{N_t - m_{at} - 1} \rightarrow 1 \text{ as } N_t \rightarrow \infty.$$

The annoying thing about this result is not that war becomes more likely *at the system level* (it is indeed plausible that the probability of war increases somewhere in the system), but that *each* state's probability tends to one.[7] A good model should allow $p_a(t)$ to be stable even when N_t increases: the mere increase in interaction opportunities does not make war unavoidable for *all* states. Of course, this stabilization could be achieved by letting the baseline hazard $\alpha(t)$ decrease. But this is not reasonable, since it would imply that the probability of war in the relevant dyads, e.g. between Iran and Iraq, would then also decrease. To achieve the desired stabilization, it is better to divide the baseline hazard a (t) by N_t if the dyad is a low-relevance dyad. To see the stabilizing effect, note that in this case

$$p_a(t) = 1 - (1 - \frac{\tilde{\lambda}(t)}{N_t})^{N_t - m_{at} - 1} \approx \tilde{\lambda}(t)$$

when N_t is large. This implies that the hazard function $\tilde{\lambda}(t)$ can be interpreted as the probability that a will get into war in *at least* one low-relevance dyad. To take an example, consider the low-relevance dyads that include a specific country, such as Norway. We argue that it is more reasonable to assume that the probability of Norway's getting into war in at least one of these low-relevance dyads is independent of the size of the group, than to assume that the creation of 100 new island-states in the Pacific will 'double' the probability just because the number of interaction opportunities is doubled.

The stabilizing effect of dividing the baseline hazard of low-relevance dyads by N_t is maintained even if we allow heterogeneity among them. Then, if d is a low-relevance dyad, its hazard of war becomes

$$\lambda_d(t) = \frac{\alpha(t)}{N_t} \exp(\sum_{j=1}^{p} \beta_j X_j^d).$$

This formulation is mathematically equivalent to

$$\lambda_k(t) = \alpha(t) \exp(\sum_j \beta_j X_j^d - \ln N_t)$$

and hence fits nicely into the general framework of Cox regression, with $-\ln N_t$ as an explanatory variable and 1 as the corresponding regression coefficient. We replace $-\ln N_t$ by $-\gamma \ln N_t$ where γ is an unknown regression parameter. This enables us to test the hypothesis that $\gamma = 1$; an estimate $\hat{\gamma}$ significantly less than 1 indicates that an increasing proportion of the wars have taken place in the low-relevance dyads.

γ can be seen as a *relevance adjustment* parameter; the higher γ, the less weight is given to the low-relevance dyads when estimating the model. $\gamma = 0$ and $\gamma = \infty$ are the extreme cases: The first corresponds to no adjustment at all; Bremer chooses this approach. The second case, $\gamma = \infty$, is the line taken by Maoz & Russett and is equivalent to removing non-relevance dyads from the sample altogether.

We have tried to motivate a discrimination between dyads based on an intuitive understanding of 'relevance' and have shown that a failure to discriminate leads to absurd war probabilities at the nation level. Unfortunately, in practice discrimination must be based on a restrictive set of variables and it is difficult to motivate any particular definition. Partly following Maoz & Russett's exclusion criteria, we classify a dyad as *low-relevance* when the component states are not neighbours by land or by sea, they are not allied, and neither are major powers. Since we are also going to model diffusion effects, we will in addition require that there is no *third country* at war with one country in the dyad and *contiguous to or allied to* the other (more about this and other variables below). This means that during great, multination wars a considerably higher number of dyads are considered 'relevant' than in times of relative peace.

6. *Explanatory Variables*

In Section 3 we noted that there is a need for different types of explanatory variables in a realistic null model for testing the democratic peace: The first set consists of the relatively stable characteristics of the dyad. We will call these explanatory variables dyad *attributes* (see Russett, 1993, pp. 25–30 for a discussion of most of these factors). Secondly, another type of variables is included in order to model the dynamics of war and war escalation, termed *diffusion variables*. Thirdly, we introduce variables characterizing intra-dyad stability and, finally, regime variables.[8] Below follows a brief presentation of the variables. More detailed coding information is found in the Appendix.

6.1 *Dyad Attributes*

Contiguity: Although often neglected or taken for granted in quantitative studies, contiguity is the most obvious dyad attribute affecting the hazard of war. Contiguous countries have adjacent territories and thus the largest conflict potential, whether in terms of disputes over natural resources, migrations across the borders, or other forms of friction. Another aspect is that minor powers lack the means to wage war over long distances and thus only fight neighbours or major powers (Boulding, 1962; Gleditsch, 1995). Countries can be contiguous through their main territory or through dependent territories. Here we will consider only the first category, since countries with dependent territories in most cases are major powers and thus assumed to be in some contact with all countries in the system (see Section 5). A dyad is considered contiguous if the countries are contiguous by land or have less than 150 miles of sea between them. We have also used contiguity to define low relevance (see Section 5).

Major Powers in Dyad: There is wide agreement that major powers are more likely to be involved in war than minor powers. By definition, the major powers have the means to and interest in interacting with a large proportion of the states in the system. We have coded each dyad as consisting of zero, one or two major powers. If a dyad consists of two major powers it is automatically a high-relevance dyad (see Section 5).

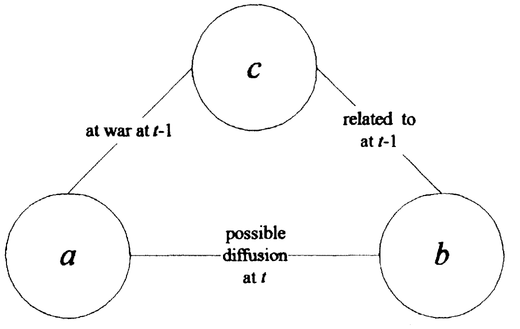
Alliances: One would expect dyads related to each other through alliances to have a lower probability of war, *ceteris paribus*. Bremer (1992a) confirms this. We distinguish between the COW project's three types of alliances (Singer & Small, 1966, p. 5): *defence pacts, neutrality and non-aggression pacts*, and *ententes*. We expect both defence pacts and ententes to reduce the probability of war, although defence pacts may have stronger effect than ententes. In the interest of parsimony, we have merged these two categories.[9] Alliances are primarily intended to protect the signatories from outside enemies. Thus they are extremely important in the war diffusion process.

