The human, social and economic costs of Rwanda’s Genocide have been staggering. Although the country has made remarkable progress over the last ten years, especially in terms of recovering some of the ground lost on education and health, GDP per capita remains much lower than what it would have been without the Genocide. Per capita GDP today would probably be between 25 and 30% higher if the conflict had not taken place. About one fourth of the population in poverty today can be said to be poor as a result of the Genocide.

Conflict and Recovery. In 2000, one in five people in sub-Saharan Africa lived in a country affected by conflict. Over the last four decades, more than a third of the region’s countries have experienced civil strife. The cost of these conflicts in terms of loss of life, human and social capital has been enormous, and the psychological impact of the violence will take a long time to heal. Yet in many areas, the populations of the affected countries have demonstrated remarkable resilience in getting back on their feet after the end of conflicts.

Rwanda is a good example of such resilience. At least 800,000 people (10% of the population) died in the 1994 Genocide, and 3 million people sought refuge in neighboring countries. The war led to widespread destruction of property, infrastructure and resources such as livestock. Large-scale migration into bordering countries and less populated areas of the country weakened social networks. A high incidence of rape contributed to the spread of HIV/AIDS, and the victims of rape and other violent crimes suffered extensive trauma. Today, 85,000 households are still headed by children, women-headed households are prevalent, and orphanhood is widespread.

At the same time, considerable progress has been achieved over the last ten years in a range of areas. Peace and stability have been maintained. Traditional Rwandan values, such as community participation, group solidarity, support to the poor, and Gacaca—the concept of conflict resolution through communal efforts—have been instrumental in advancing reconciliation and accountability following the Genocide.

Substantial progress has been achieved in education. World Bank estimates show that only five years after the end of the conflict, the number of primary school students has rebounded to its pre-Genocide long term trend-line. Rwanda’s gross primary enrollment ratio, at 107%, is higher today than that observed in other Sub-Saharan countries of similar income levels, and the number of secondary school students has almost tripled since 1996. While there are issues of quality (including high repetition rates), and some of the loss in human capital (due to deaths, injuries, and permanent school dropouts) cannot be recouped, the country has recovered rapidly.

Key health indicators have also improved substantially. World Bank estimates of infant mortality suggest that after increasing from 85 to 137 per thousand between 1988-92 and 1992-94, the infant mortality rate dropped to 104 per thousand over 1998-00. Similarly, the child mortality rate increased from 150 to 247 per thousand between 1988-92 and 1992-94, but it fell to 178 per thousand in 1998-00. The rate of malnutrition among children under five was lower in 1998-00, at 24%, than in 1988-90, at 27%.

Overall, while additional efforts will be required to meet the education and health targets of the Millennium Development Goals, recovery has been impressive. Social indicators are clearly improving for Rwanda’s next generation. For children being born and entering the education system, the impact of the conflict is not necessarily high a few years later, at least as measured through the type of indicators reviewed here (the psychosocial effects of the
Genocide will undoubtedly still be felt many years from now).

The impact of the Genocide on the economy, however, may prove to be longer lasting. Measuring the economic costs of conflicts is not easy. Violent conflicts may affect a country’s short- and long-run growth prospects. In the short run, casualties and damage to physical capital (such as infrastructure) directly affect production. In the long run, a civil conflict can inhibit markets and foreign investors, and thus constrain the country’s access to external savings and technology transfers that are crucial for growth. Furthermore, it is possible that the economic consequences of conflict in one country extend beyond its borders. For example, if regional trade or risk perceptions are affected then one could find negative spillovers resulting in lower regional growth (this is clearly the case in some regions in Africa).

**Methodology.** The objective of the paper on which this note is based is to provide a measure of the economic cost of the Rwanda Genocide using a technique for the identification and correction of outliers in time series. Specifically, the detection of an outlier in the GDP per capita time series that can be traced to the conflict allows us to estimate the GDP losses associated with the Genocide. Outlier identification and correction, or intervention analysis, is a commonly used procedure when working with time series. The inclusion of a dummy variable into a model to measure the effect of a particular event could be considered the simplest form of intervention analysis. But the inclusion of the dummy assumes first that an event has been identified and second that the impact of that event is of a particular type. In the absence of precise information on the likely effects of a shock, analysts have recently developed and resorted to more refined procedures for outlier identification and correction. In the paper on which this note is based, we exploit work by Tsay (1986, 1988) and Gomez, Maravall and Peña (1997) who have developed unified procedures for detecting and handling outliers with different patterns in univariate time series, such as our trend in GDP per capita.

