Knowing Unknowns: The Effect of Uncertainty in Interstate Conflict

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Abstract: Bargaining theories of interstate conflict posit that war stems from a state's uncertainty about its rival's capabilities or resolve. While theoretically compelling, this model is difficult to test empirically. A direct test of the theory calls for some way to measure a state's uncertainty about its rival's capabilities, which has so far eluded international relations scholars. This paper develops several new measures of state uncertainty, based on publicly available estimates of states' military capabilities. These estimates are often revised as better information becomes available, and the extent to which given estimates change over time is likely to be indicative of uncertainty about a state's capabilities. In addition, multiple sources often make competing assessments in the same time period, and the variation over these assessments provides another indicator of uncertainty. Finally, the data collectors themselves often mark judgments as particularly uncertain, or even omit uncertain estimates altogether. Using these new measures, we conduct the first direct tests of whether increased uncertainty is associated with conflict, as bargaining theories of war predict. Our findings have important implications for continued efforts to refine bargaining approaches to conflict and for our understanding of the underlying causes of war.

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Identifying the causes of war and peace is one of the most fundamental and enduring projects of international relations scholarship. Over the last two decades, the so-called bargaining approach to war has risen to prominence, arguing that a major factor driving international conflict is uncertainty—incomplete information about an adversary's capabilities or resolve. If only adversaries had the full picture, these theories argue, they would choose to avoid the costly enterprise of war in favor of a negotiated settlement that leaves both parties nominally better off.

This theoretical insight has had a large and growing influence on the contemporary understanding of why nations and other groups fight, infusing thinking about the origins of conflict, the practice of mediation, peace-keeping, and other activities. However, the theory has also stubbornly resisted empirical scrutiny. Scholars employing both qualitative and quantitative approaches have struggled to measure uncertainty in the real world. The absence of a measure of this key concept creates a substantial omitted variable problem, casting doubt on other empirical insights about war, including the roles played by democracy, military capabilities, trade, nuclear weapons, alliances, and third-party intervention in conflict initiation and resolution.

Is it true, then, that uncertainty makes international conflict more likely? We answer this question by developing new quantitative measures of uncertainty over a state's military capabilities, exploiting several features of publicly available estimates of states' military strength. Our approach allows for the first direct test of the critical

component of the bargaining approach to war. Our proposed measures also permit us to distinguish between two categories of uncertainty—"known unknowns" and "unknown unknowns," contributing to a richer theoretical treatment of the concept of uncertainty.

We proceed in four parts. First, we discuss the theoretical link between uncertainty and conflict and existing efforts to incorporate uncertainty into empirical studies of conflict. Next, we describe our new empirical measures of uncertainty. Third, we conduct an empirical test of the link between uncertainty and conflict. Finally, we address potential objections to this approach.

Uncertainty in theory and practice

Uncertainty is often theorized as a central driver of many important phenomena in international relations. The concept of uncertainty is closely related to misperception, which may contribute to a security dilemma between states, leading to escalating arms races and the increasing risk of war. In international political economy, uncertainty about exchange rates or a state's economic growth may depress international trade or foreign direct investment. Uncertainty about state compliance with international law may be a major determinant of the success or failure of international agreements.

Bargaining approaches to understanding international conflict emphasize uncertainty about a state's capabilities or resolve as a major factor in the onset of international conflict. Fearon's (1995) seminal work, distilling earlier treatments of the

subject (Blainey 1988; Morrow 1989), argues that because war is costly, there will always be an agreement between adversaries prior to war that would leave both parties better off than they would be after a conflict. The key question, then, is why do states fail to reach more efficient agreements? Fearon suggests three possibilities. First, states may have private information about their own capabilities or resolve, along with incentives to misrepresent this information. Second, states may be unable to credibly commit to possible agreements. Third, relevant issues may be indivisible, preventing agreement.

Scholars writing in the rationalist/informational perspective have extended these insights and conceptualized war as organic to the bargaining process (Filson and Werner 2002; Wagner 2000), reflecting a venerable tradition of treating war as the continuation of politics (Clausewitz 1976). The conduct of war itself should thus provide the information needed to overcome uncertainty and end conflict (Slantchev 2003). Theorists have also examined why states misrepresent their capabilities, finding conflicting incentives both to under- and overstate military power when faced with the prospect of war (Meirowitz 2008; Slantchev 2010).

Current theoretical approaches, however, largely fail to distinguish between situations in which states have knowledge of their own uncertainty ("known unknowns") and those in which states are uncertain without realizing the extent of

their uncertainty ("unknown unknowns").[1] States that are aware of their uncertainty may be more cautious about escalating hostilities in advance of a dispute, or take steps to resolve their uncertainty, and so are less likely to become involved in full-fledged military conflict. States unaware of their own uncertainty, on the other hand, cannot adjust for it, and so may bargain confidently with an incorrect understanding of an adversary's capabilities. This may lead to a greater likelihood of conflict outcomes.

The theoretical insights of the rationalist explanation for war have rarely been tested empirically, and then only indirectly. Tests of the bargaining model are complicated by our inability to measure uncertainty in a satisfactory way. Scholars generally see uncertainty as difficult or impossible to measure (Slantchev 2004). The implications of this empirical gap extend to the entire enterprise of identifying the causes of war. Morrow (1989) points out that the misspecification that results from omitting uncertainty from empirical analysis throws just about all other findings on war onset into question.

