Abstract

This paper uses panel data from a sample of Sub-Saharan African countries over the 1960-1996 period and Instrumental Variables estimator to investigate the effect of the *incidence* and *severity* of civil wars on the growth rate of per capita income. We find that the *incidence* and *severity* of civil war have robust, negative, and statistically significant effect on the growth rate of per capita income. We find that civil war affects the growth rate of income partly through reduced investment in physical capital. However, if one does not control for the correlation between civil war *incidence* and other growth factors, the estimated effect of effect of civil war on economic growth is not robust. We find that civil war has no effect on the level of per capita income.

KEY WORDS: CIVIL WARS, *INCIDENCE*, *SEVERITY*, ECONOMIC GROWTH, SUB-SAHARAN AFRICA, INSTRUMENTAL VARIABLES ESTIMATOR, PANEL DATA

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Civil Wars and Economic Growth in Sub-Saharan Africa

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1 Introduction

This paper uses panel data from a sample of African countries during the 1960-1996 period to investigate the effects of civil war on the growth rate of per capita income. We do so by estimating an endogenous growth equation that includes the *incidence* (*severity*) of civil war as an added regressor. We also investigate a mechanism through which civil war affects the growth rate of income. The distinguishing feature of our model is that we instrument for the incidence of civil war to get around the possible correlation of civil war *incidence* with the error term of the income growth rate equation. Empirical research on the growth impact of the *incidence* of civil wars has yielded non-robust results. While some researchers find evidence of negative effects, others do not find any significant negative effects. Part of the inconclusive results may stem from the fact that the variables that cause civil wars, such as ethno-linguistic fractionalization, primary commodity dependence, and low stocks of human capita, are also determinants of the growth of per capita income. Indeed the economics of civil war literature suggests that the incidence of civil war is partly explained by income as well as variables that determine income growth. This makes the incidence of civil war an endogenous variable. Since the incidence of civil war is correlated with other explanatory variables, its growth impact may not be distinguishable from those of the underlying factors with which it is correlated. We account for this unmeasured endogeneity of civil war incidence in our study.

The economic performance of Sub-Saharan Africa over the last three decades has been nothing but abysmal. It is the only part of the developing world where per capita income and living standards have declined over the period due, in part, to slow growth of total GDP and rapid population growth. The deteriorating living standards has been accompanied by a large increase in the incidence of civil wars. Since the attainment of independence in the 1960s, about 20 Sub-Saharan African countries have experienced at least one period of civil war. Indeed some Sub-Saharan African countries (Angola, Mozambique, Sudan) have hardly had any period without civil war since independence. While civil wars have declined in other parts of the world, the incidence and intensity of civil wars have increased in Sub-Saharan Africa. Of the 27 active armed conflicts going on around the world in 1999, about 41% of them were civil wars taking place in Sub-Saharan Africa, a region with less than 11% of the world's population.[1]

Does the incidence of civil war have any negative effect on the growth rate of per capita income

in Less Developed Countries (LDCs) besides the growth impact of the underlying factors that cause civil war? If civil war incidence has a negative effect on the growth rate of income, is this affect a permanent one? The "new" growth literature indicates that civil wars, other ethnic conflicts, and state failure generally, have deleterious effects on economic growth (Easterly and Levine: 1997, Easterly *et al*: 1993, Barro: 1991, and Barro and Lee: 1994, Sala-I-Martin: 1997, Gyimah-Brempong and Traynor: 1999, Murdock and Sandler: 2001). Although not explicitly stated, civil war can affect economic growth either directly through the disruption of production or indirectly through a reduction in accumulation or the destruction of productive resources as well as the ability to formulate and implement growth enhancing economic policies. Civil war, we note, is another manifestation of state failure; events that may include guerilla wars, mass violence, political assassinations, and various forms of political instability. The results of studies that have estimated the growth impact of civil war have been mixed. While some of these studies find significantly negative growth impact of civil war, others find no significant impact. Levine and Renelt, (1991), however, finds that the effect of civil war on the growth rate of per capita income is not robust; the sign, magnitude, and statistical significance of the civil war dummy variable changes with conditioning variables.

Recent studies of the causes, initiation, and duration of civil war indicate that civil wars have economic as well as non-economic causes (Collier and Hoeffler: 1998, 2000, 2001; Collier: 2000a, b; Elbadawi and Sambanis: 2000a, b; and Dudley and Miller: 1998). In particular, low and slow income growth, high unemployment rate, primary export dependency, and highly unequal income distribution have been suggested as possible causes of the *incidence*[2] of civil war. The findings of the two strands of research suggest the possibility that cross-country differences in the growth rate of income and the propensity for civil war are being driven by the same set of factors. It is possible that the lack of robustness of the relationship between civil and economic growth found by Levine and Renelt (1991) is due to unobserved endogeneity of civil war; endogeneity that stems from the correlation between civil war and other variables that determine economic growth rate in the current period.

As an example, Nigeria and Gabon are oil exporting Sub-Saharan African countries with divergent growth paths. Nigeria has experienced slow economic growth, civil war, and political instability while Gabon has experienced respectable economic growth, no civil war, and a relatively long period of what passes for political stability in Sub-Saharan Africa. It is suggested that Nige-

ria's slow growth rate is due to high degree of ethno-linguistic and religious fractionalization that result in high propensity for civil war. The usual approach to investigating the impact of civil war on economic growth is to include a dummy variable for the incidence of a civil war and interpret the coefficient of this dummy variable as the growth effect of a civil war. The coefficient of a civil war dummy variable in a growth equation cannot distinguish between the growth effect of civil war and unobserved country heterogeneity that explains the propensity to have a civil war. In the Nigeria Gabon example, the civil war dummy cannot distinguish between the growth effect of ethnic fractionalization, which retards economic growth and may cause civil war, and the growth effect of the occurrence of civil war itself. It is not clear whether the growth rate of Nigeria would be any higher had she not experienced a civil war. It is therefore necessary to account for the endogeneity of civil war incidence if researchers are to properly identify the growth impact of civil war incidence.

The civil war literature gets around this possible endogeneity problem by lagging the growth rate of income in the probability of civil war equation. Elbadawi and Sambanis (2000a) tests and finds economic growth rate to be exogenous in the incidence of civil war equation, a result that seems to be at variance with the results obtained by empirical growth research. However, if in addition to initiation, civil war is sustained by poor economic performance, then economic growth is likely to be an *endogenous* variable in the *incidence* of civil war. Moreover, most of the variables used to explain the incidence of civil war (ethnic fractionalization, education, primary export dependency, political freedoms) are the same set of variables used to explain the growth rate of income (Barro: 1991, Barro and Lee: 1994, Easterly and Levine, 1997, Rodrik: 1999, Sachs and Warner: 1997, among others). These variables change very slowly over time. Third, it is possible that slow growth of income is unrelated to the incidence of civil war but is related unmeasured country heterogeneity. The result is that it is not easy to isolate the growth impact of civil war incidence when one uses a simple dummy variable approach to investigate the effects of civil on economic growth rate across countries. The growth empirics literature has, generally, not tackled this issue.

The approach we use to investigate the civil war/growth relationship is as follows: We specify and estimate an endogenous growth equation which include the incidence of civil war as an added regressor. To overcome the possible endogeneity variables for ever having a civil war, we use a one period lead of the predicted probability of civil war (propensity for civil war) as an instrument for the incidence of civil war. Our rationale for using this instrument is as follows: The probability of a

civil war is a function of underlying socio-economic factors such as ethno-linguistic fractionalization, political freedoms, stocks of human capital, and primary export dependence, among other factors. Since these factors are highly persistent over time, the propensity for civil war will also be highly persistent over time; hence current civil war propensity will be highly correlated with future civil war propensity, which in turn will be highly correlated with the incidence of civil war in the current period. However, because the propensity for civil war is a future value, it is not correlated with the error term of the growth equation in the current period. This makes the propensity for civil war a "good" instrument of the incidence of civil war in our study. We employ two different measures of civil war in this study, thus increasing confidence in our results. Before estimating the growth equation, we show that not accounting for the endogeneity of civil war results in non-robust and, possibly, biased estimates of the growth impact of civil war.