6.2 *Diffusion of War*

As argued, we do not want to make a priori ad hoc distinctions among the dyad wars between initiators and joiners. Moreover, we want to investigate whether democracies and autocracies have diverging war-joining behaviour. Thus, we will define a set of *diffusion variables*, which model the diffusion process as it is intuitively understood. Our definitions of the diffusion variables can be viewed as extensions of those defined by Siverson & Starr (1990).

In our dyadic framework, diffusion of war implies that an ongoing war somewhere outside a dyad *ab* triggers a war in that dyad. Like Siverson & Starr, we will restrict this to wars involving at least one of the states, say *a*, in *ab*. Diffusion is defined as the event that a war breaks out in *ab*, where *a* is already at war with a third country *c* – in our terminology, *a* becomes part of another dyad war *ab* in addition to *ac*.

Figure 1. Visualization of the War Diffusion Variables



See Table I for a listing of the variables.

In all situations where there is a possibility of diffusion to the dyad *ab* under study, country *a* is at war with (at least) one other country *c*. Accordingly, we term the diffusion variables *War with Third Country*, abbreviated WTC. WTC is a classification of the dyad by the answer to the question: what is the relation between *b* and *c*? The definition of the WTC categories is summed up in Table I. See also Figure 1.

As an illustration of these coding rules, consider the Germany-Belgium dyad during WWI: From 3 August 1914 a third country *c* (France) was at war with *a* (Germany) and contiguous to *b* (Belgium). Dyads like these are coded 1 on WTC 1. Then let us return to the Germany-UK dyad in 1939: From 1 September 1939 a third country *c* (Poland) was at war with *a* (Germany) and allied in a Defence pact with *b* (UK). This is coded 1 on WTC 2. The first three WTC cate-

Table I. *War with Third Country*

Category	Definition
WTC 1	*a* at war with *c* and *b* contiguous to *c*
WTC 2	*a* at war with *c* and *b* allied with *c* in a Defence pact or an Entente
WTC 3	*a* at war with *c* and *b* allied with *c* in a Neutrality/Non-aggression pact
WTC 4	*a* at war with *c* but not WTC1-WTC3

Categories WTC 1, WTC 2, and WTC 3 are not disjoint. If *a* is at war with more than one state *c*, or if *c* is related to *a* by more than one criterion, the dyads may be coded as members of more than one of the three categories. However, a dyad is coded as a member of the fourth (and general) category, only if it is not a member of any of the other three.

gories are deduced from the dyadic relations described in Sections 6.1.1 and 6.1.3.

The last category, WTC 4, is a generalization of the diffusion situation: for the dyad *ab* there exists a country *c* at war with *a*, but not contiguous to or allied to or in war with *b*; i.e. there is no observed relationship between *b* and *c*. This category is meant to account for a general effect of war in the system: to what degree will a war between two countries spread to the dyads that these countries form part of?

We have used the first three diffusion categories to define relevance: A dyad will be classified as high-relevance if it fulfils any of these criteria. A non-contiguous, non-allied dyad of minor powers, for instance, changes status from low-relevance to high-relevance from the moment a war onset changes one of the diffusion variables. We define WTC 4 as *not* implying high-relevance. There is no known interaction between *a* and *c*, and hence we cannot infer that there is interaction between *a* and *b* either.

6.3 *Intra-Dyad Stability*

Another hypothesis relevant for modelling the hazard of war is that political stability in each of the constituent countries of a dyad and in the relation between them will decrease the probability of violent conflict. We include a simple time-dependent measure of stability in our model: The time (in days) passed since the *last* of the following events: (i) one of the states in the dyad became a system member either for the first time or after an occupation, or (ii) a war between them ended.

We assume that immediately after a war has ended, or a new dyad has been created, the probability of war is high. However, the effect will decrease as time passes. To model this, we computed a decaying function of the number of days in peace. Our *Time in Peace* variable thus reads: $Exp\left(-\frac{\text{Days in peace}}{3{,}162}\right)$. When dividing the number of days in peace by 3,162 this variable's partial effect on the hazard is being halved every sixth year.[10] This choice builds on the recognition that 'disputes occurring more than a generation apart may be only remotely related to the previous dispute's outcome' (Hensel, 1994, p. 290). We assume that the probability of war in a dyad will be higher if the dyad has formerly been at war, as demonstrated empirically by Hensel (1994). The *Time in Peace* variable is therefore supplemented by a dichotomous variable called *Past War*, denoting whether the peace period started with the end of a war.[11]

Until recently, democracy has been confined to a limited number of old, established nations. Thus, double democracy dyads have in general a higher degree of stability than other dyads. If stability has an effect on the hazard of war, there is a danger of spurious correlation. However, our model will control for this. The model presented in this article is also appropriate for testing more elaborate hypotheses related to stability – cf. for instance the hypotheses presented in Maoz (1989).

6.4 *Regime Variables*

As a measure of regime type, we use a version of Polity III (Jaggers & Gurr, 1995; Gurr, Jaggers & Moore, 1990). For the sake of simplicity, we follow Bremer and Maoz & Russett in dichotomizing the regime variable.[12] We define a country as democratic if it scores 6 or higher on the Polity 'Institutionalized Democracy' index, following Gleditsch (1995) and others.

In our dyadic framework, the dichotomous regime variable yields three categories for a dyad: 'Two Democracies', 'Two Autocracies', or a 'Politically Mixed Dyad'. We define the mixed dyad as the baseline dyad, such that the 'effect' of the other two categories must be interpreted as relative to the mixed dyads.

