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Final Draft: Thesis Proposal
Junior Honor Seminar
May 10, 2004

Rainfall, Economic Shocks and Civil Conflicts in the Agrarian Countries of the World

Introduction

Peace and prosperity are two major political and economic goals of people around the world. One is often related to the other. Civil conflicts, or the disruption of domestic peace, have caught more and more attentions of political scientists. Nicholas Sambanis, in his review of existing literature on civil war, explains why political scientists are interested in the study of civil war. Enormous human sufferings, economic costs and international instability, which affect the well-being of humankind, are three most important concerns underlying the study of civil war (Sambanis 2001). Understanding the cause of civil war can help political scientists and policy makers in “designing prevention and management strategies” (Sambanis 2001). Agreeing on the importance of the study of civil conflicts, political scientists have not reached their consensus on the cause of civil war. Sambanis categorizes all causal theories into four different groups: One is economic theory of war, emphasizing the effect of economic development on the occurrence of civil conflicts, such as Marxism. The other is rational choice theory, often related with economic theory of war, focusing on the impact of economic condition through rational calculation of opportunity cost. Third theory is international relation hypothesis, stressing the roles played by the superpowers. The last one is constructivism, calling attention to the impact of social and political structures, such as the level of democracy and ethnicity. In this paper, I do not intend to explore all the theories or compare them. Instead, I will

focus on the combination of economic and rational choice theories and investigate how the onset of civil conflicts is affected by economic shocks estimated by an instrumental variable, rainfall, in the agrarian countries of the world.

Literature Review

Several studies have been done on the relationship between economic conditions and civil conflicts; however, these studies suffer from the problem of endogeneity: on the one hand, economic downturns may increase the likelihood of civil strife; on the other hand, civil strife may also increase the likelihood of economic downturns.

In "On Economic Causes of Civil War," Paul Collier and Anke Hoeffler (1998) undertook an investigation on the reasons for rebellion. Based on their model, people will get involved in civil conflicts only when the utility associated with participation in civil conflicts outweighs that of non-participation. Economic growth affects the utility of undertaking civil conflicts in two ways. First, higher economic growth leads to higher government revenue and military expenditure, which in turn results in a lower probability of rebel victory and a higher cost of rebellion. Second, higher economic growth leads to higher personal income from production. As income increases, people would have more to lose if they chose to rebel and failed to succeed. Thus, the opportunity cost of rebelling is much larger in a country with high economic growth than in that with low economic growth. Because of the above effects, high economic growth is expected to be associated with a low level of civil conflicts. Collier and Hoeffler also included in the model the coordination cost as part of the cost of rebellion. They expected that as the level of ethnic heterogeneity increases, it would become more difficult to communicate and coordinate within the nation and thus the cost of rebellion should go up. Collier and Hoeffler found

a negative and statistically significant relationship between income per capita and the likelihood of civil wars. They also found that the likelihood of civil wars is higher in polarized societies than in either homogeneous or heterogeneous societies. In their following series of studies, Collier and Hoeffler (2001, 2002) also tried to measure and evaluate the effect of democracy, region, population and geographic factors on the probability of the onset of rebellion. The work of Collier and Hoeffler spells out the possible causal model underlying the relationship between economic growth and civil conflicts. However, Collier and Hoeffler overlooked the potential effect that civil conflicts might have on economic growth.

In “Economic Growth in a Cross Section of Countries,” Robert Barro (1991) did a study on all the possible social and political factors that might affect economic growth. The peacefulness of a country, measured by the level of civil conflicts, is one of the factors studied. A low level of economic growth is found to be associated with frequent civil conflicts. Barro questioned the causal direction. He is not certain about whether it is a low level of economic growth that leads to civil conflicts or if it is the other way around. Barro’s finding provides evidence that the problem of endogeneity might exist in the study of the one-way relation between economic shocks and civil conflicts. Part of the economic shocks, measured in terms of GDP or income per capita, may actually be the result of civil conflicts.

How to measure “pure” economic growth without the influence of civil conflicts became a new challenge facing political scientists. An instrumental variable approach is needed. Political scientists have to look for a so-called “instrumental variable” that is not affected by either economic growth or civil conflicts and is able to influence the level of

economic growth but not the civil conflicts. By employing such an instrumental variable, the part of economic downturn that results from civil conflict is sorted out. The problem of endogeneity is addressed. However, how to determine what a “good” instrumental variable is remains a question. In both “Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments” and “Problems with Instrumental Variables Estimation When the Correlations Between the Instruments and the Endogenous Explanatory Variable is Weak”, Angrist and Krueger (2001) and Bound, Jaeger and Baker (1995) point out that in order to secure the validity of a model based on the instrumental approach, the instrumental variable chosen has to satisfy three basic criteria: 1) it must have a strong and statistically significant relationship with the independent variable; 2) it must have no direct relationship with the dependent variable; 3) a plausible causal model could be established between the instrumental variable and the independent variable. Angrist and Krueger (2001) and Bound, Jaeger and Baker (1995) provide a method to evaluate the validity of the employment of a specific instrumental variable.

