DOCUMENTS DE TREBALL

DE LA FACULTAT D'ECONOMIA I EMPRESA

Col·lecció d'Economia
E09/211

Population Size and Civil Conflict Risk:

Is There A Causal Link?

Markus Brückner*

---

* Department of Economics, Universitat Pompeu Fabra, and CAEPS, Universitat de Barcelona. Contact e-mail: markus.bruckner@upf.edu. The paper has benefited from discussion at the Second Riccardo Faini Doctoral Conference, the labor workshop at Pompeu Fabra, and the CAEPS seminar at the Universitat de Barcelona. I am grateful to Marta Reynal-Querol, Roland Vaubel, Joachim Voth, and in particular to Antonio Ciccone for helpful comments and suggestions. The usual caveats apply.

Abstract: Does an expansion of the population size expose nation states to a higher risk of suffering from civil conflict? Obtaining empirical evidence for a causal relationship is difficult due to reverse effects and omitted variable bias. This paper addresses causality issues by using randomly occurring drought as an instrumental variable to generate exogenous variation in population size for a panel of 37 Sub-Saharan countries over the period 1981-2004. Instrumental variable estimates yield that a one percentage point increase in population size raises the risk of civil conflict by over 5.2 percentage points.

Keywords: Population Size, Civil Conflict, Reverse Causality

JEL codes: O10, O55, P0, Q0

Abstract: La estimación del impacto del tamaño de la populación sobre la probabilidad de conflicto civil se complica por el sesgo de endogeneidad y las variables omitidas. Este artículo trata el problema de causalidad utilizando métodos de variables instrumentales en un panel de 37 países del África Sub-sahariana en el período 1981-2004. Encontramos que un aumento de la población en un 1% aumenta la probabilidad de conflicto civil por un 5.2%.

"The prodigious waste of human life occasioned by this perpetual struggle for room and food was more than supplied by the mighty power of population. ...An Alaric, an Attila, or a Zingis Khan, and the chiefs around them, might fight for glory, for the fame of extensive conquests...but the true cause was a scarcity of food, a population extended beyond the means of supporting it." Thomas R. Malthus (1798) in: An Essay on the Principal of Population (p. 23)

1. Introduction

At least since Malthus (1798) it has been argued that a larger population size increases a country's likelihood of suffering from civil conflict. The immense humanitarian and economic costs associated with civil conflicts are now well recognized (e.g. World Bank, 2003; Copenhagen Consensus, 2004). Fearon and Laitin (2003) estimate that since the end of World War II civil conflicts have caused more than 16.2 million battle casualties. Many more people have been killed or disabled in civil conflict as a result of strategic violence against the civilian population and the spread of lethal diseases (Ghobarah, Huth and Russeth, 2003; Montalvo and Reynal-Querol, 2007). Highly concerning is also evidence by Bellow and Miguel (2006) that shows that the negative impact of civil conflict on economic development may have long-run effects, translating into permanently lower levels of per capita GDP. The Malthusian claim thus bears substantial implications for public policy and theories of economic development as it raises concern that population increases may not only have a potentially negative effect on per capita income levels but also on aggregate output and social and political stability.

Obtaining a clean estimate on the impact that population size exhibits on civil conflict risk is not an easy task. In particular, it is very difficult to establish a causal relationship. The majority of empirical studies investigating the link between population size and civil conflict has relied on the analysis of panel data, exploiting both cross-country as well as within country time series variation (Gleditsch and Urdal, 2002; Fearon and Laitin, 2003; Collier and Hoeffler, 2004; Urdal, 2005;

Hegre and Sambanis, 2006). It is questionable though to what extend this research has achieved testing for a causal relationship as the employed econometric framework does not address large biases that arise from reverse causality and omitted variables (e.g. Blattman and Miguel, 2008). The mass killing associated with civil conflicts and the waves of migration streams that often set in even before warfare activity has fully escalated make (past) population size a highly endogenous regressor to the presence of civil conflict (Davenport, Moore, and Poe, 2003; Montalvo and Reynal-Querol, 2007; UNHCR, 2007). Many difficult to measure variables proxying for social fragmentation, institutional quality, and economic conditions further complicate inference, pushing total biases in arbitrary directions.

This paper digs into the question of a causal effect going from larger population size to a higher probability of civil conflict by constructing instrumental variable estimates for a panel of 37 Sub-Saharan countries over the period 1981-2004. Sub-Saharan Africa has been, and continues to be (e.g. World Bank, 2003), one of the world's top concerns in terms of intra-state instability as more than two-thirds of the Sub-Saharan countries have suffered from a civil conflict in the past 25 years. To generate for these countries variations in population size, I use randomly occurring drought as an instrumental variable. The negative response of the Sub-Saharan population to drought provides a unique opportunity to obtain an exogenous source of variation in population size both for the cross-section of Sub-Saharan countries as well as within countries across time. I show that once biases are accounted for, population size has a quantitatively large and statistically significant effect on African civil conflict.

The foundation for my instrumental variable analysis is that Sub-Saharan economies depend heavily on a poorly irrigated agricultural sector with crop yield highly vulnerable to rainfall (e.g., IPCC, 2001; WDI, 2007). A combination of government subsidies and unemployment insurances cushion the adverse effects of drought in economically developed countries, but these buffer mechanisms are either widely lacking in Sub-Saharan countries, or if present highly ineffective (Sen, 1981; Fafchamps, 2003). The impact of drought on poor, credit-constrained, African households is thus much more dramatic. So much so, that famines caused by extremely harsh and repeated drought go hand in hand with a reduction in birth rates, widespread migration, and higher mortality rates (WHO, 2006; UNHCR, 2007).

A first stage regression supports this identification strategy: Sub-Saharan population size decreased in response to drought by an average of 1.6 percentage points, significant at the 1% level. In the second stage, I exploit this relationship to construct instrumental variable estimates linking exogenously driven variations in country population size to civil conflict. I find that a one percentage point increase in the population of Sub-Saharan countries raises civil conflict incidence by over 6.6 percentage points and increases the risk of a new or recurrent civil conflict onset by over 5.2 percentage points. Instrumental variable estimates therefore point towards population size having a quantitatively large effect on civil conflict risk in Sub-Saharan Africa.

An important part to my instrumental variable analysis is that I estimate the impact that population size exhibits on civil conflict likelihood conditional on per capita GDP. Since extremely low rainfall not only reduces population size, but also total output, the validity of drought as an instrumental variable would not be guaranteed without controlling in the second stage for per capita GDP. Per capita GDP is highly endogenous to both civil conflict and population size and I address this issue by building on prior work of Miguel, Satyanath, and Sergenti (2004) and Brückner and Ciccone (2007), using smooth variations in rainfall and plausibly exogenous variation in international commodity prices as additional instrumental variables. More rainfall and higher prices for exported commodities significantly increase real per capita income of African countries, but have no significant effect on population size.