Investigating the effects of civil war on economic growth in Sub-Saharan Africa is an important policy issue since the quest for faster growth rate will include finding an end to the many civil wars in the region if we find that civil war has a robust and negative effect on the growth rate of income. Alternatively, if policy makers cannot prevent the civil war, they may have to take measures to counter the growth effects of the civil war if living standards are not to deteriorate on account of the war. On the other hand, if we find no robust negative growth effect, then the quest to end civil wars in Sub-Saharan Africa should be justified on political and humanitarian, rather than economic, grounds.

We adopt Elbadawi and Sambanis' (2000a,b) definition of civil war *incidence* in this study. The incidence of civil war in any period is the sum of two probabilities; the probability that a civil war starts in a period given that there was no civil war at the beginning of the period and the probability of observing a civil war in a period given that there was a war in the previous period. This definition of civil war *incidence* therefore encompasses the onset as well as the duration of civil war. This definition of civil war incidence does not allow for the *severity* of civil war. It does not account for differences in the duration of civil wars in a period across countries and through time, thus treating wars that last for three weeks in a year in the same way as it treats a war that lasts for 12 months in a year. Second, it treats a civil war with 1,000 casualties annually as of the same intensity as one with 10,000 casualties annually. We believe that the duration and intensity of a civil war will have an impact on the growth on an economy quite apart from the growth effect of the *incidence* of civil war, hence failure to account for war *severity* in a growth equation may

provide the total growth effect of the war. We therefore estimate the effect of the *severity* of civil war on the growth of per capita income in addition to the growth effect of the *incidence* of civil war.

This paper differs from previous research on the effects of civil war on economic growth and the economic analysis of civil war in many ways. First, our analysis is on the effects of civil war incidence on economic growth rather than on the determinants of civil wars. Second, we use an Instrumental Variables (IV) estimator, which accounts for the possible endogeneity of civil war, to estimate the growth equation in this study. Third, we estimate the effects of civil war *incidence* as well as the *severity* of civil war on economic growth. Fourth, we use two measures of civil war to estimate the growth equation. Fifth, we investigate one of the several possible mechanisms through which civil war affects the growth of income. Finally, we investigate whether civil has a lasting effect on the levels of per capita income. To our knowledge, this is the first study to address all these issues in one paper.

We find that civil war has a negative, significant, and robust effect on the growth rate of per capita income in Sub-Saharan African countries. In addition to the direct negative effect, we also find that civil war also decrease the growth rate of income through decreased investment in physical capital. The negative growth effect is, however, robust only if we use an IV estimator that accounts for the correlation between civil war and the error term of the growth equation, to estimate the growth equation. Failure to do so results in a biased and non-robust coefficient estimate of the civil war variable in the growth equation. The negative growth effect of civil war is, however, a short run effect as civil war has no significant effect on the level of per capita income. We also find that the *severity* of a civil war has a negative growth effect apart from the growth effect of the incidence of civil war. Our results are quite robust to the measures of civil war as well as the measure of income we use in this study.

The rest of the paper is organized as follows: Section II briefly reviews the recent empirical literature on the relationship between civil war and economic growth. Section III introduces the econometric model we use to investigate the relationship between economic growth and civil war incidence while section IV discusses the data used for the study. Section V presents and discusses the statistical results and draw some policy conclusions. Section VI concludes the paper.

2 Literature Review

The empirical economic growth literature has been growing at exponential rates in the last decade.[3] Because the literature is vast, we briefly mention a few of the studies that include civil war as an explanatory variable. Barro and Lee (1994) estimates an endogenous growth model that include both the duration and the occurrence of civil war as an added explanatory variable. Measuring civil war as the occurrence of a civil war, they find that civil war has a negative but insignificant effect on the growth rate of per capita income after adjusting for other factors that influence economic growth. When they measured civil war as the *duration* of the war, they found a positive, though statistically insignificant, relationship between civil war and economic growth. Easterly *et al* (1993), using war casualties per capita, finds a positive but statistically insignificant relationship between war casualties and growth rate. Sala-I-Martin (1997) uses the incidence of civil war and finds a significantly negative growth effect of war. Easterly and Levine (1997), in a review of the economic performance of African countries, points strongly to ethnic conflicts, be they ethnic wars, religious or political tensions, as a major source of Africa's poor economic performance.

Ritzen, Easterly, and Woolcock (2000) develops a model in which lack of social cohesion leads to conflict and war, which in turn leads to reduction in growth rates of per capita income. Rodrik (1999), although not directly addressing civil war, argues that the failure of some developing countries to recover for external shocks in the 1980s can be attributed to ethnic conflicts. He further argues that the problem does not lie in ethnic or religious fractionalization as much as in the failure to develop institutions to effectively mediate the inevitable conflicts that arise in any society. Caselli *et al* (1996), on the other hand find no significant growth impact of civil war incidence. We note that none of these studies was interested primarily in investigating the impact of civil war on growth; they only used civil war as one of the conditioning variables.

Murdoch and Sandler (2001) is the first study we know of whose purpose is to investigate the effects of civil war on growth. Using the augmented neoclassical growth model of Mankiw, Romer and Weil (1992) with civil war incidence and intensity as added regressors, the paper finds that the incidence of civil war has a moderately negative impact on the levels of per capita income and substantially negative impacts on the growth rates of per capita income in neighboring countries. They find that the greater the intensity of the civil conflict, the greater the spatial spill-over effects. They find that the impact of civil war on income levels is short-term in nature. However, as noted

earlier, Levine and Renelt (1991) find that the significance of the war variable changes with model specification and the variables included in the growth equation making civil war and unreliable predictor of the growth rate of income.

The economics of civil war literature, "launched" with Collier and Hoeffler's 1998 paper, casts the causes of civil wars in terms of utility maximization: rebels will initiate a civil war if the expected benefit of rebellion exceed the cost of such a rebellion. Using data on civil wars during the 1960-1992 period and probit and tobit analyses, they find that ethno-linguistic fractionalization, initial income, dependence on natural resource exports, and population size are strong determinants of the probability of the incidence of civil war. In subsequent papers, Collier and Hoeffler (2000a,b) and Collier (2000a,b) expand on the economic causes of civil war using both theoretical and empirical analyses of the initiation and duration of civil war. Of particular interest to our paper, they find that lagged economic growth, low income, and primary export dependency are important economic determinants of the initiation and duration of civil wars, besides political and ethno-linguistic variables.

Elbadawi and Sambanis (2000a,b) applies a variant of the Collier-Hoeffler model to African data. Defining the *incidence* of civil war as the sum of the probability of war initiation in a period given the presence of peace in the previous period and the probability of war in a period given the presence of war in the previous period, they confirm the Collier-Hoeffler thesis of civil war initiation. Their test for the endogeneity of growth rate did not find economic growth to be endogenous. Dudley and Miller (1998) evaluates four theories of the incidence of civil war and finds strong support for the economic model of civil war initiation and duration. The economic determinants of civil war strongly show that lagged economic growth is an important determinant of the probability that a nation will experiencing a civil war. It also shows that the same set of variables that determine economic growth rate also determine the incidence of civil war. We use these relationship in the model below.