In “The Impact of Income on the Taste for Revolt,” Robert MacCulloch (2003) tries to address the problem of endogeneity by using “revolutionary taste” rather than “actual occurrence of violent uprisings” as the dependent variable. The so-called “revolutionary taste” is measured through two surveys, asking 89,908 people from 41 countries—mostly in Europe—their attitudes toward current society. Whether the cases selected constitute enough diversity is questionable. MacCulloch also uses foreign demand and the oil import price as the instruments in measuring GDP, but he fails to explain and demonstrate the reason why an increase in the level of “revolutionary taste”

may not lead to a drop in GDP. “Revolutionary taste” may be related to the level of rebellion and thus, in turn, affect the level of GDP. MacCulloch also fails to justify why he chose foreign demand and the oil import price as the instrumental variables in measuring GDP.

Building on the causal model of Collier and Hoeffler, Edward Miguel, Shanker Satyanath, and Ernest Sergenti (2003), choose rainfall as the instrumental variable to study the effect of economic shocks on civil conflicts in Sub-Saharan African countries. The rationale behind their instrumental model is as follows: Most Sub-Saharan African countries are less developed countries whose economic growth mainly depends on agricultural production. While the special regional characteristic of the continent makes rainfall naturally a crucial factor in agriculture production, the poor irrigation system limits human ability in mitigating the negative effect of rainfall. As a result, a significant positive relationship between rainfall and economic growth is expected. The economic shock independent from the influence of civil conflicts is measured and its relationship with civil conflicts is found to be negative and statistically significant. At the same time, Miguel, Satyanath and Sergenti also found that other independent variables used in previous studies-such as the regime type, ethnic heterogeneity, and geographic factors-do not affect the impact of economic growth on the civil conflicts.

The approach chosen by Miguel, Satyanath and Sergenti is innovative; however, limitations still exist. The fact that the study is done only in Sub-Saharan Africa casts doubt on the generalization and implication of the findings to the rest of the world. The fewer variations within Sub-Saharan Africa may result in the insignificant and weak relationship between regime type, ethnic heterogeneity and the civil conflicts.

In order to add explanatory power to their finding, I want to test the instrumental model established by Miguel, Satyanath and Sergenti in other parts of the world. Since some countries in Sub-Saharan Africa are richly endowed in natural resources, the economic growth of these countries is not significantly affected by rainfall. Including those countries in the study might underestimate the effect of rainfall on GDP. More generally, grouping countries based on regions will cause the problem of underestimation by including countries where the effect of rainfall on GDP is not significant or is too small; this method of categorization also limits the sample size and reduces the variation within the sample group. Thus, instead of looking at a specific region, I plan to pick out countries resembling the situation of Sub-Saharan Africa- “neither have extensive irrigation systems nor are heavily industrialized” (Miguel, Satyanath and Sergenti 2003, 2))-to produce the same significant effect of rainfall on economic growth.

Recognizing the limitations of their study, Miguel, Satyanath and Sergenti highly urge researchers to conduct case studies “to illuminate the precise causal channels linking economic conditions to civil conflicts, and to allow researchers to draw more credible policy prescriptions” (18). As a result, besides the statistical analysis, I will conduct case studies in some countries to examine the detailed sequence of the events during civil wars.

I will also conduct case studies to investigate the situation when economic turndown does not lead to domestic violence. Based on Collier and Hoeffler’s causal model, economic condition matters in two aspects: First, it influences a central government’s ability to defend itself. Second, it affects opportunity costs facing individuals. According to this rationale, either government or individual households may

help reduce the risk of civil conflicts by saving adequately during good years and dissaving to make up their loss due to rainfall shocks in bad years. The theoretical possibility is confirmed in reality demonstrated in Christina H. Paxson's study on farmers of Thailand on their response of savings to transitory income, defined as "the difference between realized and expected income" (Paxson 1992, 16). Paxson used rainfall as the instrumental variable in measuring transitory income and found the existence of a large marginal propensity to save on transitory income, which means that a large proportion of transitory income is saved by farmers of Thailand. Paxson's finding suggests that the welfare of farmers in Thailand is not threatened by rainfall shock because of their saving habit. If the causal model of Collier and Hoeffler is true, I expect to see a group of countries where economic growth is significantly related with changes in rainfall but the relationship between civil conflicts and economic growth is weak or insignificant. Case studies on those countries will assist policy makers in determining whether governmental aid is needed in case of natural shocks in order to prevent domestic violence. They will also provide policy makers of countries suffering from civil wars due to natural shock a possible way to solve the problem.

