Where's Waldo?
The Search for the Elusive Relationship Between Population Growth and International Conflict *

Skyler J. Cranmer
University of California, Davis
And Harvard University

Randolph M. Siverson
University of California, Davis

December 15, 2006

Abstract

We examine the propensity of states to be involved in international conflict conditioned on three primary explanatory variables: percentage change in population over varying lags, democratic status of the state, and major power status of the state. Our aim is to have a better understanding of the effect of population growth on conflict involvement. We posit that the responsiveness of a government to the needs of its citizens is sufficiently important that the effect of population growth cannot be properly examined independently of democracy and that major powers tend to become involved in disputes for a much wider set of reasons than minor powers. Thus, we expect to find the strongest effect of population change on conflict participation and initiation in democratic minor powers. A series of Poisson and negative binomial regressions over 20 yearly time lags lends robust support to our expectations. However, contrary to what we anticipated, the effect of population growth on dispute participation and initiation in minor power democratic states is relatively rapid. Finally, when conflict is over the issue of territory, population growth has an impact on both participation and initiation for all types of regimes except major power democracies. This is most pronounced in the period after the end of World War I. We conclude with a discussion of the implications of our results.

*We express our thanks to Colin Cameron, Paul Diehl, Jeff Gill, Cindy D. Kam, Lanny Martin, Richard Stoll, Jaroslav Tir, James L. Ray and Michael Ward for helping us try to do things the right way. We also thank John Daniels of the UC Davis Social Science Data Service for his generous help with data manipulation.

There is no shortage of research on the consequences of population size and rates of population growth. It covers a broad spectrum of concerns, many of which relate to the problem of sustaining life without destroying the environment that supports it. A subsidiary concern in this literature has focused on the consequences of population growth for various political phenomena, including its possible contribution to the onset of international conflict. The basic question that motivates much of this research is, does an increase in a state's population increase the probability of its participation in international conflict?

That question is at the center of our inquiry. We approach it in the following manner. In the first section, we outline the basic empirical literature on the relationship between population change and international conflict. In that same section we also describe how our research both complements and differs from the most comprehensive and rigorous previous empirical treatment of the subject by Tir and Diehl (1998). We also present the reasoning behind our expected results, which differ in part from theirs. In the second section we describe our data, research design and method of analysis. In the third section we present our analyses, using a series of graphs for the main results. In the final section we reflect on what has and has not been shown in the analysis.

1 Population Growth and Conflict

While there is empirical research on the question of population growth and international conflict, the results are mixed. Wright (1955), after extensive empirical research, concluded that "population pressures never create a necessity to go to war though they may create a *necessity for action*" (p. 363, emphasis added). More recently, the research of Choucri and North (1975) stands out. They hypothesized that the conflict behavior of states was powerfully shaped by changes in three master variables: population, resources and technology. In brief, as the population of a state increases there are corresponding increases in the material needs of this population and that these are supplied by the application of technology to resources. When population and technological

growth outstrip the resources available, states will often look outside their borders to solve the problem, resulting in what Choucri and North term "lateral pressure." Some states will export population, but more frequently they turn to trade or the use of force to acquire what they need, including more territory. While our brief description does not do justice to the full complexity of Choucri and North's treatment of the process that can generate lateral pressure, it nonetheless conveys the central place in its logic for the idea that population growth may lead to conflict. Their research–first on World War I and the great powers and later on Japan in the period before World War II (Choucri, North, and Yamakage, 1992) – traces out in detail the positive effects of population growth on the needs of the state that may have contributed to war.

This, to be sure, is only one of the several sets of ideas about population growth's consequences for international conflict. Tir and Diehl (1998), for example, mention two others: resource scarcity and the contribution of population size to military capability. Krebs and Levy (2001) in their almost encyclopedic review of the topic add to this list by identifying the possible effects of population growth on communal conflict and international migration, which can themselves lead to international conflict.

While there is a fairly rich theoretical and conceptual literature on population growth and international conflict, there are difficulties in empirical attempts to test the link. Although Choucri and North have strikingly portrayed the effects of lateral pressure on the tensions that produced World War I, their conclusions, as noted by Tir and Diehl (1998, p. 326), are difficult to accept with full confidence, inasmuch as they are the result of a research design that contains selection bias. That is, the states whose behavior they observed were the states known *ex post* to have participated in World War I. States whose population may have changed since 1870, the beginning of their empirical domain, but that did not participate in the war's outbreak, such as, among many others, Spain, Sweden, the United States, Japan or many others, were not included in the research design. Thus no matter how persuasive their theory or innovative their data analysis, it becomes somewhat problematic to make a causal argument about the role of population change in the onset of international war.

Moreover, many studies that have examined significantly broader numbers of cases report either no or weak relationships. As described by Krebs and Levy (2001): "Reviewing the literature of the last several decades, one is struck by how little progress has been made since Wright wrote on the subject over forty years ago." Similarly, Tir and Diehl (1998) note: "Although there has been a fair amount of theorizing concerning the connections between population pressures and international conflict, the empirical evidence in support of the propositions is scant, largely because of the limited systematic research available on the subject."

Tir and Diehl set out to rectify this. They approached the relationship of population growth and international conflict by applying a rigorous research design to a widely accepted data set that covered a large number of states over the period 1930-1989 (Tir and Diehl, 1998). Reasoning plausibly that the effects of population growth will not turn up immediately, Tir and Diehl use "the percentage rate of change across the ten years prior to the year under study." In their test they also employed a number of control variables, such as the state's military expenditures, energy consumption and its number of borders. Because the dependent variable was any militarized interstate dispute (MID) in which a state participated they used logit analysis. They investigated a number of hypotheses, including the following: "The greater the growth of a state's population, the greater the probability of that state being involved in international militarized conflict" (Tir and Diehl, 1998, p.328). Note that this hypothesis does not center around evaluating any of the specific theories in which population growth is embedded. Their goal, and the one we adopt here, is simply to examine whether there is any reason to think that population growth itself is linked to international conflict.

Their results with respect to this hypothesis are straightforward, showing a statistically significant coefficient for the effect of population growth of .01 on dispute onset (with a standard error of .003 and a corresponding p of .001). When they examined the marginal effect of this result, they report the average rate of population change over a ten year period appears to increase the probability of a state's participation in an international militarized dispute by about seven per cent. More importantly, after they

partitioned the data into major and minor power states, they demonstrated that the observed effect is largely confined to the latter.[1] Their explanation for the fact that the major powers do not show an effect for population pressures on dispute involvement is that because of the position they occupy in the international system these states have many more opportunities to become involved in conflict than minor powers. Thus the effect of population growth, if any, gets lost in the noise of major powers doing what major powers typically do.