3 Model

3.1 Growth Rate Equation

Civil wars could affect economic growth through several channels. First, civil war is likely to decrease the stock of physical capital through a destruction of infrastructure as well as reduction

in investment in capital as a result of capital flight, reduced savings, and increased uncertainty. In creased uncertainty is also likely to decrease the inflow of foreign direct investment (FDI). In the same way, the stock of human capital is expected to decreased by civil war as people are killed by fighting, as educated and skilled people emigrate and fewer people get trained as resources are diverted to fight the civil war. A civil war, especially an ethnically-based one, is likely to destroy social capital and social and political institutions that are necessary to mobilize and utilize resources for economic growth.

In empirical research, civil war research treats lagged economic growth rate as exogenous while economic growth research treats contemporaneous civil war as exogenous. We combine the insights of the two strands of literature to develop a growth equation that treats the incidence of civil war as endogenous. Our model consists of two equations—the growth rate of per capita income and the *incidence* of civil war. Following the endogenous growth literature, (Barro: 1991, Barro and Lee: 1995, Caselli *et al*: 1996, Romer: 1986, Jones: 1995, Hall : 1995), we make aggregate output a function of technology (A),labor (L), the stocks physical and human capital (K, H) and environment factors, including civil wars. Because we are interested in the growth impacts of civil war, we disaggregate the environment friable into civil war ($civwar$) and all other environmental variables ($\mathbf{Z}$). The aggregate production function is given as:

$$Y = Y(A, K, H, L, civwar, \mathbf{Z}), \qquad \partial Y/\partial A, \partial Y/\partial K, \partial Y/\partial L \geq 0, \qquad \partial Y/\partial civwar \leq 0 \qquad (1)$$

where all variables are as defined in th text above. Writing the production in output per capita terms, we obtain output per capita function as: $y = y(a, k, h, civwar, \mathbf{Z})$ where lower case letters are per capita units while upper case letters represent aggregates. We note that $\mathbf{Z}$ and $civwar$ in the per capita income equation are written in aggregate terms to reflect the fact that aggregate institutions determine per capita output. It also reflects the externalities and "publicness" inherent in these variables. The growth rate of per capita income ($\dot{y}$) is determined by the growth rate of the arguments in the per capita income equation. That is: $\dot{y} = \dot{y}(\dot{a}, \dot{k}, \dot{h}, civwar, \mathbf{Z}) \qquad \partial \dot{y}/\partial civwar \leq 0$ As indicated above, technical progress as well as the formation of both physical and human capital will be negatively impacted by the incidence of civil war while they are positively influenced by the proportion of income devoted to physical and human capital formation (s), the level of human capital, as well as the institutional environment. Disregarding depreciation for the moment, this assumption implies that physical and human capital, as well as technology evolve in the following

way:

$$\begin{aligned}
\dot{k} &= \dot{k}(s, h, civwar, \mathbf{Z}) \qquad \partial\dot{k}/\partial civwar \leq 0 \\
\dot{h} &= \dot{h}(s, h, civwar, \mathbf{Z}) \qquad \partial\dot{h}/\partial civwar \leq 0 \\
\dot{a} &= \dot{a}(s, h, civwar, a, \mathbf{Z}) \qquad \partial\dot{a}/\partial civwar \leq 0
\end{aligned}$$

Substituting these equations int the growth rate of per capita income equation, we obtain the growth rate of per capita income as:

$$\dot{y} = \dot{y}(a, s, h, civwar, \mathbf{Z}) \qquad \partial\dot{y}/\partial civwar \leq 0 \tag{2}$$

where all variables are as defined in the text above.

To estimate the growth equation in (3) above, we have to provide a specific functional form as well as define the variables in the **Z** vector. We follow previous research and proxy the savings rate by the domestic investment/GDP ratio (k), while we measure h as the level of educational attainment of the adult population in a country. The variables in the **Z** are variables that have been found by earlier researchers to affect the growth rate of income. Following Barro (1991), Mankiw, Romer, and Weil (1992), and other researchers, we include initial income level (y_0) in the income growth equation. Following Barro (1991), we include government consumption (gov) as one of the regressors to reflect government economic policy. Edwards (1998), Feder (1983), and Sachs and Warner (1997), among others, argue that openness of an economy has a positive effect on the growth rate of income because the efficiency of the export sector relative to the non-trade sector as well as the ability open economies to absorb imported technologies compared to closed economies. We follow these researchers and include the openness of the economy, which we proxy with the trade/GDP ratio ($trgdp$) as an additional regressor.

The growth rate of per capita income equation we estimate is given as:

$$\dot{y}_{it} = \alpha_0 + \alpha_1 k_{it} + \alpha_2 edu_{it} + \alpha_3 y_{0,it} + \alpha_4 gov_{it} + \alpha_5 trgdp_{it} + \alpha_6 civwar_{it} + \varepsilon_{it} \tag{3}$$

where ε_{it} is a stochastic error term and all other variables are as defined in the text above. In the absence of guidance as to the functional form, we estimate the per capita income growth equation in the linear form as earlier researchers have done. We expect the coefficients of k, $trgdp$, and edu to be positive while the coefficients of gov and $civwar$ are expected to be negative. If conditional convergence operates in African countries, we expect the coefficient of y_0 to be negative.

The growth equation we presented above assumes that all regressors in the equation are exogenous. However, there are reasons to doubt the assumption that civil war can be treated as exogenous in this equation. First, we measure the incidence of civil war as the initiation and duration of civil wars. Since it takes partly economic forces, especially low employment and income growth to sustain a civil war, economic growth in the current period will affect the incidence of civil war in the current period, which in turn affects economic growth in the current period. Second, most of the variables used to predict the probability of civil war *incidence* (ethnic heterogeneity, low stocks of human capital, primary export dependency, among others), are the same set of variables that have been used by researchers to explain the growth rate of per capita. If the probability of a civil war *incidence* is systematically correlated with these growth explanatory variables, the correlation creates unobserved endogeneity of *civwar* in the growth equation. Besides, slow growth may not be caused by the incidence of civil war, but by unobserved cross country heterogeneity. It may be impossible to disentangle the effects of civil war incidence on growth from the effects of unobserved country heterogeneity unless one controls for this heterogeneity in the growth equation.

Table I presents some comparative statistics of variables for some Sub-Saharan African countries that experienced civil war and those that did not during the period under consideration. The data shows that countries that experienced civil war during the sample period had average per capita incomes that were 50% lower than countries that experienced no civil wars, and had investment/GDP rates, and stock of education human capital that were at least 50% lower than the average for countries that experienced no civil war. The civil war group of countries are more primary export dependent, have less civil liberties, less effective legislatures, and experience higher rates of inflation than the countries that experienced no civil wars. The upshot is that countries that had civil war had lower endowments of growth enhancing characteristics than the countries that did not have civil war. It is not surprising that the average growth rate of per capita income in the civil war group of countries was -.36% while the average growth rate for countries not experiencing civil war was 1.16%. Can the cross national differences in growth rate be explained by differences in observed growth factors alone? If the answer to this question is in the affirmative, then the coefficient of any war variable should be zero, once has included the observable growth variables in a cross country growth equation.

Table I suggests that the propensity to have of civil war lowers some of the variables that determine the growth rate of per capita income. The correlation may be causal or it may not;

both sets of variables may be influenced by a third set of factors. The possible endogeneity of *civwar* in the growth rate of income equation implies that estimating the equation directly with either a Fixed Effects (FE) or a Random Effects (RE) estimator will produce biased, and possibly inconsistent, estimates. One therefore needs an Instrumental Variable (IV) estimator to estimate the growth equation. We therefore instrument for *civwar* in estimating the growth rate of income equation.