My empirical analysis also takes into account unobservables related to both civil conflict and population size. Country fixed effects are implemented to capture difficult to measure cross-country heterogeneity such as differences in institutional quality, ethnic and religious fragmentation, or time-invariant geographic conditions, such as mountainous terrain. Additional heterogeneity arising from trends in population size or global climate change is addressed by considering the use of country specific time trends and year fixed effects.

The paper's findings may be specific to the Sub-Saharan region, but this does not prevent them from shedding new and relevant empirical insights on a theoretical debate of general interest related to an optimal design of the size of nations (e.g. Alesina and Spolaore, 1997, 2003, 2005, 2006). The adverse effects of civil conflict on economic development and social stability are a strong channel through which smaller country size could yield substantial improvements to human welfare. The strength of this paper is that by using an instrumental variable approach it takes a step forward to make it credible that the link between population size and civil conflict is of causal nature. In contrast, an analysis based on simple correlations can not shed insight on this debate as it is silent about the direction of causality.

The remainder is organized as: Section 2 provides a review of the related literature, Section 3 discusses the estimation methodology, Section 4 describes the data, Section 5 presents the main results, and Section 6 concludes.

2. The Population-Conflict Nexus: Some Theory and Evidence

The hypothesis that a larger population size can act as a destabilizing force to poor countries' political and social order can be traced back at least to Thomas Robert Malthus (1798) who argued that population increases lead to a reduction in per capita output of agricultural goods due to a fixed supply of (fertile) land. The human body needs a minimum amount of calories intake in order to survive so population expansions around the proximity of subsistence income levels may be perceived as a threat to survival. Malthus (1798, pg. 22) claimed that in the midst of such population induced resource scarcity a "struggle for existence" arises with "young scions [being] pushed out from the parent-stock to gain happier seats for themselves by their swords".

Malthus's thoughts immediately ignited a fierce debate in the circles of policy makers concerning the necessity of population control and the benefits derived from government lead poverty relief programs (Hart, 1992). They had also a substantial impact on a broad spectrum of scientists ranging from evolutionary biologists such as Charles Darwin to economists like John Meynard Keynes. It was not however until the end of the 20th century that a systematic effort was made to study the connection between population and organized forms of intra-state violence in an empirically rigorous manner.

Exceptionally rich case study evidence was provided by Thomas Homer-Dixon (1994, 1999), linking population expansions in the presence of resource scarcity to forms of civil strifes that occurred in the Eastern Islands, the Senegal river valley, southern parts of the Philippines, or the Assam region in India. Perhaps the most striking of these examples is the 1994 Rwandan genocide, where over half a million Tutsi were slaughtered by Hutu militias. Though a popular explanation of the Rwandan genocide has been ethnic hatred between two very polarized groups, Homer-Dixon points out that Rwanda was at the time of the conflict one of the most densely populated countries in the world. Moreover, fertile land was in extremely short supply due to a consistent degradation of the environment, making food an extremely scarce good. Interviews of Rwandan war casualties collected by Andre and Platteau (1998) echo Homer-Dixon's argument that overpopulation and scarcity played a major role in causing the Rwandan genocide. Andre and Platteau report: "The 1994 events provided a unique opportunity to settle scores, or to reshuffle land properties, even among [326] Hutu villagers....It is not rare, even today, to hear Rwandans argue that a war is necessary to wipe out an excess of population and to bring numbers into line with the available land resources."[1]

Although these case studies revealed important and detailed insights on the mechanism of population pressure induced civil conflict, they were heavily criticized for suffering from selectivity bias and lack of generality (Gleditsch, 2001; Urdal, 2005). In particular, it was argued that one could readily find counter examples where larger population size did not lead to conflict.

Two prominent studies by Collier and Hoeffler (2004) and Fearon and Laitin (2003) that used panel data analysis found however also evidence pointing towards countries with larger

1 Quoted from Diamond (2005, Ch. 10)

population size to be exposed to a higher risk of intra-state conflict. To motivate their finding Collier and Hoeffler (2004) argued that the causes of civil conflict can be best understood by modeling civil conflict as a "business activity". Both rebel and government forces need finance in order function and soldiers to fight in their armies. A larger population size, which is associated with a greater diversity in preferences, will then provide both camps with a larger pool from which to draw potential recruits. Moreover, these recruits can be hired at a cheaper rate due to supply effects. Fearon and Laitin (2003) on the other hand argued that a larger population size leads to a debilitation in the power of the central government in terms of keeping the "taps" on local activity.

Many other empirical panel-data studies followed, finding a similarly adverse impact of population on civil conflict likelihood (e.g. Hegre and Sambanis, 2006). But as Blattman and Miguel (2008) emphasize, there is no reason to belief yet that there exists a causal relationship between civil conflict and country population size as these studies do not address biases arising from omitted variables and the endogenous response of population size to civil conflict.

3. Estimation Methodology

The econometric framework employed in this paper to overcome these problems follows a two-stage instrumental variable approach that treats both population size and per capita GDP as endogenous variables to the incidence and onset of civil conflict. In a first stage regression country population size and per capita GDP are regressed on a set of instruments and control variables. Equations (1a) and (1b) show formally the functional specification,

(1a) $\log(POP_{c,t}) = \alpha_{1,c} + \beta_{1,c}*t + \gamma_{1,t} + \theta_{1,1}\,Drought_{c,t} + \theta_{1,2}\log(Rain_{c,t}) + \theta_{1,3}\log(Index_{c,t}) + \varepsilon_{1,c,t}$

(1b) $\log(GDP_{c,t}) = \alpha_{2,c} + \beta_{2,c}*t + \gamma_{2,t} + \theta_{2,1}\,Drought_{c,t} + \theta_{2,2}\log(Rain_{c,t}) + \theta_{2,3}\log(Index_{c,t}) + \varepsilon_{2,c,t}$

where *POP* stands for country population size, *GDP* is the level of (real) per capita GDP, *Drought* is a dummy variable indicating episodes of drought, *Rain* is the amount of rainfall observed in a given country-year, and *Index* is an index of international prices for exported commodity goods (see Section 3 for a description of these variables). The control variables are: (i) country fixed effects

α_c, (ii) country specific time trends β_c*t, and (iii) year fixed effects γ_t. The first sub-indice "1" refers to equation number "1" while the second sub-index identifies the coefficient on the regressor; *log* stands for the natural logarithm.

