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INSTITUTE FOR PUBLIC POLICY  
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## THE ENERGY DIMENSION IN RUSSIAN GLOBAL STRATEGY

FOUR WAY STREET?  
SAUDI ARABIA'S BEHAVIOR AMONG THE SUPERPOWERS, 1996-1999

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*The story of America's role in Saudi Arabia begins with oil, but it hardly ends there. Over seven decades, hundreds of thousands of Americans have lived and worked in Saudi Arabia. They brought the country industrialization, electricity and telephones, modern medicine, mechanized agriculture, air conditioning, and jet aviation. One way or another, Americans have had a formative influence on almost every aspect of contemporary Saudi life except religion.*

(Lippman, 2004: 5)

## **INTRODUCTION**

As the quote above illustrates, the United States and Saudi Arabia have had an intimate connection that goes back to the earliest days of Saudi Arabia's emergence as an independent state. The comment implies that the relationship has been a positive, mutually beneficial one for both countries. But other observers, while also seeing a close relationship between the two countries, cast it in a very different light. The title of Baer's (2003) recent book, *Sleeping with the Devil: How Washington Sold Our Soul for Saudi Crude*, conveys this alternative perspective.

It would be ludicrous to suggest that a single paper could arbitrate the difference between these two perspectives. But nevertheless, we believe it is possible to conduct a systematic examination of Saudi behavior and shed some light on the nature of Saudi relations with the U.S., Russia, and China over an extended period of time. Such an examination does not replace or supersede the judgment of experts. But it does provide an additional (and hopefully useful) perspective.

The specific goal of this paper is to relate Saudi behavior toward the United States and Russia for the time period 1979 through 1999 (with particular attention to the 1996-1999 time period), taking into account the triangle relations between the U.S., Russia, and China. The behavior of all four countries is tapped through the use of events data. These data<sup>1</sup> are then statistically analyzed in several ways to discern the interrelationships. In part I, we analyze these data using vector autoregression (VAR). In part II, we also use measures known as hubs and authorities to provide an additional analysis. In this second layer of analysis, we add an additional element; we

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<sup>1</sup> A more complete description of the nature of events data and the specific information used in this study is provided below.

compare Saudi Arabia's relationship with the superpowers, to its relationship with a variety of states in its neighborhood.

### **What is Events Data?**

Events data represent a very basic form of information in international relations. A basic technical definition of events data is:

...an interaction associated with a specific point in time, that can be described in a natural language sentence that has as its subject and object an element of a set of *actors* and as its verb an element of a set of *actions*, the contents of which are transitive verbs.

(Gerner, Schrod, Francisco, and Weddle, 1994: 95).

More informally, events data track the individual actions that take place in international relations. The essential elements of an "event" are the *date* that the event took place, the *actor* that initiated the event, the *action* initiated by the actor, and the *target* of the action. There are a variety of events data schemes in the international relations literature. For the most part, actors and targets are countries (although subnational and non-governmental actors are part of some schemes). Every events data scheme also consists of a list of actions (specific types of event). Finally, many events data schemes have an associated conflict/cooperation scale that assigns a value to each event type. In most analyses, individual events are not analyzed, but aggregated measures are used (for example, weekly or monthly scores).

In the early days of events data research, human coders were used. They read news sources (for example, *The New York Times*) and followed instructions about what to look for in the source. The two most well-known events data collections were the Conflict and Peace Data Bank (COPDAB; Azar, 1980) and the World Event Interaction Survey (WEIS; McClelland, 1999). This approach required a large number of human coders, and consequently, a significant amount of external funding. When the funding ended, so did the data collection.

Fortunately, several recent advances have led to both a renewed interest and an increased ability to collect events data. One advance is the increasing availability of media websites. These sites not only contain current news stories, but also archives of past stories. These sites provide the

raw material for events data collections. The second advance is the development of computer software to extract events data from these websites. In our opinion, we are not quite at the stage where it is as simple for individual researchers to (a) develop their own events data schemes, and (b) extract events from online sources. But that day will come in the near future. For the present, there are several sources of computer generated events data. The best source (because individuals can download the software and create their own data collections) is available through the Kansas Events Data System (KEDS, 2004). This website contains both the software that allows users to create their own events data and a number of regularly updated events datasets.

In our analysis for this paper, we combine human coded and computer generated events data, both using the WEIS coding scheme (and the associated conflict/cooperation scale for WEIS data developed by Goldstein (1992)) and the KEDS generated data. We look at interactions between the following four countries: the United States, Russia, China, and Saudi Arabia, from 1966 through 1999.<sup>2</sup>

### **Problems and Pitfalls with Events Data**

Events data are a unique resource because they allow the research to trace the low-level behavior of countries. But these data are by no means perfect. If the data are coded by humans, they may make mistakes. If the data are coded by a computer program, it will not make “mistakes,” but the program may not correctly interpret the text and extract the correct event. Moreover, the coding scheme used may not be a good match to the events of interest in the news source.

Of course, there can be problems as well with the original news source (note that the problems mentioned above all occur in the process of converting from stories to events data). Coverage in a source (or even across several sources) may be incomplete; i.e., some events may be missing from the news sources. Coverage may also be distorted; i.e., a source may include accounts of some events that did not take place or incorrectly report the wrong event type for something that did take place.

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<sup>2</sup> The human-coded WEIS data go from January 1, 1966 through December 31, 1978. The computer generated KEDS data begin April 15, 1979 through March 31, 1999.