3.2 Estimation Method

Estimating the traditional growth equation, as argued above, could lead to biased and non-robust estimates of the impact of civil war incidence on economic growth. Part of the problem stems from possible endogeneity of some of the regressors (correlation of the regressors with the error term). A possible way to resolve this problem is to estimate structural equations. However, because there are so many variables that affect the growth rates of countries, there is not a generally acceptable growth equation that is estimated. Indeed there are as many growth equations estimated in the growth empirics literature as there are researchers (see Durlauf and Quah: 1998 and Temple: 1999). It is therefore not clear what the structural growth equations are. Alternatively, one could use an instrumental variables (IV) estimator to estimate the growth equation to account for possible endogeneity of some of the regressors, an approach that has been used by some researchers (Caselli *et al*: 1996, Sachs and Warner: 1997). However, it is hard to come up with valid instruments that are excludable from the growth equation. For example, ethno-linguistic fractionalization and reliance on primary exports are variables that could be used as instruments for civil war but are themselves determinants of economic growth (Easterly and Levine: 1997, Collier and Gunning: 1999, Sachs and Warner: 1997).

We use an IV estimator in this study. The instrument we use for *civwar* (*ethnwgur*) is the probability of civil war (ethnic war) one period forward ($pcivwar_{t+1}$, $pethnwgur_{t+1}$). This variable is measured as the predicted value of the probability of the incidence of civil war (ethnic war) in the next period. We make the predicted probability of civil war (*pcivwar*, *pethnwgur*) a function of civil liberties (*civ*), primary export dependency (*primary*), legislative effectiveness ($legeffct$) and ethno-linguistic fractionalization (elf). The probability of civil war is dependent on some underlying characteristics of countries. Since the propensity for civil war depends on underlying factors that are persistent over time, the probability of civil war will be persistent over time.

Because it a predicted value it is also highly correlated with the incidence of civil war. However, because the instrument is the forward value of the probability of the incidence of civil war, it is not likely to be correlated with the error term of the growth equation in the current period. This makes it a "good" instrument for civil war incidence. We use a Hausman test to test to see if the IV estimates are the same as estimates using civil dummy as the measure of the incidence of civil war. In addition, we estimate an equation that includes both the probability of civil war (ethnic war) and $pcivwar_{t+1}$ ($pethnwgur_{t+1}$) to test to see of after the inclusion of the propensity of civil war, the residual of civil war has any additional explanatory power.

4 Data

The dependent variable in this study is the growth rate of real per capita income ($\dot{y}$). We measure this variable as the annual growth rate of real per capita income in 1987 constant PPP dollars. The explanatory variables are the initial level of per capita income (y_0), investment/GDP ratio (k), education (edu), openness of the economy ($trgdp$), government consumption (gov), and the *incidence* of civil war. We measure y_0 is measured as real per capita GDP in 1987 PPP dollars in the previous period. We follow earlier researchers (Barro: 1991, Barro and Lee: 1996, Levine and Renelt: 1991, Sachs and Warner: 1997) and measure k as the investment/GDP ratio in a year, while gov is government measured as consumption/GDP ratio. We measure edu as the average years of education attained by the population that is 25 years or older in a country in a year. We proxy the openness of an economy by trade/GDP ratio ($trgdp$) which we measure as the ratio of total trade ($exports + imports$) to GDP in a year. The variables used to predict the probability of civil war are civil liberties index (civ), legislative effectiveness of a country ($legeffct$), primary export dependency ($primary$), and ethno-linguistic fractionalization. $legeffct$ is a measure of the effectiveness of a country's legislature while elf is the probability that two randomly selected individuals in a country belong to different ethnic group. civ is the Gastil's civil liberties index as transformed by Barro into 1-0 scale. It is measured as: $civ = (7 - civil \quad liberty)/6$.

The variable of major interest in this study is the *incidence* of civil war. It is hard to measure what constitute a civil war since several conflicts could conceivably be classified as civil wars. Yet a distinction between major armed conflicts involving the central government and an organized army and a minor conflict that involve very few people over relatively short period of time has to

be made because they have different implications for economic growth rate. For example, a minor conflict over property between two small groups may have a growth implication different from that of a major conflict involving the central government, the nation's armed forces, and a large armed group with the war fought over a large proportion of the country's land mass for a long period of time. Because our concern is with the growth impact of civil war, we focus on major conflicts. We admit that the criteria for determining what constitutes a major conflict is bound to be an arbitrary one. We measure civil war incidence as a dummy variable that equals unity for any period in which a country is actually engaged in a civil war, zero otherwise. For example, civil is equal to 1 for the 1968-71 period for Nigeria when she fought a civil war; it is zero for all other years. Civil war, as measured here, is therefore time and country specific.

We use two different measures of civil war, *civwar*, and *pethnwgur* to measure the *incidence* of civil war. Both are dummy variables that take the value of unity in a year in which a civil war occurs in a country and zero otherwise. *civwar* is derived from Singer's Correlates of War Project. Singer defines an armed conflict as a civil war if it meets four criteria: (i) major battle ensued entirely within the borders of a country; (ii) the government is a major combatant; (iii) effective resistance occurred on both sides, and (iv) at least a 1000 fatalities occurred during the course of the war. There were a total of 13 countries that had civil wars in at least one year during the sample period. *pethnwgur* is derived from Gurr's *Minorities at Risk Project* and is defined as episodes of violet conflict between the national government and national, ethnic, religious, or other communal groups which seek major changes in their status through armed conflicts. To be classified as *pethnwgur*, each side must mobilize and field at least 1000 combatants and must have at least 100 war fatalities annually. Acts unrelated to war, such as government sponsored mass murders and communal violence do not qualify in this regard as *pethnwgur*. The fatality threshold is lower for *pethnwgur* than for *civwar*. 14 countries had at least one incident of an *pethnwgur* during the sample period. We note that we instrument for these variables with one period forward of their predicted values in the estimation.

The data used to estimate the effects of civil war on economic growth were obtained from a variety of sources. Data on y_0, $\dot{y}$, k, $trgdp$, and gov were obtained from the World Bank's *World Development Indicators, 2000*, (Washington DC: World Bank, 2000). Data for elf, $legeffct$, and civ were obtained from R. Bates' African Research Project at Harvard University. The data was downloaded from the Project's website at http://www.govharvard.edu/resarch.bates while the

data for *edu* were obtained from Barro and Lee (2000). The data for the calculation of *primary* were obtained from various issues of *United Nations' Statistical Yearbook*. Data on *civwar* and the average number of war casualties (*avdeaths*) were obtained from Singer's *Correlates of War Project: Internal and Civil War Data, 1816-1994*, ICPSR 09905 (University of Michigan, Ann Arbor, MI). Data on the second dependent variable, *pethnwgur* was obtained from Ted Gurr's Internal Wars and Failures of Governance, 1954-1996 data file of the State Failure Task Force Project website at: http//www.bsos.umd.edu//cidem//stfail/sfdata.htm.

The data was for the 1960-1996 period for 43 Sub-Saharan African countries.[6] To reduce noise in the data and also to reduce the effects of business cycles, we took 5 year period averages of the data giving us potentially 8 observations for each country. However, we did not have complete information for all countries for all periods. Thus we had an unbalanced panel of 210 observances for the 1960-1996 period. Of the 43 countries in the sample, 13 experienced at least one period of civil war and 14 countries had at least one period of *pethnwgur* for a total of 44 period-*civwar* and 46 period-*pethnwgur*s respectively out of a total of 220 *civwar*-periods and *pethnwgur*-periods.[7] Another advantage of using the five-year averages of the variables is that it allows the growth impact of civil war incidence not be limited entirely to the period of actual fighting. We coded *civwar* as being equal to unity in any period even if there was a war for only three months out of the five-year period. Since the average civil war lasted 1.23 months out of the year, the five-year averages allow the growth impact of a civil war incidence to be spread over a reasonable period around the time the civil war is actually fought.