We report here an extension and modification of the research of Tir and Diehl on the relationship between population growth and international conflict. It is an extension of their work in five ways. First, our data cover the time period 1816 to 1994, a considerably longer period than they explored. Second, while we agree with their basic premise that population pressures will not have an immediate affect on the conflict behavior of states, it seems unreasonable to expect that any political system will respond to the gradual pressures of population change with rapidity. Because we have little in the way of theoretical or empirical guidance, except for the results reported by Tier and Diehl for the ten-year lag, we analyze data on twenty lags, ranging from one year to twenty years.

Third, the data used by Tir and Diehl were effectively a pooled cross sectional time series, but they were not treated as such, probably because the methods for this type of analysis were not well known when the research was reported. We take advantage of what is now known in the literature and available in statistical packages about analyzing panel data. Briefly, we capture random effects in the data by using a dummy variable for each year covered in the analysis and we cluster on the state identities (i.e., country codes) to capture the lack of independence in the observations of the individual states across time.

A fourth difference between this research and that of Tir and Diehl is the nature

[1]This is only a brief summary of the full scope of Tir and Diehl's research. They not only looked at the effect of population growth over a ten year period, but they examined, as well, the growth of urban population and the presence of both population growth and urban population growth given conflict. That is, when there was a dispute, what was a state's past rate of growth for population and urban population.

and measurement of the dependent variable. The militarized interstate dispute data set has a number of disputes that are of little or no consequence. Indeed, some of the disputes in the data set are of so little import that they do not record a response from the target. Does it make sense to think about these as being the dependent variable of interest? We think not, and so we center our attention on those disputes minimally involving the display of force, that is, MIDs at level 3, 4 and 5. In addition, as we explain below, to gain more information we use a count of the number of such disputes a state enters into in a year. We also report separate analyses in which the dependent variable is (1) the number of annual state participations in disputes, (2) the number of annual dispute initiations and (3) the number of annual dispute initiations when the issue of the conflict is territory.

If population growth in a state has an impact on dispute involvement, our expectation is that it will be least pronounced in the case of dispute involvement and more pronounced in the case of dispute initiation. Involvement in disputes can take place for many reasons not having to do with population growth, and so we expect this effect to be weak relative to the other dependent variables. However, when population growth creates, as Wright put it, the "necessity for action" states are likely not just to participate in disputes, but to be the initiator. We comment on the involvement in territorial disputes below.

A fifth difference relates to the possible effect of the political institutions of the state. Despite the cottage industry that has developed around the idea that democratic states pursue different policies from their non-democratic counterparts, the research on population change and conflict has not, insofar as we are aware, differentiated the effects of population growth across different types of political systems. This is so in spite of the fact that there is more than ample reason to suspect that some types of political systems might be much less responsive than others in the provision of the resources needed by a growing population. For example, states with small winning coalitions (that is, institutional monarchies and autocracies) will, as argued by Bueno de Mesquita et al. (2003), be inclined to provide private goods for the cronies of the

leader within the winning coalition rather than public goods for the larger group that makes up the politically relevant portion of the population, the group they term the selectorate. The latter group typically has little to do with securing the tenure of the leader and, consequently, is less likely to find its needs fulfilled. In essence, the political system's structure makes it easier for the political elite to ignore or repress needs that might exist because of increasing population.

Democratic states, that is, those with large winning coalitions, have institutions that encourage leaders to provide for the welfare of large numbers of people. Leaders who do not do this expose themselves to an increased risk of removal. To be sure, we agree with Tir and Diehl's observation that minor powers will more sharply reveal the relationship between population increase and conflict, but here we also explore the possibility that minor power democratic states with high rates of population growth will be more inclined to participate in militarized interstate disputes than democratic and non-democratic major powers and even non-democratic minor powers.

There is, however, a large part of our argument that runs counter to the theoretical structure given by Bueno de Mesquita et al. since they contend that states with large winning coalitions will be disinclined to enter into disputes over territory, which is a private good (pp. 405-55). Why do we then expect there to be a positive relationship? Their statement is a general one, and the argument we put forward is that under the special circumstance of a growing population there may be a greater inclination to engage in territorial disputes than when population is not increasing substantially.

2 Research Design

Much of our research design is explained in the section above; here we provide some missing details with respect to the states that constitute the data to be analyzed, the measurement of population growth, the nature of the lags, the measurement of democracy, and the form of the statistical analysis.

The states that constitute the basis of our study are those contained in the Corre-

lates of War data base. We identified them and obtained data on their total population in each year between 1816 and 1994 through the use of EUGene (Bennett and Stam, 2000). As mentioned above, a key covariate in the analysis is the percentage change in population over several lag lengths.[2] This variable simply measures the percentage change in population growth over a number of years equal to the lag length used. We computed this quantity for all lag lengths from 1 to 20.

We created a dummy variable for democracy by subtracting a state's autocracy score from its democracy score. This resulted in a 21 point scale ranging from -10 to +10, and those states with a resulting positive score of 4 or more were assigned a 1. Those whose score was less than 4 were assigned a 0. The missing data codes of -66, -77 or -88 were given 0; those codes cover several circumstances, none of which can be characterized as institutionally democratic. We created a dummy variable for the major powers, as given in Small and Singer (1982) and continued in EUGene, in which the major powers were assigned a 1 and all other states were given a 0.

As we stated above, many recent studies of international conflict have used a dummy variable to indicate whether a dispute took place or not. Indeed, it may be seen as the standard approach to the measurement of international conflict. In a dyadic context, where disputes are relatively rare events, this probably makes sense; more than one dispute a year between two states in a particular dyad is likely be rare. However, in a monadic context this is not necessarily the case. For example, depending upon the lag in use, our data cover approximately 8,500 to 11,000 nation-years of data. These data contain 2,335 national dispute participations with hostility levels of 3 or greater. These are tabulated in Table 1. In these data, just over 13.5 per cent of the cases contain a dispute of interest to us. As compared to dyadic studies, where disputes may take place in about one per cent of the cases, what we see in the data are events that are not nearly as rare. In addition, as can be seen in Table 1, a not inconsequential

[2] $$\text{Percentage Change in Population} = \frac{P_t - P_{t-\ell}}{P_{t-\ell}} \times 100.$$
where P is the population variable, t is the time period, and ℓ is the lag length.

number of the states participated in more than one dispute in a year. More precisely, of the total 2,325 disputes, 1127 (48 per cent) took place in the context of a state becoming involved in more than one dispute in a single year. This does not count the continuation of ongoing disputes.[3]

Count data of the kind displayed in Table 1 may be analyzed by the Poisson or negative binomial models. Because of considerable over-dispersion in the data we use the negative binomial on the participation and initiation counts and the Poisson on the far less dispersed territorial dispute initiations (Cameron and Trevedi, 1998).