The second stage estimates the impact that variations in population size and per capita GDP exhibit on civil conflict. Formally, it is represented by equation (2),

(2) $Conflict_{c,t} = \alpha_{3,c} + \beta_{3,c}*t + \gamma_{3,t} + \theta_{3,1}\, Drought_{c,t} + \theta_{3,2} \log(Rain_{c,t}) + \theta_{3,3} \log(Index_{c,t}) + \varepsilon_{3,c,t}$

where *Conflict* is an indicator function that is one in the event of civil conflict and zero else. Note, that despite the presence of a binary dependent variable equation (2) is specified as a linear probability model as this is in two-stage instrumental variable estimation the usually preferred method (Angrist and Krueger, 2001; Wooldridge, 2003).[2]

4. Data and Measurement

I obtain data on civil conflict from the 2007 Armed Conflict Dataset of the Uppsala Conflict Data Program (UCDP) and the Centre for the Study of Civil War at the International Peace Research Institute, Oslo (PRIO). The UCDP/PRIO Armed Conflict Database defines civil conflict as a "contested incompatibility which concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle deaths." According to UCDP/PRIO, a conflict over government is an "incompatibility concerning the type of political system, the replacement of the central government or the change of its composition;" a conflict over territory is an "incompatibility concerning the status of the specified territory, e.g. secession or autonomy." Roughly speaking, for every 2 civil conflict outbreaks over territorial autonomy, there were about 3.5 civil conflict outbreaks over government. For detailed summary statistics see Table 1, Panel A.

Data on population size and real per capita GDP is taken from the Penn World Tables 6.2

2 Note also that population and per capita GDP are introduced in the second stage explicitly in levels, rather than growth rates. This guarantees that all possible information contained in the levels of these variables is exploited for specific country-years. Moreover, a level specification is immune to producing potentially confounding effects associated with a corresponding growth specification that arise due to rapid reversion of rainfall to its mean (see here Ciccone, 2008).

(Heston et al., 2006). More specific measures of population size -- working age population (ages 15-64), youth bulges (ages 0-14), and male population -- come from the World Development Indicators (2007). The summary statistics for these variables (in log points) can be found in Table 1, Panel B.

Following Miguel, Satyanath, and Sergenti (2004) observations on rainfall for the Sub-Saharan region come from the NASA Global Precipitation Climatology Project, Version 2 (Adler et al, 2003). Based on this data, droughts are identified by an indicator function that is one for the 5% largest negative drops in the level of rainfall over two consecutive years. Drawing on data provided by the Universite Catholique de Louvain's EM-DAT (2008) natural disaster database, Appendix Table I shows that these rainfall identified droughts affected in nearly all cases at least hundreds of thousands of people, and in many instances the numbers were even in the millions.

The index of international commodity prices is taken from Brückner and Ciccone (2007) who construct this measure for 19 commodities using fixed export shares. The fixed export shares ensure that the instrument's time-series variation stems entirely from fluctuations contained in international commodity prices, which are plausibly exogenous to the incidence of African civil conflict. For summary statistics on rainfall, drought, and the commodity price index see Table 1, Panel C.

5. Empirical Results

5.1 Drought, Population Size, and Per Capita GDP

The first stage estimates are reported in Table 2, where control variables are country fixed effects, country specific time trends, and common year fixed effects (all jointly significant at the 1 percent level). Column (1) shows that drought lead to an average decrease in the total population size by over 1.6 percentage points, significant at the 1 percent level. Minor changes in the level of rainfall, as captured by the linear rainfall term, had no significant effect. The international commodity price index is also insignificant. Columns (2) and (3) investigate whether this relationship is maintained when restricting attention to working age population or youth bulges. This yields virtually the same point estimates as in column (1) with the drought dummy being highly significantly negative. Column (4) shows that drought had also an equally significantly negative effect on male population.

In column (5), I examine whether one of the reasons why country population size decreased in response to drought was because drought increased the incentives for migration to other countries (e.g. Sen, 1981; Fafchamps, 2003). Drawing on annual data made publicly available by the United Nations Higher Commission for Refugees (UNHCR) from 1991 onwards, I find that this was indeed the case -- drought increased the number of refugees in the country of origin by over 80 percent, significant at the 94 percent confidence level. Smooth variations in rainfall and international commodity prices are on the other hand insignificant.

In column (6), I report first stage estimates for per capita GDP. Similar to Miguel, Satyanath, and Sergenti (2004), I find a positive effect of rainfall on income: a ten percentage point increase in the amount of rainfall is associated with an average increase in per capita GDP by 0.75 percentage points, significant at the 2 percent level. Also, windfalls from commodity prices were a blessing for Sub-Saharan countries: a ten percentage point increase in the international price for exported commodities increased per capita GDP by over 0.91 percentage points, significant at the 5 percent level. Note that drought in the first stage per capita GDP regression is insignificant. Columns (7) and (8) show however that drought does have a significantly negative effect on total GDP.[3]

5.2 Population Size, Per Capita GDP, and Civil Conflict

5.2.1 Civil Conflict Incidence

In Table 3 I present estimates on the effect that population size exhibits on civil conflict incidence. In columns (1) and (2) I regress the civil conflict incidence indicator on a set of cross-sectional

3 The insignificance in the per capita GDP regression arises because drought has also a negative effect on population size. The overall effect of drought on per capita income is therefore ambiguous because as population size declines more resources (capital and land) become available per worker.

control variables, the log of population size, and the log of (real) per capita GDP.[4] The probit model of column (1) is estimated using maximum likelihood and reported coefficients are marginal effects evaluated at sample means. It turns out that the only variable significant at conventional confidence levels is the log share of mountainous terrain. Population size and per capita GDP are both insignificant. Also cross-sectional differences in ethnic fractionalization, colonial origin, and political decentralization are not significantly associated with a higher or lower average incidence of civil conflict. In column (2) exactly the same set of variables are included but the functional form is changed to a linear probability model. Comparing these point estimates with the marginal effects of column (1) shows that the least squares and probit estimates yield coefficients that are both quantitatively and statistically quite similar. Moreover, the only variable significant is a country's share of mountainous terrain.

The regressions in columns (1) and (2) need to be interpreted with care since there remain many difficult to measure variables related to cross-sectional differences in social fragmentation, institutional quality, or geographic conditions that have only been captured imperfectly by the set of included control variables. Column (3) therefore implements country fixed effects to account for unobserved cross-country heterogeneity. This has the implication that point estimates increase somewhat in absolute size. Yet, statistically they remain insignificant at conventional confidence levels.

