THE RISE OF CHINA
AND ITS ENERGY IMPLICATIONS

Is Chinese Foreign Policy Targeting Sub–Saharan Africa?

Richard J. Stoll, Ph.D.
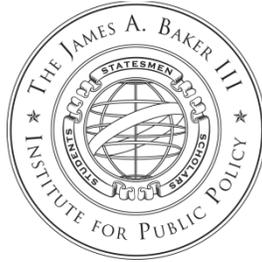
JAMES A. BAKER III INSTITUTE FOR PUBLIC POLICY
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ABOUT THE STUDY

The Rise of China and Its Energy Implications is a major research initiative to investigate the implications of China's oil and natural gas policies and domestic energy market development on global energy markets. This study focuses on the influence of China's energy development on U.S. and Japanese energy security and global geopolitics. Utilizing geopolitical and economic modeling and scenario analysis, the study analyzes various possible outcomes for China's domestic energy production and its future import levels. The study considers how trends in China's energy use will influence U.S.-China relations and the level of involvement of the U.S. oil industry in China's domestic energy sector.

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About The Institute of
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The Institute of Energy Economics, Japan (IEEJ), was established in June 1966 and specializes in research activities in the area of energy from the viewpoint of Japan's national economy in a bid to contribute to sound development of Japanese energy supply and consumption industries and to the improvement of domestic welfare by objectively analyzing energy problems and providing basic data, information and the reports necessary for policy formulation. With the diversification of social needs during the three and a half decades of its operation, IEEJ has expanded its scope of research activities to include such topics as environmental problems and international cooperation closely related to energy. The Energy Data and Modeling Center (EDMC), which merged with the IEEJ in July 1999, was established in October 1984 as an IEEJ-affiliated organization to carry out such tasks as the development of energy data bases, the building of various energy models, and the econometric analyses of energy.

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Stoll's current research includes forecasting terrorism, accounting for Chinese international economic activity and predicting support for NATO's mission in Afghanistan among European countries. The bulk of his previous research has focused on the quantitative study of international conflict, using both statistical analysis and computer simulation. Stoll has been co-principal investigator on several large National Science Foundation-funded projects. He has published six books and a number of articles and book chapters. During his time at Rice, he has won ten teaching awards, and after winning the Jones College Associate of the Year Award on multiple occasions, in 2007 the award was named after him. In 2009, he was a recipient of the Association of Rice Alumni's Meritorious Service Award. He has been interviewed numerous times by the media on issues involving national security and international conflict.

Stoll received his B.A. (with distinction) from the University of Rochester and his Ph.D. from the University of Michigan.

I. Introduction[1]

It is no secret that China's economy has been growing and developing at a rapid rate for many years. Energy is a critical element in this expansion and oil is an important source of energy. Many observers feel that to feed its need for energy, China has particularly targeted Sub-Saharan Africa.[2] And to be sure, there have been a number of deals between Chinese oil companies with African[3] governments. But has the drive for oil led China to *focus* its economic activity on Africa?

In this paper I will look at the bilateral trade between China and other countries from 1990 through 2006. When looking at the overall picture, does it appear that China's trade is predicted by general factors or is it the case that that China has particularly strong trading relationships with developing countries (particularly those in Africa) that have oil?

II. Chinese Growth

Figure 1, below, shows the growth of Chinese GDP since 1970. It is really not necessary to go on at great length about this plot; the pattern is clear. China has had a sustained period of economic growth. Two figures summarize these data. First, the average percentage growth rate from 1970-on is 9.3 percent. Second, across the entire time period, there has only been one year of negative growth.[4] This is truly an impressive performance.

Figure 1.

Chinese GDP 1970-2009
(Millions of 2005 Constant Dollars)

Source: United Nations (2011)
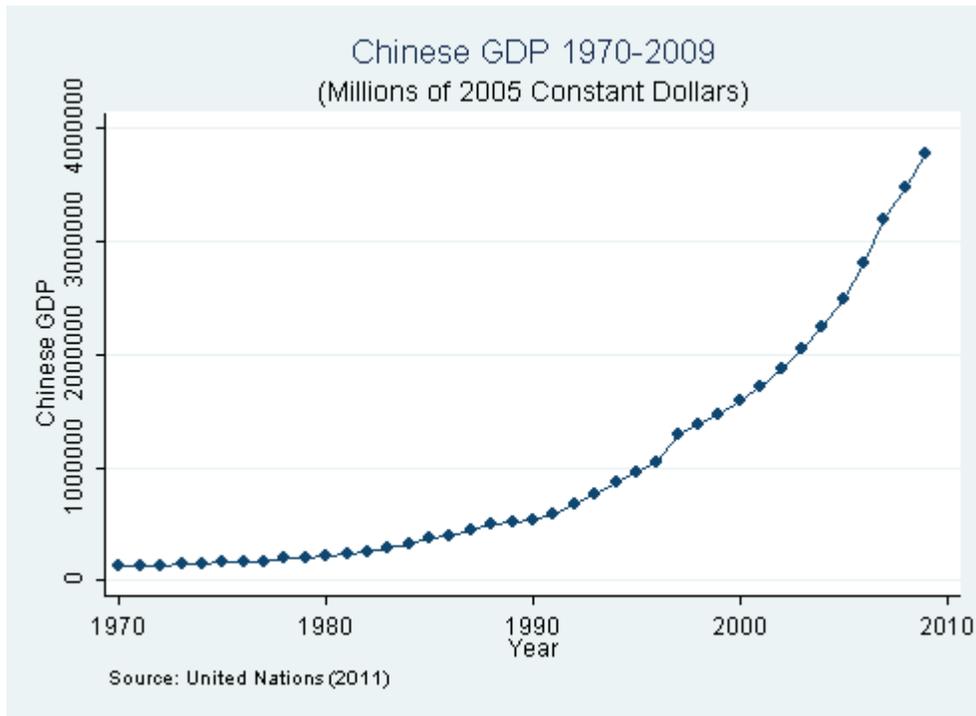
III. China's Focus on Africa