There may also be a problem with what is often regarded as bias in sources. That is, media outlets may have particular “slants” to their coverage. But this is probably a lesser problem than the other problems already mentioned. Consider the following thought experiment. Suppose there is an American bombing raid on a terrorist camp along the border between Afghanistan and Pakistan. Now imagine the coverage of this event on FOX News and in Al Jazeera. We might expect that these two sources would provide completely different characterizations of the raid. But it seems likely that both would report the raid itself in a way that would lead to the same event (actor, action, target, and date) being coded from each source. So in this hypothetical case, even if one believes that one (or both) of these sources is very biased, the event would be coded correctly.<sup>3</sup>

While we could discuss the shortcomings of events data at much greater length, it seems prudent at least to acknowledge that, like any other source of information, events data has its flaws. But we believe that despite these problems, it still provides a useful way to track the behavior of countries.

## **Two Collections of Data**

Before discussing the two sets of analysis, we want to be clear about a fundamental difference in the content of the two datasets (WEIS and the KEDS Gulf dataset). The WEIS dataset was meant to be universal. That is, the goal was to collect *all* events. This was (and is) an impossible goal to reach, but the point is that WEIS events were coded for states throughout the world. The KEDS Gulf dataset has a more limited scope. It was collected only from stories that mention the Persian Gulf actors.<sup>4</sup> Thus, events involving, for example, the United States and China, that were not reported in stories about Gulf actors are not part of the KEDS dataset. It is an interesting tradeoff. WEIS attempts universality, but the KEDS data are collected based on a

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<sup>3</sup> This example would suggest that one problem with events data is that the same event would be coded multiple times if it appears (a) in multiple sources, or (b) several times in the same source. However, most events data collections have a limit of one event of each type per actor-target pair per day. While this is probably a necessary rule to adopt, it does mean that on those days in which the same actor-target pair engages in multiple events of the same type, activity would be undercounted.

<sup>4</sup> The actors that are coded in the dataset are Saudi Arabia, Iran, Iraq, Kuwait, the GCC, Oman, Yemen, Qatar, Bahrain, the United Arab Emirates, Dubai, and Abu Dhabi.



subset of stories. On the other hand, the international news coverage during the years of the WEIS data collection (1966-1978) was probably less extensive than the more recent coverage used to code the KEDS data. We do not form a judgment on whether one of these approaches is superior, but we feel it is critical for the reader to understand the difference.

## **PART I: ANALYSIS USING VECTOR AUTOREGRESSION**

We begin with a brief discussion of vector autoregression. While it is virtually the “standard” method used to analyze the interactions of groups of countries (as measured by events data), it is still important to justify its use. As always, a good method is one that matches (as closely as possible) the underlying theory and the data that are to be used. There is no virtue in using an overly complicated (or overly simple) method for its own sake.

While the focus of this paper is on Saudi Arabia, we consider Saudi Arabia in the context of its interactions with the United States, Russia, and China; i.e., we conceive of this as a four way street.<sup>5</sup> There are a number of elements to this “street.”

- Reciprocity. In many situations, bilateral relations between countries are dominated by reciprocity. Countries respond to cooperation with cooperation; countries respond to conflict with conflict.
- Inertia (Persistence). There is a certain amount of “stickiness” in international relations. Countries behave today as they behaved yesterday.
- Indirect relationships. In some cases, one country’s behavior is influenced by the interaction of two other countries, rather than being directly influenced by the behavior of a single country.
- Interventions. Occasionally, the underlying dynamic of relationships changes dramatically; this is usually due to a dramatic event.

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<sup>5</sup> Apologies to Goldstein & Freeman’s book on the interactions of the United States, Russia, and China: *Three-Way Street*. And to Crosby, Stills, Nash, and Young.

The goal of our analysis is to characterize the behavior of Saudi Arabia toward the United States and toward Russia.<sup>6</sup> In order to do this, we need to characterize the behavior of all four countries toward each other. In turn, this involves looking at each pair of countries, A and B, and predicting events directed by A toward B, and (separately) events directed by B toward A. Finally, we need to determine if the behaviors change after watershed events.

Vector autoregression<sup>7</sup> is a statistical technique that has been used in studies similar to ours (Goldstein and Freeman, 1990, 1991; Goldstein and Pevehouse, 1997; Goldstein, Pevehouse, Gerner, and Telhami, 2001). Consider the following brief illustration of a vector autoregression for a set of three countries, A, B, and C. Call  $E_{ABt}$  the measure of events in which A is the initiator and B is the target over time period  $t$ . The set of vector autoregression equations would be:

$$\begin{aligned} E_{ABt} &= a_1 + b_1E_{ABt-1} + c_1E_{BA t-1} + d_1E_{AC t-1} + e_1E_{CA t-1} + f_1E_{BC t-1} + g_1E_{CB t-1} \\ E_{BA t} &= a_2 + b_2E_{ABt-1} + c_2E_{BA t-1} + d_2E_{AC t-1} + e_2E_{CA t-1} + f_2E_{BC t-1} + g_2E_{CB t-1} \\ E_{AC t} &= a_3 + b_3E_{ABt-1} + c_3E_{BA t-1} + d_3E_{AC t-1} + e_3E_{CA t-1} + f_3E_{BC t-1} + g_3E_{CB t-1} \\ E_{CA t} &= a_4 + b_4E_{ABt-1} + c_4E_{BA t-1} + d_4E_{AC t-1} + e_4E_{CA t-1} + f_4E_{BC t-1} + g_4E_{CB t-1} \\ E_{BC t} &= a_5 + b_5E_{ABt-1} + c_5E_{BA t-1} + d_5E_{AC t-1} + e_5E_{CA t-1} + f_5E_{BC t-1} + g_5E_{CB t-1} \\ E_{CB t} &= a_6 + b_6E_{ABt-1} + c_6E_{BA t-1} + d_6E_{AC t-1} + e_6E_{CA t-1} + f_6E_{BC t-1} + g_6E_{CB t-1} \end{aligned}$$

Notice that while the event variable being predicted (the variable on the left end of the equation) changes from equation to equation, the set of event variables used to make the predictions is identical for all equations. Of course the coefficients in the equations (label  $a_1$  through  $g_1$ ,  $a_2$  through  $g_2$ ,  $a_3$  through  $g_3$ ,  $a_4$  through  $g_4$ ,  $a_5$  through  $g_5$ , and  $a_6$  through  $g_6$ ) can be different.