In the absence of direct measures of uncertainty, empirically minded scholars have taken three broad approaches. First, some have focused on the narrow strategic settings within which uncertainty may be isolated. States may be more uncertain about the resolve of an adversary, for example, when the adversary has just experienced a

[1] Mitzen and Schweller (2011) is a rare exception.

change in leadership (Rider 2013; Wolford 2007). Mediators may have more knowledge of the private information of state parties when they are allied with or otherwise biased in favor of one of the parties (Boehmer, et. al. 2004; Kydd 2003; Rauchhaus 2006). More uncertainty may be present at the system level when there are more great powers, more clusters of states, more diffusion of capabilities across states or clusters, or when there are more alliances between clusters (Huth, Bennett, and Gelpi 1992). The outcomes of particular battles may reduce uncertainty about the outcome of the war overall (Reiter 2009; Smith and Stam 2004). These proxies, while useful in advancing our understanding of the effect of uncertainty, have limited utility in general studies of conflict onset, duration, or termination because they are context specific, limited to a particular unit of analysis, or closely associated with other likely drivers of conflict.

A second approach treats uncertainty as an element of the underlying statistical model—an actor error that mirrors the familiar regression error term (Bas 2012; Signorino 2003). This approach, however, is heavily dependent upon assumptions about the error structure of a particular model, and interpreting results in terms of the effect of uncertainty can be difficult in some model specifications. These modeling approaches are an important advance, but technical complexity and specification questions mean that they have yet to be widely adopted by the larger conflict literature.

Finally, some analysts have attempted to identify additional testable implications of rationalist explanations for war (Slantchev 2004). Finding evidence for these

additional implications lends support to the underlying theory, but it does not constitute a direct test of the role played by uncertainty in conflict. Each of these existing approaches is a second-best solution: researchers would benefit from a more direct measure of uncertainty.

Measuring uncertainty

We develop new measures of uncertainty by exploiting the structure of multi-year data collection efforts in international affairs. Our focus here is on measuring uncertainty over military capabilities. Of course, other types of uncertainty discussed in the literature, including uncertainty about the resolve of a state or about a state's intentions, may play an important role in conflict onset. Uncertainty over capabilities, however, is fundamental in the sense that states make judgments about others' resolve or intentions based in part upon their demonstrated capabilities. States might signal their intentions, for example, by investing in costly military forces, expending resources to mobilize them, or risking their survival by placing them in harm's way. Our emphasis on measuring uncertainty about military capabilities, then, may take us at least part of the way toward understanding the importance of other forms of uncertainty in international relations.

To measure uncertainty over capabilities, we employ publicly available datasets on military expenditures and the size and makeup of military forces. We draw in particular from the estimates of the size of national armed forces in the World Military

Expenditures and Arms Transfers (WMEAT) dataset, compiled originally by the U.S. Arms Control and Disarmament Agency and now by the U.S. State Department.[2] There are several other data sources, however, that have similar characteristics. We exploit three features of these data. First, these data are a time series that is revised over time, allowing us to consider a *retrospective* measure of uncertainty. Second, these data are collected by multiple sources in a given time period, allowing us to consider *inter-source* measures of uncertainty. Third, the collectors of these data frequently indicate where they lack confidence in particular estimate, providing a *coder-assessed* measure of uncertainty. We address each of these measures of uncertainty below.

Retrospective uncertainty

When a single source makes overlapping estimates across multiple years, we have the opportunity to derive a retrospective measure of uncertainty. Most WMEAT volumes, for example, provides estimates for the previous ten years: the 1973 edition covers the years 1963 to 1973, and the 1983 edition covers the years 1973 to 1983. Thus, each new edition revisits and often revises the estimates given in previous years. The 1973 edition of WMEAT provides a roughly contemporaneous estimate of military expenditures in 1973, while the 1983 edition provides an estimate for 1973 that has

[2] WMEAT was published most years between 1964 (as "World-wide Defense Expenditures") and 2000. The most recent edition was released in 2012. For more on WMEAT, including potential regional bias in its estimates, see Lebovic (1998).

been revised with the benefit of ten years of hindsight.[3] The relative change between the contemporaneous estimate and an estimate for the same time period that comes a number of years later is an effective proxy for uncertainty about the state's military capabilities in that original time period.

For example, the 1973 edition of the WMEAT data judged that Egypt had military expenditures of about $1.3 billion in that year. By the time of the 1983 volume of WMEAT, however, the estimate of Egypt's military expenditures in 1973 had nearly doubled to $2.3 billion. The relative or percent change in estimates like this one over time can tell us something about the level of uncertainty surrounding the original judgment.

Importantly, retrospective measures capture a kind of uncertainty that may not be recognized by states at the time. They are "unknown unknowns." Policymakers may be quite confident in an assessment, only to find later that the estimate did not reflect the true level of capabilities held by a state. Retrospective uncertainty clarifies the accuracy of the original assessment, rather than the level of confidence that policymakers have in that assessment.