In some situations, it does not make sense to code regime characteristics. In Polity, countries have in these cases received codes for polity interruption, interregnum, or transition. For simplicity, we have grouped these cases together with cases where data are lacking altogether in Polity (e.g. small states that are COW system members but not Polity members). If a dyad contains at least one country with missing data, it has been coded as a fourth regime category: 'Missing Regime Data'. Twenty-three percent of our observations fell in this category.

For our purpose, a big disadvantage of this data set is that it is coded on an annual basis, with many temporal mismatches as a result. For instance, Norway is implicitly coded as occu-

Table II. Estimation Results

Variable (X)	Category ('x')	$\hat{\beta}_{'x'}$	Standard deviation	p-value	$\exp(\hat{\beta}_{'x'})$	High-relevance/ Low-relevance ratio ($N = 150$)
Regime	Two democracies	−0.84	0.34	0.01	0.43	
	Two autocracies	−0.40	0.14	0.005	0.67	
	Missing regime data	−0.03	0.17	0.86	0.97	
Contiguity	Non-contiguous	−0.65	0.17	<0.001	0.52	36.8
Major powers	Two major powers	0.74	0.21	<0.001	2.09	40.3
	One major power	0.67	0.13	<0.001	1.95	
Time in peace	exp(−Days in Peace / 3,162)	0.80	0.23	<0.001	2.23	
War history	Past war	0.84	0.15	<0.001	2.31	
Alliance	Defence pact	−0.93	0.23	<0.001	0.39	7.6
	Non-aggression pact	−0.53	0.40	0.17	0.58	11.3
	Entente	−1.75	0.49	<0.001	0.17	3.3
War with third country	WTC 1: *a* at war with *c* and *b* contiguous to *c*	1.80	0.15	0.001	5.98	115.1
	WTC 2: *a* at war with *c* and *b* allied with *c* in a defence pact or entente	3.06	0.17	0.001	21.32	410.0
	WTC 3: *a* at war with *c* and *b* allied with *c* in a neutrality/ non-aggression pact	0.25	0.25	0.33	0.78	15.1
	WTC 4: *a* at war with *c* and *b* not contiguous to nor allied with *c*	1.94	0.28	<0.001	6.95	
γ		0.59	0.06	<0.001		
−log-likelihood		1723.5				

For each variable X, $\exp(\beta_{'x'})$ is, ceteris paribus, the hazard of war for a dyad in category 'x' relative to a dyad in the reference category, provided that both have equal relevance. γ is the relevance-adjustment parameter (see Section 5).

pied from 1 January 1940. When attacked by Germany on 9 April the same year and subsequently occupied, using Polity III actually yields a war between an autocracy and an occupied country. To avoid such problems, we use a redesigned version of the data set; Polity IIId, which codes regime changes by day where possible (McLaughlin et al., 1997).[13] Polity IIId allows us to assign regime category at the day of war outbreak. The data set correctly records, for instance, that Norway was a democracy when attacked by Germany in 1940.

7. *Results*

The model was estimated by means of a maximum likelihood algorithm implemented as a GAUSS program. The results are shown in Table II.

The first (numerical) column of Table II contains the parameter estimates, the second column the estimated standard deviations, whereas the third column shows the p-values when testing whether the parameters are zero. These tests are based on the t-statistic (with variance estimates equal to the diagonal of the inverse Hessian). In the fourth column we have calculated $\exp(\hat{\beta}_{'x'})$ where $\beta_{'x'}$ for categorical variables is the parameter corresponding to category 'x' of the variable X. For the baseline case, $\beta_{'x'} = 0$ *a priori* (and therefore not stated in the table). This is an identifying restriction only, implying that all parameters must be interpreted relative to the reference category (cf. Section 4). Of course, for continuous variables $\beta_{'x'}$ is simply the linear coefficient of X.

For explanatory variables X which *are not* involved in the definition of relevance, the hazard of war changes by the factor $\exp(\beta_{'x'})$ when X goes from the reference category to the category 'x'. For *Regime*, for instance, the reference category is the politically mixed dyad, so $\exp(\beta_{2Democracies})$ is the relative risk between, ceteris paribus, a double democratic dyad and a mixed dyad.

For explanatory variables which *are* a defining characteristic of a relevant dyad, the situation is more complex. For example, the reference category of *Contiguity* is 'Contiguous', so $\exp(\beta_{Non\text{-}Contiguous})$ is the ratio of the hazards of war of a non-contiguous and a contiguous dyad *provided both dyads are relevant*. However, going from contiguous to non-contiguous could mean going from a high-relevance to a low-relevance dyad. In that case, the ratio of the hazards of war (the relative risk) is $\exp(\beta_{Non\text{-}Contiguous} - \gamma \ln N_t)$, which depends on the number of states N_t in the international system. This is the rationale for the last column in Table II, where for the special case that $N = 150$ states we have computed the estimated relative risk between any high-relevance and any low-relevance dyad characterized by (i) the variable X is either in the reference category or in category 'x' and (ii) they are equal with respect to all other explanatory variables.[14]

When all categorical variables are in their reference categories and the model's only continuous explanatory variable, *Time in Peace*, is zero, the hazard of war is $\alpha(t)$ – the baseline hazard.

7.1 *Regime Type and War Diffusion*

Our analysis seems to confirm the evidence for the democratic peace at the dyadic level: a dyad consisting of two democracies has an estimated probability of war which is, ceteris paribus, less than one-half of a politically mixed dyad. The statistical significance of this finding is quite high (the p-value is 0.01). Moreover, the democratic peace cannot be explained by virtue of democracies' being non-contiguous, or to their having long histories of peace among them, or by their alliance patterns. The parameter estimate for the regime category 'Two autocracies' is also negative and clearly significant, thus, paradoxically, providing some evidence for an *autocratic peace* as well.