Energy supplies—particularly oil—are critical to the continued growth and development of China's economy. At first glance, a Chinese emphasis on Africa appears curious since other regions of the world have much larger oil reserves. But Ghazvinian[5] points to a number of reasons why China appears to be devoting so much effort to a region that only contains perhaps 10 percent of the world's oil reserves:

- Significant amounts of African oil (for example, the oil found in the Gulf of Guinea) are light sweet crude; this is a highly desirable type of oil. In addition, a number of Chinese refineries are configured to handle this type of oil; heavy oil (which is common in the Middle East) is more costly for China to refine.[6]
- Since Africa is surrounded by water, transportation costs are lower and in most cases less risky than shipping via pipelines.
- Most Sub-Saharan African countries allow production sharing agreements (PSAs). While this means that oil companies must pay the costs of exploration and production, if oil is

discovered, the oil company does not have to share revenues with the host government until after the company has recovered its initial costs.

- Most African countries are not members of the Organization of the Petroleum Exporting Countries (OPEC). Nigeria and Angola are exceptions; and Gabon was a member until 1994.

- A number of African oil fields are offshore. This puts them at some distance from potential (and actual) sites of internal unrest.

- Where else can China go for new oil? A great deal of the world's known reserves are already locked up.

As a consequence, in 2010, four of China's 10 fastest growing imported crude suppliers were African countries.[7]

Chinese attention to Africa goes beyond an interest in oil (and other resources). For example, in 2000, China sponsored the First Ministerial Conference of FOCAC, the Forum on China-Africa Cooperation,[8] and 2010 marked the fourth ministerial conference. China declared 2006 "The Year of Africa"; that year's FOCAC ministerial conference involved 48 African countries. As well, in that same year high-ranking Chinese officials made significant state visits to at least 16 African countries.[9] And Chinese attention to Africa extends beyond the governmental level; it is estimated that by the end of 2006 there were 750,000 Chinese residents in Africa.[10]

There are numerous popular accounts[11] and scholarly studies[12] that paint a convincing picture of a Chinese presence in Africa that is already significant and still growing. But what if we step back from a focus on China's economic activity in Africa and put it in a broader context? What if we look at Chinese economic activity throughout the world? Using this broader focus, does it appear that China is *disproportionately* involved with Africa? I will look at Chinese economic activity for an extended period of time (beginning in 1990) to seek an answer to this question.

IV. Chinese International Economic Activity

In order to proceed, I need to find a measure of the level of economic interaction between states. As with most things of interest to scholars of international relations, there is no direct measure of the concept. So we are forced to find indirect measures; these are called indicators. The indicator most commonly used by international relations scholars to represent the economic interaction between states (countries) is international trade. Although it is not a perfect indicator, it has a number of advantages. One is that governments and international agencies (for example, the International Monetary Fund) keep track of these data for their own purposes (tariffs, taxes, etc.). That means that trade data are relatively easy to find for most countries and also exist for an extended period of years. A second advantage is that since state A's imports from state B are state B's exports to state A, we have a "double check" on trade values. (However, the corresponding import and export figures are generally not identical. Imports are typically recorded as cost, insurance, and freight [CIF] while exports are usually recorded as free on board [FOB]). Third, in the current era, trade and foreign investment tend to be linked.[13] So if we know the amount of trade from one state to another, we have a good idea of the foreign investment from one state to another. For all these reasons trade is a good indicator of the economic relations between countries. Below I will describe the particular trade dataset I will use in the analysis. But now I turn to how to I will model the trade relationship between a pair of countries.

V. How Much Trade Should We Expect Between a Pair of States?

My approach to determining whether China is disproportionately focusing its economic attention on African and/or developing countries with oil is as follows:

- Predict the level of bilateral trade between China and other countries assuming there is nothing special about the pair of countries (including the fact that the other country has large reserves oil).
- Determine whether dyads involving Sub-Saharan African countries with oil are systematically under-predicted by the model.

- Incorporate additional variables in the model that represent oil resources and whether the country is African. Predict the level of bilateral trade between China and other countries using this model.

- Determine if the additional variables help the accuracy of the model.

Next I discuss a simple model of bilateral trade.

A Simple Gravity Model

The gravity model is a simple model developed in the early 1960s to account for the level of trade between a pair of countries.[14] It "has long been one of the most successful empirical models in economics" despite the fact that it is usually viewed as "an intellectual orphan, unconnected to the rich family of economic theory."[15] It has also been used by political scientists.[16]

Suppose we wanted to predict the level of trade between two states, A and B. Assume we know nothing about the specifics of the overall relationship between the two and nothing about the specific items that are traded between them (for example, how rare the items are or how important they are to the economies of each state). Under these circumstances, what factors could we use to predict trade? A simple gravity model uses:

- The previous level of trade between A and B. Like many economic and political variables, dyadic trade is not likely to fluctuate dramatically from year to year. The level of A and B's trade this year is very likely to be similar to their level last year.[17]

- The size of the economies of the two states. Bigger economies are capable of producing higher levels of exports. They are also capable of consuming higher levels of imports.

- The distance between the two states. Two states that are a great distance away from one another will have lower levels of trade due to higher levels of transportation costs.

These factors interact together in a multiplicative fashion.[18]

While I (and many others) would argue that each of these relationships is inherently reasonable, one can easily think of situations in which this model would not produce accurate predictions. Consider the United States and Cuba. While the Cuban economy is not large, the United States has the largest economy in the world. And Cuba is only a short distance (by sea) from the United

States. So a gravity model would expect (predict) a significant amount of trade between the two countries. But we know that is not true. The United States has maintained a trade embargo on Cuba for more than 40 years. This is one example where a critical factor that determines trade (the political relationship between the two countries) is totally absent from the gravity model. So the model should greatly over-predict U.S.-Cuban trade.