One assumption underlying a retrospective measure of uncertainty is that estimates converge on the true value given enough time. That is, we assume that the

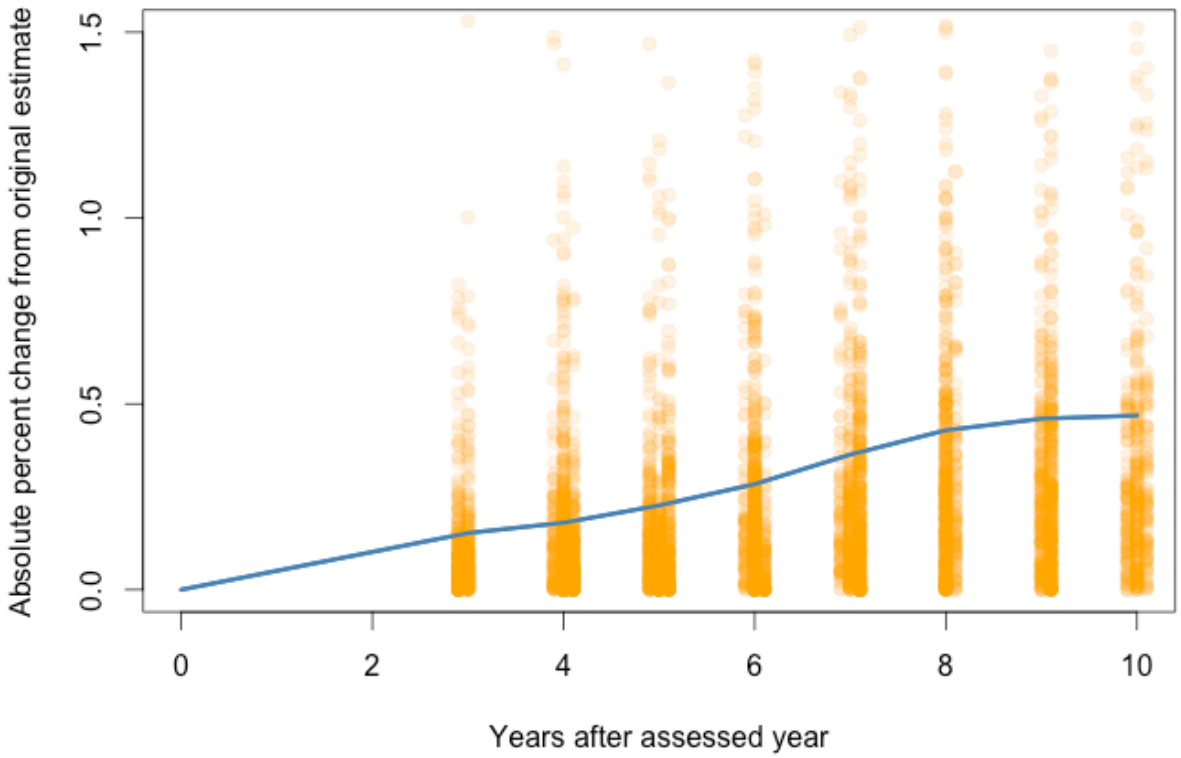
[3] Estimates for the most recent year in a WMEAT volume—the 1973 estimate in the 1973 edition of WMEAT, for example—usually do have the benefit of some reflection; the 1973 edition of WMEAT was actually released in 1974.

WMEAT estimate of military capabilities made ten years after the fact is at least more accurate than the estimate made contemporaneously. This seems plausible in most cases. New information about military capabilities comes to light over time, allowing analysts to refine and improve their estimates. Sometimes countries themselves make reliable declarations about their own capabilities after the fact—prompted by alliance ties or international arms control agreements—allowing earlier assessments to be revised.

If later estimates of a given year are more accurate than earlier ones, then we would expect to see this pattern in our data on military capabilities. An assessment of a given state's capabilities should change more in the years closer to the original estimate, with variation decreasing as the assessment converges on a final value. And indeed the data seems to behave in this way. WMEAT estimates of military expenditures in 1973, for example, changed by an average of about 19 percent between the 1973 edition of WMEAT and the 1975 volume. Two years later, the estimates had changed by an average of 8 additional percentage points, and two years after that by about 6 percentage points. Between the 1979 and 1983 volumes, however, the estimates changed by less than two percentage points on average.

Figure 1 illustrates this convergence using data from the WMEAT volumes in which several estimates are available for a given year. Each dot shows the relative change between the original estimate and the revised estimate three through ten years

Figure 1: Relative change in estimates of military capabilities over time



later.[4] The solid line plots the mean of these relative changes. There is a substantial change, on average, between the original assessment and the first revision three years later. But by ten years after the contemporaneous assessment, the average estimate is no longer being adjusted, having settled at about a 50 percent change from the original judgment. This flattening of the line representing the mean change in estimates over time is what we would expect to see if estimates were converging on the true level of states' military capabilities.

[4] Some outlier data points, with changes from the original assessment of greater than 150 percent, are omitted from Figure 1 for clarity.

Intersource uncertainty

Where multiple contemporaneous sources collect the same data, the variation across these estimates constitutes another indicator of uncertainty. Both the WMEAT datasets and the IISS Military Balance, for example, collect annual data on military capabilities for nearly all countries. Comparing the WMEAT estimate with the Military Balance estimate for a given country in a particular year provides some sense of the level of uncertainty around a specific estimate of military capabilities. We can operationalize the level of uncertainty directly as the proportional difference between the two estimates, and apply the resulting variable in quantitative tests.