N	**Freq.**	**Percent**	**Cum.**
0	10,241	86.41	86.41
1	1,198	10.11	96.52
2	278	2.35	98.86
3	83	0.70	99.56
4	22	0.19	99.75
5	11	0.09	99.84
6	7	0.06	99.90
7	2	0.02	99.92
8	1	0.01	99.92
9	2	0.02	99.94
10	2	0.02	99.96
11	1	0.01	99.97
14	2	0.02	99.98
15	1	0.01	99.99
23	1	0.01	100.00

Table 1: Annual Number of Militarized Interstate Disputes at Hostility Levels 3, 4, and 5.

To explore the effects of population growth on conflict conditioned on political system types and power status, we construct three variables. Initially, we construct indicator variables for minor power democracies (scored 1 when the state is both a democracy and a minor power and 0 otherwise), minor power non-democracies (scored 1 when the state is not democratic and is a minor power and 0 otherwise), and major power non-democracies (scored 1 when the state is both a major power and not

[3]Perhaps surprisingly (at least to us) Iran in 1987 was the over-achiever, with 23 violent disputes, all of which were level 4. This was the height of the so-called Tanker War, which was part of the larger Iraq-Iran War, and involved Iranian attacks of a limited sort against ships registered under a variety of flags.

democratic and 0 otherwise). We then form an interaction by multiplying these indicator variables by the individual state's rate of population growth across the individual yearly time lags. We do not construct a similar variable for major power democracies, as including it would saturate the model; the estimates for these states, however, can be seen in the coefficients for population growth itself.

There are two other aspects of the analysis that merit mention. The first is the question of statistical significance. The data we use constitute a population of data rather than a sample; our dataset includes *all* recorded militarized interstate disputes between 1816 and 1994, not just a representative sample of them. As such, measures of significance such as p-values cannot be interpreted in the same manner they would be if our data were a sample. Instead, the confidence intervals we present in this paper may be interpreted as a measure of model fit rather than a measure of uncertainty in an inference. Specifically, p-values and confidence intervals cannot reflect uncertainty about an inference in this setting because there is no uncertainty about the "truness" of the trends in the data: the data are observed and all trends in them are factual.[4] The confidence intervals we present reflect the degree to which our model fits the observed data; small confidence intervals indicate that our model fits the observed data quite well, larger confidence intervals indicate the model fits the data less well.

A second aspect of our research that requires a bit of explanation is that our results are presented in something close to a control variable free environment. The relative absence of the "usual suspects" of control variables is due to two reasons. First, we take control variables seriously. By which we mean that in our view they are included in models to assess the possibility that the observed relationship between the independent variable and the dependent variable is not due to their mutual relationship but instead to some other variable or variables. This is a controversial, indeed even contentious, position as number recent papers demonstrate, but it is a position that we believe

[4]To argue that this statement is false implies that we can rewind and re-run history and infinity of times, making our observed history in this plane of existence a (potentially) representative run of history. This is, however, a more metaphysical position than we are willing to take.

is soundly rooted in the basic elements of research design.[5] To be sure, if there are variables that might plausibly be included, we should not ignore them in our analysis. Below we discuss the possible role of increasing national wealth on the relationship between population growth and conflict.

Second, we are at a loss to propose a set of factors that could be related to *both* population growth over the various lags in our analysis and the number of violent MIDs in which a state participates. Can we plausibly draw a theoretical or empirical link between, for example, the number of a state's alliances or its involvement in intergovernmental organizations and both population growth and conflict involvement? We think this is doubtful. Should we include the size of the state's military forces? Initially this might seem appropriate, since states with a growing population will have the opportunity to increase the size of the military. However, it is hard to imagine that the size of the military generally leads to population growth - although Baby Boomers will believe that demobilization does - and the size of the size the military is probably better seen as an intervening variable.

3 Results

Because of the exceptionally large number of coefficients potentially of interest, we display our principal results in so-called "rope ladder" plots of the coefficients for each of the independent variables across the time lags from 1 to 20.[6] Using the graphs will have the advantage of facilitating the comparison of coefficients across lag lengths. Each of the graphs displays the point estimate, a horizontal line representing its 95 per cent confidence interval, and, if zero falls between the lowest value of the lower confidence bounds and the highest value of the upper confidence bounds, a vertical

[5]We recognize there is a good deal of controversy on this point, but we find the position taken by Ray (2003, 2005) persuasive and have adopted it here. For a discussion of this issue, see the several papers in the special issue of Conflict Management and Peace Science (Kadera and Mitchell, 2005) on this subject

[6]We considered and discarded the idea of several big tables, each showing the values of the five main variables across the 20 periods; this struck us as unwieldy and more difficult to interpret. That is, they would be ugly and hard to follow. What we propose is, we think, easier to follow.

line representing it is included in the plot.

Figure 1 displays the results of the 20 analyses when the dependent variable is dispute participation. Across the various lags three results appear with consistency. First, democracy shows a distinct negative trend with reasonably tight confidence intervals, indicating that the model fits the data well. Second, major power status shows a distinct positive trend and also has reasonably tight confidence intervals. For these variables results similar to these will be repeated consistently below. However, in themselves they are not particularly interesting, since they represent the impact of democracy and major power status when population growth is zero.

Third, of the four types of political systems and power status combinations only minor power democracy population growth shows a positive effect on dispute involvement.[7] Further, note that the confidence intervals become smaller as the lag length increases. This trend in the confidence intervals indicates that, while even in low lag lengths our model is not a poor fit to the data, as lag length increases our model fits the data increasingly well. We must also note that the magnitude of this positive effect decreases as lag length increases. This general result is what we expected on the basis of our beliefs about the necessity of democratic states responding to the needs of the population. What we did not expect was for the effect to appear so quickly. That is, the strongest effect, which is a coefficient of .028, appears in the three year lag. However, while it appears relatively quickly, it persists over a long period. It is not until lag 13 that the size of the coefficient is cut in half (.017). None of the values for the other interactions come close to being informative.[8]

We now consider changes that might have taken place across time in the relationship between population growth and conflict participation. We do this for two related reasons. First, the number of minor power democratic states has not been constant. The number of democratic states increased sharply in the years following World War I.

[7]Recall that major power democracy population growth is captured in the population growth variable.

[8]Because so many of the cases involve no conflict participation, we also used a hurdle model in which the first stage modeled dispute participation and the second the number of disputes. The results from these are not materially different across those we report here and below. We are grateful to Lanny Martin for suggesting this procedure.