Consider as well states that have a great need for a specific item (for example, oil). Oil reserves are not randomly located throughout the world. If you need oil, you have to import it from wherever it is available. If China really is concentrating its efforts to import significant amounts of oil from developing countries in Sub-Saharan Africa, and if it is working hard to establish significant economic relations with these countries, then the gravity model should significantly *under-predict* Chinese trade with these countries. This is because the size of the other states' economies is generally small and the distance between China and these countries is large, so the gravity model would predict only a modest amount of trade.

Incorporating African Countries with Oil

If China is targeting countries in Sub-Saharan Africa, this leads to a very different vision of what predicts the level of dyadic trade between China and other countries. It suggests that the following should have an important effect on the level of trade:

- The level of oil reserves within the other country. China's need for oil should lead it to engage in extensive economic relations with states that are believed to have large amounts of oil. A good proxy (indicator) for this is the amount of proven oil reserves in the state.

- Whether the country is in Sub-Saharan Africa. China would find it easy to exert influence over these countries. This would be true for several reasons. First, China has the third-largest economy in the world. Consequently, its economic power and resources should give it the tools to have a powerful presence in these countries, including a significant trading relationship. Second, since the earliest days of the People's Republic of China, it has portrayed itself as a member of the developing world. While some may question this characterization today, China has worked hard to promote this view and to argue that it has a great deal in common with developing countries such as those in Sub-Saharan

Africa. As well, China and most African countries saw (and still see) themselves as non-aligned countries while most Middle Eastern oil producers were anti-Communist and sided with the West. This meant the Chinese-African connection was politically compatible. This should facilitate the development of close relations between China and the countries of Sub-Saharan Africa.

- If the country has significant oil reserves *and* is located in Sub-Saharan Africa there should be an even greater trading relationship with China. Note that this argument is that the status of the country and the presence of oil reserves should interact together and lead China to be particularly focused on this set of countries (i.e., the impact should be greater than the additive impact of the two factors separately).

- If the country has one or more oil investment deals with China. While the presence of oil reserves in a country is an indication of the potential for extensive economic relations, these deals represent a tangible commitment from China. Such commitments should be associated with a significant economic relationship between the countries.

- If the country has significant oil reserves *and* is located in Sub-Saharan Africa. Countries that share these characteristics should be particularly important to China and therefore have extensive economic relationships with it.

Note that this perspective is very different from that of the gravity model. With this perspective, specific characteristics of countries have a large influence on the trading relationship with China.

VI. Operationalization

This study will involve all Chinese dyads (i.e., China paired up with every other state[19] in the world) and span the years 1990 through 2006. The end point is dictated by the limits of the trade dataset that I will use (discussed below). The starting point is admittedly a bit arbitrary, but it is not capricious. The 1980s, particularly the later part of the decade, was a time of inward focus in China. Inflation and internal unrest were significant issues;[20] this culminated in the Tiananmen Square massacre in 1989. As well, with the end of the Cold War, Africa received much less attention from the West.[21] In the early 1990s, the Chinese government realized that its domestic oil production was going to fall and that oil imports would be necessary to continue to sustain its

economic growth. So it was about this time (1990) that China began to extend itself internationally (both because it turned outward and the end of the Cold War broke down the antagonistic bipolar system) and, at the same time, the West was contracting its involvement in Africa. Below are the operationalizations of the variables for the gravity model.

- Dyadic Trade. The trade data are from the Correlates of War Project.[22] The primary source of their trade data is the International Monetary Fund (IMF). Their data run through 2006. Data are measured in current dollars.

- GDP Data. The GDP data are from the United Nations database.[23] GDP is measured in current dollars.

- Distance. The distance data are from country capital to country capital. These data were calculated using the program EUGene.[24]

- Oil Reserves. Proven reserves are taken from the tab "Oil–Proved reserves" in the spreadsheet that accompanies the BP Statistical Review of World Energy.[25]

- Sub-Saharan Africa. A state is coded as being in Sub-Saharan Africa if its Correlates of War Project nation number is in the range 400-599 or 625.[26]

- Oil Investments. The Energy Forum of the Baker Institute has collected data on Chinese oil investments from 1992 to 2011.

VII. Analysis

I conduct two series of regression analyses predicting dyadic trade with China. The first series of analyses are for the years 1990-2006 and contain:

- Gravity model
- Gravity model with fixed effects
- Gravity model plus Sub-Saharan African dummy, oil reserves, and their interaction
- Gravity model plus Sub-Saharan African dummy, oil reserves, and their interaction with fixed effects

The second series of analyses are for the years 1993-2006 and contain:

- Gravity model[27]
- Gravity model plus Sub-Saharan African dummy, yearly oil investment deals, and their interaction

- Gravity model plus Sub-Saharan African dummy, yearly oil investment deals, and their interaction with fixed effects

- Gravity model plus Sub-Saharan African dummy, total number of oil investments, and their interaction

- Gravity model plus Sub-Saharan African dummy, total number of oil investments, and their interaction with fixed effects

The first set of analyses (using oil reserves) represents African states that are *potential* partners with China. The second set of analyses (using oil investment deals) represents African states that are actual partners with China. Note that the following two variables are constant for a dyad and therefore drop out of fixed effects estimation: distance, and the variable for Sub-Saharan Africa.[28]

Gravity Model, Sub-Saharan Africa, and Oil Reserves

Table 1. Predict Dyadic Trade with China, 1990-2006: Gravity Model, Sub-Saharan Africa, and Oil Reserves