Some caution is in order when evaluating intersource uncertainty because different sources often do not make truly independent estimates of military capabilities. Different sources, for example, are likely to draw on the same raw data for their assessments—these may be public statements military officials, reports by government agencies, or declarations by the states in question. And in some cases different sources may actually use each other as a primary source. This is particularly a problem when one contemporaneous source is published with a delay. The WMEAT volumes, for example, are often released two or three years after the most recent time period covered in a particular edition, giving coders a chance to refer to sources like the Military Balance when formulating their own assessments. The fact that these estimates are not

independent suggests that intersource measures will tend to be conservative, understating, on average, the true level of uncertainty over military capabilities.

Coder-assessed uncertainty

In some datasets, the collectors of the data build in ways to indicate their confidence in a particular assessment. Several volumes of the WMEAT data, for example, mark some military expenditure figures with an "E," indicating that this is only an estimate, or an "R," indicating a more uncertain rough estimate. Data can also be omitted altogether, where uncertainty was so high that no reasonable estimate could be made. Where multiple types of uncertainty are indicated by the collectors of the original dataset, as in the WMEAT case, these can be thought of as representing different levels of confidence, or they can be aggregated into a single dichotomous variable for the purposes of empirical testing.

These coder assessments provide a useful measure of uncertainty, and in particular they offer a rough proxy for the uncertainty about which a contemporary policymaker might have been aware. Put another way, coder-assessed uncertainty is a measure of "known unknowns." This type of uncertainty focuses on the confidence that states may have in a particular assessment, rather than the fundamental accuracy of the underlying estimate.

Comparing measures of uncertainty

The differences between retrospective, intersource, and coder-assessed measures of uncertainty are a source of strength—threats to the validity of the data are less likely to persist across all three operationalizations than in a single measure. By using three versions of the proxy variable for uncertainty, then, we can have more confidence in our quantitative findings. And, as discussed above, each measure emphasizes a slightly different aspect of the underlying concept of uncertainty. Finally, one or two of these measures are available in several substantive areas across multiple years for nearly all countries, making them well suited for general tests of the role of uncertainty in international affairs.

Retrospective uncertainty over military capabilities is relatively high. Drawing from 14 WMEAT volumes, we calculated the absolute percent change between an early estimate of military capabilities and an estimate with the benefit of hindsight. Estimates of military expenditures changed by an average of 37 percent from the early to the retrospective estimate. The original judgment was off by more than 100 percent in 6 percent of cases, and more than 200 percent for 3 percent of the estimates. Even estimates of the size of a state's armed forces, in some ways a much more straightforward assessment, had significant retrospective uncertainty. These assessments varied by an average of about 11 percent with the benefit of hindsight. There is also substantial intersource uncertainty in our data. The difference between

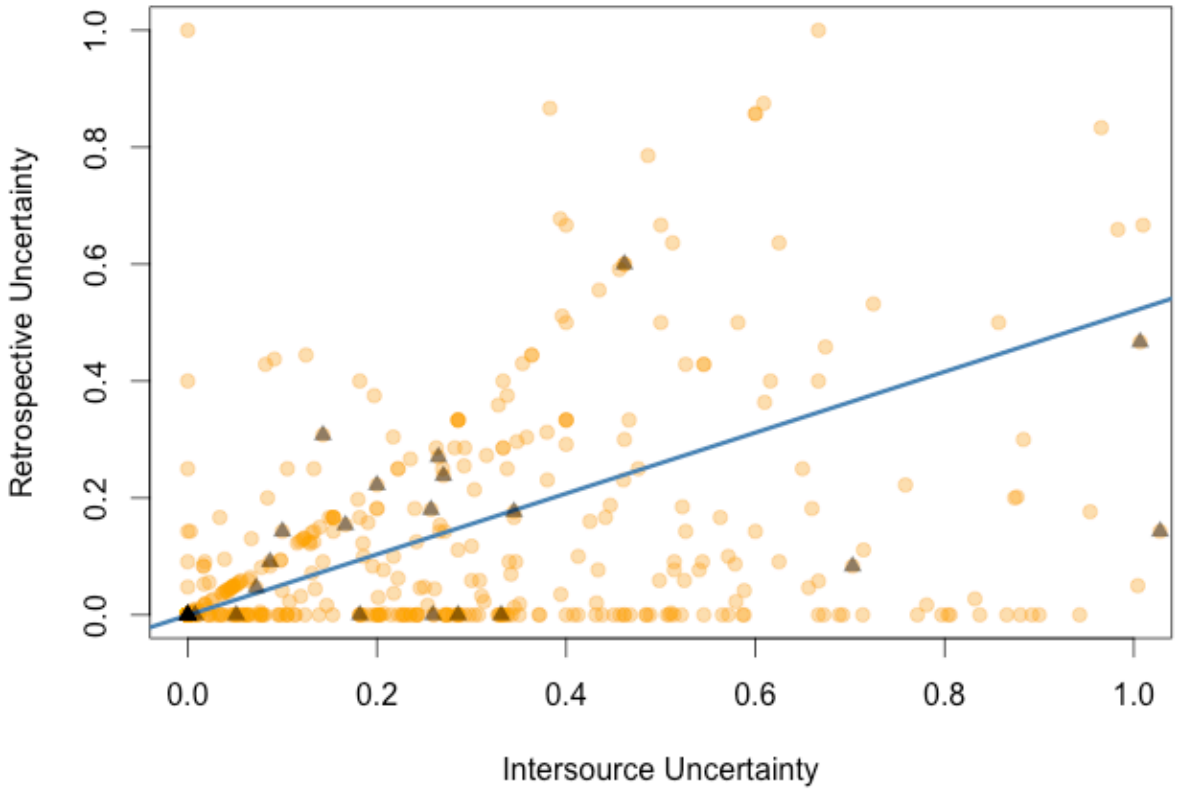
WMEAT and Military Balance estimates of the size of state's armed forces in a given year averaged about 19 percent.