Causal Model

There are many different causal models established about the reasons of civil conflicts. Some argue that civil conflicts are triggered by income inequality while others argue that ethnic heterogeneity is the fundamental reason. Here, I will focus on the causal mechanism cited by Miguel, Satyanath and Sergenti, which is a combination of the models used by Collier and Hoeffler (1998, 2001, 2002) and Fearon and Laitin (2003). The basic argument is that people are rational and their ultimate goal is to maximize their

profit. People will choose one action over the other only when the expected utility associated with the action chosen is greater than that of the other. The utility of participating in civil conflicts is, in part, a decreasing function of the probability of losing the battle, the opportunity cost of alternative actions, especially production, and the anticipated economic destruction because of the war. The probability of losing the battle is determined by the military capacity of the central government, which is in turn a function of government income. Poor governments cannot afford a strong and well-equipped army to repress the rebellion. The higher the government income, the more a government is able to spend on military and the higher the probability that the rebels will lose the fight. The opportunity cost of alternative actions and the anticipated economic destruction are determined by the potential income from production and the current wealth. The higher the potential income and current wealth, the higher the opportunity cost of undertaking civil conflicts. Only when the utility of participating in civil conflicts outweighs that of alternative actions will people choose to undertake civil conflicts.

In summary, the model takes into account two factors: the previous economic development, which decides the level of military expenditure and the cost of economic destruction, and the current economic conditions, which influences the potential income from production. The role rainfall plays is to change the level of those two factors through its effect in agricultural production. However, such change will occur in magnitude only in countries where agricultural production constitutes a large portion of GDP, the growth of major crops depends on a large amount of water, and the irrigation system is not well developed. If those requirements cannot be satisfied, the change in rainfall level would not be an accurate indicator of the economic growth or the level of

civil conflicts. In other words, the instrumental model based on rainfall will fail to depict the true picture.

Testable Hypothesis

In generating a first stage relationship, I expect to see an increase in both the significance level and the strength of the relationship between rainfall and economic growth when agricultural value added as a percentage of GDP and non-irrigated land area as a percentage of the total cropland area increases. Depending on the existence of a significant first stage relationship, I expect to see as the rainfall level increases, the number of civil conflicts in a country per year decreases. Due to the nonconcurrence on the effect of other political and social factors on civil conflicts, the most commonly studied factors, such as the level of democracy and ethnic diversity, will be controlled in the analysis of both the first and second stage relationship.

Data

Since the purpose of my research is to generalize the finding by Miguel, Satyanath and Sergenti, to be consistent, I will employ the same data used in their work. Miguel, Satyanath and Sergenti collected four different kinds of data sets:

- 1) Rainfall data from Global Precipitation Climatology Project (GPCP) at <http://cics.umd.edu/GPCP>, dating from 1979 to 2003;
- 2) Civil Conflict Data Sets from Armed Conflict Data – International Peace Research Institute of Oslo, Norway and the University of Uppsala, Sweden (PRIO/Uppsala) at <http://www.prio.no/cwp/ArmedConflict>
- 3) Economic, Demographic, and Development Controls from Global Development Network Growth Database (GDNGD) at <http://www.nyu.edu/fas/institute/dri/index.html>;

World Development Indicators (WDI) CD-ROM: World Development Indicators 2002 Database; FAO Stat at <http://apps.fao.org/default.jsp> ; Fractionalization Data from Alesina, Alberto, Arnaud Devleeschauwer, William Easterly, Sergio Kurlat, and Romain Wacziarg - Journal of Economic Growth at <http://www.stanford.edu/~wacziarg/papersum.html>

4) Political Institutional Controls from Polity IV at <http://www.cidcm.umd.edu/inscr/polity/>; Database of Political Institutions (DPI) at <http://www.worldbank.org/research/bios/pkeefers.htm>; Freedom House at <http://www.freedomhouse.org/ratings/index.htm>; *The Logic of Political Survival* Data Set at <http://www.nyu.edu/gsas/dept/politics/data/bdm2s2/Logic.htm>; Barro (1991) Levine and Renelt – American Economic Review LXXXII (1992) at <http://www.worldbank.org/research/growth/ddlevren.htm>

In order to generate a larger sample group with a significant first stage relationship, I will add a fifth data set named Country Agricultural Characteristics Controls including variables of:

- Land use, irrigated land as a percentage of cropland, defined as "areas equipped to provide water to the crops, [including] areas equipped for full and partial controlled irrigation, spate irrigation areas and fitted wetland or inland valley bottoms" by FAO (<http://www.fao.org/waicent/faostat/agricult/landuse-e.htm#irr>)

- Agriculture, value added as a percentage of GDP

This data set is drawn from the WDI database.