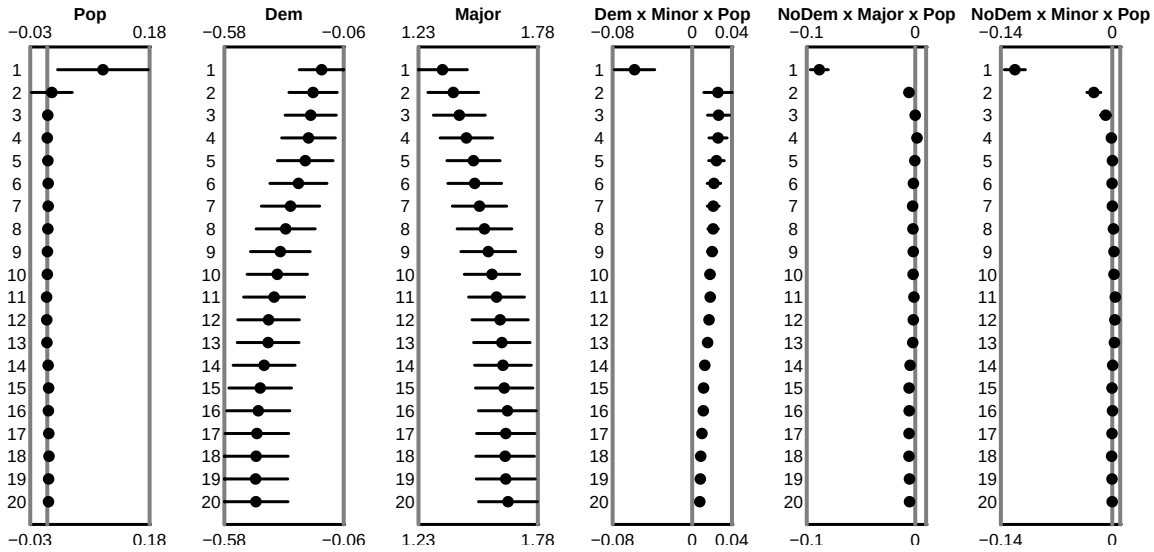

Figure 1: Negative Binomial Coefficients and Confidence Intervals for Annual Lags 1-20: Dispute Participation 1816-1994. The one-year lags show sharp positive effects of population growth for the democratic major powers (captured in the coefficient for per cent population growth), but the same lag for the other types of states are all negative. For subsequent lags the only enduring pattern is a positive relationship for the democratic minor powers that attenuates across time. The 95 % confidence intervals for the other types of states all include zero.

For example, in the year 1913 there are only 12 states in our data set (about 30 per cent of all the states) that qualify as democratic, and only nine of these are minor powers. However, by 1925 the number of democratic states had increased to 25 (42 per cent of the states), and 21 of these were minor powers. Second, because of the significant changes in the franchise made by many states after World War I, a number of those earlier classed as institutionally democratic effectively became "more democratic" as political participation increased sharply. Under that change in circumstances we might expect governments to be even more accommodating of the needs of the population.

Accordingly, we divide the data at 1919-1920 and run the same model as presented in Figure 1. The results appear in Figure 2. The data for the period prior to 1920, displayed in the top part of the figure, show mixed results. There is scant evidence that democratic minor powers were more inclined to participate conflict as a response to population increases. In this time period only the democratic major powers give evidence of a relationship between population growth and dispute involvement.

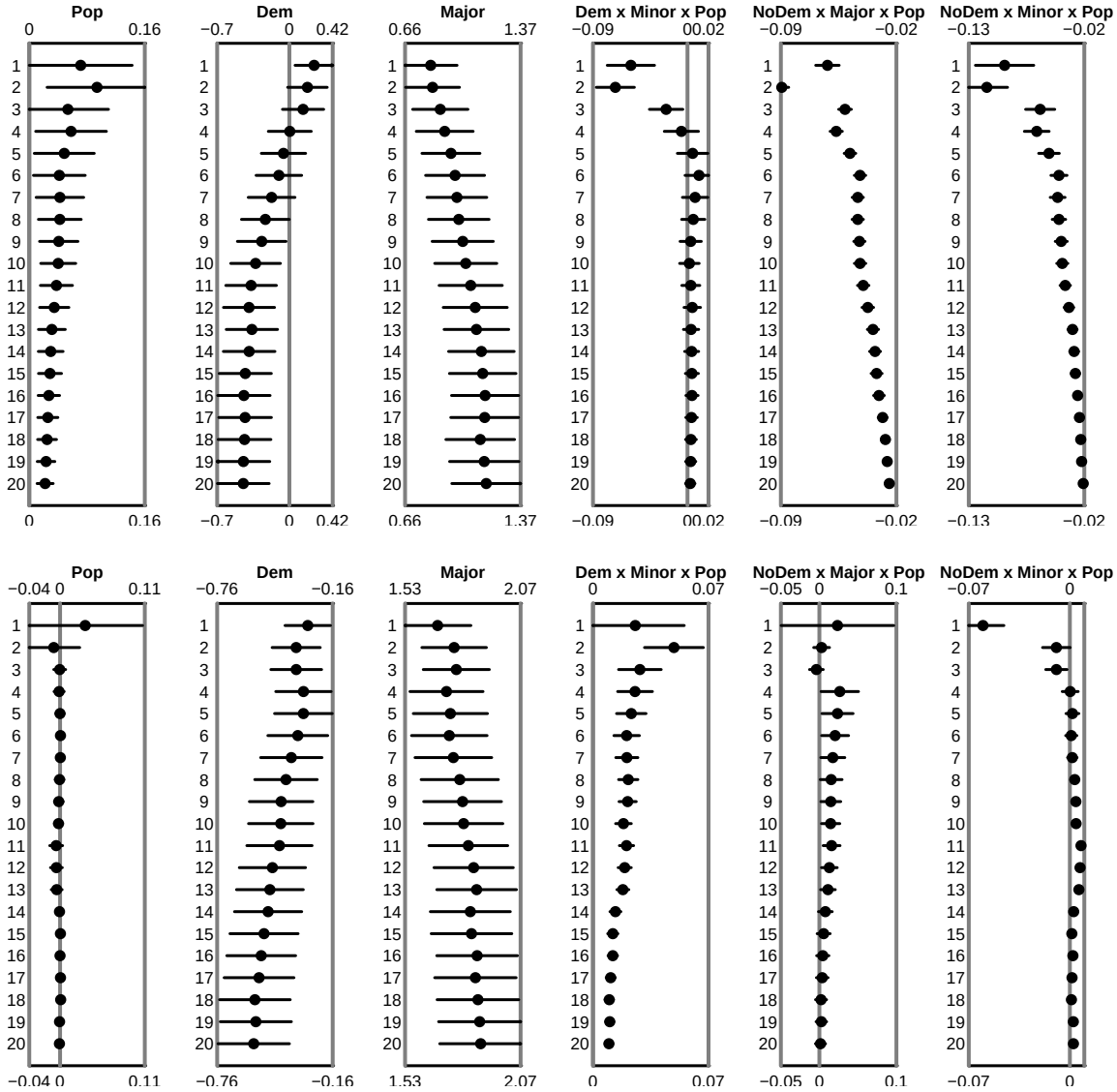

Figure 2: Negative binomial coefficients and confidence intervals for dispute participation for annual lags 1-20, (a) 1816-1919 and (b) 1920-1994. In the first segment, the percentage growth of population in the democratic major powers has a pronounced effect on conflict participation across the various time lags, although it decreases across them. This is not discernible in the second segment, where the effect is not different from zero. None of the other types of states shows a positive effect for population growth on conflict participation in the first segment, but in the second segment population growth has an unmistakable effect in the minor power democratic states.