	Gravity Model	Gravity, FE	Oil, Africa	Oil, Africa, FE
Lag: Ln(Trade Data)	0.904***	0.552***	0.879***	0.553***
	(0.0074)	(0.0147)	(0.0083)	(0.0148)
Lag: Ln(Chinese GDP Data)	0.281***	0.870***	0.319***	0.882***
	(0.0417)	(0.0588)	(0.0418)	(0.0593)
Lag: Ln(Other State GDP Data)	0.0371***	0.730***	0.0470***	0.702***
	(0.0070)	(0.104)	(0.0071)	(0.109)
Ln(capital distance)	-0.181***		-0.135***	
	(0.0394)		(0.0407)	
Ln(Oil reserves)			0.0435***	-0.0447
			(0.0165)	(0.124)
Sub-Saharan dummy			-0.248***	
			(0.0471)	
(Sub-Saharan)(Oil reserves)			0.0840	0.113
			(0.0582)	(0.199)
Constant	0.351***	-5.976***	-0.0658	-5.902***
	(0.488)	(0.432)	(0.496)	(0.448)
Observations	2,339	2,339	2,313	2,313
R-squared	0.911	0.747	0.913	0.749
Number of dyads		155		155

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 1 presents the results using the gravity model and those additional estimations that include oil reserves. The results are clear-cut. In each regression, all the variables that are part of the gravity model are in the expected direction and are statistically significant. The oil reserve dummy is significant and positive, which is consistent with the idea that China seeks extensive economic relationships with countries that have oil. As for the two other variables that are part of the alternative perspective, while the dummy variable for Sub-Saharan Africa is significant, it is negative. This is not what was expected; it indicates that, all else being equal, China trades less

with countries in this region. The interaction between the Sub-Saharan dummy and oil reserves is positive but not significant. But evaluating such interactions is not simply a matter of examining the direction and significance of individual coefficients; I will conduct a more in-depth assessment of the impact of region and oil on trade below.

An additional step to assess the fit of the gravity model is to examine its residuals. Residuals are defined as the predicted value from the regression minus the observed value. None of the variables in the gravity model represent Sub-Saharan Africa, oil reserves, or most importantly, the interaction between these two variables. If China was disproportionately economically engaged with Sub-Saharan African countries that have oil, then there should be a large number of cases with these characteristics that have very big negative residuals.

I identified the cases with extreme residuals[29] and then determined how many of them were (a) Sub-Saharan African, and (b) Sub-Saharan African with oil. Table 2 shows the number of extreme residuals for each of these categories, and also compares the proportions with the overall proportion of such cases in the entire dataset. Remember, each case is a country-year.

Table 2. Proportion of Sub-Saharan Country-Years and Sub-Saharan/Oil Reserve Country-Years

Sub-Saharan/ Sub-Saharan with Oil	Sub-Saharan African		Sub-Saharan African with Oil	
	Overall Dataset	Extreme Residuals	Overall Dataset	Extreme Residuals
No	1637 (70.0%)	33 (57.9%)	2205 (95.3%)	49 (92.4%)
Yes	702 (30.0%)	24 (42.1%)	108 (4.7%)	4 (7.6%)
Totals	2339	57	2313	53

Note: Only cases that were used in the regression analysis for the gravity model are included in the table (missing data removed a number of cases from the regression analysis).

As you can see, the proportion of extreme residuals for Sub-Saharan African country years is somewhat higher (42.1 percent) than the proportion in the overall dataset (30.0 percent). This suggests that there is something beyond the gravity model that accounts for trade with these countries. However, an examination of the 24 extreme residuals reveals that they are evenly split between negative and positive; 12 are negative and 12 are positive. The cases with

negative residuals are consistent with the argument that China is targeting Sub-Saharan African countries, but the (equal number) of cases with positive residuals are not. It is not surprising that the gravity model cannot account for all the cases. But it is useful to note that the gravity model's failures are not simply because China is trading at greater than expected levels with Sub-Saharan African countries.[30]

The situation with extreme residuals for Sub-Saharan countries with oil is straightforward. All residuals are negative. This is consistent with the argument that China is disproportionately engaging in economic activity with this subset of countries. However, the percentage of extreme residuals is essentially the same as the percentage in the overall dataset. This is inconsistent with the argument about targeting. If China was systematically targeting Sub-Saharan African countries with its international economic policies, the proportion of cases with large negative residuals should be much higher.

Taken together, the foregoing analysis shows that the gravity model is a surprisingly good predictor of Chinese trade. This is despite including additional variables that are consistent with the argument that China is targeting Sub-Saharan countries with oil. In the next analysis I will shift from looking at countries that are of potential interest if China is pursuing energy security (countries that have oil reserves), to examining countries that are of *actual* interest by including measures of the actual energy engagement of China. But first I return to the impact of the interaction between the Sub-Saharan Africa dummy and the level of oil reserves.

I examine the predicted values for log of trade based on this interaction. Specifically, I put the values of log of oil reserves into seven ordered groups (category 1 is the lowest category of oil reserves, and category 7 is the highest). I then compare the predicted values for each group for those countries that are in Sub-Saharan Africa, and the rest of the world. Table 3 displays the results.

Table 3. Average Predicted Values of Logged Trade Values by Logged Level of Oil Reserves and Region

Log of Oil Reserves: Ordered Group	Region	
	Not Sub-Saharan Africa	Sub-Saharan Africa
1	12.87	10.32
2	12.91	10.44
3	12.95	10.57
4	13.00	10.70
5	13.04	10.83
6	13.08	10.95
7	13.13	11.08

The results of Table 3 are clear-cut. Predicted Chinese trade increases with the level of oil reserves in the other country. But holding the level of oil constant, Chinese trade is *lower* with countries in Sub-Saharan Africa. When incorporating a series of measures that are designed to tap the potential for trade with oil countries in Sub-Saharan Africa, we find that China might be targeting countries with oil (although the analysis of residuals suggests this is not a dominant drive of Chinese foreign economic policy). But there is nothing in the analysis so far that is consistent with a particular focus on Sub-Saharan Africa.