There are several additional complications that can be introduced to a set of vector autoregression equations. First, additional lags can be included on the right hand side of the equations (remember; all equations contain the same set of predictor variables). Second, other exogenous variables can be included on the right side of the equations. In our analyses, these

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<sup>6</sup> Ideally we would like to characterize Saudi behavior toward China as well, but this proved to be very difficult because of the lack of events involving Saudi Arabia and China.

<sup>7</sup> A good brief introduction to vector autoregression, along with a summary evaluation of the usefulness of the technique is Stock and Watson, 2001.

exogenous variables can be used to represent the “shocks” to the countries. Suppose an event (for example, a war or terrorist attack) occurs. It is reasonable to suspect that such an event would produce a “shock” that alters all the behaviors in among the countries (perhaps producing a higher level of hostility between all countries). This sort of shift can be modeled with the inclusion of an exogenous variable.<sup>8</sup>

## **Research Design**

We now turn to the specifics of our research design in Part I. As noted above, we are exploring the interaction between the United States, Russia, China, and Saudi Arabia, with the goal of understanding the behavior of Saudi Arabia toward the United States and Russia. We will undertake this by using vector autoregression. There are two dependent variables for each pair of countries, A and B. One variable consists of the sum of the scale scores<sup>9</sup> of all the events that A initiates against B over a two week period. The other is the analogous variable for the events that B initiates against A.

Two lags are used for each of the predictor variables. Consequently, each of the twelve equations contains twenty variables that represent the effects of events directed by one country toward another. In addition, we include a number of dummy variables to represent the effects of potentially significant “shocks” (i.e., events that we believe could temporarily alter the behavior countries toward one another). In general, we assume that these impacts are only temporary and last for a period of one month. Table 1 contains the list of the shocks. Note that most are assumed to last only several weeks, but several are assumed to last from the time they occur to the end of the dataset.

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<sup>8</sup> As can be easily discerned, even with a modest number of pairs of countries and limited lags, this technique can produce a very large number of equations and coefficients.

<sup>9</sup> Recall that for most events data schemes (including WEIS, which we are using), each type of event is assigned a scale score that indicates the degree to which it is conflictual or cooperative.

**Table 1: Potential “Shocks” Included in Analysis**

<b>Event</b>	<b>Date(s)</b>	<b>Biweeks in Dataset</b>
Six Day War	6/5/1967–6/10/1967	38-40
Oil Embargo	10/16/1973	>= 204
Iran-Iraq War	9/22/1980	383-385
Saudis tie oil prices to spot market	8/1985	510-512
Iraq invades Kuwait	8/2/1990	640-642
Post Cold War	9/12/1990	>= 636

Note: The Iranian Revolution (beginning with the Shah’s exile of 1/16/1979) was not included because this event occurred during the gap in the dataset between the WEIS data and the KEDS data. The post-Cold War period is assumed to begin with the signing of the treaty on the final settlement of Germany.

The time span of the analysis is 1966 through March 31, 1999. The original (human coded) WEIS data cover January 1, 1966 through December 31, 1978. The KEDS Gulf data (which was computer generated) cover April 15, 1979 through March 31, 1999. It is unfortunate that there is a gap between these two collections of data. As noted above, data are aggregated over two-week periods, i.e., the scale scores of all events initiated by A against B are summed up.

We want to control for the impact two possible watershed events in the time period under investigation. The first is the 1973 oil embargo. The second is the end of the Cold War. The most straightforward way of assessing the impact of these events would be to include both dummy variables for both events, the interactions between these two variables and the other variables in the equation, and the second order interactions between the two dummy variables and the other variables. Needless to say, this would create an extremely large number of variables for each equation. We believe that the results produced by such an analysis strategy would be unmanageable. That is, due to the large number of coefficients produced, we believe that it would be difficult—perhaps impossible—to fully comprehend the findings.

We adopt an alternative strategy that contains several elements. First, we conduct a series of vector autoregressions, each of which is much simpler than the very large models with interactions discussed above. Second, we focus in on those equations that predict Saudi behavior toward the United States and Saudi behavior toward Russia. We believe that this approach will

allow us to gain a clear picture of Saudi behavior. The time periods for the vector autoregressions run are:

- The pre-oil embargo time period.
- The post-oil embargo time period.
- The post-Cold War time period.

## Analysis

The full results of the vector autoregression analysis are available as a .pdf file at <http://www.ruf.rice.edu/~stoll>. In this section, we consider only a portion of these results. In particular, for each analysis we will discuss the statistically significant coefficients<sup>10</sup> for the equations predicting Saudi behavior toward the United States, and Saudi behavior toward Russia.

### *Analysis: Pre-Embargo*

**Table 2: Significant Coefficients, Analysis of Pre-Embargo Cases**

<b>Variable</b>	<b>Coefficient</b>	<b>Significance</b>
<i>Saudi Behavior Toward United States</i>		
Russia to Saudi Arabia, t-2	-1.304	.000
<i>Saudi Behavior Toward Russia</i>		
USA to Russia, t-1	.014	.015
Russia to USA, t-2	.006	.040

The significant coefficients are displayed in Table 2. The influences on Saudi behavior are quite clear and very reasonable. First, consider Saudi behavior toward the United States. When Russia behaved in a negative fashion toward Saudi Arabia at t-2, Saudi Arabia behaves positively toward the United States. We interpret this to mean that when Russia is hostile toward Saudi Arabia, Saudi Arabia seeks the protection of the United States by behaving in a cooperative fashion. As for Saudi behavior toward Russia, the two positive coefficients suggest

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<sup>10</sup> The level of statistical significance that we use to identify coefficients was .05.

to us that it is “cued” based on the overall relationship between the United States and Russia. When the U.S. and Russia went through a period of positive relations, Saudi Arabia also behaved positively toward Russia. But when U.S. and Russian relations were conflictual, Saudi Arabia behaved negatively toward Russia.