Summary statistics of our data are presented in Table II. The average annual growth rate of real per capita income in the sample countries over the 1960-96 period is .502. The probability of a civil war (*pethnwgur*) *incidence* in a period in a country in the sample period is .213 (.1269) with the average duration of civil war of 1.23 months. Although the average duration of conflict tended to be short, average fatalities of civil wars tended to be relatively high at 964 per incidence of civil war. One striking feature of the data is the wide variation in all the variables as evidenced by the large standard errors and extremely wide ranges in the variables.

5 Results

We used an IV fixed effect estimator to estimate the growth equation. As argued above, we instrumented for the *civwar* (*pethnwgur*) variable with the one period forward predicted value of that variable ($pcivwar_{t+1}$, $pethnwgur_{t+1}$) using a probit equation. The probit equation correctly predicted 86% (93%) of all pairs of civil war (ethnic war) incidence in the sample while the likelihood ratio test to test the null hypothesis that the coefficients of all regressors in the probit equation are jointly equal to zero produced a χ^2 statistic of 58.365 and 108.69 for the *pcivwar* and *pethnwgur* equations respectively. With 4 degrees of freedom, these statistics reject the null at $\alpha = .01$. The correlation between $pcivwar_{t+1}$ ($pethnwgur_{t+1}$) and *civwar* (*pethnwgur*) is .62 (.73). We conclude that $pcivwar_{t+1}$ and $pethnwgur_{t+1}$ are "good" instruments for *civwar* and *pethnwgur* respectively, so we use them as the instruments in estimating the income growth equation. In estimating the growth equation, we include time fixed effects to account for common time trends. We present and discuss the growth effects of civil incidence in the first subsection while the second subsection is devoted to a discussion of the growth effects of the *severity* of civil war. In both subsections, we discuss the effects of civil war on the growth rate of per capita GDP as well as the growth rate of per capita GNP to ensure that our results do not depend on the measure of income we use. We also present estimates based on *civwar* and *pethnwgur* to test whether our results are also robust to the measure of civil war we use.

5.1 Growth Effects of Civil War

Coefficient estimates of the growth rate equation are presented in Tables III and IV. Table III presents the estimates of the growth rate equation that uses *civwar* to measure the incidence of civil war while Table IV presents the estimates that uses *pethnwgur* as the measure of the incidence of civil war. In both equations, columns 2-5 present the estimates with the growth rate of GDP per capita as the dependent variable while columns 5-9 present the estimates for the growth rate of GNP per capita. Column 2 presents the estimates of the growth rate of per capita GDP without *civwar* as a regressor, column3 presents the estimates of the growth equation with *civwar* as a regressor, column 4 presents the estimates with $pcivwar_{t+1}$ as a regressor, while column 5 presents the estimates of the growth equation with both *civwar* and $pcivwar_{t+1}$ as regressors. Columns 6-9 present similar estimates for the growth rate of per capita national income. The regression statistics

in Table III indicate that the growth equation fits the data relatively well. The equation explains about 40% of the variation in the growth rate of per capita GDP across countries and through time in Africa. We reject the null hypothesis that all coefficient estimates are jointly equal to zero at $\alpha = .01$. All coefficient estimates are of the expected signs and most of them are significantly different from zero at reasonable confidence levels.

The coefficients of k, edu, and $trgdp$ in columns 2-5 in Table III are positive and significantly different from zero at $\alpha = .05$ or better.[8] This suggests that investment rate, openness of an economy and education have positive and significant effects on the growth rate of per capita GDP in African countries. The coefficient of gov in columns 2-5 is negative and significant, suggesting that government consumption decreases the growth rate of per capita GDP in African countries, all things equal. The coefficient of y_0 and significant suggesting that conditional convergence operates in African countries. The coefficient estimates in columns 2-5 of Table III are in accord with our expectations and are similar to the results of earlier research.

The coefficient of $civwar$ in column 3 of Table III is negative and significantly different from zero at $\alpha = .05$ suggesting that the incidence of civil war has a negative and statistically significant effect on the growth rate of GDP per capita. This negative coefficient is consistent with the results obtained by earlier researchers who find that civil war has a negative and statistically significant effect on the growth rate of income (Barro: 1991, Murdoch and Sandler: 2001, Sachs and Warner: 1997, Sala-I-Martin: (1997, among others). It is also consistent with the results of research that finds that ethnic tensions and strife decrease the growth rate of income in African countries (Rodrik: 1999, Easterly and Levine, Gyimah-Brempong and Traynor: 1999, Temple: 1999). In column 4, we present coefficient estimates of the growth equation that replaces $civwar$ with its instrument, $pcivwar_{t+1}$. The coefficient of $pcivwar_{t+1}$ is negative, relatively large and significantly different from zero at any reasonable degree of confidence, suggesting that the probability of civil war has a large, negative and significant effect on the growth rate of per capita GDP, all things equal. Moreover, the inclusion of $pcivwar_{t+1}$ does not *qualitatively* the coefficient estimates on other regressors. Column 5 presents the estimates of the growth rate equation that includes both $civwar$ and $pcivwar_{t+1}$ as regressors.. The coefficients of k, edu, $trgdp$, gov, and y_0 are as expected and most of them are significantly different from zero at 5% confidence level or better. The coefficient of $civwar$ is negative but not significant at $\alpha = .05$. The coefficient of $pcivwar_{t+1}$ is negative, relatively large, and significantly different from zero at $\alpha = .01$, suggesting that $pcivwar_{t+1}$ is

robust to the inclusion of *civwar* as a regressor in the growth of per capita GDP equation. On the other hand, *civwar* is not robust to the inclusion of variables that are correlated with it.

Do our estimates depend on the income measure we use? To investigate this issue, we estimate the growth rate equation using the growth rate equation using the growth rate of per capita GNP, instead of the growth rate of per capita GDP, as the dependent variable. The estimates are presented in columns 6-9 of Table III. The coefficient estimates in columns 6-9 are *qualitatively* similar to the estimates presented in columns 2-5. In particular, the coefficients of *civwar* and $pcivwar_{t+1}$ are negative and significantly different from zero at $\alpha = .05$ or better in columns 7 and 8. In column 9, the coefficient of *civwar* is negative but insignificant while that of $pcivwar_{t+1}$ is negative, relatively large, and significantly different from zero.

How robust is the coefficient estimate of civil war in the growth equations presented in Table III? We conducted some robustness tests by including additional regressors in the growth rate equation to see what happens to the coefficient of *civwar*. We added elf to the growth rate of per capita GDP equation and re-estimated the equation. This rendered the coefficient of *civwar* insignificant. Adding *primary*, instead of elf, to the equation produced similar results.[9] This suggests that the coefficient of *civwar* in the growth equation is not robust. The basic results are also unaffected whether we measure income as per capita GDP or per capita GNP.

The coefficient estimates suggest that civil war has a negative and statistically significant effect on the growth rate of per capita income. The basic results stand whether we use *civwar* or $pcivwar_{t+1}$ as our measure of the incidence of civil war. However, there are both *qualitative* and *quantitative* differences between the direct FE estimates and those of the IV estimates. Generally, the coefficient estimate of $pcivwar_{t+1}$ is about 4 to 5 times as large as that of *civwar* in the growth rate equations. Moreover, the coefficients of other variables are more precisely estimated in the IV estimates than for the direct FE estimates. A Hausman test to test the null hypothesis that FE and the IV estimates of the growth equations are the same produce χ^2 statistics of 58.629. With 6 degrees of freedom, this leads to reject the null hypothesis at $\alpha = .01$. We conclude from this comparison that the coefficient of *civwar* is biased downwards. Our results also suggests that while *civwar* has a negative effect on the growth rate of income, the coefficient estimate of *civwar* is not robust. This lack of robustness of the coefficient of *civwar* may stem from the fact that it is correlated with same set of variables that influence the growth rate of income, thus producing a correlation between the *civwar* and the error term in the growth rate of income contemporaneously.