Sub-Saharan Africa, and Oil Investment Deals

While the conclusions from the first set of analyses are reasonably clear-cut, some additional work would help clarify the findings and (hopefully) put them on a firmer foundation. The second set of analyses has a structure similar to the first. All estimations start with the base of the gravity model and add additional variables that are meant to tap some of the characteristics that are associated with assertions that China is disproportionately targeting Sub-Saharan countries with oil. I begin by discussing the non-gravity model variables that will be included.

I continue to include the dummy variable for Sub-Saharan countries since it is a simple and direct indicator of the arguments for a Chinese foreign policy of targeting Africa. In the previous analyses the level of oil reserves (logged) was used. This is an indicator of *potential* Chinese interest. That is, if the arguments for Chinese targeting are correct, then the *potential* set of Sub-Saharan countries of interest are those with oil. But China also has a number of *direct interests* in the region: the set of countries with which China has made one or more oil deals. So instead of

using a variable with oil reserves, I use several different variables representing the number of oil investment deals that China has with each country.[31]

Data on Chinese oil investment deals are available beginning in 1992 (since I lag variables this means the subsequent analysis will be conducted over the time period 1993-2006). Potentially there are a number ways to use such data. But in the absence of a body of previous work it is prudent to begin with several simple measures. In the analysis that follows I use two different indicators. The first is the number of investment deals concluded in each year. This represents new involvements. The second is the total of deals to date. This is an indication of the level of Chinese involvement in oil in that country. As with other variables in the analyses, these variables are lagged a year and of course they are logged. Figure 2 plots the number of new deals each year. It displays both the total number of deals and the number of deals in Sub-Saharan Africa.

Figure 2.
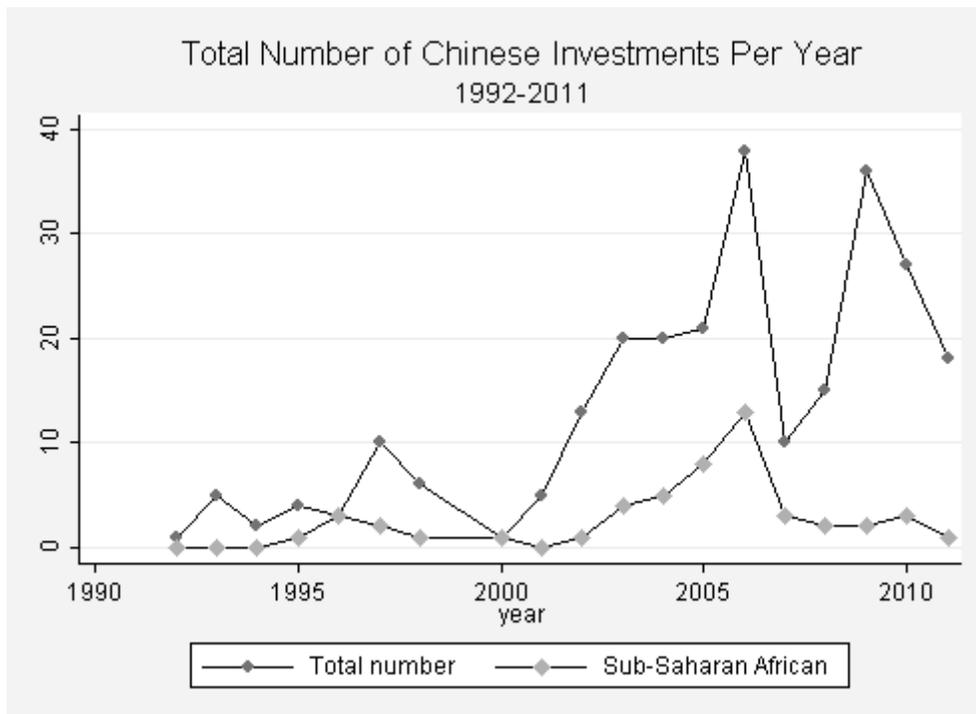
As can be seen, there is a rough trend of increasing the total number of deals through time. But the picture in Sub-Saharan Africa is a bit different. There is an increase in deals through time but

it spikes in 2006. Of course, the number of deals ignores a lot of other information, such as the amount of the investment and the subsequent amount of oil discovered. But incorporating this kind of information is not easy. Deals can be signed but not carried out. Deals can be changed. Oil may or may not be found. These complications have led me for the time being to focus on the simplest possible indicators of Chinese oil investment.

Table 4. Predict Dyadic Trade with China, 1993-2006: Oil Investments, Sub-Saharan Africa, Total Oil Investments

	Gravity model	Deals, Africa	Deals, Africa, FE	Total Deals, Africa	Total Deals, Africa, FE
Lag: Ln (Trade Data)	0.946***	0.931***	0.499***	0.928***	0.499***
	(0.00670)	(0.0074)	(0.0180)	(0.0075)	(0.0180)
Lag: Ln (Chinese GDP Data)	0.303***	0.332***	1.179***	0.339***	1.179***
	(0.0457)	(0.0460)	(0.0677)	(0.0459)	(0.0677)
Lag: Ln (Other State GDP Data)	0.0165***	0.0252***	0.651***	0.0261***	0.651***
	(0.00612)	(0.0064)	(0.106)	(0.0064)	(0.106)
Ln (capital distance)	-0.0663*	-0.0218		-0.0239	
	(0.0340)	(0.0352)		(0.0351)	
Sub-Saharan Dummy		-0.191***		-0.210***	
		(0.0404)		(0.0422)	
Ln (Number of deals)		0.0539	-0.0230		
		(0.200)	(0.190)		
(Sub-Saharan)(Number of deals)		0.290	0.0524		
		(0.406)	(0.387)		
Ln (Total number of deals)				0.0272	0.00982
				(0.0316)	(0.0525)
(Sub-Saharan)(Total number of deals)				0.121*	0.0187
				(0.0690)	(0.1280)
Constant	-1.218**	-1.662***	-7.528***	-1.686***	-7.531***
	(0.483)	(0.491)	(0.455)	(0.490)	(0.454)
Observations	1,982	1,982	1,982	1,982	1,982
R-squared	0.940	0.940	0.766	0.940	0.766
Number of dyads			155		155

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The results of these new analyses are displayed in Table 4. I begin by repeating the analysis using the gravity model over the shorter time period. These results are consistent with those presented in Table 2. All the variables that are part of the gravity model are statistically significant and in the predicted direction. But note that the log of distance has declined in significance from the results presented in Table 1.[32] As in the previous analysis, the dummy variable for Sub-Saharan Africa is significant, but negative. All else being equal, the level of Chinese trade with these countries is *lower* than its trade with the rest of the world.