Column (4) estimates the effect that larger population size exhibits on civil conflict incidence by two-stage least squares (2SLS). Using the drought dummy, rainfall, and the international commodity price index as excluded instruments, an IV estimate yields a highly significant coefficient on the population variable that is nearly ten times larger than the corresponding least squares estimate of column (3): a one percentage point increase in population

4 The sources of the cross-sectional variables are as follows: ethnic fractionalization, the share of mountainous terrain, and colonial origin are from Miguel, Satyanath, and Sergenti (2004); primary school education is from WDI (2007); and political decentralization, measured by an indicator variable that is one if the country has a federal/semi-federal government, is from Polity III.

size increases the likelihood of civil conflict by over 1.2 percentage points (p-value 0.034).[5] Per capita GDP enters this second stage with the correct sign, although insignificant at conventional confidence levels (p-value of 0.141). In column (5) I include country trends and common year effects as additional control variables.[6] This bears the result that the coefficient on country size becomes even larger: a one percentage point increase in the population raises the likelihood of civil conflict by as much as 6.6 percentage points. Per capita GDP enters now as highly statistically significant (p-value 0.020): a positive shock in per capita GDP by one percentage points reduces civil conflict incidence by over 1.9 percentage points.

Column (6) shows that the negative relationship between per capita GDP and civil conflict is maintained when elevating the benchmark for coding an event as civil conflict to 1000 battle deaths per annum (civil war). But this is not true for country population size. In this case the estimated coefficient on the population variable is insignificant and quantitatively only about one-third of the size of the coefficient obtained in column (5).[7]

4.2.2 Civil Conflict Onset.

Since civil conflict incidence incorporates elements of conflict duration, one possible interpretation of the results in Table 3 is that larger country population size and lower per capita GDP increase the

---

5 A Hausman test rejects similarity of the IV and least square estimate at over 95 percent confidence. One of the reasons for this large difference between IV and least squares estimate is that civil conflict has a large negative effect on population size because of battle casualties, the spread of disease, and masses of refugee movements that set in even before warfare activity has fully escalated (Davenport, Moore, and Poe, 2003; Ghobarah, Huth and Russeth, 2003; Montalvo and Reynal-Querol, 2007). A least squares estimate will therefore suffer from substantial downward bias. Another reason for the quantitatively small coefficients obtained from the least squares regression is measurement error, which is presumably large in Sub-Saharan account statistics (Heston, 1994; Deaton, 2005). To the extend that this is classical, least squares estimates will be attenuated towards zero.

6 The year fixed effects capture events such as the end of the Cold War, global business cycle, climate change, or a decline in the costs to trade. The country time trends capture additional time series variation that is specific to each country.

7 Note that by analyzing civil conflicts that incur more than 1000 battle deaths one systematical excludes those conflicts that may be minor for countries with large populations but potentially major for smaller African countries. To illustrate the implications, consider for instance Sierra Leone that had an average sample population size of around 4 million. During the period 1981-2004 more than 41% of all observations were coded as civil conflict, but only 8% were coded as civil war. On the other hand, for a large country like Sudan that had an average sample population size of over 28 million this coding difference mattered little as 92% of all observation were marked as civil conflict, and 83% percent were marked as civil war. The choice of the battle death benchmark hence not only affects the coding of civil conflict across countries but also across time within countries. Increasing the battle-death benchmark will therefore act as a selection mechanism that downward biases the estimate on the population variable as small countries rarely experience civil war.

likelihood of an already ongoing civil conflict. Equally plausible, and from the policy perspective more interesting, is that increases in country population size increase the likelihood of an outbreak of new or recurrent civil conflict.

To explore this channel, Table 4 presents estimates where the dependent variable is a civil conflict onset indicator that takes on the value of one each time there is an outbreak of civil conflict. The first column reports the least squares estimates. Just as in Table 3 these estimates are quantitatively small and statistically insignificant. In column (2) population size and per capita GDP are instrumented by drought, smooth variations in rainfall, and the index of international commodity prices. Now the effect of population size is quantitatively larger and statistically significant. In column (3) I include in addition to the country fixed effects country specific time trends and year fixed effects. An instrumental variable estimate yields that a one percentage point increase in population size raises the likelihood of a civil conflict onset by over 5.2 percentage points, significant at the 4 percent level. Higher per capita GDP in turn significantly reduces this probability.

Columns (4) and (5) show that the impact of population size on civil conflict risk is particularly pronounced in countries that are characterized by above average levels in ethnic fragmentation, while in countries that have federal governments it is attenuated towards zero. This may be an indication that part of the reason why larger country population size -- conditional on per capita income levels -- significantly increased the risk of civil conflict because there was a greater demand by a sub-population for sovereignty (Sambanis, 2008; Spolaore, 2008; see also Alesina and Spolaore, 1997, 2003). Columns (6) and (7) further explore this channel by distinguishing between those civil conflicts that arise because of incompatibilities over government and those civil conflicts that arise because of incompatibilities over territory.[8] One would expect that if larger population size increases the risk of civil conflict because a sub-population, dissatisfied with public policies of

8 Recall that civil conflicts over government relate to incompatibilities concerning the type of political system, the replacement of the central government or the change of its composition, while conflicts over territory are incompatibilities concerning the status of the specified territory, e.g. secession or autonomy. See here also the PRIO/UPSALLA web-site for further detail (www.pcr.uu.se).

the central government, demands greater self-determination over political decision-making at the sub-national level then there is a significant effect of population size on those conflicts that arise because of motives related to secession and autonomy. Column (6) shows that this is indeed the case: a one percentage point increase in population size significantly increased the risk of civil conflict over incompatibilities arising from territorial autonomy by over 2.2 percentage points. Interestingly, for these secessionist conflicts, per capita GDP is insignificant. Column (7) therefore shows that higher per capita GDP significantly reduced civil conflict onset on average because it was associated with less conflict arising from incompatibilities over government.

5.3 Robustness

5.3.1 Overidentification Tests

Underlying the validity of the instrumental variable estimates is that drought, rainfall, and the international commodity price index have no effect on civil conflict other than through per capita GDP or population size. At the bottom of Tables 3 and 4, I had provided evidence supporting this assumption by computing the p-values of the Hansen J-test that examines the hypothesis that instruments are jointly uncorrelated to the second stage error term. Since none of these p-values are statistically significant, formal overidentification tests support the assumption that the employed instruments fulfill the exclusion restriction.