*Analysis: Post-Embargo*

**Table 3: Significant Coefficients, Analysis of Post-Embargo Cases**

<b>Variable</b>	<b>Coefficient</b>	<b>Significance</b>
<i>Saudi Behavior Toward United States</i>		
USA to Russia, t-2	.091	.019
USA to China, t-1	-.208	.024
Saudi Arabia to USA, t-2	.087	.050
Iraq invades Kuwait	13.208	.000
Post Cold War	-1.020	.004
<i>Saudi Behavior Toward Russia</i>		
USA to Saudi Arabia, t-2	.008	.000
Saudi Arabia to USA, t-2	-.013	.007
Post Cold War	.117	.003

In the post-embargo time period, Saudi behavior to the U.S. is of the same nature as recent (t-2) United States behavior to Russia. Recent U.S. behavior toward China has the opposite impact on Saudi behavior. Hostile American behavior toward China is correlated to positive Saudi behavior toward the United States, and positive American behavior is correlated to negative Saudi behavior toward the United States. There is inertia in Saudi behavior toward the U.S.; recent (t-2) positive behavior by Saudi Arabia is followed by additional positive behavior.

As measured by the significance levels, the two variables with the largest impact on Saudi behavior toward the United States are the two dummy variables. In the immediate aftermath of the Iraqi invasion of Kuwait, there is an extremely sharp rise in the positive behavior of Saudi Arabia toward the United States. The end of the Cold War is associated with a much smaller (in absolute size) but significant negative impact on Saudi behavior to the United States.

Turning to Saudi behavior toward Russia, we find that three separate influences play a significant role. Saudi Arabia behaves in the same way toward Russia as the U.S. behaves toward Saudi Arabia. Current Saudi behavior toward Russia is also negatively related to past Saudi behavior toward the United States. Finally, Saudi behavior toward Russia is more favorable after the end of the Cold War.

In the post embargo era, the analysis indicates that Saudi Arabia's behavior to the United States and to Russia is as if it is very much conditioned on cues from the U.S. When the United States behaves positively to Russia, Saudi Arabia behaves positively to the U.S. This is suggestive of a relationship in which the behaviors of all three countries move in the same direction.

*Analysis: Post-Cold War*

**Table 4: Significant Coefficients, Analysis of Post-Cold War Cases**

<b>Variable</b>	<b>Coefficient</b>	<b>Significance</b>
<i>Saudi Behavior Toward United States</i>		
USA to China, t-1	-.403	.032
Saudi Arabia to USA, t-1	.170	.045
<i>Saudi Behavior Toward Russia</i>		
USA to China, t-2	.051	.033
USA to Saudi Arabia, t-2	.012	.002
Saudi Arabia to USA, t-1	.022	.043
Saudi Arabia to USA, t-2	-.028	.009
China to Saudi Arabia, t-1	.357	.020

In the post-Cold War era, Saudi Arabia's behavior toward the United States is a function of two factors. First, there is persistence (inertia) in Saudi behavior. Saudi behavior at time t is—all else being equal—in the same direction as it was at time t-1. Second, U.S. behavior toward China also affects Saudi behavior toward the U.S. When the U.S. has a positive relationship with China, Saudi Arabia behaves in a negative fashion toward the United States. When the U.S. is engaged in conflict toward China, Saudi Arabia behaves in a cooperative fashion toward the U.S. This is suggestive of an arrangement where by Saudi Arabia seeks the “protection” of the U.S. when there is hostility from the U.S. to China, and Saudi Arabia pursues an independent course

(behaves negatively toward the U.S.) when there is a positive relationship from the U.S. to China.

There are a variety of influences on Saudi behavior toward Russia. For the first time in the vector autoregression results, both lags of the same variable are significant. Both lags of the Saudi behavior to the U.S. have a significant impact on Saudi behavior toward Russia, and the two coefficients have different signs. But since the absolute values of the two coefficients are very similar (.022 versus .028), understanding the overall effect of recent Saudi behavior toward the U.S. on subsequent Saudi behavior toward Russia is relatively straightforward. Examine the two most recent values for Saudi behavior toward the U.S. (the value at t-1 and the value at t-2). Whichever of these values has a larger absolute value will drive Saudi behavior toward Russia. Table 5 summarizes the possibilities.<sup>11</sup>

**Table 5: Impact of Recent Saudi Behavior Toward the U.S.  
on Current Saudi Behavior Toward Russia**

	Direction of Recent Behavior	
Recent Behavior with Larger Absolute Value	Behavior is Conflictual	Behavior is Cooperative
T-2 Absolute Value Larger	Positive behavior to Russia	Negative behavior to Russia
T-1 Absolute Value Larger	Negative behavior to Russia	Positive behavior to Russia

There is an indirect relationship that runs from the U.S. to China to Saudi Arabia and ultimately to Russia. If recent behavior from the U.S. to China is favorable, subsequent Saudi behavior to Russia will be positive. In addition, Saudi behavior toward Russia reflects both recent U.S. behavior toward Saudi Arabia and recent Chinese behavior toward Saudi Arabia (i.e. Saudi Arabia will behave toward Russia in the same manner as the United States and China have recently behaved toward Saudi Arabia).

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<sup>11</sup> Of course this oversimplifies the situation a bit because the coefficients are not exactly equal. However Table 5 will serve to produce the correct prediction in most circumstances.



### **Discussion of Saudi Relationships As Identified in Vector Autoregression Analysis**

The picture that emerges in the pre-embargo era is clear and coherent. Saudi behavior is consistent with the idea that the government sought the protection of the United States when it was threatened by Russia. Saudi Arabia behaved cooperatively toward the United States when Russia was hostile to Saudi Arabia and behaved in a negative fashion toward the United States when Russia behaved in a positive fashion toward Saudi Arabia.