Only one variable that is not part of the gravity model achieves any level of significance: the interaction of Sub-Saharan country and total number of deals. In order to get a better feel for the results, I compute the marginal mean prediction for dyadic trade, as was done in the earlier analysis and displayed in Table 3. I put the values of the log of total deals into seven ordered groups and display the predicted trade value for Sub-Saharan Africa and the rest of the world. Table 5 displays the results.

Table 5. Average Predicted Values of Logged Trade Values by Logged Total of Oil Deals and Region

Log of Total Oil Deals: Ordered Group	Region	
	Not Sub-Saharan Africa	Sub-Saharan Africa
1	13.08	10.54
2	13.09	10.62
3	13.11	10.69
4	13.12	10.76
5	13.13	10.84
6	13.15	10.91
7	13.16	10.99

The results displayed in Table 5 are clear-cut. These results parallel those of Table 3. Chinese trade increases with the logged total of oil deals. But the levels of trade are smaller for Sub-Saharan Africa than they are for the rest of the world. As with the earlier results, I find that the factors in the gravity model are the dominant drive for Chinese economic engagement. A secondary factor is Chinese economic involvement with countries that have oil. But there is not systematic evidence of Chinese targeting of Sub-Saharan Africa.

VIII. Discussion

In this paper I have found that a simple gravity model does a very good job of accounting for Chinese trade. While the predictions from this model are not perfect, examination of the gravity model's mispredictions (the residuals) does not support the argument that Sub-Saharan Africa is a particular focus of Chinese economic activity. As well, incorporating several sets of variables that are indicators of the reasons why China is supposed to be targeting these countries shows these additional variables contribute very little to the fit of the model. Why is this the case? Before discussing some of the issues with the research presented here that may have obscured a Chinese focus on Sub-Saharan Africa, let me present a simple picture of Chinese trade patterns for the time period under study; this is displayed in Figure 3.

Figure 3.
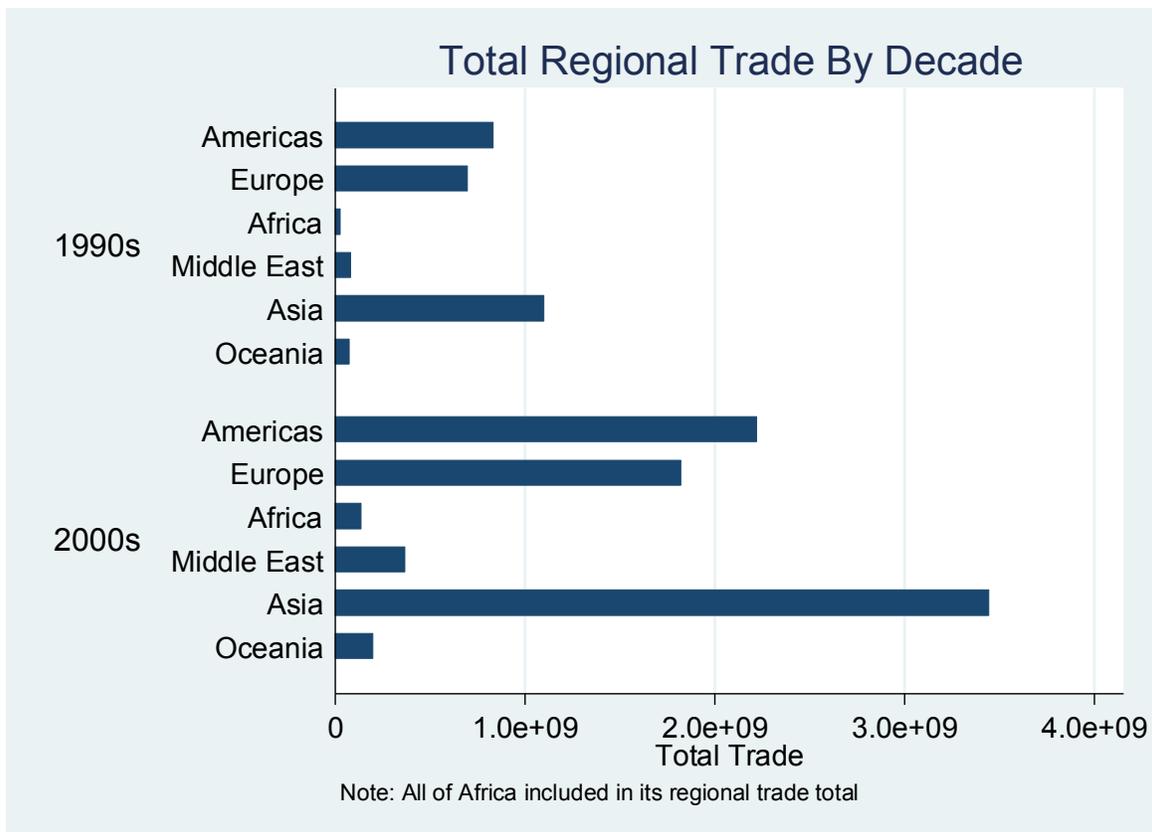
The conclusions from Figure 3 are straightforward. First, there has been a tremendous increase in the amount of Chinese trade through time (note that the number of years in the 2000s is less than

that of the 1990s, so the increase is understated). Second, the ranking of trade by region is unchanged; for example, Asia is the region with the largest amount of trade with China in both decades. Third, although there has been a tremendous increase in trade with Africa,[33] it remains the region with the *smallest* amount of trade with China. By focusing only on Africa (or Sub-Saharan Africa) we see the great growth in economic activity. But when put in comparative perspective, we see that China is more engaged economically with every other region in the world. This is consistent with the analyses in this paper. But it is also important to consider the possible weaknesses of the work presented here.