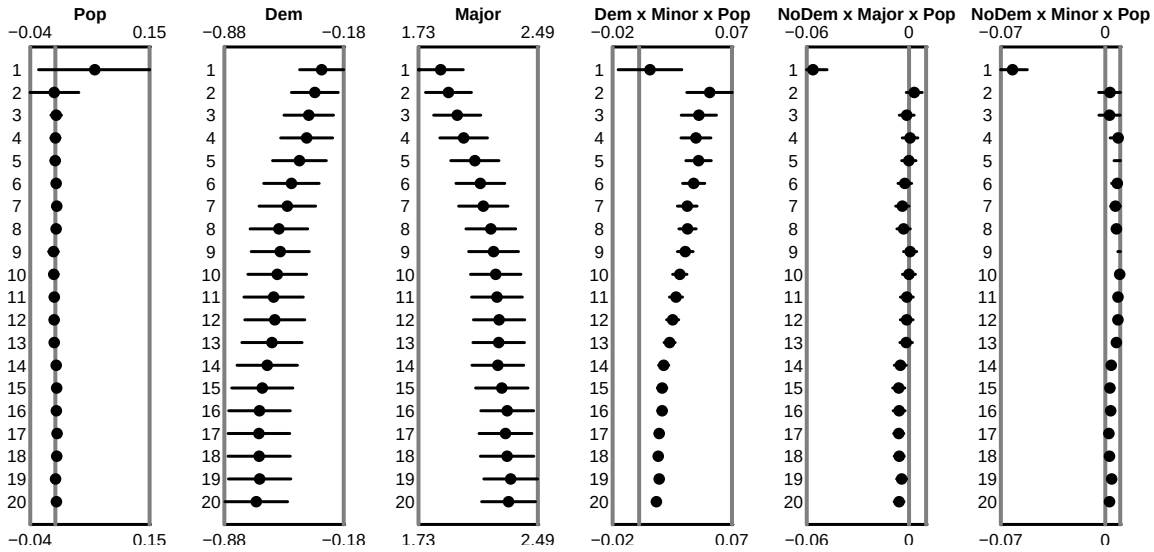

Figure 3: Negative binomial coefficients and confidence intervals for dispute initiation for annual lags 1-20, 1816-1994. For both types of democratic states, the one-year lag shows a positive effect of population growth on conflict initiation, while the same relationship is negative for both types of non-democratic states. However, after the one-year lag the only clear effect in the data is a notable positive relationship for the non-democratic minor powers which diminishes over time, but is still present in the twenty-year lag.

Given these results and those reported above, it is an easy guess about what we find in the post-1919 data shown in in the lower portion of the figure. Here the results are unequivocal: population increases in democratic minor power states are clearly associated with conflict participation, much as we observed earlier. They begin strongly and then wane across time. There is an apparent effect in the case of the major power non-democratic states, but the confidence intervals all include zero.

We now turn to the initiation of disputes. The results for the entire period are shown in Figure 3 and parallel those in Figure 1, except that the effect of population growth in democratic minor powers appears in the second year and is substantially larger, .057, than what we observed in the earlier results. It also displays a steady decrease, halving in value at the 11 year lag and then dropping off to smaller values, but still with tight and increasingly tighter confidence intervals, indicating a high degree of model fit.

Figure 4 displays the coefficients when we divide the data into the same two time periods used above. In the early period two patterns of note may be seen. First, both

major and minor power democratic states show evidence of an effect of population growth on conflict initiation. The effect is greater in the case of the major powers, but this is perhaps more apparent than real since all of the confidence intervals include zero. For the democratic minor powers, the initial effect is negative, but beginning with the five-year lag it is positive and the confidence interval does not include zero. While the relationship weakens across time, even in the twenty-year lag it remains positive, and the confidence interval does not include zero.

The results in the later period are generally negative for all the types of states except the minor power democratic states. To be sure, there is some evidence of a positive relationship for the major power non-democratic states, but the confidence intervals include zero. Strong evidence is shown for their minor power counterparts, but the coefficients are substantially smaller than those shown for the minor power democratic states.

To make the interpretation of the graphs above easier, and to give an idea of their substantive impact, in Table 2 we present the marginal effects of population growth in minor power democratic states on dispute participation and initiation for the 5 and 10 year lags. This table shows the effect of a one standard deviation increase in population growth on the count of dispute participation and initiation. For example, a standard deviation increase in population growth for the five-year lag during the period 1920-1994 produces a 13.6 per cent and 28.5 per cent increase in the counts of dispute participation and initiation, respectively. These are not inconsiderable effects.

Besides showing the substantive impact, there is another aspect of the effects that merits comment. While the graphs show the differences in the effects of population growth across time, the magnitude of the differences is perhaps better shown in Table 2 than in the graphs. For both dispute participation and initiation, the marginal effects for the time period 1920-1994 approximate those of the entire time period, while those from the period 1816-1919 are substantially smaller. Put simply, the overall results are largely driven by the later time period, are probably because of larger variation in the population growth variable for democratic minor powers in the period following the