Our results show that war has a strong tendency to spread. If a state a engages in war with another state c, and b is a neighbour of c, the probability of war between a and b increases six times relative to the reference category 'No war with third country'. The (partial) effects of defence pacts and ententes are even stronger: the danger of war between a and b increases by an estimated factor of 21 if a gets into war with a state c which is allied to b. We also find strong evidence that if a is already at war somewhere in the system, this increases the probability of war in ab even if b has no known relation to the country at war with a (WTC 4).

Bremer (1992a) finds that dyads consisting of at least one democracy had a lower probability of war than the double autocratic dyads. Since he does not distinguish between dyads consisting of one or two democracies and because the double democratic dyads are a minority in this merged group, our finding – that the politically mixed dyads are the most 'dangerous' – seems inconsistent with Bremer's result. The probable explanation for this discrepancy is that Bremer only analyses *war onset*, i.e. outbreak of a new war, while discarding dyad wars emerging from diffusion (see Gleditsch & Hegre, 1997, pp. 292–293). We can obtain regime parameters that are comparable to Bremer's by allowing interactions between *Regime* and *War Diffusion*. Let 'x' denote any of the three regime categories 'Two democracies', 'Two autocracies', or 'Missing regime data'. We divide 'x' into two sub-categories, where the one sub-category is '(Regime type) 'x' when there is no risk of war diffusion' (i.e. an outbreak of dyad war will be a war onset), and the other is '(Regime type) 'x' when there is risk of war diffusion'. In the latter case, the dyad is coded 1 on at least one of the four WTC categories. We may now ask: Is the effect of regime the same in both situations? The parameter estimates for the new regime variables are presented in Table III. (The changes in the other parameter estimates are negligible, so we do not report them.)

The democratic peace in a non-diffusion situation is strengthened in terms of estimated relative risk compared with the estimate in Table II (0.29 versus 0.43). As expected from the increase in the number of parameters, the p-value is higher, although still yielding a significant result at the 0.05 level. The estimate for double autocracies is close to zero and insignificant. Consequently, we are unable to reproduce Bremer's result; that the double autocratic dyads are the 'most dangerous'. Our extensive

Table III. Estimation Results with Interaction between Regime and War Diffusion (Regime Variables only)

Variable	Category ('x')	$\hat{\beta}_{'x'}$	Standard deviation	p-value	$\exp(\hat{\beta}_{'x'})$
Regime – no war with third country	Two democracies	−1.23	0.60	0.04	0.29
	Two autocracies	−0.17	0.24	0.48	0.84
	Missing regime data	−0.31	0.32	0.33	0.73
Regime – war with third country	Two democracies	−0.60	0.41	0.14	0.55
	Two autocracies	−0.51	0.16	0.001	0.60
	Missing regime data	0.07	0.19	0.71	1.07
−log- likelihood		1720.8			

discussion of the methodological problems in 'Dangerous Dyads' provides at least two possible explanations: Firstly, Bremer's finding may partly be a spurious effect caused by correlation between the increasing share of democracies and the increasing size of the international system (see Section 3.2). Secondly, his p-values are likely to be biased because of serious problems with inter-dyad dependencies.

Table III shows that the 'autocratic peace' indicated by the results in Table II is entirely a diffusion phenomenon: the politically mixed dyads (the reference category) have the highest hazard of war only when there is a risk of war diffusion. The result is clearly significant (p-value = 0.001). Can the explanation of this phenomenon be that democracies have a higher tendency to join wars, as suggested by Gleditsch & Hegre (1997, p. 294)? If a war starts in an autocratic or politically mixed dyad, and other democracies join in the fight against the autocracy in that dyad, this will increase the number of politically mixed dyads at war, but not the number of autocratic dyads. The two world wars, the Korean war, and the 1991 Gulf War all exhibit this pattern.

Within the framework of our diffusion variable *War with third country*, this situation can be modelled as follows: consider the dyad *ab*. If there is a third country *c* at war with *a*, and the reasoning above is correct, we would expect the probability of war in *ab* to depend on whether *b* and *c* are democracies, autocracies or a politically mixed dyad. To test this hypothesis, we defined two new WTC categories: *a* at war with *c* and both *b* and *c* democratic (WTC 5), and *a* at war with *c* and both *b* and *c* autocratic (WTC 6). Since WTC 5 or WTC 6 implies (at least one of) the categories WTC 1-WTC 4, the WTC 5 (WTC 6) parameter must be interpreted as an *additional* diffusion effect for the dyad *ab* in the case that *bc* is double democratic (double autocratic). For example, if *bc* is an allied (WTC 2) and double democratic dyad (WTC 5), the change in the hazard of war relative to a non-diffusion situation is $\exp(\beta_{'\mathrm{WTC}\ 2'} + \beta_{'\mathrm{WTC}\ 5'})$. The results of our third model are presented in Table IV.

The estimates for the WTC 5 and WTC 6 parameters are high and extremely significant – the log-likelihood has increased by 55 points compared to Table III. If some country *a* is at war with a democracy *c*, the probability of war between *a* and another democratic country *b* is nine times higher than if *b* were an autocracy! This result is hardly surprising, though. We know that democracies have sided with each other in multination wars like World Wars I and II, the Korean War, and the Gulf War. The tendency for autocracies to join autocracies is also substantial: The probability of war in the dyad *ab*, given that *a* is already at war with some third country *c*, is three times higher if *b* and *c* are both autocracies than if *bc* is a politically mixed dyad. The effect of regime is negligible in these situations; if *a* is at war with *c*, what matters is the regime characteristic of *bc* not that of *ab*.

In *non-diffusion* situations, dyads consisting of two democracies have an estimated 59% lower probability of war than the politically mixed dyad, whereas double autocratic dyads have a 13% higher probability. However, contrary to Table III, neither of these estimates is statistically significant. We have no good explanation for the rather substantial change in the estimate of 'Two democracies – *no* WTC' (from −1.23 to −0.88) when including WTC 5 and WTC 6. But a close examination of the variance-covariance matrix reveals that this is due

Table IV. Estimation Results with Regime Effects on War-joining.