Saudi behavior toward Russia was associated with the overall tenor of the Cold War. If relations between the United States and Russia were positive, Saudi Arabian behavior toward Russia was also positive. When the U.S. and Russia are engaged in conflict, Saudi Arabia behaves in a negative fashion toward Russia. Thus, the three countries are part of a three-way reciprocating system. While one must be a bit cautious because of the relatively small number of events involving Saudi Arabia, this picture painted by the data analysis is very plausible.

In the post-embargo era, relationships among the countries become more complicated. Saudi behavior to the United States reciprocated U.S. behavior toward Russia. As well, in a manner similar to Saudi behavior with regards to Russia prior to the oil embargo, there are signs that Saudi Arabia sought protection against China from the United States. That is, when the U.S. engages in conflict with China, Saudi Arabia behaves cooperatively toward the U.S. The Saudi behavior reverses when the U.S. cooperates with China. Saudi Arabian behavior toward the United States also displays inertia. Finally, two dramatic events—the Iraqi invasion of Kuwait and the end of the Cold War—both produce changes in Saudi Arabia's behavior toward the United States. There is a dramatic increase in Saudi cooperative behavior toward the U.S. in the aftermath of the Iraqi invasion and a decrease in cooperative behavior after the end of the Cold War.

The flip side of the post-Cold War change in the relationship between Saudi Arabia and the United States is that Saudi behavior toward Russia becomes more cooperative. Two remaining factors account for the Saudi Arabian relationship to Russia. First, Saudi Arabian behavior to Russia is synchronized with U.S. behavior toward Saudi Arabia, forming a mutually reinforcing

reciprocation relationship. At the same time, Saudi Arabia behaves toward Russia in the opposite way than it behaves toward the United States. This suggests that while Saudi Arabia still takes cues from the United States, it also tries to display some independence in its relationship with Russia.

## **PART II: ANALYSIS USING HUBS AND AUTHORITIES**

Our goal using vector autoregression was to understand what behaviors had an impact on Saudi Arabia's actions toward the United States and Russia. We now shift focus. We will use measures of hubs and authorities to look at the level of activity of Saudi Arabia vis-a-vis the three superpowers. Because of data issues we are only able to explore this matter with the KEDS data (April 15, 1979 through December 31, 1999).

### **Hubs and Authorities: What are they?**

While the technology of hubs and authorities scores has been around for a while, in recent years it has become a popular way to evaluate and organize the world wide web. How do we determine which websites are important? We can think of two kinds of important web sites.

One important type of website is one that is referenced by a lot of other important websites. Let us call a website that is referenced by a number of important websites an *authority*. Another important type of website is one that that references a lot of important websites. Let us call this type of website a *hub*.

There are a variety of ways to determine hub and authority scores; it is a topic of current research by computer scientists and others. But since we will be using the concept in this paper, we would to provide an informal description of a way to calculate these scores. We base our discussion on an article by Members of the Clever Project (Chakrabarti et al., 1999). They describe calculating hubs and authorities scores for a topic and we offer the following sequence of steps based on their discussion.

1. Using a standard search engine, search for the term of interest and identify the first 200 web pages that are returned by the search.
2. Add to this list of 200 web pages, all web pages that link to or from the 200. This is called the root set and the researchers have found that the root set will usually contain anywhere from a thousand to fifteen hundred pages.
3. Assign initial hub and authority scores to each page in the root set. Set the initial hub score for a page to be equal to the number of pages in the root set that the page references. Set the initial authority score for a page to be equal the number of pages in the root set that link to the page.
4. Update the hub and authority scores, using the initial hub and authority scores for a page to weight its contribution to other pages hubs and authorities.
5. Iterate the hubs and authority scores, updating them using the scores from the previous iteration until they stabilize.<sup>12</sup>

### **Hubs, Authorities and International Events**

We are now going to provide a more explicit explanation and description of hubs and authorities, as applied to the study of international events. We begin by introducing the concept of a *graph*, as defined in the field of mathematics known as graph theory (Harary, Norman, and Cartwright, 1965). Think of a collection of objects (“dots;” in our case, countries) and the connections between them (“lines;” the events that take place between a pair of countries). In graph theory a “dot” is called a node, and a “line” is called an edge. An edge can be directed; that is, it can indicate the direction of the connection between nodes, not just that there is a connection. A multi-graph is a graph in which pairs of nodes can be connected by more than one edge.

We model interactions between nations as a directed multi-graph with countries as nodes with multiple edges between nodes. Each directed edge represents the degree to which actions from one country to another are conflictual or cooperative. Such interaction graphs can be easily constructed from events data. The emerging field of link analysis explores the information stored

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<sup>12</sup> Chakrabarti et al., 1999 say that stabilization occurs fairly quickly. They say that a root set of 3000 pages will stabilize after about five iterations [note: we cannot provide page references to this piece because we accessed it through the web].

in interaction graphs. The primary goal of link analysis is to identify important nodes and edges using information about the structure of the graph alone. It has been particularly effective in identifying and ranking web pages (Kleinberg, 1998) relevant to a user query (see simplified discussion above), and for understanding scientific citation data (Osareh, 1996).

Key structural concepts in link analysis are hubs and authorities. To review, a node that points to several important nodes is called a hub. In citation analysis, a good review paper with links to seminal papers on a topic is a hub. In our context, a hub country is an *initiator* of significant events. A node with edges from several important nodes is called an authority. In the citation domain, a seminal paper on a topic is referred to by many papers on that topic, and is thus an authority. A country that is an authority is the *target* of significant events.