This implies that researchers should use an IV estimator in order to be able to isolate the growth effects of civil war from the growth effects underlying socio-cultural factors that cause civil wars.

The estimates presented in Table III indicate that civil war has a negative effect on the growth rate of income. It is possible that result we have obtained is dependent on the measure of civil war we use. To test whether our results depend on the measure of civil war we use, we re-estimated the growth equation but measured civil war as *pethnwgur* instead of *civwar*. The results are presented in Table IV. Columns 2-5 present the estimates of the growth rate of GDP per capita while columns 6-9 present the estimates for the growth rate of per capita GNP. As in Table III, the regression statistics indicate that the growth equation fits the data relatively well. All the coefficient estimates are of the expected signs and most of them are precisely estimated. In particular, the coefficients of *pethnwgur* and $pethnwgur_{t+1}$ are negative and significantly different from zero, indicating that ethnic wars have negative and statistically significant impact on the growth rate of income. As in Table III, the absolute magnitude of the coefficient of $pethnwgur_{t+1}$ is significantly greater, and more precisely estimated, than the coefficient of *pethnwgur* in both sets of income growth equations. This may suggest that the coefficient of *pethnwgur* is biased downwards. Alternatively adding elf or *primary* renders the coefficient *pethnwgur* insignificant. Also estimating the growth equation with both $pethnwgur_{t+1}$ and *pethnwgur* renders the coefficient of the latter variable insignificant. A Hausman test to test the null that both sets estimates are equal produce χ^2 statistic of 79.512, leading us to reject the null. These exercises confirm our result from Table III that the coefficient of *civwar* (*pethnwgur*) is not robust in the growth rate of income equation, if only one uses an instrumental variable technique; a result that is consistent with the results obtained by Levine and Renelt (1991).

5.1.1 Transmission Mechanism

Our estimates suggest that civil war (ethnic conflicts) has a negative and statistically significant effect on the growth rate of per capita income. It does not, however, indicate the mechanism through which this negative effect occurs. We mentioned in Section 3 above that civil war can negatively affect economic growth through reduce investment in both physical and human capital, among other things. Though our paper does not delve into the mechanisms through which civil war affect the growth rate of income, we briefly investigate one mechanism through which civil war can affect the growth rate of income investment in physical capital. We do so by specifying

and estimating a simple accelerator model of investment with civil war as an added regressor. In addition to the growth rate of income, investment is likely to be positively impacted by openness of an economy since investors in open economies may have access to new technologies and more sources of investment funding than their counterparts in closed economies. Investment is also likely to be negatively correlated with government consumption on account of crowding out effect of government consumption.

We regress investment rate (k) on the one period lag growth rate of per capita income ($\dot{y}_{t-1}$), civil war, *govcon*, *trgdp*. The investment equation we estimate is given as:

$$k = \gamma_0 + \gamma_1 \dot{y}_{t-1} + \gamma_2 civwar + \gamma_3 govcon + \gamma_4 trgdp + \mu \tag{4}$$

where μ is a stochastic error term and all other variables are as defined in the text. The coefficients of *civwar* and *govcon* are expected to be negative while those of $\dot{y}_{t-1}$ are expected to be positive. Coefficient estimates of this rudimentary investment equation are presented in Table V. Column 2 presents the k equation with *civwar* as the measure of civil war, while column 3 presents the estimates for the equation that uses *pethnwgur* as the measure of civil war. The regression statistics indicate that the simple accelerator investment equation fits the data reasonably well.

The coefficients of y_{t-1} and *trgdp* are positive and significantly different from zero at $\alpha = .01$ while the coefficient of *govcon* is negative and significant. The coefficient estimates are consistent with our expectation. The positive and significant coefficient estimate on y_{t-1} suggests that investment in African countries can be partly explained by the accelerator model. The coefficients of *civwar* and *pethnwgur* are negative, relatively large, and significantly different from zero at $\alpha = .05$ or better, indicating that civil war has a negative and significant effect on physical capital formation in African countries. The estimates of the investment equation suggest that one mechanism through which civil war affects the growth rate of income is reduced investment in physical capital.

Our tentative conclusion is that civil war has relatively large, negative, and significant impact on the growth rate of per capita income. Since our data are five year averages, the analysis here can be thought of as a short-term effect. Do these negative growth effects persist over long periods of time? We investigate this issue in a very simple way by regressing the level of per capita income on civil war, education, and openness of the economy.[10] The income level equation we estimate is

given as:

$$y_i = \gamma_0 + \gamma_1 edu_i + \gamma_2 trgdp_i + \gamma_3 civwar_i + \xi_i \tag{5}$$

where ξ_i is a stochastic error term and all variables are as defined in the text above. Since we are interested in a long run relationship, we estimate a cross-section regression using the sample period averages of the variables. There are, therefore, 43 observations for this regression.

The coefficient estimates of the income level equation are presented in Table VI. Columns 2 and 3 present the estimates for the GDP per capita equation while columns 4 and 5 present the estimates for the per capita GNP equation. Columns 2 and 4 estimates are based on the measure of civil war (*civwar*, *pethnwgur* while columns 3 and 5estimates are based on the instruments of civil war ($pcivwar_{t+1}$, $pethnwgur_{t+1}$). The equation explains about 40% of the cross country variation in income level and we reject the null hypothesis that all coefficient estimates in the income level equation are jointly equal to zero at any reasonable confidence level. The coefficients of *edu* and *trgdp* in the income level equation are positive and significant, indicating that education and openness are positively correlated with the level of income in African countries. None of the coefficient estimates of the indicators of civil war (*civwar*, $pcivwar_{t+1}$, *pethnwgur*, $pethnwgur_{t+1}$) is significant in the income level equation, indicating that civil war has no significant correlation with the level of per capita income. This suggests that the negative effect that civil has on the growth rate of income is short term in nature. It is possible that civil war decreases the growth rate of income during and immediately after the war but after the war, reconstruction leads to an acceleration of economic growth. This leads to income levels catching up with those of countries that never had a civil war

5.2 Growth Effects of Civil War Intensity

The analysis above has focused on the *incidence* of civil war which ignores the *intensity* of the civil war. A war that lasts a long time and has more fatalities is likely to have more deleterious growth effect than one that lasts for a short period of time with few casualties. We therefore investigate the effect of civil war *severity* on the growth rate of per capita income. The Minorities at Risk data from which we obtained data for *pethnwgur* provided an overall score for the intensity of a civil war (*avemags*). This variable is a composite of conflict duration, war casualties, average number of combatants, and the portion of the country covered by the civil war. The scale ranges from 0 to 4 with zero implying non-existence of war or no intensity and 4 being the most intense conflict.

Since a large number of countries in the sample had 0 score of *avemags* on account of no war, we re-scaled this variable in the following way: We created a dummy variable MAG1 that takes the value of 1 if *avemags* is between .2 and 1.5, zero otherwise to represent moderate severity; MAG2 representing severe civil war intensity takes the value of unity if *avemags* is greater than 1.5, zero otherwise. We used these dummy variables to measure the effect of severity of ethnic wars on the growth rate of per capita income in Sub-Saharan Africa. The control group are countries with *avemags* score of .2 or less. The coefficients on these dummy variables measure the effect of the severity of civil war relative to the control group

The *civwar* data did not have a composite variable on the severity of conflict, hence we have no readily available measure of civil war severity. We created two measures of civil war severity from the civil war data. Our first measure of civil war severity is measured as follows: we took the product of average duration of civil war in a period (in months) and the average number of war deaths in the period. If the product of war duration and war fatalities is greater than zero but less than or equal to 15,000 per war period, we call it $LOWINT$, a dummy variable that takes the value 1 if the product of *months* and average deaths is between 0 and 15,000, zero otherwise. If the product is greater than 15,000, we call it $HIGHINT$ and assign $HIGHINT$ a value of 1, zero otherwise. $LOWINT$ and $HIGHINT$ are our dummy variables to capture the effects of the severity of civil war on economic growth. The second index of civil war severity we created is the normalized first principal component formed from the combination of *months*, the average duration of civil wars and the number of war fatalities. Since we normalize the principal component, it is a z score of civil war severity, hence it should be interpreted as the number standard deviations from the mean civil war severity. We label this variable $prin1$ for lack of a better label and use it as an indicator variable for the severity of civil war.