Method

First, I will assign an index number to each individual country, measuring the dependence of its economy on rainfall. I am not sure on which variable, either agricultural value added as a percentage of GDP or non-irrigated land area as a percentage of the total cropland area, will be more significant in measuring the dependence of a country's economy on rainfall. As a result, I will experiment generating the index number in three ways: In the first method, the index number will equal to agricultural value added as a percentage of GDP. In the second method, the index number will equal to non-irrigated land area as a percentage of the total cropland area. Thirdly, the index number would be the addition of a country's agricultural value added as a percentage of GDP and non-irrigated land area as a percentage of total cropland area. The sample will include all the countries listed in the World Development Indicator Database. Under each method, I will run statistical analysis within the entire sample on the first stage relationship between rainfall shock, measured by the proportional change in average rainfall from the previous year, and economic growth, measured by the log of per capita income growth, controlling for all other country characteristics. The equation used in the first stage analysis is from the work of Miguel, Satyanath and Sergenti:

$$GROWTH_{it} = a_{it} + X'_{it} b_1 + c_{1,0} _R_{i,t} + c_{1,1} _R_{i,t-1} + d_{it} YEAR_t + e_{lit}$$

$GROWTH_{it}$ refers to the per capita economic growth in country i , year t . X'_{it} denotes other country characteristics while $_R_{i,t}$ and $_R_{i,t-1}$ denote respectively current and lagged rainfall growth.

If there is no significant first stage relationship, I will eliminate 10% of the sample with the lowest index score and rerun the analysis. The same process will continue until a significant first stage relationship is found.

Second, if there is no significant difference between the sizes of sample groups of the first two methods, I will choose the method that produces the largest sample group for the use of second stage relationship. If a significant difference did exist, I would construct a new weighted average index number combining both factors and rerun the statistical analysis.

Second, after finding sample groups containing a significant first stage relationship, I will then evaluate the relationship between “pure” economic growth due to rainfall only-generated based on the established first stage relationship and rainfall level- and civil conflicts, measured by numbers of civil conflicts with at least 25 battle death per year of one country in a certain year, once again controlling all other country characteristics. Again, I will employ the same equation and denotation used by Miguel, Satyanath and Sergenti:

$$CONFLICT_{it} = \alpha_0 + \alpha_1 X'_{it-2} + \alpha_2 GROWTH_{it-1} + \alpha_3 GROWTH_{i,t-1} + \alpha_4 YEAR_{it}$$

Finally, after the statistical analysis, I will conduct case studies on countries in which both the first and second stage relationships are found to be highly strong and significant. In order to test the validity of the causal model, I will exam whether civil conflicts happened before economic downturns or whether economic downturns lead to civil conflicts. I will also investigate the composition of the rebel-to see whether most of them are poor farmers-and to study their purpose and aim and their gains if they did

succeed. I will also conduct case studies on countries in which a significant first stage relationship exists but the second stage relationship is weak or insignificant. I will search for a possible mechanism to explain why a significant second stage relationship is missing. I will investigate the effects of government agriculture policy, saving tradition, household income structure and family structure on the income of farmers.

Conclusion

If I am able to generate a sample group larger than that of Miguel, Satyanath and Sergenti, in which a significant first stage relationship is found, my study will help generalize the instrumental approach of Miguel, Satyanath and Sergenti on rainfall shocks, economic growth and civil conflicts. My study may provide political scientists and researchers a rough measurement in predicting the possibility of insurgence if a rainfall shock happens based on a country's agricultural value added as a percentage of GDP and non-irrigated land area. A larger sample may bring in greater diversity in political and social characteristics-the variables I will control for in both tests-such as, the level of democracy and ethnic fractionalization. The finding may help answer questions whether factors, other than economic growth, also contribute to the onset of civil wars. In addition, my case study on micro-level of a country may provide insight to the causal model and justify the adoption of instrumental approach by Miguel, Satyanath and Sergenti. It may also assist policy makers in designing countermeasures to prevent domestic violence and to increase the global security.

However, limitations and flaws still exist. First, a larger sample size does not necessarily lead to a greater variety in country characteristics. Agricultural value added as percentage of GDP measures a country's level of industrialization. A low score in it is

probably related to high level of industrialization. High level of industrialization may also contribute to the low score of a country in non-irrigated land area. As a result, it is possible that most countries in the final sample pool are less developed countries, which are not very different from each other in the level of democracy. Second, as Miguel, Satyanath and Sergenti point out in their study, since PRIO-UU does not include domestic violence in which a government is not a party, the strength of the relationship between economic growth and civil conflicts may be reduced. Third, the strength of the relationship between economic growth and civil conflicts measured may also be actually larger than that in the reality since PRIO-UU does not distinguish ethnic civil wars, which may have a very different causal model, from non-ethnic civil wars. Further studies may be needed to address measurement problems.

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