Earlier in the paper I argued that trade is a widely used measure of economic activity and that economists have noted that it correlated with other forms of economic activity.[34] This makes dyadic trade a good stand-in (indicator) of the broader economic relationship between countries. But nevertheless it may be an inadequate indicator for this study. The results of the analysis might be different if a more all-encompassing measure of Chinese economic involvement was the dependent variable.

The analyses in this paper presume a simple and direct link between the putative causes of Chinese economic activity (for example, the amount of oil in the country or the number of oil investment deals) and its effects (high levels of trade). Since this paper is a preliminary effort, I felt that it was important to begin with the simplest approach. But that approach may be inadequate and only a more sophisticated one will uncover the expected relationship between Sub-Saharan African oil and Chinese economic involvement. For example, it may take years for the impact of oil reserves (or oil deals) to have an impact on overall Chinese economic activity.

A final point is that the analyses presented here assume that Chinese economic activity is conducted as if it were directed by a single rational actor. This assumption is commonplace in the international relations literature (and with many other academics and policymakers as well). But that assumption may be a poor way to model Chinese economic activity. China has four major oil companies: China National Petroleum Corporation (CNPC), China Petroleum and Chemical Corporation (Sinopec), China National Offshore Oil Corporation (CNOOC), and China National Chemicals Import and Export Corporation (Sinochem).[35] It is possible that each

company (note that all of them are profit-making entities) has different goals and/or operates differently from the others. So there is no "China"; there are four independent actors. That would call for a very different (and vastly more complicated) model.

IX. Conclusion

China is growing rapidly and has done so for an extended period of time. One of the keys to maintaining and increasing this growth is energy. But China's energy needs cannot be met by its own resources. It must look outside its borders to obtain enough energy. Many observers have noted that China is increasingly involved in Sub-Saharan Africa. It appears to many that China is particularly focused on countries in this region that have oil. And there is plenty of evidence that supports this assertion.

But the analysis presented here offers a simpler view of what predicts Chinese economic activity (as measured by dyadic trade). A gravity model does a good job of accounting for its trade from 1990-on. Including additional variables that are indicators of a Chinese focus on Sub-Saharan Africa and oil did not improve the predictions. In fact, the analysis of this study suggests that China is *less* economically engaged in Sub-Saharan Africa than it is in other regions of the world. At least in its broad contours, Chinese international economic policy does not play favorites. The overall volume of Chinese trade is well predicted by simple factors that are unrelated to politics, history of friendship or enmity, and special needs.

The plain truth is that while Chinese trade showed tremendous increases (trade for the years of the 2000s in this study is about 190 percent higher than trade for the entire decade of the 1990s), the rank order of trade among the regions has not changed (refer back to Figure 3). It is true that Chinese trade with Africa as a whole has increased by over 350 percent from the decade of the 1990s to the 2000s. But this only meant that Africa moved from 1 percent of total Chinese trade to 1.7 percent of total Chinese trade. Contrast this to trade with the number one ranked region—Asia. It increased from 39 percent of total trade to 42 percent.

What does this mean for the U.S. foreign policy? China is a rapidly growing power. It needs energy to sustain its growth and Africa is a logical source for this; we can expect that Chinese involvement in Africa will increase. But this should not obscure the greater truth: China is simply becoming a more important international actor. This makes China a competitor. We can expect it to contend with the United States across a variety of arenas; for example, natural resources, investments, and overall political influence.

But this does not mean that China is destined to become an enemy. There are a number of areas of common interest with the United States. For example, Chinese naval vessels are operating with those of other nations (including the United States) to stem piracy off the coast of Somali. China and the United States also share a common interest in finding a "soft landing" for North Korea. Above all, both countries share a strong interest in having a prosperous and growing world economy. This forms a significant basis for a cooperative (although wary) relationship. Only time will tell if the positive aspects of the U.S.-Chinese relationship will outweigh the competitive elements. But the overall pattern of Chinese trading relationships indicates that China is engaging throughout the world, and that should be seen as a positive sign.

Notes

1. I would like to thank Omar M.G. Keshk for his methodological advice, Brian Pollins for careful reading of the manuscript, Steven Lewis for helpful comments, and James Coan and Baker Institute interns for collecting the data on Chinese oil investments. Finally, I express my appreciation to Amy Myers Jaffe, director of the Baker Institute Energy Forum, for her advice and encouragement. Any remaining errors are my responsibility.

2. Peter Brookes, *Into Africa: China's Grab for Influence and Oil* (Washington, D.C.: Heritage Foundation, 2007), http://www.heritage.org/research/lecture/into-africa-chinas-grab-for-influence-and-oil; Cindy Hurst, *China's Oil Rush in Africa* (Potomac, MD: Institute for the Analysis of Global Security, 2006), http://www.iags.org/chinainafrica.pdf.

3. The main focus of this paper is Sub-Saharan Africa. But for the sake of variety, I will sometimes speak of Africa, rather than Sub-Saharan Africa.