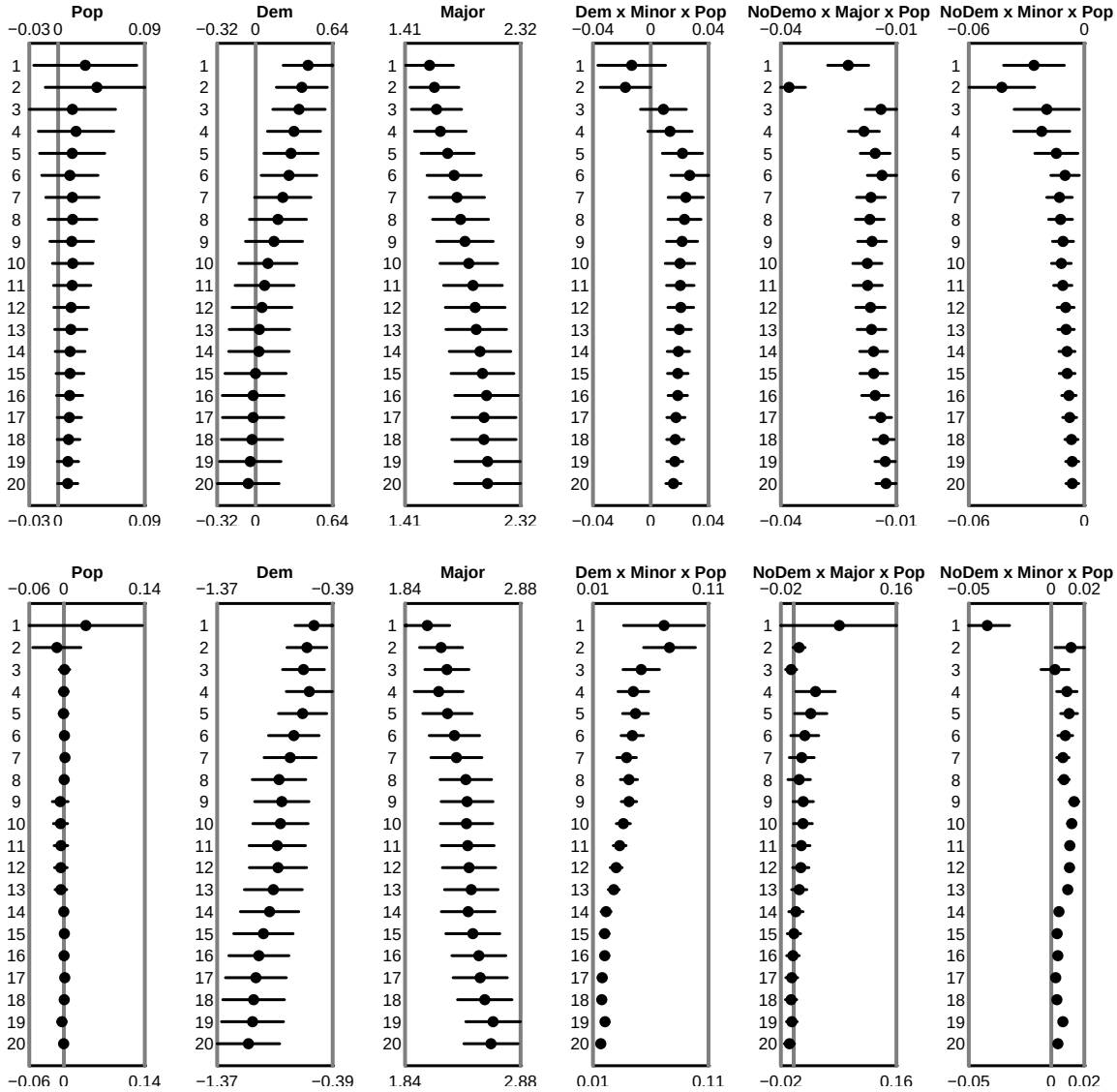

Figure 4: Negative binomial coefficients and confidence intervals for dispute initiation for annual lags 1-20, (a) 1816-1919 and (b) 1920-1994. For the major power democracies there is an effect of population growth on conflict participation in the early segment of the data that essentially disappears after 1920. For the non-democratic states the relationship is negative in the first period and quite modest in the second. The coefficients for minor power democracies show a modest positive effect in the first period, but a pronounced effect in the period after 1920. Note the change in the scale across the boxes for the minor power democratic states in these two periods.

		Participation	**Initiation**
Variable	Date Range	% 1 SD Change	% 1 SD Change
Democratic	1816-1994	13.4	25.2
Minor-powers	1816-1919	4.5	9.6
Lag = 5	1920-1994	13.6	28.5
Democratic	1816-1994	19.1	34.1
Minor-powers	1816-1919	4.5	15.9
Lag = 10	1920-1994	20.7	45.2

Table 2: Table 2: Marginal Effects for a One Standard Deviation Change in Population Growth for Democratic Minor Powers at 5 and 10 Year Lag Lengths. Note that the effects for the entire period are driven by those for the period 1920-1994.

end of World War I.

We now move to the issue of control variables. One factor that might well be connected to both population growth and conflict over time is increasing national wealth. As wealth increases, it is likely that life-spans will increase and child mortality will decrease. Both of these are likely to lead to increases in population. Increasing wealth may also make it easier to extract resources that could be used for military purposes and might thereby foster conflict involvement (Organski and Kugler, 1980). Reliable data on national wealth are lacking for the states we cover over almost all the time period we draw upon for data, so we use a surrogate for national wealth that is available in the COW data: percentage change in national energy consumption. To explore the effects of this we the included in the analysis the percentage change in energy consumption using the same lags we use with the population change data in all the results presented. Because the coefficients for changes in energy consumption are consistently close to zero and the results obtained when omitting the energy change variable are virtually identical to those obtained when including it, we have chosen not to report the estimates for energy change.[9]

Thus far the results are largely in accord with the expectations we advanced initially. The effects of population growth on dispute participation and initiation appear

[9]We also considered whether the activities of particular states could be responsible for the results we obtained for the minor power democracies in the period 1920-1994. One minor power democracy with a notable increase in population and a significant involvement in international disputes is Israel. However, when we included it in the model as a dummy variable, the results were not materially affected.

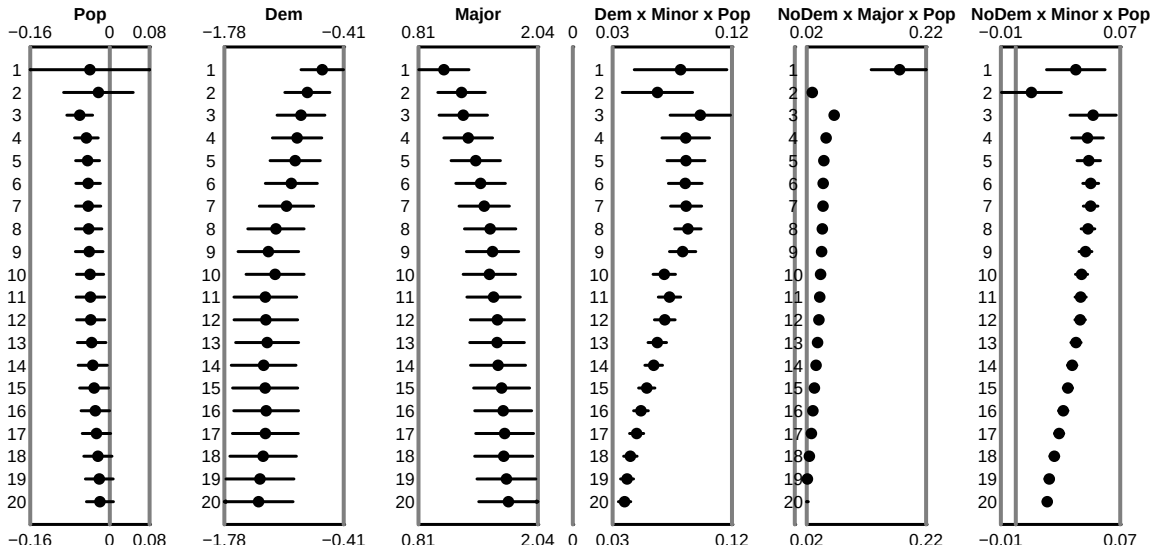

Figure 5: Poisson coefficients and confidence intervals for annual lags 1-20 when the issue of dispute is territory, 1816-1994. Minor power democratic states show a sharp effect of population growth on conflict initiation, but so too do both types of non-democratic states, but at lower levels.

clearly and consistently only for the minor power democratic states. We now turn to a consideration of dispute initiation when the issue of the dispute is territory. As will be seen, the results that we present below are markedly different from those above.