There is a mutually reinforcing relationship between hubs and authorities. A good hub points to many good authorities; good authorities are pointed to by many good hubs. Identifying hubs and authorities in the multi-graph of political interactions helps us identify significant events as well as significant political actors and targets.

For each country, we calculate two weights: an authority weight  $Aw$ , which reflects how other countries treat it, and a hub weight  $Hw$ , which reflects how it treats other countries. Hub and authority weights can be computed using the equations shown below. Since we have interactions of both the positive and negative variety, between countries, we compute separate authority and hub weights for these interactions.

$$\begin{aligned}
 posAw(p) &= \sum_{q:(q,p) \in E} e(q,p) * posHw(q) \\
 posHw(q) &= \sum_{p:(q,p) \in E} e(q,p) * posAw(p)
 \end{aligned}$$

Here  $E$  is the set of the edges in the interaction multigraph, and  $e(q,p)$  is the scale score associated with an event in which country  $q$  is the initiator and country  $p$  is the target (i.e., the degree to which the event is cooperative or conflictual). Note that the positive authority weights are defined in terms of the positive hub weights, and the positive hub weights are defined in

terms of the positive authority weights. A similar relationship holds between the negative authority and hub weights.

$$\begin{aligned} negAw(p) &= \sum_{q:(q,p) \in E} e(q,p) * negHw(q) \\ negHw(q) &= \sum_{p:(q,p) \in E} e(q,p) * negAw(p) \end{aligned}$$

We can compute the hub and authority weights by a fix-point iterative method. Alternatively, by reformulating the above equations in matrix form, with  $PosAw$ ,  $PosHw$  and  $NegAw$  and  $NegHw$  standing for the vector of hub and authority weights and  $W$  for the interaction matrix (edge weights in the interaction graph), we see that:

$$\begin{aligned} PosAw &= W * PosHw \\ PosHw &= W^T * PosAw \end{aligned}$$

which after algebraic simplification yields:

$$\begin{aligned} PosAw &= (WW^T) PosAw \\ PosHw &= (W^T W) PosHw \end{aligned}$$

$PosAw$  and  $PosHw$  are eigenvalues of  $WW^T$  and  $W^T W$  respectively. They can be computed by standard eigenvector computation techniques (Golub and Van Loan, 1996) that are part of statistical packages such as Matlab and R.

### **Hubs and Authorities as a Measure of Activity**

As we just described, we can generate four types of scores. But finding a good way to both simultaneously analyze and correctly interpret all four scores is a daunting task, particularly

since to our knowledge no one has attempted to do this with events data.<sup>13</sup> Since this analysis is a first cut, we will adopt a simpler strategy. We begin by taking the absolute value of all four scores. We then create a total hubs score, by adding together the positive and negative hubs scores, and a total authorities score, by adding together the positive and negative authorities scores. We also create a third score, by adding together the total hubs and total authorities scores.

We view these scores as indicators of the *activity* of Saudi Arabia. The hubs score indicates the amount of activity (in terms of events) that Saudi Arabia is directing toward other countries. The authorities score indicates the amount of activity that is directed toward Saudi Arabia. Finally, the score formed by adding the two other scores together we see as indication of total Saudi activity.

We are going to compare Saudi activity (as measured by these three scores) with two groups of states. The first is the three superpowers. The second is the set of Gulf actors over which the KEDS data are collected.<sup>14</sup> In each case, we will be able to see how Saudi activity levels compare to the each of the groups of states. We want to know the following:

- Does Saudi activity relative to the Gulf actors change through time? For example, does Saudi Arabia participate in more activity (relative to Gulf actors) through time, which would suggest that Saudi Arabia is becoming more dominant (in activity)?
- We want to learn the same thing about Saudi activity relative to the three superpowers in the region.
- Finally, we want to compare Saudi Arabia's activity across the two groups of states. For example, does their activity become more dominant with one group, but not with the other?

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<sup>13</sup> In fact, calculating these four types of scores is a significant step forward. Most hubs and authorities scores are based solely either (a) on whether edges exist or do not exist between nodes or (b) on whether the edge is positive or negative.

<sup>14</sup> See footnote 4 for a list of these actors. Please recall the discussion in the section "TWO COLLECTIONS OF DATA;" all data were generated only from stories that mention Gulf actors.

We are going to explore these questions by plotting some simple graphs. We will look separately at hubs, authorities, and activities. We will construct two ratios for each of these three measures of behavior. To illustrate, we will discuss the ratios for hubs. The ratios for authorities and activities are computed in an analogous manner. Note that to simplify matters, we aggregate the data to the yearly level before we create the ratios.

For the Gulf hubs data, we take the total hubs score for Saudi Arabia, and divide this by the average hub score for the rest of the Persian Gulf states. Using the superpower data, we calculate the equivalent ratio: the Saudi hubs score divided by the average superpower score. Note that these two Saudi hubs scores are *not* identical. The Saudi hubs score for the Gulf states is based just on their interactions with the Gulf states, while the Saudi hubs score for the superpowers is based just on their interactions with the superpowers. One final caveat: recall that some of the hubs and authorities scores were calculated on the basis of just a few incidents.