Coefficient estimates of the war intensity variables are presented in table VII.[11] Columns 2 and 3 present the estimates for *civwar* while column 4 presents the estimates for *pethnwgur*. The coefficient estimate of $prin1$ is negative, relatively large, and significantly different from zero, suggesting that, conditional on the presence of civil war incidence, growth rate of per capita income decreases with the severity of civil war, all things equal. A one standard deviation increase in the severity of a civil war decreases the growth rate of per capita income by about .8 percentage points in a period. The interpretation of the coefficient of $prin1$ is problematic since there is no unit of measurement. It is not clear what a standard deviation change in $prin1$ represents in terms of war

intensity. One cannot therefore use the coefficient estimate to make any inference on policy about the effect of any particular variable, like civil war fatalities or the duration of war, on the growth rate of per capita income.

Column 3 presents the coefficient estimates of $LOWINT$ and $HIGHINT$. Both coefficient estimates are negative and significantly different from zero at $\alpha = .10$ or better. Moreover, the coefficient of $HIGHINT$ is larger in absolute magnitude than that of $LOWINT$, suggesting that the negative growth effect of civil war increases with the severity of war, a reasonable proposition. The estimates suggest that this effect is nonlinear the growth impact of civil war severity increases at an increasing rate. Column 4 presents the estimates for $MAG1$ and $MAG2$. The coefficient estimates for both variables are negative and significantly different from zero. The pattern of these coefficient estimates are similar to those of $LOWINT$ and $HIGHINT$ in the sense that the coefficient estimate for high intensity index is larger in absolute magnitude than the coefficient estimate for the low intensity index. This suggests that the growth reducing effect of civil war increases with the severity of the war at an increasing rate.

We conclude from the coefficient estimates in Table VII that the severity of civil war has a negative impact on the growth rate of per capita income in Sub-Saharan Africa, after controlling for the incidence of civil war and other growth variables. Moreover, the negative growth effect of the *severity* of civil war increases at an increasing rate with the intensity of the war. This implies that countries that are involved in civil wars could reduce the negative growth effect of such wars through a reduction in the severity of the civil war or better still, ending the civil war itself. Our conclusion that the growth rate of per capita income decreases with the intensity of civil war should be interpreted with caution. Our measure of the intensity of war is a composite index of the *duration* of war and war fatalities. This implies that a long war with low fatality rate may have the same severity index as a short war with high fatality rate in this study. It is most likely that the two wars may have different growth effects, a difference our war severity index cannot capture.

Based on the IV estimates presented above, we conclude that civil war has a significantly negative and robust effect on the growth rate of per capita income in Sub-Saharan African countries. However the civil war-income growth relationship is robust *only if the researcher takes care to control for possible unmeasured endogeneity of civil war*. By accounting for this unmeasured endogeneity, we are able to resolve the non-robustness issue noted by Levine and Renelt (1991). We find that civil war decreases the growth of income partly through decreased investment in physical capital.

We also show that the *severity* of civil wars have negative, an effect that increases at an increasing rate with war intensity, effect on the growth rate of income quite apart from that of the *incidence* of civil war. The growth impact of civil war, however, is a short- run phenomenon.

Our results have both research and policy implications. From a research perceptive, it is necessary for researchers who use the *incidence* of civil war as a regressor in growth equations to control for the endogeneity of civil wars. This can be achieved by either estimating a structural equation or by using an IV estimator to estimate the income growth equation. Accounting for the endogeneity of civil war incidents results in unbiased and robust estimate of the effect of civil war incidence on economic growth rate. Second, researchers should distinguish between the growth effects of civil war incidence and that of the severity of civil wars as they have separate growth effects. Third, researchers should explore the mechanisms through which civil war affects income growth.

If there exists a stable, robust negative impact of the *incidence* of civil wars on the growth rate of per capita income, then one way to increase the growth rate of per capita income is high reduction in the incidence and severity of civil wars. While increasing the accumulation of both human and physical capital and technology to increase the pace of economic growth in Africa is a long term proposition, economic growth can be given a boost by the cessation of civil wars, a process that requires mainly the political will on both parties to stop fighting. This is especially true in Sub-Saharan Africa where economic resources are so scarce, the need for rapid economic growth is so pressing, and civil wars abound to compound human misery. However, to the extent that the impact of civil war on income growth is short term in nature, policy makers should focus on measures to counter these short term effects since the short-run could be relatively long. Better still, policy makers should focus on avoiding civil wars to begin with.

6 Conclusion

This paper investigated the effects of the incidence and severity of civil wars on the growth rate of per capita income and the robustness of such effects in Sub-Saharan Africa. Using panel data from a sample of 43 Sub-Saharan African countries of the 1960-1996 period and an Instrumental Variables estimator to account for the endogeneity of civil war incidence, we find that the incidence of civil war has significantly negative effect on the growth rate of per capita income, all things equal. Civil war, we find, has a negative growth effect partly through reduced physical capital

formation. However, the robustness of the relationship disappears if one does not account for possible endogeneity of civil war. We also find that the severity of a civil war has a negative effect on the growth rate of per capita income apart of the negative growth effect of civil war incidence. It is therefore necessary to distinguish between the growth effect of war incidence and the growth effect of the severity of civil wars. Our results have implications for growth research and policies to promote economic growth in Sub-Saharan Africa.

7 Notes

1. These figures are from Stockholm International Peace Research Institute's *SIPRI Yearbook, 2000*, (Oxford: Oxford University Press, 2000).

2. We use the term civil war incidence to refer to the initiation and duration of a civil war n a given period.

3. See Temple (1999) and Durlauf and Quah (1998) for an excellent review of the "new" growth literature.

6. Countries in the sample are: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo Republic, Cote d'Ivoire, Ethiopia, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, Somalia, Sudan, Swaziland, Tanzania, Togo, Uganda, Zaire, Zambia, and Zimbabwe. Of these countries, 14—Angola, Burundi, Chad, Ethiopia, Kenya, Mozambique, Nigeria, Rwanda, Sierra Leone, Somalia, Sudan, Uganda, Zaire, and Zimbabwe had at least one incidence of civil war during the sample period.

7. These statistics are derived from country civil war incidences pairs. Hence there are only 44 incidences of civil war in our sample during the sample period.

8. Where we postulate an expected sign on a coefficient, we test hypothesis using one-tailed tests. Hypotheses tests are based on two- tailed test in situations where we are not able to sign coefficients *a priori*.

9. We do not present these coefficient estimates for space considerations. They are, however, available from the authors, upon request.

10. We note that this is a very rudimentary and rough way to investigate the income level-civil war relationship. However, we are only interested in the correlation between civil war and the level of income. We believe that this simple equation will, at least, indicate the direction of the relationship.