4. The one year of decline using United Nations data was 1976; the decline was 1.6 percent.

5. John Ghazvinian, *Untapped: The Scramble for Africa's Oil* (Orlando: Harcourt, 2007), 9-12.

6. Amy Myers Jaffe and Steven W. Lewis, "Beijing's Oil Diplomacy," *Survival* 44, no.1 (2009): 124.

7. Daniel Workman, "China's Top Suppliers of Imported Crude Oil by Country in 2010," *International Trade @suite101,* March 4, 2011, http://www.suite101.com/content/chinas-top-suppliers-of-imported-crude-oil-by-country-in-2010-a355760.

8. Forum on China-Africa Cooperation, http://www.focac.org/eng/.

9. Sarah Raine, *China's African Challenges* (New York: Routledge, 2009).

10. Serge Michel and Michel Beure, *China Safari: On the Trail of Beijing's Expansion in Africa* (New York: Nation Books, 2009), 4.

11. Ghazvinian, *Untapped*; Michel and Beuret, *China Safari*.

12. Hurst, *China's Oil Rush*; Bo Kong, *China's International Petroleum Policy* (Santa Barbara: ABC-CLIO, 2009); Raine, *China's African Challenges*; Robert I. Rothberg, *China Into Africa: Trade, Aid, and Influence* (Washington, D.C.: Brookings Institution Press, 2008).

13. Barry Naughton, *The Chinese Economy: Transitions and Growth* (Cambridge: MIT Press, 2007), 378.

14. Jan Tinbergen, *Shaping the World Economy: Suggestions for an International Economic Policy* (New York: Twentieth Century Fund, 1962).

15. James E. Anderson, "The Gravity Model" (working paper, National Bureau of Economic Research, No. 16576, 2010), http://www.nber.org.ezproxy.rice.edu/papers/w16576.pdf?new_window=1.

16. Omar M. G. Keshk, Brian M. Pollins, and Rafael Reuveny, "Trade Still Follows the Flag: The Primacy of Politics in a Simultaneous Model of Interdependence and Armed Conflict," *The Journal of Politics* 66, no. 4 (2008): 1155-1202; Omar M.G. Keshk, Rafael Reuveny, and Brian M. Pollins, "Trade and Conflict: Proximity, Country Size, and Measures," *Conflict Management and Peace Science* 27, no. 1 (2010): 3-27. These two articles directly inform my work. I now provide a brief description of the logic and components of a simple version of the gravity model.

17. In the original presentation of the gravity model (Tinbergen, 1962: 262-293), lagged trade was not included. However as Kehsk, Pollins, and Reuveny (2008: 1161) note, recent studies have included lagged trade for the reason I noted in the text. Note that some scholars also include the populations of both states in addition to their GDPs. Unfortunately, because of a high degree of multicolinearity I had to drop the population variables from my estimations.

18. The multiplicative effect is achieved by taking the log (the natural log) of all of these variables before estimating the equation.

19. I use the Correlates of War Project definition of a state. For the period of time under study, a state is defined as an entity that is a member of the United Nations or (a) has a population greater than 500,000 and (b) receives diplomatic missions from at least two major powers (Correlates of War Project, 2008).

20. Raine, *China's African Challenges*.

21. Li Anshan, "China's New Policy Toward Africa," in *China Into Africa: Trade, Aid, and Influence*, ed. Robert I. Rotberg (Washington, D.C.: Brookings Institution Press, 2008), 21-49.

22. Katherine Barbieri, Omar Keshk, and Brian Pollins, "Correlates of War Project Trade Data Set Codebook, Version 2.0," 2008, http://correlatesofwar.org; Katherine Barbieri, Omar M.G. Keshk, and Brian M. Pollins, "Trading Data: Evaluating Our Assumptions and Coding Rules," *Conflict Management and Peace Science* 26, no. 5 (2011): 471-491.

23. "National Accounts Main Aggregates Database," United Nations, accessed 2011, http://unstats.un.org/unsd/snaama/Introduction.asp.

24. D. Scott Bennett and Allan Stam, "EUGene: A Conceptual Manual," *International Interactions* 26 (2000): 179-204.

25. BP, "Statistical Review of World Energy 2011," http://www.bp.com/sectionbodycopy.do?categoryId=7500&contentId=7068481.

26. "State System Membership List, v2008.1," Correlates of War Project, 2008, http://correlatesofwar.org. States in Africa are in the range 400-599. Country codes for states in North Africa and the Middle East begin with country code 600. But Sudan is country code 625, so it is included in the coding of Sub-Saharan Africa.

27. The analysis of the gravity model is repeated because the time period for the second set of analyses is not the same as the time period for the first set of analyses.

28. As an additional check, I repeated all the analyses reported here using a dummy variable that takes on the value one for *all* African countries instead of the dummy for Sub-Saharan Africa. The results are essentially identical to those reported here.

29. Residuals always have a mean of zero. The residuals of the gravity model estimation have a standard deviation of about .81. I defined an extreme residual as having a value of 2 or above, or a value of -2 or less.

30. If we restrict attention to negative extreme residuals, these only represent 21 percent of the extreme residuals. This is a lower percentage of Sub-Saharan African country-years than is present in the overall dataset.

31. These data were collected by the Baker Institute Energy Forum. I want to thank Amy Jaffe, director of the Baker Institute Energy Forum; James Coan, research associate and assistant to the director, Baker Institute Energy Forum; and several Baker Institute Energy Forum interns for making these data. Making data is a long, difficult, and boring process. We should be grateful to those individuals who put in the effort to provide us with this vital service.

32. It is beyond the scope of this paper to conduct an extensive exploration of the reasons for this. But I might speculate that as China grows economically, distance plays a smaller and smaller role in its trade relationships.

33. As noted in Figure 3, the trade total for Africa is for the entire continent, not just Sub-Saharan Africa. Consequently, the figure *overstates* the amount of trade with the countries of interest.

34. Barry Naughton, *The Chinese Economy: Transitions and Growth* (Cambridge: MIT Press, 2007): 378.

35. Kong, *China's International Petroleum Policy*, 31.