In the WMEAT data, coder-assessed uncertainty also is common. For the years in our data in which WMEAT coders indicated multiple levels of uncertainty, 27 percent of military expenditure assessments were marked as an estimate, seven percent were judged a more uncertain rough estimate, and an additional two percent were omitted altogether. More than a third of the possible data thus is either marked as an estimate of some kind of is missing.

These different forms of uncertainty are certainly correlated, but there is also real variation between the different measures. Figure 2 illustrates the different types of uncertainty derived from WMEAT data on the size of state armed forces.[5] The vertical axis represents retrospective uncertainty—the absolute relative change between an early estimate and an assessment that benefits from a number of years of hindsight. The horizontal axis shows intersource uncertainty, the relative difference between contemporaneous WMEAT and Military Balance estimates. Each circle represents an estimate for a given country in a given year. Triangles denote states whose military capabilities in a given year were marked by the collectors of the WMEAT data as particularly uncertain—as estimates or rough estimates. Data points located further from the origin are thus more uncertain by the retrospective and intersource measures.

[5] Figure 2 includes assessments only for those years in which all three measures of uncertainty are available: 1989 to 1993, 1999, and 2005.

Figure 2: Uncertainty over the size of a state's armed forces



States whose estimates of military expenditures were missing in a given year are omitted from Figure 2, as are a handful of outliers with retrospective or intersource uncertainty greater than 100 percent.

The line of best fit shown in Figure 2 illustrates the correlation between the intersource and retrospective measures of uncertainty. Estimates that differ markedly between multiple contemporaneous sources are likely to be revised more dramatically over time. Similarly, coder assessments of uncertain estimates are associated with higher levels of uncertainty according to the other measures. Six percent of states with a

retrospective or intersource uncertainty measure of greater than 20 percent were also assessed by coders to have uncertain estimates in those years. This rate falls to about two percent among states with retrospective or intersource uncertainty of less than 20 percent.

But there is also substantial variation between these different uncertainty measures. A number of triangles are clustered close to the origin in Figure 2. Estimates of the size of military forces in those states were thought to be uncertain by those collecting the data, but only small disagreement over the estimate existed among contemporaneous sources and only small revisions were made to these estimates over time. Similarly, many states have high values for intersource but not retrospective uncertainty, or vice versa.

Testing the role of uncertainty in conflict

Bargaining approaches to international conflict posit a link between uncertainty over capabilities and the onset of hostilities, but these theories have been stubbornly resistant to empirical testing. In this section, we employ the three measures of uncertainty described above in a direct test of the hypothesized link between uncertainty and international conflict.

A quantitative model of interstate conflict

We construct a quantitative model of international conflict onset. Our data is structured as a pooled time series, with the unit of analysis as the undirected dyad-year. The dependent variable in this analysis is a dichotomous variable set to one when a conflict between two states begins in a particular year, and zero otherwise, employing the UCDP/Prio Armed Conflict Dataset (Gleditsch et al. 2002).[6] Conflict dyads are dropped from the dataset after the first year of conflict, reentering the data once the conflict has concluded.

Our primary independent variables are measures of uncertainty over military capabilities. We constructed three uncertainty measures based on estimates of the size of a state's armed forces found in 14 volumes of the WMEAT dataset. To measure retrospective uncertainty, we used as a baseline assessment the earliest available estimate for a given state and year so long as that estimate was released no more than five years after the year being assessed. We then calculated the absolute percent change using the latest available estimate for a given year so long as that estimate was released at least eight years after the year being assessed.[7] This procedure yielded 28 years of

[6] Tests using version 3.1 of the Militarized Interstate Dispute dataset from the Correlates of War Project yield similar results (Ghosn, Palmer, and Bremer 2004). As of this writing, dyadic MID data was not yet available for version 4.

[7] The years used for these cut-offs are the time between the actual preparation of the data and the assessed year, without regard to the sometimes-arbitrary year included in the title of the WMEAT volume. Our choice of cut-offs for early and retrospective estimates in the data was suggested by an analysis of the rate of convergence on a final

data between 1967 and 2005.[8] To form a dyadic variable, we set retrospective uncertainty equal to the greater of the two values within the dyad-year.