Variable (X)	Category ('x')	$\hat{\beta}_{'x'}$	Standard deviation	*p*-value	exp ($\hat{\beta}_{'x'}$)	High-relevance/ Low-relevance ratio ($N = 150$)
Regime – no war with third country	Two democracies	−0.88	0.60	0.14	0.41	
	Two autocracies	0.12	0.25	0.63	1.13	
	Missing regime data	−0.02	0.33	0.95	1.02	
Regime – war with third country	Two democracies	0.03	0.43	0.94	1.03	
	Two autocracies	0.05	0.21	0.81	1.05	
	Missing regime data	0.71	0.22	0.001	2.03	
Contiguity	Non-contiguous	−0.88	0.18	<0.001	0.41	31.0
Major powers	Two major powers	0.72	0.22	<0.001	2.05	26.4
	One major power	0.64	0.14	<0.001	1.90	
Time in peace	exp(−Days in peace / 3,162)	0.84	0.23	<0.001	2.32	
War history	Past war	0.97	0.15	<0.001	2.64	
Alliance	Defence pact	−0.82	0.22	<0.001	0.44	5.7
	Non-aggression pact	−0.63	0.40	0.74	0.53	6.9
	Entente	−1.49	0.51	<0.001	0.23	2.9
War with third country	WTC 1: *a* at war with *c* and *b* contiguous to *c*	1.37	0.17	0.001	3.94	50.7
	WTC 2: *a* at war with *c* and *b* allied with *c* in a defence pact or entente	2.68	0.18	0.001	14.59	187.8
	WTC 3: *a* at war with *c* and *b* allied with *c* in a neutrality/ non-aggression pact	−0.09	0.27	0.74	0.91	11.8
	WTC 4: *a* at war with *c*	1.27	0.30	0.001	3.56	
	WTC 5: *a* at war with *c* and both *b* and *c* are democratic	2.23	0.20	0.001	9.30	
	WTC 6: *a* at war with *c* and both *b* and *c* are autocratic	1.06	0.15	0.001	2.89	
γ		0.51	0.06	0.001	1.67	
−log-likelihood		1665.7				

For each variable *X*, exp($\beta_{'x'}$) is, ceteris paribus, the hazard of war for a dyad in category 'x' relative to a dyad in the reference category, provided that both have equal relevance. γ is the relevance-adjustment parameter (see Section 5).

to a complicated correlation pattern between several parameters.

7.2 *Control Variables*

From Table IV, column 4, we see that contiguous dyads have an estimated probability of war which is approximately twice as high as non-contiguous high-relevance dyads, and the effect is clearly significant. A similar effect is found for 'Two major powers'. When interpreting *Time in Peace*, note that values close to 1 on this variable correspond to a short time in peace, whereas values close to 0 correspond to long peaceful coexistence (cf. Section 6.3). The positive parameter estimate confirms that the longer the dyads have experienced peaceful coexistence, the lower the probability of war. Dyads that have coexisted peacefully as system members less than one year are estimated to have twice as high a hazard of war as dyads with peaceful relations for at least 40 years. If the peace period was preceded by a war between the two states, we get another doubling of the hazard of war.

Bremer and Maoz & Russett both concluded that alliances reduce the probability of war in the dyad, but they did not distinguish between the different types. As expected, we find that states joining together in a defence pact have a significantly lower probability of fighting each other. Somewhat surprisingly, signatories in ententes have an even stronger tendency to keep peace between themselves. We have no good explanation for this effect – perhaps this is a type of alliance most often signed between countries that have no obvious clash of interests, and in times of relative peace.

The third class of alliance is fundamentally different: Signing a non-aggression pact actually implies that there are conflicting interests among the signatories, and is frequently only a device for 'buying time' in the diplomatic game leading up to war – the 1939 Molotov–Ribbentrop pact being a prime example.

Our distinction between high-relevance and low-relevance dyads is, indeed, justified. The estimate of γ (the relevance-adjustment parameter) is 0.51. The parameter is sharply identified; the standard deviation is only 0.06. $\hat{\gamma}$ is significantly different from 0 – but also from 1 (cf. Section 5): the estimate indicates that the probability of war in a low-relevance dyad decreases by a factor close to $\frac{1}{\sqrt{N_t}}$ rather than to $\frac{1}{N_t}$. As can be seen in the right-hand column of Table II, the adjustment is substantial: Contiguous dyads have a 31 times higher hazard of war than non-relevance dyads in a system of 150 states. Since $\gamma > 0$, the probability of war in a dyad randomly chosen from the set of all low-relevance dyads decreases as the number of dyads increases. However, since $\gamma < 1$ an increasing share of all ongoing wars seems to be in the low-relevance dyads. In this sense, our operationalization of the concept of relevance is not entirely satisfactory.

To examine how robust our findings are regarding the low-relevance/high-relevance classification of dyads, we re-estimated the model with $\gamma = 0$, i.e. no discrimination between low-relevance and high-relevance dyads. Neither parameter estimate changed much (hence we do not report them). As anticipated, the democratic peace is strengthened when we do not control for relevance, but the change in estimate (from -0.88 to -0.95) is small. The most dramatic effect of not adjusting for relevance is a 45 point decrease in the log-likelihood function, a drastic worsening of the fit of the model.

7.3 *The Baseline Hazard*

Figure 2 shows the estimated hazard function of the baseline dyad, which (at t) consists of two states that are (i) contiguous (and therefore high-relevance), (ii) one state is a democracy and the other an autocracy, (iii) they are not allied, (iv) there is no major power in the dyad, (v) they are old system members with no history of past war, and (vi) neither is at war with a third country (at t).