To show this also more intuitively, Table 5 adds one-by-one the drought dummy, the linear rainfall measure, and the index of international commodity prices as exogenous regressors. The reduced form estimates in columns (1) and (5) yield that drought, conditional on rainfall and the international commodity price index, has a significantly negative effect on civil conflict. If this is because of channels other than per capita income or population size, then one expects that drought enters as significantly negative in the second stage regression, where population size and per capita GDP are treated as endogenous regressors. Columns (2) and (6) show that this is not the case -- the coefficient on drought is positive, quantitatively small, and statistically insignificant. The estimates in columns (2) and (6) therefore support the assumption that drought only affects civil conflict through income or population size, and that otherwise, it is insignificant.

Columns (3)-(4) and (7)-(8) repeat this exercise for the linear rainfall measure and the international commodity price index. As can be readily seen, there is no evidence that these instruments affect civil conflict through channels other than per capita GDP or population size. Table 5 therefore echoes the results of the Hansen J-test that showed that instruments are uncorrelated to second stage error terms. The assumption of instrument validity hence stands up quite comfortably against formal econometric analysis.

5.3.2 Fuller Limited Information Maximum Likelihood Estimates

Also essential for the instrumental variable regressions to yield consistent estimates is that instruments provide a sufficiently precise first stage fit. Staiger and Stock (1997) suggested as a rule of thumb criteria a first stage F-stat of around 10, which for the population (per capita GDP) regression was 10.79 (8.75). The Cragg-Donald statistic is however substantially lower (3.02), indicating that instruments may be weak (see Stock, Watson, and Yogo (2002)). To address this I present second stage estimates using Fuller limited information maximum-likelihood estimators. These estimators have been shown to be more robust to weak instruments than two-stage least squares (e.g. Stock, Wright, and Yogo, 2002; Hahn and Hausman, 2003). The two Fuller limited-information maximum likelihood estimates are calculated for Fuller constants 4 and 1. The Fuller 1 estimator yields the most unbiased estimator and is recommended when one wants to test hypotheses; the Fuller 4 estimator minimizes the mean squared error of the estimator (Fuller, 1977). Table 6 shows that using either of these Fuller estimators produces estimates that are quite similar to the 2SLS estimates of Table 3 and 4. In all cases is the effect of population size and per capita GDP quantitatively large and statistically significant.

5.3.3 Alternative Drought Data

As an additional robustness check, I present in Table 7 instrumental variable estimates based on the use of alternative drought indicators. In columns (1)-(3) second stage estimates are computed when extending the drought dummy to include also those instances where rainfall was in the lower 5%-10% quantile. In Panel A, where I control for country fixed effects, an IV estimate on the population variable yields a significantly positive effect with coefficients ranging from 1.244 to 2.094 (the corresponding p-values are 0.003 and 0.081 respectively). In Panel B, where in addition to the country fixed effects country specific time trends and year fixed effects are included, coefficients are very imprecisely estimated and are not statistically significant at conventional confidence levels (coefficients remain quantitatively quite large, ranging from 3.30 to 6.36). In general, extending the cut-off much beyond the 5 percent quantile, say, to the 15 percent quantile, does not yield significant first nor second stage point estimates (regressions not shown). This negative result should not surprise however given that it are severe and repeated droughts, rather than episodes of low rainfall that lead to the famines associated with mass migration, lower fertility, and higher mortality rates (Sen, 1981; Fafchamp, 2003; FAO, 2005; WHO, 2006).

An alternative to the rainfall based drought indicator is to use data on drought provided by the Universite Catholique de Louvain's International Emergency Disasters Database (EM-DAT, 2008).[9] In this database a drought is reported if any of the following minimum criteria are fulfilled: (i) ten or more people reported killed; (ii) hundred or more people affected; (iii) a declaration of a state of emergency; or (iv) a call for international assistance.

In columns (4)-(6) of Table 7 I compute second stage estimates that use instead of the rainfall based drought dummy the EM-DAT drought indicator as an instrumental variable. I define the EM-DAT indicator in complete analogy to the rainfall based drought indicator, assigning it a value of one for the 5 percent harshest droughts (measured by number of people affected according to EM-DAT). Columns (4)-(6) show that using the EM-DAT drought indicator as an instrument yields for population size significant second stage estimates with coefficients ranging between 1.17

9 The data is publicly available at www.emdat.be.

to 1.90 (the p-values are 0.005 and 0.085 respectively). As a further robustness check, I combine EM-DAT drought data with the GPCP rainfall based drought indicator, generating a dummy variable that is one if both EM-DAT and GPCP jointly agree on the event of drought. This yields somewhat smaller point estimates on the population variable (coefficients range between 1.56 and 1.06), which are nevertheless significant at the 95 percent confidence level (see columns (7)-(9)).

It should be pointed out that for purposes of instrumental variable analysis the rainfall based drought indicator has at least three important advantages over the EM-DAT data. First, rainfall based drought is interpretable as triggering famine, which in Sub-Saharan Africa reduces population size because of lower fertility, migration, and higher mortality rates. Second, since rainfall is random the drought indicator is completely exogenous to the presence of Sub-Saharan civil conflict. This stands in stark contrast to the EM-DAT drought indicator, which is an outcome variable potentially endogenous to the conditions of the local environment. Moreover, generating a drought indicator based on number of people affected may produce confounding effects because of cross-country differences in the size and the trend of the population variable. A rainfall based drought indicator is therefore preferable from the standpoint of instrumental variable analysis.

6. Conclusion

Testing the link between country population size and civil conflict risk requires an exogenous source of variation in population size. I argued that drought induced variations in the population of Sub-Saharan countries satisfy this condition. By exploiting the negative response of the Sub-Saharan population to randomly occurring drought and constructing instrumental variable estimates that linked exogenously driven variation in population size to civil conflict risk, I addressed issues at the heart of identifying causal effects that arise in the presence of endogeneity bias and omitted variables. I showed, that failure to address these biases may lead to the conclusion that population size had no significant effect on civil conflict risk.

Two main messages follow from the paper's empirical results: first, larger population size places African states at a significantly higher risk of suffering from civil conflict -- smaller country size leads to more state stability -- and second, as nations become richer they will have less armed conflict. The instrumental variable estimates showed that part of the reason why the Sub-Saharan region had suffered from civil conflict was because of rapid increases in country population size that triggered a wave of intra-state conflicts concerning incompatibilities over territorial autonomy. Adverse income shocks in turn threatened the stability of nation-states because they triggered civil conflict arising from incompatibilities over government.