We measured intersource uncertainty by calculating the percent difference between estimates of the size of military forces taken from the WMEAT data and the Military Balance.[9] Assessments from the Military Balance were drawn from the edition associated with the assessed year, and WMEAT estimates included the earliest available assessment for a given state and year that was within four years of the assessed year. This procedure yielded intersource estimates for ten years: 1989 to 1993, 1999, 2005, and 2008 to 2010.[10] To use intersource uncertainty in the context of dyadic data, we set the variable of interest equal to the highest uncertainty value within the dyad-year.

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estimate over time, described in the previous section. While these cut-offs seem reasonable given constraints on the availability of data, our results do not depend on these parameters. More restrictive rules for including baseline assessments (limited to two, three or four years from the year being assessed) or final assessments (at least nine or 10 years from the year being assessed) yield similar results.

[8] That we analyze these particular years is purely a function of the availability of the WMEAT data in digital form. These editions were not selected based on any judgment about the incidence of conflict in these years, and we have no reason to believe that these years are more likely than others to yield some association between uncertainty and international disputes. We plan to add additional WMEAT volumes to the data set in future work.

[9] Military Balance data was drawn from the World Bank's World Development Indicators dataset (World Bank 2015).

[10] Again, the years subject to analysis are a function of data availability. More restrictive cut-off values for including WMEAT data (two or three years since the assessed year) do not affect our primarily result.

As a measure of coder-assessed uncertainty, we created a dichotomous variable that takes on a value of one when at least one of the estimates of armed forces size in a dyad-year is marked by the WMEAT coders as particularly uncertain (that is, marked with an "E" for estimated or an "R" for roughly estimated). Estimates are included in our data if they are the earliest available assessment released within five years of the assessed year.[11] This procedure yielded 32 years of data between 1967 and 2010.

Our models include a number of control variables commonly used in the empirical conflict literature that might also influence of independent variables of interest. To represent parity or disparity in state capabilities, we take the CINC score—a broad index of state military and economic capabilities—of the more powerful state divided by the combined CINC scores within the dyad (Singer 1988). Because the absolute levels of capability may affect both conflict onset and the ability to estimate a state's capabilities, we also include the CINC scores themselves in the model.

Some kinds of military forces might be easier to assess than others—the fact that a state has nuclear weapons, for example, may simplify assessments of military strength or focus attention on the details of military capabilities in that state. Nuclear weapons may also influence the risk of interstate conflict. We therefore include in our analysis a dichotomous variable set to one if at least one state in the dyad possesses nuclear weapons, using data from Gartzke and Kroenig (2009).

[11] As before, more restrictive inclusion rules do not affect the results of the analysis.

The task of assessing military capabilities may also be affected by a state's history of conflict. States that have engaged in interstate disputes in recent years may well be seen as more threatening in general, with their capabilities drawing increased scrutiny from other countries. Further, engaging in conflict may reveal a state's capabilities in more detail, making assessment easier. At the same time, however, states that anticipate future conflict have additional incentives to conceal military forces. Because conflict history is likely to be a strong determinant of future conflict, these are potential confounding factors in our analysis. We thus create a dichotomous variable that takes on a value of one if at least one of the states in the dyad has engaged in a militarized interstate dispute in the previous five years (Ghosn, Palmer, and Bremer 2004).[12]

Democracy is another likely driver of both conflict and uncertainty over military capabilities. Democratic states may be more transparent as to the make-up of their armed forces. Democracies may be more likely to subject military budgets to public debate, to have independent press reporting of military activities, and to engage with private enterprise in the procurement of military capabilities. We control for dyads with two democracies, and dyads with one democracy and one non-democracy, leaving fully non-democratic dyads as the omitted case.

[12] Alternative specifications of this variable, such as a moving average of the number of recent disputes, yield similar results.

Finally, geographically proximate states are at greater risk of conflict. We include two measures of the dyad's geographic closeness: a dummy variable for contiguous states and a measure of the minimum distance between the states (Weidmann, Kuse, and Gleditsch 2010).

Because conflict initiation is infrequent, we employ penalized likelihood logistic regression models to correct for rare-event bias (Firth 1993; Zorn 2005).[13] Temporal dependence is a concern in time-series cross-sectional studies. We thus include in our models a "peace years" variable that counts the number of years a dyad has gone without a conflict, along with its squared and cubed term (Carter and Signorino 2010).

Findings

The results of our quantitative tests appear in Table 1. Model 1 examines retrospective uncertainty, Model 2 intersource uncertainty, and Model 3 coder-assessed uncertainty. Models 1 and 2 find strong support for a central hypothesis of the bargaining approach—that uncertainty over military capabilities leads to conflict. Increased retrospective or intersource uncertainty was significantly associated with the increased likelihood of conflict onset.

The coefficient on the variable of interest in Model 3—coder-assessed uncertainty—reached significance at the $p < 0.10$ level. That the association between coder-assessed uncertainty and conflict onset was not as strong as for the other

[13] Rare-event logit models provide similar results (King and Zeng 2001).