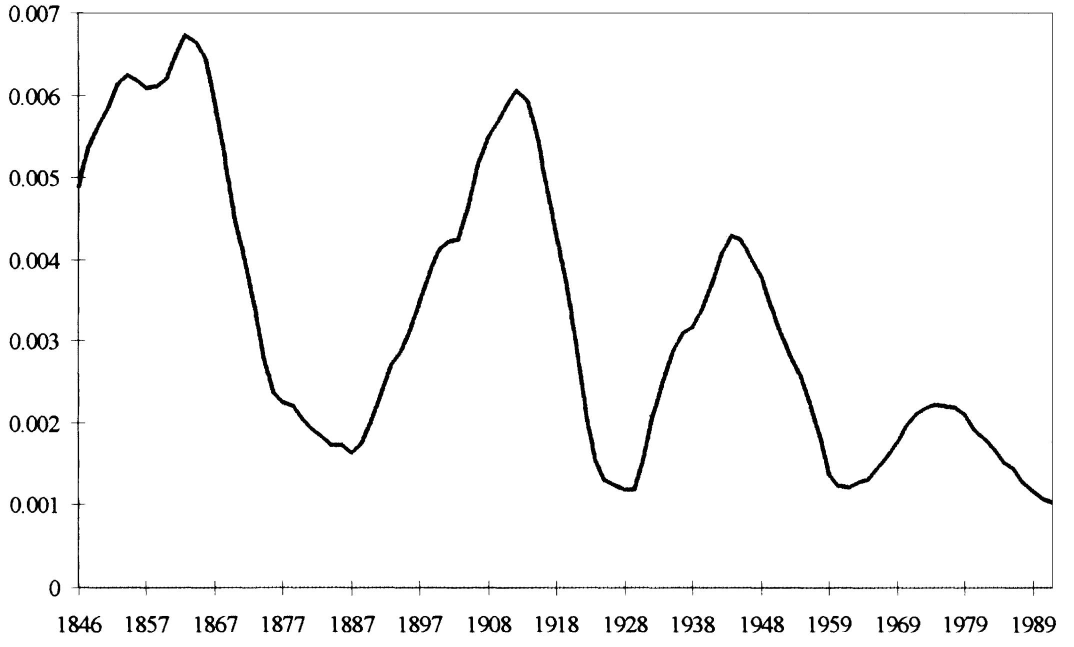
Most notable are the three peaks corresponding to the Seven Weeks' War, and World Wars I and II. Figure 2 also confirms that the probability of war is highly time-dependent, even when we control for our explanatory variables. There is also some evidence of a negative trend in the baseline hazard. This could be interpreted as a confirmation of the 'obsolescence of war' (Mueller, 1989). But one should be very careful when interpreting the baseline hazard, which depends critically on the model specification, in particular the choice of relevance criteria and the modelling of war diffusion. For example, a trend would occur if our relevance criteria are inadequate and unable to remove the negative trend in dyadic war probabilities generated by the increase in the number of states (cf. the discussion in Section 5). What might repudiate the latter hypothesis, though, is that the trend in Figure 2 seems to vanish after World War II, when the increase in the number of states was most dramatic.

The first war outbreak in our data set occurred in 1846, the last in 1991. These dates define the time-span for the estimated baseline hazard.

8. *Discussion*

The results in Table IV show that the regime variable is not significant at the 5% level in either the diffusion or the non-diffusion situation. A closer examination of the data reveals that there are four instances of war onset between democracies in our data set, and at least two of these are debatable (see Gleditsch & Hegre, 1997, pp. 286–288, and Ray, 1993). The Turkish invasion of Cyprus in 1974 accounts for two of the four cases, although this is clearly a

Figure 2. Estimated Baseline Hazard, 1846–1991



The figure plots the estimated probability of an outbreak of dyad war during one year for the baseline dyad.

miscoding since Cyprus suffered a Greek-instigated coup d'état just prior to the Turkish invasion. The remaining two are the Spanish-American war in 1898, and the Lithuanian-Polish war in 1919–20. Removing dubious cases of wars between democracies would obviously strengthen the democratic peace finding. Of course, these anomalous cases of war have received much closer attention than other possible anomalies. But it seems highly unlikely that an investigation would throw into doubt as large a share of the 40 cases of war onset between autocracies as the case is for double democratic dyads.

The motivation for modelling war diffusion in the first place was to account for dependence between units when testing statistical hypotheses about the democratic peace. Our diffusion variables enabled us to study inter-dyad interactions, not only relations within the dyad, and, as a spin-off, we have been able to improve on Siverson & Starr's (1990) model of war diffusion. More importantly, we have discovered a distinct contrast between the war-joining behaviour of democracies and autocracies: democracies tend to join democracies in their wars, whereas – although to a much lesser extent – autocracies tend to join other autocracies.

Democracies' war-joining can be seen as an integrated part of the democratic peace: If an interstate war starts in a mixed dyad, and democracies have a strong tendency to participate on the same side in the conflict, this will create few dyad wars between democracies. It also explains why democracies may be as war-prone as autocracies; the democratic peace means that democracies keep peace among themselves, not that they are peaceful. These features of the relations between democracies make them distinct from other regime types. Of course, the nature of these relations is not just due to their sharing a political system. The group of democracies is also heavily interdependent (see Keohane & Nye, 1977).

The only trace of an autocratic peace, we find, is the tendency of autocracies to join each other in wars: The difference between the politically mixed and the double autocratic dyads found in Table II is a mere artifact of the regime types' war-joining behaviour.

In view of our results, what are the most likely implications on the system level of a democratizing world? Our results indicate that there will be a decreasing frequency of war onsets, but that the wars that do start may evolve into multination wars. This prediction also fits well into the literature on increased interdependence.

9. *Conclusion*

This article has identified methodological weaknesses in the empirical studies of the democratic peace, as exemplified by Bremer (1992a) and Maoz & Russett (1993). We have proposed a more suitable approach, in particular emphasizing the importance of modelling inter-dyad dependencies due to diffusion of war.