It may be tempting to conclude from these results that partition may be a solution to African civil conflict. This would be precipitous however for two main reasons. First, partition will create asymmetric payoffs. If losers are not compensated sufficiently, then what was fought as an intra-state war may simply turn into an inter-state conflict between two new states. Second, there are other alternatives available, such as birth control and migration policy, that correspond more closely to the mechanism identified in this paper to keep countries' population size in check. A further strategy to be considered in the fight against civil conflicts is political and fiscal decentralization (see here for instance, Lake and Rothchild, 2005; or Sambanis, 2008). This type of strategy would therefore accommodate increases in population size by decentralizing political and fiscal decision-making, reducing conflict potential that arises from regional demands for greater self-determination over the allocation of resources and the drafting of social policy.

6. References

Adler, R.F., G.J. Huffman, A. Chang, R. Ferraro, P. Xie, J. Janowiak, B. Rudolf, U. Schneider, S. Curtis, D. Bolvin, A. Gruber, J. Susskind, P. Arkin, and E. Nelkin (2003). “The Version 2 Global Precipitation Climatology Project (GPCP) Monthly Precipitation Analysis (1979-Present).” *Journal of Hydrometeorology* 4: 1147-1167.

Alesina, A. and E. Spolaore (1997). "On the Number and Size of Nations." *Quarterly Journal of Economics* 112: 1027-1056.

Alesina, A. and E. Spolaore (2003). *The Size of Nations*. Cambridge, MA: MIT Press.

Alesina, A. and E. Spolaore (2005). "War, Peace and the Size of Countries." *Journal of Public Economics* 89:1333-1354.

Alesina, A. and E. Spolaore (2006). "Conflict, Defense Spending and the Number of Nations." *European Economic Review* 50:91-120.

Angrist, J. and A. Krueger (2001). "Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments." *Journal of Economic Perspectives* 15: 69-85.

Blattman, C. and E. Miguel (2008). "Civil War." *Journal of the Economic Literature,* forthcoming.

Brückner, M. and A. Ciccone (2007). "Growth, Democracy, and Civil War." *CEPR Discussion Paper* No. 6568.

Ciccone, A. (2008). "Transitory Economics Shocks and Civil Conflict." Working Paper UPF, Barcelona.

Collier, P. and A. Hoeffler (2004). "Greed and Grievance in Civil War. *Oxford Economic Papers* 56 (4): 563-596.

Davenport, C., W. Moore, S. Poe (2003). "Sometimes You Just Have to Leave: Domestic Threats and Refugee Movements: 1964-1989." *International Interactions* 29: 27-55.

Deaton, A. (2005). "Measuring Poverty in a Growing World (Or Measuring Growth in a Poor World)." *Review of Economics and Statistics* 87 (1):1-19.

Diamon, J. (2005). *Collapse. How Societies Choose To Fail Or Succeed.* New York: Penguin Press

EM-DAT (2008). "EM-DATA: The OFDA/CRED International Disasters Database." Universite Catholique de Louvain, Brussels, Belgium, available at www.emdat.net.

Fafchamps, M. (2003). *Rural Poverty, Risk, and Developmen*t. Cheltenham: Edward Elgar.

FAO (2005). "Food Supply Situation and Crop Prospects in Sub-Saharan Africa." Food and Agriculture Organization of the United Nations, Africa Report, April 2005.

Fearon, J. and D. Laitin (2003). "Ethnicity, Insurgency and Civil War." *American Political Science Review* 97 (1): 75-90.

Fuller, W. (1977). "Some Properties of a Modification of the Limited Information Estimator." *Econometrica* 45: 939-954.

Ghobarah, H., P. Huth, and B. Russet (2003). "Civil Wars Kill and Maim People Long after the Shooting Stops." *American Political Science Review* 97 (2):189-202.

Gleditsch, N. and H. Urdal (2002). "Ecoviolence? Links Between Population Growth, Environmental Scarcity and Violent Conflict in Thomas Homer-Dixon's Work." *Journal of International Affairs* 56 (1): 283–302.

Hart, M. (1992). *The 100: A Ranking of the Most Influential Persons in History.* New York: Carol Publishing Group.

Hegre, H. and N. Sambanis (2006). "Sensitivity Analysis of Empirical Results of Civil War Onset." *Journal of Conflict Resolution* 50 (6):937-961.

Heston, A. (1994). "A Brief Review of Some Problems in Using National Accounts Data in Level of Output Comparisons and Growth Studies." *Journal of Development Economics* 44: 29-52.

Heston, A., Summers, R., and B. Aten (2006). *Penn World Table Version 6.2*. Center for International Comparisons of Production, Income and Prices, University of Pennsylvania, September 2006.

Homer-Dixon, T. (1994). Environmental Scarcities and Violence Conflict: Evidence from Cases." *International Security* 19 (1): 5-40.

Homer-Dixon, T. (1999). *Environment, Scarcity and Violence.* Princeton, NJ: Princeton University Press.

Intergovernmental Panel on Climate Change (2001). *Climate Change 2001: Impacts, Adaptation and Vulnerability.* New York, Cambridge University Press.

Lake, D. and D. Rothchild (2005). "Territorial Decentralization and Civil War Settlements." in P. Roeder and D. Rothchild, eds., *Sustainable Peace: Power and Democracy after Civil Wars*. Ithaca, NY: Cornell University Press, 2005.

Malthus, Thomas Robert (1798/1997). *An Essay on the Principle of Population.* London: Electronic

Book.

Miguel, E., S. Satyanath, and E. Sergenti (2004). 'Economic Shocks and Civil Conflict: An Instrumental Variables Approach.' *Journal of Political Economy* 112 (41):725-753.

Montalvo, J. and M. Reynal-Querol (2007). "Fighting Against Malaria: Prevent Wars While Waiting For The Miraculous Vaccine." *Review of Economics and Statistics* 89 (1): 165-177.

UNHCR (2007). "Global Report 2006". United Nations High Commissioners for Refugees, June 2007.

Urdal, H (2005). "People vs. Malthus: Population Pressures, Environmental Degradation and Armed Conflict Revisited." *Journal of Peace Research* 42 (4):417-434.

Sambanis, N. (2008). "Globalization, Decentralization, and Secession: A Review of the Literature and Some Conjectures." in G. Ranis, D. Cameron, and A. Zinn, eds., *Globalization and Self-Determination: Is the Nation-State under Siege?* New York: Routledge, 2006.

Sen, A. (1981). *Poverty and Famines.* Oxford: Clarendon Press.

Spolaore, E. (2008). "Civil Conflict and Secessions." forthcoming, *Economics of Governance*.

Stock, J., J. Wright, M. Yogo (2002). "A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments." *Journal of Business & Economic Statistics* 20 (4):518-529.