The first set of results, presented in Figure 5, cover the entire period, 1816-1994. Unlike the earlier results, population growth shows a clear effect on dispute initiation for both both sets of minor powers, a result that is consistent with the more limited temporal analysis of Tir and Diehl (1998). The effect is slightly more pronounced for the democratic minor powers, but both follow the same pattern across the various lags. Democratic major powers, captured in the results for the population growth variable, are generally negative and often close to zero. The non-democratic major powers show a large positive effect in the first time lag, which then quickly diminishes. Nonetheless, it remains positive over all the lags.

We again split the data at 1919-1920, and patterns emerge that are significantly different from those just described. As shown in the top part of Figure 6, in the early period the democratic major powers show a positive effect, but the confidence interval usually includes zero. The three other types of states are generally similar

to each other. In the early lags there is an abundance of negative coefficients, which grow progressively less negative as the lags increase. However, despite the similarity of the pattern over time, the effects for both the minor power democracies and major power non democracies are either negative or essentially zero. Only the non-democratic major powers reveal a clear set of positive coefficients. As far as population growth is concerned, it appears that in the period prior to 1920, it had relatively little effect on the initiation of disputes over territorial issues.

The lower part of this figure displays the results for the period between 1920 and 1994. The major power democratic states show little effect of population growth on territorial dispute initiation, but the other types of states are markedly different; all of them show a clear and substantial effect, and these are often large relative to what we observed earlier. To be sure, the coefficients for the non-democratic minor powers are consistently the weakest of these states, but even for them the effect is both positive and enduring.

Focusing on the five and ten-year lags, Table 3 displays the marginal effects of population growth on the count of territorial dispute initiations for both types of minor powers and for the non-democratic major powers over the period 1920-1994, the time where we see the greatest effects. Some of the results are remarkable. For example, a one standard deviation increase in population growth over a ten year period will increase the count of territorial dispute initiations of the minor power non-democratic states by almost 400 per cent.

4 Conclusion

What are we to make of these results? The good news is that, like Tir and Diehl, we can identify a process in which population growth has a palpable effect on a state's participation in and initiation of serious international conflict. Moreover, the estimates in our analysis point not just to minor powers but to minor powers with democratic political institutions, something that has not been identified before, as far as we are

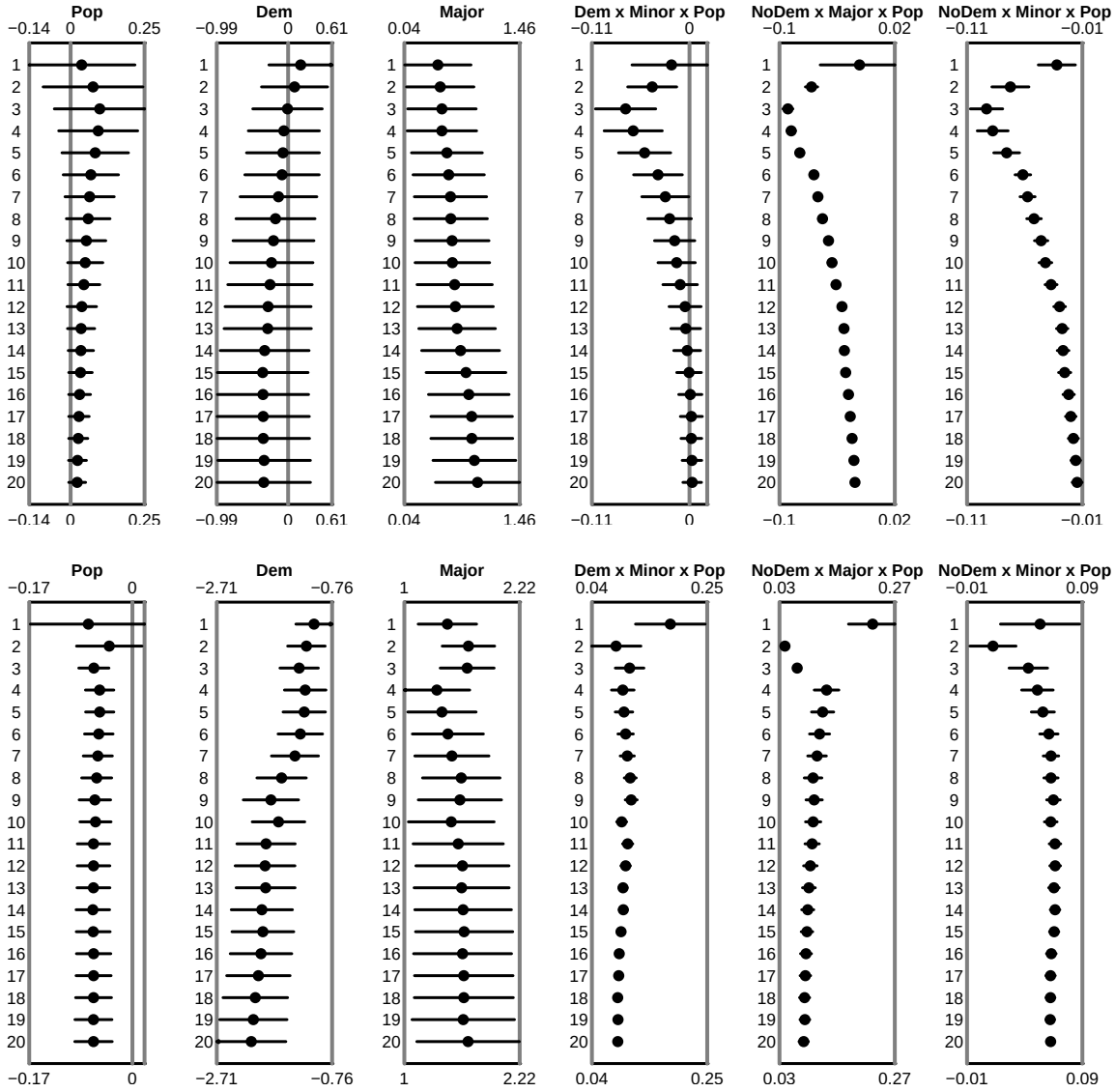

Figure 6: Poisson coefficients and confidence intervals for annual lags 1-20 when the issue of dispute is territory, (a) 1816-1919 and (b) 1920-1994. (a) When the issue of the dispute is territory the data for the early period show only a modest effect of population growth on dispute initiation for the non-democratic major powers. (b)In the period between 1920 and 1994 only the major power democracies show no effect of population growth on dispute initiation. Albeit to varying degrees, all the other types of states show substantial effects. This effect is strongest for the non-democratic major powers, but it is unmistakable for both the democratic and non-democratic minor powers. In each of these three cases the effect appears early, rises slightly and then declines across time. Note the differences in scale across the top of the boxes.