In our first analysis, we replicated the findings of Maoz & Russett (1993, p. 632); that dyads consisting of two democracies have a significantly lower probability of war than other dyads, when controlling for contiguity, alliances, power status, time of peaceful coexistence in the dyad, past wars, and war diffusion. To model war diffusion, we coded for all dyads *ab* whether there existed a third country *c* that was at war with one of them, *a*, and related to the other, *b*, in some way: either contiguous to, or allied with, or just present in the international system at the same time. Our results show that war diffusion is extremely important for the probability of outbreak of war in a dyad.

We also confirmed the finding in Gleditsch & Hegre (1997, p. 292) that dyads consisting of two autocracies have a significantly lower probability of war than politically mixed dyads. We found this result paradoxical because there is nothing in the theoretical explanations for the democratic peace that implies that there should be any difference between the mixed and the double autocratic dyads.

In order to resolve this paradox, we refined the model focusing on war diffusion. Firstly, we distinguished between regime type in a situation where there is *no* risk of war diffusion, and regime type when there *is* such a risk. The first case corresponds closely to a situation where an outbreak of war would mean 'war onset' in the sense of Bremer (pp. 320–321). Secondly, we introduced a further decomposition of the war diffusion variables. In addition to coding whether *bc* was contiguous, allied, or coexisting, we entered information on the combination of regimes in this dyad; are *b* and *c* two democracies, two autocracies, or politically mixed?

These refinements altered the results dramatically: We found that (i) democracies have a much stronger tendency to join other democracies in their wars than to join autocracies, (ii) autocracies have a stronger tendency to join other autocracies than to join democracies, (iii) in a diffusion situation the regime category of the dyad plays no role, and (iv) in a non-diffusion situation we can still identify a democratic peace (most 'war onsets' between democracies found in the data are anomalous cases).

The most distinct difference between democracies and autocracies becomes visible when studying war diffusion: democracies tend to join democracies in their wars, whereas – although to a much lesser extent – autocracies tend to join other autocracies. This suggests a reinterpretation of the democratic peace. In times of war, the democratic peace is manifest as a tendency of democracies to collaborate, and hence characterizes the dyad's relationship to the outside world (i.e. to other dyads) rather than the relations within the dyad itself. Consequently, we have identified two aspects of the democratic peace: (i) a tendency that democracies do not start new wars against each other and (ii) a strong inclination towards collaboration in times of war. The latter phenomenon explains why democracies are as war-prone as autocracies.

APPENDIX: THE DATA

Compilation of the Data-File

We have made use of the Correlates of War Project data on interstate wars as well as on system membership, contiguity, power status and alliances. The diffusion variables were derived from the start dates and end dates for war participation in the interstate war data set, and from the alliance and contiguity data sets. The intra-dyad stability variables were calculated from the dates for end of war participation in the interstate wars. To allow all dyads an 'exposure time' of at least 24 years, we analyse only war outbreaks during the period 1840–1992.

The war and regime data are coded by day, enabling us to code the diffusion and intra-dyad stability variables very precisely. Data on alliances specify the month of signing treaties. The other variables are coded by year in the original sources.

When compiling the data-file, all wars were identified, since these also identify the set of t_w's – times of which we need to know the values of the explanatory variables. The Cox regression model requires that all t's are unique – that no dyad wars start simultaneously (i.e. ties). The Correlates of War data set is coded by day and as many as three-quarters of the dyad wars form ties. We have solved this by first using the information on initiator in the data set to split the ties in a group containing an initiator country and a group without initiators. Within these groups, we have ordered the ties sequentially by a random procedure, and thus defined the dyad wars to follow each other within the same day – first the initiator dyad wars and then the non-initiator dyad wars. The diffusion variable was coded as when the diffusion process takes place over several days. Another solution to the ties problem would be to treat them as simultaneous and independent events.

Then, for each t_w, we coded the values on the explanatory variables for each dyad in the risk set, i.e. the dyads that are system members at t and not already at war; 343 dyad wars and a risk set varying from 666 dyads in the first war outbreak in 1848 to 15,576 in 1991 yielded a data-file of 965,166 cases.[15]

The Dependent Variable: Dyad War

As a basis for coding dyad wars we used the Correlates of War Project data set on interstate war. This includes all wars causing more than 1,000 battle deaths per year, see Section 2. Based on the project's coding of each country's participation we created a data set that included all pairs of countries that simultaneously were on opposite sides of a war. This transformation procedure yielded a total of 343 dyad wars in the period 1840–1992. Re-entries in the same interstate war were counted as new dyad wars, since there is some arbitrariness in Small & Singer's distinction between war re-entry and outbreak of a new war. For example, Small & Singer code the first Schleswig-Holstein war between Germany and Denmark in 1848–49 as starting on 10 April 1848 and ending on 26 August 1848. Then both participants re-entered what is coded as the same war on 25 March 1849. When Denmark and Germany resumed fighting after fifteen years of peace in 1864, COW has coded this as a new war. This war also had a break and a re-entry. Small & Singer may have good historical reasons for distinguishing between pausing a war and starting a new one, but to avoid inconsistencies it seems better for our purpose to code each re-entry as a new dyad war. The Schleswig-Holstein wars thus make up four dyad wars in our data-file.

The threshold for a participant in a war is low compared to the threshold for war itself: A country is counted as a participant if more than 1,000 of its troops were involved, *or* if the country lost more than 100 people on the battlefield. Because of this, an unknown number of our dyad-wars have a low number of casualties. We positively know that not only was there no fighting between Finland and the US in 1941–44, but the two countries were not even formally at war (Gleditsch, 1995, p. 552). However, the COW data set simply puts all participants in multi-country wars into two opposing camps. Thus, the dyad wars are very heterogeneous. In addition, in transforming the data set, the distinction between the Correlates of War data set on Militarized Interstate Disputes (MIDs) and the war data set is misleading: Many MIDs that do not meet the threshold for the war data set, because they involve too few casualties, consist of dyad wars with a higher number of casualties than the least bloody dyad wars derived from the war data set. This inconsistency has to be addressed at some point. The ideal solution would seem to be to code both the wars and the MIDs at the dyad level.