Wooldridge, J. (2002). *Econometric Analysis of Cross Section and Panel Data.* Cambridge, Mass.: MIT Press.

World Bank (2003). *Breaking the Conflict Trap: Civil War and Development Policy*. Oxford University Press.

WHO (2006). "WHO Responding to the Drought Crisis in the Horn of Africa Region." World Health Organization, ICP/EHA-HAC, May 2006.

Table 1
Descriptive Statistics

	Mean	Std. Dev.	Observations
A. Measures of Civil Conflict			
Civil Conflict Incidence > 25 Battle Deaths	0.267	0.443	888
Civil Conflict Incidence >1000 Battle Deaths	0.123	0.328	888
Civil Conflict Onset > 25 Battle Deaths	0.047	0.212	888
Civil Conflict Onset >1000 Battle Deaths	0.023	0.148	888
Conflict Onset over Secession / Autonomy	0.020	0.141	888
Conflict Onset over Government	0.035	0.184	888
B. Population Size and Per Capita Income			
Total Population	15.854	1.150	888
Population Aged 15-64	15.186	1.158	888
Population Aged 0-14	15.040	1.159	888
Male Population	15.138	1.153	888
Number of Refugees	2.890	2.397	462
Real Per Capita GDP	6.996	0.734	888
C. Instrumental Variables			
Rainfall (GPCP)	6.743	0.629	888
Commodity Price Index	4.094	0.494	888
Drought (GPCP)	0.050	0.217	888

Table 2
Drought, Population Size, and Per Capita Income

	Population Size					GDP		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All	Age 15-64	Age 0-14	Male	Refugees	GDP Per Capita	GDP	GDP
Drought	-0.016***	-0.017***	-0.017***	-0.016***	0.837*	-0.001	-0.017	-0.036**
	(0.005)	(0.005)	(0.006)	(0.005)	(0.451)	(0.014)	(0.016)	(0.15)
Log Rainfall	-0.006	-0.006	-0.007	-0.004	-0.305	0.075**	0.070**	
	(0.012)	(0.015)	(0.011)	(0.013)	(0.421)	(0.029)	(0.033)	
Log Commodity Price	0.012	0.018	0.011	0.013	0.336	0.085**	0.098**	0.099**
	(0.010)	(0.013)	(0.11)	(0.010)	(0.380)	(0.041)	(0.047)	(0.048)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects and Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No Observations	888	888	888	888	462	888	888	888

Note: Method of estimation is least squares. Heteroscedasticity and autocorrelation consistent standard errors are shown in the parentheses. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.

Table 3
Population Size, Per Capita Income, and Civil Conflict Incidence

	Civil Conflict					Civil War
	(1)	(2)	(3)	(4)	(5)	(6)
	Probit	LS	LS	2SLS	2SLS	2SLS
Log Population Size	0.022	0.009	0.145	1.208**	6.589*	2.354
	(0.042)	(0.037)	(0.144)	(0.569)	(3.901)	(2.424)
Log Per Capita GDP	-0.093	-0.064	-0.154	-1.178	-1.887**	-1.210**
	(0.068)	(0.057)	(0.103)	(0.800)	(0.812)	(0.586)
Mountainous Terrain	0.078**	0.083**				
	(0.043)	(0.042)				
British Colonial Origin	-0.062	-0.043				
	(0.116)	(0.107)				
Ethnic Fractionalization	0.101	0.087				
	(0.247)	(0.263)				
Education	-0.176	-0.186				
	(0.112)	(0.121)				
Decentralization	0.004	-0.001				
	(0.03)	(0.137)				
Overidentification	.	.	.	0.2646	0.5371	0.8280
Country Fixed Effects	No	No	Yes	Yes	Yes	Yes
Year Effects and Trends	No	No	No	No	Yes	Yes
No Observations	888	888	888	888	888	888

Note: Method of estimation in column (1) is maximum likelihood, with marginal effects evaluated at sample means; columns (2)-(3) least squares, and columns (4)-(6) two-stage least squares. The excluded instruments in columns (4)-(6) are the drought indicator, the log level of rainfall, and the log level of the international commodity price index. The Hansen J-test statistic on the overidentification restrictions is provided in form of p-values. Heteroscedasticity and autocorrelation consistent standard errors are shown in the parentheses. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.

Table 4
Population Size, Per Capita Income, and Civil Conflict Onset

	Civil Conflict					Territory	Government
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	LS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
Log Population Size	-0.008 (0.057)	0.679* (0.385)	5.189** (2.556)	8.430** (3.782)	8.543** (4.067)	2.218* (1.290)	3.014 (2.121)
Log Per Capita GDP	0.008 (0.030)	-0.870* (0.535)	-1.325** (0.575)	-0.768 (0.794)	-1.958* (1.041)	-0.180 (0.312)	-1.573*** (0.578)
Log Population Size* Ethnic Homogeneity				-2.420 (5.578)			
Log Per Capita GDP* Ethnic Homogeneity				-1.072 (1.804)			
Log Population Size* Decentralization					-4.971 (4.163)		
Log Per Capita GDP* Decentralization					1.915 (1.633)		
Overidentification	.	0.6069	0.4111	0.4889	0.5748	0.7626	0.8133
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects and Trends	No	No	Yes	Yes	Yes	Yes	Yes
No Observations	888	888	888	888	888	888	888

Note: Method of estimation in column (1) is least squares, columns (2)-(7) two-stage least squares. The dependent variable in columns (1)-(5) is civil conflict onset that arises either because of an incompatibility concerning territory or an incompatibility concerning government. In columns (6) (column (7)) the dependent variable is a civil conflict onset that arises because of incompatibilities concerning territory (government). The excluded instruments in columns (2)-(7) are the drought indicator, the log level of rainfall, and the log level of the international commodity price index. The Hansen J-test statistic on the overidentification restrictions is provided in form of p-values. *Ethnic Homogeneity* is an indicator function that is one if ethnic fractionalization is below the cross-sectional average and zero otherwise. *Decentralization* is an indicator function that is one for federal/semi-federal states and zero for unitary states. Both the interaction terms on the population variable (columns (4) and (5)) are jointly significant at the 6% level. Heteroscedasticity and autocorrelation consistent standard errors are shown in the parentheses. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.