11. We do not present the full estimates of this equation. We only present the coefficient estimates of interest.

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Table I

COMPARATIVE STATISTICS

	NO CIVIL WAR		**CIVIL WAR**	
Variable	**Mean***	**Standard Deviation**	**Mean**	**Standard Deviation**
$\dot{y}$	1.1604	5.2396	-0.3568	4.5167
$y(87PPP\$)$	1224.09	1004.37	786.04	292.71
$gov(\%)$	22.754	8.586	22.845	7.2065
$k(\%)$	11.868	7.4881	6.3819	5.6789
edu	2.381	1.323	1.4658	0.6763
$trgdp$	0.0249	0.0113	0.0249	0.0114
civ	0.389	0.1862	0.1762	0.2813
$legeffect$	2.078	0.498	1.021	1.809
primary export/GDP (%)	15.577	10.579	19.1416	11.8027
inflation rate (%)	13.4568	16.882	108.413	713.439
N	176		44	

* these are unweighted averages.

Table II

SUMMARY STATISTICS OF SAMPLE DATA

Variable	Mean*	Standard Error	Minimum	Maximum
$\dot{y}$ (%)	0.502	5.072	-17.782	12.913
$y(87PPP\$$	1086	874.44	267.4	6159.33
$gov(\%)$	22.78	8.17	3.46	49.97
$k(\%)$	10.16	7.42	1.133	43.44
$months$	1.23	3.44	0.00	12
$civwar$	0.213	—	0.0	1.0
$avdeaths$	964.06	4171.89	0.0	39963
edu	2.08	1.228	0.276	5.57
$trgdp$ (%)	67.131	33.8797	6.32	164.150
civ	0.3104	0.2179	0.0	0.833
$legeffect$	1.078	0.693	0.0	3.0
$ethnwgur$	0.1269	—	0.0	1.0
$avemags$	0.319	0.835	0.0	3.80
$N = 220$				

* these are unweighted averages.

Table III

COEFFICIENT ESTIMATES OF GROWTH EQUATION

Variable	Coefficient Estimates							
	GDP	**GROWTH**	**RATE**		**GNP**	**GROWTH**	**RATE**	
k	0.1420	0.3007	0.4577	0.4541	0.4512	0.4564	0.5281	0.5272
	(2.57)*	(6.08)	(5.84)	(5.828)	(5.85)	(6.08)	(6.95)	(6.93)
gov	-0.1368	-0.1661	-0.0295	-0.0399	-0.2451	-0.2455	-0.1398	-0.1434
	(2.79)	(3.68)	(1.87)	(2.481)	(3.66)	(3.18)	(3.01)	(2.829)
edu	0.3009	0.1116	0.1789	0.2085	0.2285	0.1622	0.1536	0.2082
	(2.09)	(1.80)	(3.98)	(2.66)	(2.69)	(2.81)	(4.49)	(4.268)
$trgdp$	0.0362	0.0186	0.0089	0.0128	0.0128	0.0115	0.0259	0.0275
	(2.75)	(2.60)	(2.69)	(2.736)	(2.15)	(2.95)	(2.16)	(2.235)
y_0	-0.0594	-0.1339	-0.1152	-0.0938	-0.0017	0.0019	-0.0021	-0.0021
	(2.15)	(1.67)	(2.05)	(1.938)	(1.84)	(1.47)	(1.90)	(2.504)
$civwar$	—	-1.0127	—	-0.9867	—	-2.0126		-0.9664
		(1.97)		(1.223)		(1.80)		(0.642)
$pcivwar_{t+1}$	—	—	-7.4201	-8.3437	—	—	-8.5640	-9.6821
			(12.67)	5.239			(8.95)	(7.987)
N	220	220	220	220	220	220	220	220
F	39.65	41.65	47.06	47.105	14.89	16.30	24.42	24.68
$\bar{R}^2$	.3795	.4209	.4338	.4329	.1960	.2420	.2787	.2801

* absolute value of "t" statistics in parentheses.

Table IV

COEFFICIENT ESTIMATES OF GROWTH EQUATION: PETHNWGUR

Variable	Coefficient Estimates							
	GDP	**GROWTH**	**RATE**		**GNP**	**GROWTH**	**RATE**	
k	0.3543	0.3772	0.3929	0.3907	0.4833	0.5000	0.5309	0.5301
	(4.32)*	(4.61)	(4.70)	(4.68)	(6.40)	(6.61)	(6.93)	(6.91)
gov	-0.1757	-0.1864	-0.1700	-0.1809	-0.2403	-0.2477	-0.2323	-0.2352
	(2.06)	(2.20)	(2.71)	(2.13)	(3.09)	(3.20)	(3.03)	(3.05)
edu	0.0480	0.1560	0.1628	0.1202	0.1340	0.1454	0.1734	0.1703
	(2.09)	(1.62)	(2.88)	(1.86)	(2.25)	(1.84)	(2.18)	(2.17)
$trgdp$	0.0493	0.0323	0.0322	0.0281	0.0234	0.0111	0.0042	0.0031
	(2.17)	(2.37)	(2.34)	(2.16)	(2.11)	(1.61)	(2.19)	(2.14)
y_0	-0.0498	-0.0155	-0.1337	-0.1423	-0.0001	0.0002	-0.0038	-0.0004
	(2.30)	(1.96)	(1.88)	(1.83)	(1.72)	(1.69)	(2.26)	(2.29)
$ethnwgur$	—	-4.0515	—	-3.0414	—	-2.9410	—	-0.7778
		(2.36)		(1.44)		(1.87)		(0.42)
$pethnwgur_{t+1}$	—	—	-5.8948	-2.9315	—	—	-6.9366	-6.1787
			(6.03)	(3.83)			(4.97)	(3.93)
N	220	220	220	220	220	220	220	220
F	15.14	17.29	19.89	19.98	12.62	16.30	18.78	18.30
$\bar{R}^2$	.1254	.1475	.1692	.1699	.1897	.1990	.2432	.2376

* absolute value of "t" statistics in parentheses.

Table V

ESTIMATES OF INVESTMENT EQUATION

Variable	Coefficient Estimates	
	CIVWAR	**PETHNWGUR**
$\dot{y}_{t-1}$	0.1684 (3.44)*	0.2273 (4.27)
gov	-0.1718 (2.69)	-0.2386 (3.51)
trgdp	0.0833 (4.89)	0.0783 (4.53)
civwar	-0.6865 (2.54)	—
ethnwgur	—	-4.0691 (2.93)
N	220	220
F	18.86	20.37
$\bar{R}^2$	.3104	.3446

* absolute value of "t:" statistics in parentheses.

Table VI

ESTIMATES OF INCOME LEVEL EQUATION

Variable	**Coefficient Estimates**			
	GDP PER	**PERSON**	**GNP PER**	**PERSON**
edu	0.0964	0.1263	0.0909	0.1028
	(4.02)*	(4.83)	(3.91)	(4.27)
$trgdp$	0.0055	0.1144	0.0052	0.0059
	(5.74)	(3.15)	(5.79)	(6.05)
$civwar$	0.1208	—	—	—
	(1.1102)			
$pcivwar_{t+1}$		-0.2096	—	
		(1.04)		
$ethnwgur$			0.1315	
			(1.53)	
$pethnwgur_{t+1}$		—		-0.2773
				(1.473)
N	43	43	43	43
F	26.55	25.95	26.67	27.03
$\bar{R}^2$	.3663	.3608	.3671	.3742

* absolute value of "t:" statistics in parentheses.

Table VII

GROWTH EFFECTS OF CIVIL WAR INTENSITY

Variable	Coefficient		Estimates
PRUN1	-0.7817 (2.880)*	—-	—
LOWINT	—-	-1.043 (2.148)	
HIGHINT		-1.516 (2.192)	—-
AVEMAG1	—		-0.4892 (1.922)
AVEMAG2	—	—-	-0.6305 (1.992)

* absolute value of "t" statistics in parentheses.