Major Powers

The COW project has coded the following countries as major powers: Austria-Hungary 1840–1918, France 1840–1940 and 1945–94, Germany 1840–1918 and 1925–45, Russia/USSR 1840–1917 and 1922–94, United Kingdom 1840–1994, Italy 1860–1943, Japan 1895–1945, United States 1899–1994, and China 1950–94.

Alliances

The Correlates of War Project lists three types of alliances (Singer & Small, 1966, p. 5):

- *Defence pacts:* where the signatories are obliged to intervene militarily on the side of any treaty partner that is attacked militarily.
- *Neutrality and non-aggression pacts:* where the signatories are to remain neutral if any co-signatory is attacked.
- *Ententes:* where the signatories are obliged to consult and/or cooperate in a crisis, including armed attack.

The COW Project has recorded the month and year of signing and ending alliances, but not the day. We have arbitrarily assigned the 15th of the month as the day of signing or leaving the alliance.

NOTES

1. Spiro (1994) and Farber & Gowa (1995) are the prime examples. Their articles have given rise to a heated debate in following issues of *International Security*. See also Thompson & Tucker (1997) with reply and response. Gates & McLaughlin (1996) and Beck & Tucker (1996) also treat methodological problems in the democracy and peace literature.
2. However, this doesn't hold if a state declares war against several states on the same day, which is an example of a 'tie' – a truly simultaneous event. Our 'solution' to the ties problem is discussed in the Appendix.
3. This problem is also noted by Gates & McLaughlin (1996), but they offer no solution to it.
4. See Gates & McLaughlin (1996) for exact figures. They propose and analyse a wider set of politically relevant dyads. This is only a marginal improvement over Maoz & Russett, however, since their data set still excludes 18% of the interstate wars.
5. Cox regression is a feature of many statistical packages, although we know of none that is able to handle our time-dependent explanatory variables. The model was proposed by Cox (1972); good introductory descriptions can be found in McCullagh & Nelder (1989) and Collett (1994).
6. That is, the dyad is formed by two states that are both system members at time t.
7. For a further discussion on the relationship between war probabilities at different *levels*, see Gleditsch & Hegre (1997, pp. 298–304)
8. This echoes Bremer's (1992b) distinction between *situational factors, national attributes*, and *systemic conditions*, although systemic conditions are not included in this analysis.
9. We ran the analysis with all three categories, and confirmed that defence pacts and ententes work in the same direction (although, surprisingly, ententes turned out to have the strongest effect). Similarly, the two categories both had a positive impact on the probability of war diffusion (see Section 6.2).
10. Our decay rate implies that the effect of a previous war is reduced to one-sixteenth of the effect of the first month after 24 years.
11. Our approach does not entirely follow the literature on enduring rivalries (e.g. Goertz & Diehl, 1992; 1993). In our model only the most recent conflict is assumed to have an effect, not the conflict preceding it or the fact that two countries have been at loggerheads over the past 50 years. We have chosen this approach partly because we do not think there is an intrinsic difference between having had one or several conflicts, and partly because our purpose is only to model a realistic background for testing hypotheses about democracy and peace.
12. Maoz & Russett also make use of a continuous measure of democracy in the dyad; JOINREG. This measure is not very useful since it measures similarity in regimes (that is, the degree to which they obtain the same score on the REG index; not similarity in institutional structure) more than it measures the degree of democratization in the dyad.
13. In the version of Polity IIId available at the time of writing, only the regime changes identified in Polity III have been re-dated. Moving from country-years as unit of analysis to 'polities' – periods with no change in a state's regime characteristica makes it possible – and necessary – to treat polities with a duration much shorter than a year. Since Polities II and III wanted to characterize the regime of all states for given *years*, such short-lived polities created a dilemma: Should they choose the polity at the beginning of the year, the one in the middle or the one at the end? Consequently, short-lived polities are not always registered in Polities II and III. With the new design, this problem can be solved in future updates of Polity. In our context, the military coup d'état which overturned the elected government in Cyprus in 1974 is a well-known and important case. The coup was followed by the Turkish invasion only five days later. This is thus erroneously coded as a war between two democracies. Waiting for a systematic recoding of these cases, we have not made any changes to the Polity IIId data set, and have retained the Turkish-Cypriot war as a war between two democracies. It is often impossible to assign an exact date for regime changes: the transition may be gradual, or it may be difficult to choose which one of a series of distinct events signals that a new polity has been established. In Polity IIId, all regime changes have been assigned a code for the level of precision of the dating. When the date assigned was chosen among more than one candidate, we have used the Polity IIId date. Gradual changes are more problematic. We identified all 42 changes from one of our regime categories to another where the level of precision was 'within the year' or 'within the month'. Nine of those coincided with an interstate war somewhere in the system, but only two got involved in new dyadic wars during the period of transition/uncertain coding: Belgium changed from 'occupied' to democracy at some time during 1915, and the Philippines changed from autocracy (with a democracy score of 4) to democracy (6) during 1950. When Bulgaria entered WWI in October 1915, we coded Belgium as still occupied. Somewhat arbitrarily, we assigned 1 January as day of change for the Philippines. Its participation in the

Korean war was thus coded as a democratic participation.

14. For the variable *Contiguity*, since the baseline dyad here is high-relevance, this ratio is $\exp(-\beta_{Non\text{-}Contiguous} + \gamma \ln N_t)$. For all other variables the ratio is $\exp(\beta_{x'} + \gamma \ln N_t)$. Note that, when calculating the ratio in Table II, the high-relevance dyad is always in the nominator.
15. Note, however, that 965,166 is not the N in our analysis. All these cases (except the 343 dyad wars) contribute to the sum in the denominator in expression (2), Section 4.

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