Table 5
Population Size, Per Capita Income, and Civil Conflict

	Civil Conflict Incidence				Civil Conflict Onset			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	LS	2SLS	2SLS	2SLS	LS	2SLS	2SLS	2SLS
Drought	-0.090*	0.070			-0.070***	0.061		
	(0.051)	(0.134)			(0.026)	(0.095)		
Log Rainfall	-0.220**		-0.077		-0.164***		-0.067	
	(0.091)		(0.115)		(0.052)		(0.073)	
Log Commodity Price	-0.051			0.085	-0.025			0.074
	(0.070)			(0.147)	(0.047)			(0.097)
Log Population Size		10.354	5.804	5.870		8.457	4.506**	4.564*
		(9.196)	(3.625)	(3.988)		(6.600)	(2.243)	(2.609)
Log Per Capita GDP		-2.115**	-1.450	-2.456**		-1.523*	-0.947	-1.821**
		(1.036)	(1.024)	(1.262)		(0.784)	(0.657)	(0.895)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects and Trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No Observations	888	888	888	888	888	888	888	888

Note: Method of estimation in columns (1) and (5) is least squares; columns (2)-(4) and (5)-(6) two-stage least squares. The instrument are the drought indicator, the log level of rainfall, and the log level of the international commodity price index. Heteroscedasticity and autocorrelation consistent standard errors are provided in the parentheses. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.

Table 6
Population Size, Per Capita Income, and Civil Conflict

	Conflict Incidence				Conflict Onset			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Fuller 1	Fuller 4	Fuller 1	Fuller 4	Fuller 1	Fuller 4	Fuller 1	Fuller 4
Log Population Size	1.227**	1.007***	6.062*	4.185*	0.617**	0.463**	4.887**	3.460**
	(0.564)	(0.384)	(3.591)	(2.488)	(0.317)	(0.219)	(2.367)	(1.581)
Log Per Capita GDP	-1.205	-0.884*	-1.788**	-1.417**	-0.776*	-0.544**	-1.270**	-0.997**
	(0.798)	(0.500)	(0.726)	(0.556)	(0.436)	(0.278)	(0.538)	(0.411)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects and Trends	No	No	Yes	Yes	No	No	Yes	Yes
No Observations	888	888	888	888	888	888	888	888

Note: Method of estimation is the Fuller limited information maximum likelihood estimator. The excluded instruments are the drought indicator variable, the log level of rainfall, and the log level of the international commodity price index. Heteroscedasticity and autocorrelation consistent standard errors are provided in the parentheses. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.

Table 7
Country Size, Per Capita Income, and Civil Conflict

	10% Drought Shock			EM-DAT Drought			EM-DAT & 5% Joint		
	Panel A: Country Fixed Effects								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	2SLS	Fuller 1	Fuller 4	2SLS	Fuller 1	Fuller 4	2SLS	Fuller 1	Fuller 4
Log Population Size	2.094*	1.738**	1.244***	1.898*	1.639**	1.172***	1.558*	1.454**	1.107***
	(1.200)	(0.801)	(0.413)	(1.101)	(0.805)	(0.418)	(0.807)	(0.701)	(0.390)
Log Per Capita GDP	-2.420	-1.899*	-1.185**	-2.104	-1.755	-1.131**	-1.659	-1.510	-0.963**
	(1.719)	(1.119)	(0.517)	(1.423)	(1.021)	(0.437)	(1.114)	(0.956)	(0.476)
Overidentification	0.8115	0.8116	0.8116	0.6740	0.6637	0.6637	0.3348	0.4343	0.4343
No Observations	888	888	888	888	888	888	888	888	888
	Panel B: Country Fixed Effects + Time Controls								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	2SLS	Fuller 1	Fuller 4	2SLS	Fuller 1	Fuller 4	2SLS	Fuller 1	Fuller 4
Log Population Size	6.357	5.655	3.295	8.401	5.224	1.390	6.167	3.980	0.336
	(5.140)	(4.532)	(2.750)	(9.440)	(5.568)	(2.256)	(8.828)	(5.856)	(2.241)
Log Per Capita GDP	-1.862**	-1.749**	-1.336**	-2.047*	-1.680**	-1.160**	-1.901*	-1.622**	-1.080**
	(-0.849)	(0.774)	(0.553)	(1.137)	(0.750)	(0.465)	(1.127)	(0.791)	(0.450)
Overidentification	0.4813	0.4746	0.4746	0.4614	0.5016	0.6183	0.3477	0.4589	0.4589
No Observations	888	888	888	888	888	888	888	888	888

Note: Method of estimation in columns (1), (4), and (7) is two-stage least squares; in columns (2), (3), (5), (6), (8), and (9) Fuller limited information maximum likelihood. The excluded instruments are the drought indicator variable, the log level of rainfall, and the log level of the international commodity price index. Control variables in Panel A are country fixed effects. Panel B includes in addition to the country fixed effects country specific time trends and year fixed effects. Standard errors are provided in parentheses. The Hansen J overidentification test is provided for all second stage regressions in form of p-values. *Significantly different from zero at 90 percent confidence, ** 95 percent confidence, *** 99 percent confidence.

Appendix Table
List of Sub-Saharan Drought (1980-2004)

Country	Period of Rainfall Shortage	Number of People Affected (EM-DAT, 2008)
Angola	1991-1992	1,900,000
Botswana	1989-1990	100,000
Botswana	2001-2003	-
Chad	1990-1991	300,000
Ethiopia	1983-1984	7,750,000
Gambia	1982-1983	400,000
Gambia	1989-1990	-
Guinea	1982-1983	*
Kenya	1983-1984	600,000
Kenya	1989-1999	1,600,000
Kenya	1999-2000	21,000,000
Malawi	1986-1987	1,430,000
Mali	1995-1996	-
Mauritania	1982-1983	1,600,000
Mauritania	1990-1992	-
Mauritania	1995-1996	447,000
Mozambique	1985-1986	4,750,000
Niger	1987-1988	1,000,000
Niger	1990-1991	1,630,000
Niger	1997-1998	8,500
Senegal	1983-1984	1,200,000
Senegal	1990-1991	-
Somalia	1980-1985	500,000
Somalia	1990-1991	-
Somalia	1999-2000	2,000,000
South Africa	1989-1990	1,320,000
South Africa	2003-2004	15,000,000
Sudan	1998-1999	-
Swaziland	1985-1986	*
Swaziland	1991-1992	200,000
Swaziland	2001-2003	970,000
Uganda	1983-1984	-
Zimbabwe	1982-1983	700,000
Zimbabwe	1991-1992	5,000,000
Zimbabwe	2001-2003	6,000,000

Note: The listed droughts are based on an indicator function that is one for the 5% largest drops in the level of rainfall over two consecutive years. Column (3) provides an estimate of the number of people affected according to EM-DAT (2008). A dash implies that EM-DAT did not list the event as drought; an asterix means that EM-DAT coded the event as drought without giving an estimate of the number of people affected.