Table 1: Analysis of uncertainty over military capabilities and armed conflict

		Model 1			Model 2			Model 3		
Uncertainty	Retrospective	0.244	(0.117)	*						
	Intersource				2.213	(0.748)	**			
	Coder-assessed							1.315	(0.774)	^
Capabilities	CINC ratio	-2.168	(1.829)		0.144	(3.578)		-1.194	(1.773)	
	CINC (stronger state)	-0.160	(0.654)		2.281	(1.203)	^	-0.261	(0.655)	
	CINC (weaker state)	0.844	(1.333)		3.082	(2.363)		1.258	(1.333)	
	Nuclear state in dyad	2.606	(0.643)	***	0.597	(1.487)		2.273	(0.609)	***
Previous conflict	MID in past five years	0.696	(1.302)		-2.503	(1.124)	*	0.841	(1.303)	
Democracy	Democratic dyad	-0.144	(0.771)		0.956	(1.102)		0.144	(0.750)	
	Mixed dyad	-0.422	(0.582)		-0.311	(1.128)		-0.078	(0.544)	
Geography	Minimum distance	-0.466	(0.171)	**	-0.286	(0.156)	^	-0.481	(0.176)	**
	Contiguity	1.904	(0.582)	**	0.460	(1.121)		2.122	(0.584)	***
	Constant	-8.127	(2.041)	***	-6.364	(3.086)	*	-8.745	(1.990)	***
	N	229,795			58,973			246,691		

Penalized likelihood logistic regression coefficients with standard errors in parentheses. A cubic polynomial of peace years is included in all models but not shown.
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, ^ $p < 0.10$

uncertainty measures may reflect the difference between "known unknowns" and "unknown unknowns." When states are aware of the uncertainty that attends to their estimates of others' capabilities—as measured in Model 3—they may be more cautious in their bargaining, helping them to avoid escalation to armed conflict.

With the exception of geographic factors—proximity is strongly associated with conflict in Models 1 and 3—the covariates in these models provided unexpected results. The presence of a nuclear weapon state in the dyad was significantly associated with an increased likelihood of conflict in Models 1 and 3. This probably reflects the fact that states with nuclear weapons tend to be conflict-prone major powers, rather than any effect of nuclear weapons themselves. In Model 2, a history of militarized interstate

disputes by at least one state in the dyad was associated with a reduced risk of conflict onset. This result may be in part a function of the particular subset of dyad-years included in the sample for Model 2. Because a substantial share of the dyad-years in the Model 2 data are from the end of the Cold War, the usual link between past and future conflict behavior may be broken. States engaged in disputes before end of the Cold War, in this sample, actually appear less likely to be involved in armed conflict once the Cold War ends.

Endogeneity and secrecy

Our findings provide strong evidence in support of the hypothesis that uncertainty in over military capabilities leads to conflict, but there are two major factors that could bias our analysis. First, endogeneit problems may confound claims of a causal link between uncertainty and conflict. Second, our measures of uncertainty may not reflect the actual uncertainty of states faced with conflict decisions. We address each of these objections in this section.

The endogeneity of uncertainty

One potential problem with our measures of uncertainty is the possibility that uncertainty is in some way determined by a state's propensity for conflict, rather than the other way around. There are two primary pathways by which a state's likelihood of dispute involvement could lead to a change in our uncertainty measures. First, a state's peacefulness may make the collection of data about its military more difficult. This may

be because of a general lack of interest by those collecting data. Civil servants with the Arms Control and Disarmament Agency might conceivably have been more driven to collect accurate data on the Soviet Union, for example, than on Trinidad and Tobago. They might also have expected that their data collection efforts on high-profile, conflict-prone targets like the Soviet Union would be subject to much more scrutiny by critics both within and outside government, leading them to take more care with more impactful estimates of military expenditures and capabilities.

In a world of scarce resources, it also is not unreasonable to judge that states more likely to be involved in conflict will have more intelligence and policy assets leveled against them by concerned governments. Some subset of this policy and intelligence work is likely to seep into the public domain, and so data collectors may find more accurate sources available when investigating more probable disputants. Finally, states anticipating conflict may be more likely to advertise their capabilities in an attempt to deter agression or win more attractive settlements. States' efforts to make claims about their own capabilities appear credible may also make third-party estimates of those capabilities more accurate.

Fortunately, if more peaceful states lead to higher levels of uncertainty in our measures, then any bias would point in the opposite direction of our findings. To the extent that it is more difficult to make accurate estimates of the capabilities of states

less likely to engage in conflict, then the association between conflict and uncertainty is even stronger than is reflected in our analysis.

A second, and more serious potential problem occurs if the fact that a state is more conflict-prone makes it more difficult to assess the state's capabilities accurately. Here, we worry that the uncertainty measures we propose are merely acting as a proxy for state hostility, and so have little or no independent effect. This might be true if, for example, conflict-prone states take steps to hide their capabilities for strategic reasons, if official government estimates of the capabilities of these states are more likely to be kept classified, or if conflict-prone states have larger, more complicated militaries than peaceful states that are more difficult to accurately assess.

While we judge that, on the whole, conflict propensity is probably associated with less uncertainty, but the alternative view is at least plausible. We address this objection in our analysis in three ways. First, we control for states' conflict history, as a close proxy for conflict propensity. This should address those cases in which a state's past involvement with interstate disputes leads to both higher uncertainty and future conflict. Second, we control for the level of capabilities within the dyad. This allows us to account for any elevated effect that conflict-prone states have on uncertainty by virtue of the size and complexity of their military forces.