		1816 - 1994	**1816 - 1919**	**1919 - 1994**
	Variable	% 1 SD Change	% 1 SD Change	% 1 SD Change
Lag = 5	Democratic Majors	-49.5	288.4	-54.9
	Democratic Minors	52.3	-13.7	71.8
	Non-Dem Majors	53.9	-68.7	21.2
	Non-Dem Minors	70.8	-42.4	104.4
Lag = 10	Democratic Majors	-63.4	213.5	-77.9
	Democratic Minors	95.6	-3.7	179.4
	Non-Dem Majors	81.2	-61.0	32.9
	Non-Dem Minors	159.7	-37.3	388.1

Table 3: Marginal Effects for a One Standard Deviation Change in Population Growth in Territorial Disputes. For democratic major powers the greatest effect is in the period 1816-1919, while for both types of minor powers it is in the period 1919-1994.

aware. That most of this effect is shown in the period after 1919 is also consistent with increasing numbers of democratic states and levels of participatory democracy in already institutionally democratic states. That the effects of population growth on conflict involvement in these states show up so quickly is perhaps a bit of a mixed tribute to the responsiveness of democratic institutions, and this was certainly contrary to our expectations.

However, there is something like bad news as well. While we can trace out the effects of population growth on conflict behavior in the democratic minor powers, there is not a large amount of conflict to be explained. More concretely, over the entire period under study, democratic minor powers initiated only 355 of the 2325 disputes in the data set, which is only slightly more than 15 per cent of the data. What is worse is that it is difficult to sustain the position that population growth in these states was the primary factor in generating their conflict behavior. How important was it? To get a rough idea of this we used the results from the best model of the entire period: the number of dispute initiations with a two-year lag. From the estimates of this model we generated predictions for the cases. Using the mean value of the predictions (.196) we created a dummy variable that was 1 when the coefficient was larger than this and 0 otherwise. We then collapsed the number of initiations into a new variable the value of which was 1 if there was one initiation or more for that state in the year and 0

otherwise. We then cross tabulated the results, which are shown in Table 4. These show the model captures just under 60 per cent of the disputes that take place when they are measured as either a 0 or a 1, but it also predicts 2,838 disputes that do not take place. While this may be typical of conflict studies (Ward, Siverson, and Cao, 2006), it is not encouraging in terms of model evaluation.

		Observed	
		0	**1**
Predicted	**0**	7,016 (71.2 %)	658 (40.6%)
	1	2,838 (28.8%)	962 (59.3%)
	Total	9,854	1,620

$\chi^2 = 587.46$ Prob $< .00$
Cramer's V $= 0.23$

Table 4: Predicted and Observed Instances of Hostility at Level 3, 4, or 5. The model captures almost 60 per cent of the disputes that took place, but over predicts many of those that did not.

While one may want our predictive results to be stronger before accepting our results, we must point out that it has never been our goal to construct a complete model of the onset of conflict. Our goal for this research has been more modest. We sought to evaluate the effect of one variable, population growth, on international conflict, and we have shown it does have an effect for certain regime types. Moreover, the effect of population growth on conflict behaves in accordance with our expectations in every respect except for the fact that minor power democracies react more quickly to population changes than we had thought they would. In the final analysis, we believe the data lend support to the theory that population growth creates a "necessity for action," and this is seen particularly among minor power democracies.

Finally, to the extent that one can use this type of analysis to say something about policy, there are some grounds for concern in our results. At present, a number of states and international organizations are pursuing policies aimed at increasing the number of democratic states. Almost all these states are minor powers. If these states can

become democratic in proximate clusters, and if the primary result of the Democratic Peace continues to hold, then we may see a diminution of serious international conflict. However, if the state is democratic and in a "bad" neighborhood, that is, contiguous to non democracies, then levels of conflict may rise. This is not to discourage the growth of democracy, but it is to say that there may be reasons to encourage democratizing minor powers to restrain population growth, a policy that may be desirable for other reasons as well.

References

[1] Bennett, D. Scott and Allan Stam. "Eugene: A conceptual manual." *International Interactions*, 26:179–204, 2000.

[2] Bueno de Mesquita, Bruce, Alastair Smith, Randolph M. Siverson, and James D. Morrow. *The Logic of Political Survival*. MIT Press, Cambridge, 2003.

[3] Cameron, A. Colin and Pravin K. Trevedi. *Regression Analysis of Count Data*. Cambridge University Press, New York, 1998.

[4] Choucri, Nazli and Robert C. North. *Nations in Conflict: National Growth and International Violence*. W. H. Freeman and Co., San Francisco, 1975.

[5] Choucri, Nazli, Robert North, and Susumu Yamakage. *The Challenge of Japan Before World War II and After: A Study of National Growth and Expansion*. Routledge, London and New York, 1992.

[6] Kadera, Kelly and Sara McLaughlin Mitchell. "Model specification and control variables." *Special Issue of Conflict Management and Peace Science*, 22(4):273–363, 2005.

[7] Krebs, Ronald and Jack Levy. "Demographic change and the sources of international conflict." In M. Weiner and S. S. Russell, editors, *Demography and National Security*. Berghahn Books, New York, 2001.

[8] Organski A.F.K. and Jack Kugler. *The War Ledger*. University of Chicago Press, Chicago, 1980.

[9] Ray James Lee. "Explaining interstate conflict and war: What should we control for?" *Conflict Management and Peace Science*, 10:1–31, 2003.

[10] Ray James Lee. "Constructing multivariate analyses (of dangerous dyads)." *Conflict Management and Peace Science*, 22:277–292, 2005.

[11] Small, Melvin and J. David Singer. *Resort to Arms*. SAGE Publications, Beverly Hills, 1982.

[12] Tir, Jaroslav and Paul F. Diehl. "Demographic pressure and interstate conflict: Liking population growth and density to militarized disputes and wars, 1930-89." *The Journal of Peace Research*, 35(3):319–339, 1998.

[13] Ward, Michael D., Randolph M. Siverson, and Xun Cao. "Disputes, democracies, & dependencies: A re-examination of the kantian peace." *Working Paper*, 2006.

[14] Wright, Quincy *The Study of International Relations*. Appleton Century Crofts, New York, 1955.