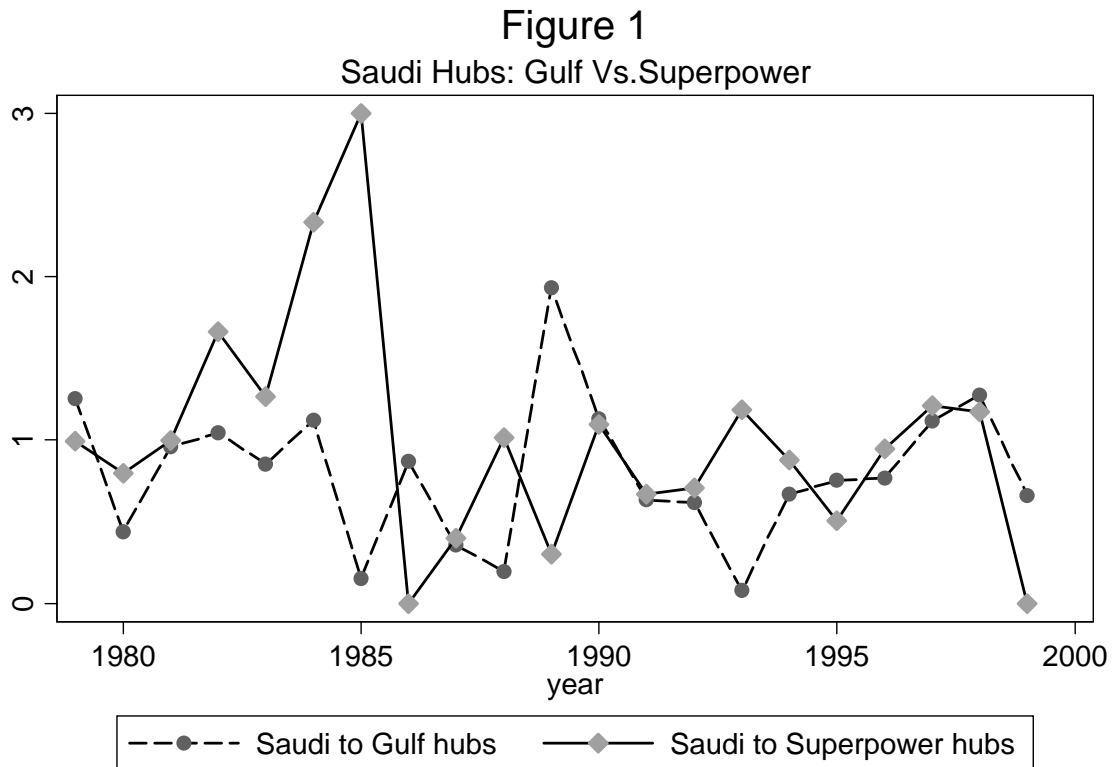


Figure 1 plots the hubs scores. There is a large spike in the Saudi to superpower ratio in 1984 and 1985. But by and large, the two sets of scores track each other fairly closely. This would

suggest that the role of Saudi Arabia vis-à-vis the Gulf states (in terms of initiating events) was very similar to the role of Saudi Arabia vis-à-vis the superpower events in the region. We are speculating here, but we wonder whether the spike in Saudi hubs vis-à-vis the superpowers is associated with Saudi Arabia's decision to tie the price of its oil to spot market prices in October of 1985.

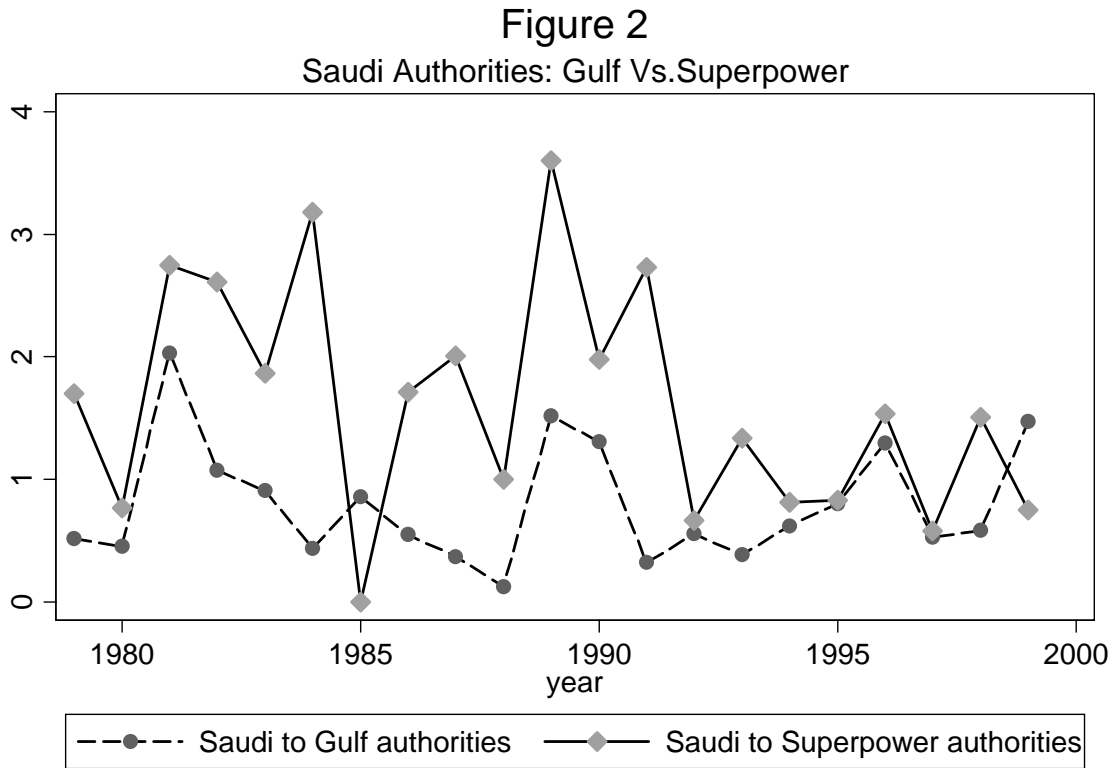
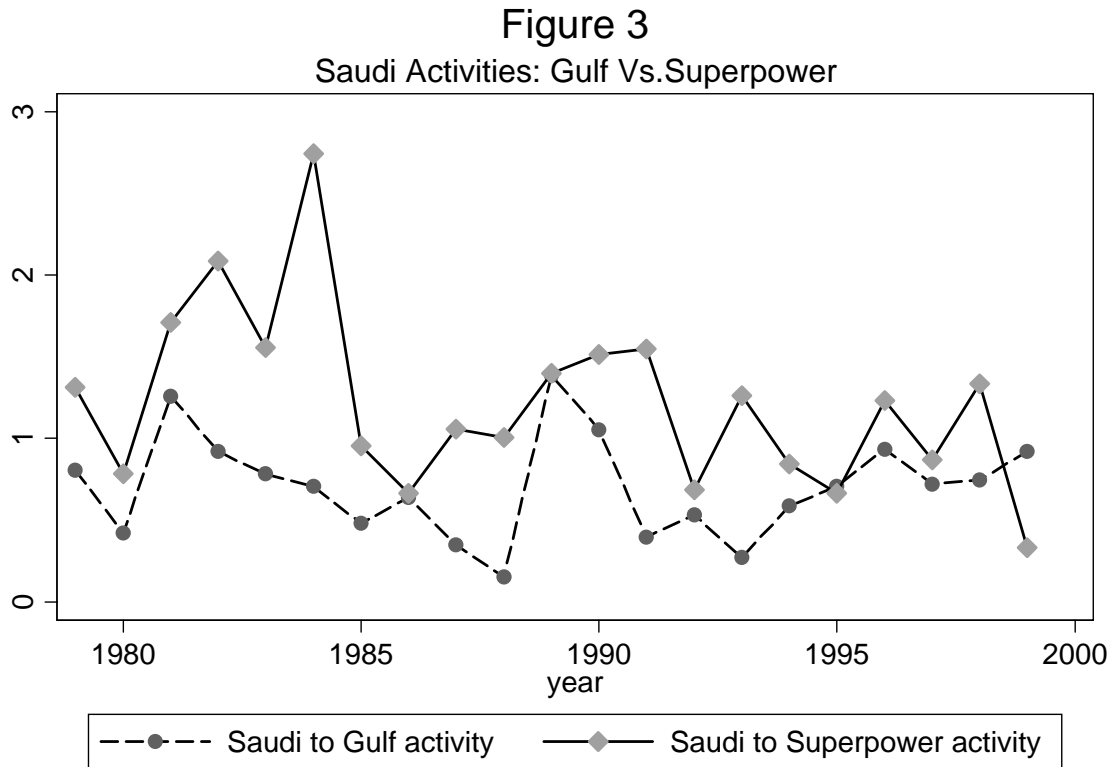