Finally, if an increased likelihood of conflict leads to higher uncertainty, then uncertainty should appear to have a greater effect on disputes in the presence of other

factors that are strongly associated with conflict—such as an enduring rivalry. We examine this implication in an additional model specification that interacts our measure of retrospective uncertainty with a dichotomous variable set to one if the states in the dyad have an enduring rivalry (Klein, Goertz, and Diehl 2006). In this model, uncertainty has less of an influence on conflict onset in the presence of an enduring rivalry; the coefficient on the interaction term is negative and statistically significant. This result is not unexpected. For rival states, which have had the opportunity to learn each others' strengths and weaknesses through repeated interactions, uncertainty about capabilities is likely to be less relevant as a preciptant of warfare. This analysis again suggests that our main results are not due merely to the endogeneity of uncertainty in conflict, but rather represent the independent effect of uncertainty on the initiation of international disputes.

The primacy of secret assessments

Our use of public datasets to derive measures of uncertainty presents another potential problem. In most cases, researchers do not have access to the actual estimates of military capabilities that are used in government decisionmaking about international conflict. If the actual government estimates are substanatially different from public estimates, then this might confound our analysis.

There is reason to believe, however, that the public nature of our data is not driving our results. Consider, first, the possibility that government estimates of military

capabilities are simply more accurate than public estimates across the board—so, for example, secret estimates might be uniformly 5 percent more accurate than public estimates. In this case, our analysis would not be affected; our measure would just form a proxy for the actual data that aid policymakers' decisions. Another possibility is that secret estimates are much more accurate than public estimates in some cases, but perhaps only slightly more accurate than public estimates in others. In this case, it seems likely that conflict propensity would be driving these differences in accuracy, in the manner discussed in the previous section, and that this too would not bias our results.

A final possibility is that secret estimates of military capabilities are unrelated to public estimates. This would be the case, for example, if intelligence estimates were always correct. Here, any relationship between our variables of interest and conflict propensity would be spurious or reflect the involvement of some intervening variable. This possibility seems unlikely, however. Public estimates routinely draw upon government reports and public statements by government officials, which are themselves linked to declassified intelligence estimates. Thus there is often an explicit connection between public and private uncertainty.

A sampling of declassified documents help to illustrate this point. A once-secret assessment of Mexico's armed forces produced by the U.S. Army's Intelligence and Threat Analysis Center (1993) repeats the military personnel counts from an

unclassified Defense Intelligence Agency assessment—reaching exactly the same estimate as the WMEAT volume produced that year. Similarly, a Defense Intelligence Agency assessment of Guatemala's military (1980), now declassified, produced a nearly identical estimate of military personnel as the public WMEAT. In perhaps a harder case, the WMEAT dataset's estimate of Chinese military forces in 1972 came within 3 percent of the secret assessment published in a National Intelligence Estimate that year (National Intelligence Council 1972).

Of course, some states may suffer from much less uncertainty in their assessments than others. These states might make more accurate assessments by virtue of their intelligence capacity or strategic situation, while the rest of the world must resort to estimates of military capability that are proportional to those available in the WMEAT data or another open source. We check the sensitivity of our results to this potential confounding factor in two ways. First, we re-run our analysis after dropping from our dataset all dyads that include the P-5 states (the United States, Russia, the United Kingdom, France, and China), because those states boast particularly robust intelligence capabilities. Second, we re-run our analysis after dropping from our dataset all dyads in which the two states in the dyad are contiguous. States are likely to find the military capabilities of their neighbors much more salient, and so may be more likely to make accurate intelligence assessments about them. In both sensitivity checks, however, our results perisist. This suggests that our findings are not confounded by the

differences between the public estimates of military capabilities that we employ, and the secret estimates employed by national leaders.

Conclusion

This work offers new empirical leverage on a theoretical framework—international bargaining—that has stubbornly resisted empirical testing. By exploiting the structure of publicly available data, we are able to derive several novel measures of uncertainty about a state's military capabilities, permitting the first direct test of bargaining models of conflict. Our results provide support for the theory; measures of uncertainty over military capabilities were strongly associated with conflict onset in quantitative tests.

This work also provides a proof of concept for a general approach to measuring uncertainty in a variety of international domains, exploiting estimates of state characteristics that overlap or change over time. Our method is general in that it can be applied to questions in international relations across substantive areas, and scalable in that it can be extended to take advantage of new data as they become available.

These measures also allow scholars and analysts to distinguish between two categories of uncertainty—"known unknowns" and "unknown unknowns." This distinction opens a variety of new avenues for theory building in future work: Do states correctly assess their own level of uncertainty? Can states mitigate the negative effects of uncertainty when they are aware of the potential for misperception? Does the

knowledge of others' uncertainty allow states to strategically manipulate this uncertainty to their advantage?

Finally, uncertainty is not a static attribute of the international system. States and other actors have a variety of tools at their disposal to build up or diminish uncertainty about capabilities and resolve, ranging from benign government reports to flat-out denial and deception against enemy intelligence capabilities. Future work might fruitfully examine the mechanisms by which states can manipulate uncertainty, identifying situations in which adversaries are more or less likely to conceal military strength or weakness. Understanding these dynamics would allow for a more clear-eyed assessment of state capabilities and the likelihood of international conflict

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