Figure 2 plots the two authority ratios. There is a large dip in the superpower ratio in 1985. So in 1985, at the same time that Saudi Arabia is initiating a lot of events against the superpowers, the superpowers are directing *no* events at Saudi Arabia (at least as reflected in the KEDS Gulf events data). Leaving aside that one year, notice that from 1981 through 1991, the superpower ratio is higher (and usually much higher) than the Gulf ratio. That is, on average the superpowers are directing relatively more important events toward Saudi Arabia, than (on average) the states in the Gulf. This suggests that during that time period Saudi Arabia was more of a player on the superpower scene than in the region.





Finally, we look at activity which is summation of hubs and authorities, which is shown in Figure 3. At this, the highest level of aggregation, the pattern is the clearest. Like the authorities data, it suggests that during this time period Saudi Arabia was (in a relative sense) a more significant “player” among the superpowers than it was among the Gulf states.

### Discussion of Saudi Activity As Identified in Hubs and Authorities Analysis

Hubs and authorities calculations represent a relatively new way to assess importance or centrality. But we think that this new approach can be very valuable in making these assessments. We have chosen to analyze these scores in a very simple manner by using graphs. What we have tried to do is to compare Saudi Arabia's relationship with the Gulf states of the region, with Saudi Arabia's relationship to the superpowers.

We note that the ratio of Saudi Arabia to the superpowers moves around quite a bit. This makes us a bit cautious about pushing our conclusions too far.<sup>15</sup> These fluctuations may not be totally due to changes in behavior among these states. The fluctuations in the ratios may in part be due to the small number of events between Saudi Arabia and China.

Nevertheless, we do find the graphs interesting. Particularly when we examine the plots comparing authorities and activities, we see a similar pattern. Through time, Saudi Arabia's relationship with its Gulf neighbors fluctuates within (admittedly this is a subjective judgment) something of a narrow range. At the same time, Saudi Arabia's involvement seems to be growing relative to the superpowers. This suggests that its regional role has been constant, but its international role has increased.

## **Conclusion**

In this paper, we have attempted to provide a quantitative characterization of Saudi Arabia's behavior vis-à-vis the superpowers from 1966 through 1999. We used two different approaches to do this. Vector autoregression is the "classic" tool for this type of analysis. Hubs and authorities are a new way to examine these data.

From the vector autoregression results, we see the influences on Saudi Arabia behavior have changed through the time. Prior to the 1973 Oil Embargo, Saudi Arabia's behavior was consistent with that of a small state seeking the protection of a major power (the United States) whenever Cold War conflict flared up. In the post-embargo era, the set of influences on Saudi behavior and the nature of these influences grows and changes. Saudi Arabia now interacts with the United States and Russia in a mutually reinforcing reciprocating cycle. To some extent, Saudi Arabia's relations with China in this era are similar to its relations with Russia in the pre-embargo era.

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<sup>15</sup> This also validates using simple analysis with graphs.

From the hubs and authorities results, we see changes in the international role of Saudi Arabia. Within the region, Saudi activity fluctuates within a fairly narrow range. But when interacting with the superpowers, we see Saudi Arabian activity increasing through time.

We believe that the two forms of quantitative used in this paper produce a reasonably consistent picture. In the early years of our study, Saudi Arabia keeps a low profile with the superpowers, and its behavior is driven by a few basic forces. But as time goes on, we see both higher levels of interaction with the superpowers and foreign policy behavior driven by a more complex set of factors. Overall, the picture that emerges is that Saudi Arabia geopolitical position is growing in international stature.

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