Note that our method is different from that used by Murdoch and Sandler (2001) in their work on conflicts and growth. These authors rely on cross-country panel data in order to assess the average effect of a war index on GDP growth. When focusing on a given country, such panel analysis is likely to be somewhat limited, especially when it is considered that war indices are usually discrete variables with low cross country variability. For example, the index proposed by the Center for Defense Intelligence (CDI) takes a value of one if there is civil war and zero otherwise. Because of the cross-country averaging involved in estimating the impact of conflicts with panel data, one year of civil war will typically have the same impact on GDP growth no matter which country is under consideration and how severe its conflict was.

Economic time series are frequently affected by outliers and structural changes. These may be caused by events such as wars, natural disasters, or policy changes, which manifest themselves as aberrant observations or level shifts that are inconsistent with an econometric model thought to be appropriate for the overwhelming majority of the observations. The statistical literature in outlier identification and correction has been concerned with the econometric implications of analyzing data affected by outliers. For example, in time series analysis the existence of outliers is known to cause significant bias in the sample autocorrelation and partial autocorrelation functions reducing the efficacy of these statistics as tools for model identification. As a result, and depending on the size and position of the outliers selected, models can be under- or over-specified. As for the properties of the time series estimators, structural changes, such as level shifts, will produce inconsistent estimates of the parameters unless the model is correctly specified. In cross section analysis, outliers and structural changes affecting the dependent variable of one of the cross section units in the sample will create problems similar to those of an omitted variables regression, that is, inconsistency of estimates.

Outlier detection and correction may also be interesting for reasons that go beyond statistical issues if interest centers on the difference between an observed series and the estimate of its hypothetical value in the case where an outlier had not occurred. For example, if one detects an outlier in a GDP series then it would be possible to estimate the GDP losses (or gains) associated with that extraordinary occurrence. In addition, if the outlier can be identified with a particular event, say a war, then the estimate of the losses could be interpreted as the GDP losses caused by the war. It is important to note that these estimates would be based on what would have seemed a reasonable evolution of the series after observing the past and future dynamics of the series rather than any particular measure of the event in question. However, to the extent that we can control for other events that may have affected economic performance in a particular year, then it is possible to have a reasonable degree of comfort in the reliability of those estimates. In principle this approach may seem less than optimal because of the limited information it uses. Also, for a country that has not suffered a civil war, this approach
would prevent the evaluation of potential spillovers from other countries in the region. Unfortunately, the available indicators of the nature of armed conflict present important problems which may produce misleading results. As noted above the CDI index takes a value of zero or one to indicate a war no matter the damage caused by the conflict, making it unlikely that a standard regression approach alone can capture the GDP losses inflicted by the conflict. Furthermore, outlier identification and correction procedures can be extended to include regression variables in the information set.

Figure 1 provides our estimates of the impact of the conflict on per capita GDP using three different models, all based on the outlier identification technique. It can be seen that without the Genocide, per capita GDP today would be up to 30 percent above its current level. Once we have estimated what level of GDP per capita would have been achieved without the conflict in the year corresponding to our household survey, it is relatively straightforward to estimate what poverty would have been without the conflict, provided we are willing to make a number of assumptions. These assumptions are necessary to translate our estimate of the impact of the conflict on GDP per capita into an estimate of how consumption per adult equivalent may have changed as measured in household surveys. In order to explain these implicit assumptions, we first briefly review how poverty was estimated in Rwanda.

**Poverty Estimates.** A detailed explanation of the method used to obtain the estimates of poverty presented in Rwanda’s Poverty Reduction Strategy is given in Ministry of Finance (2002). The estimates rely on data from the Integrated Household Living Conditions Survey (Enquête Intégrale sur les Conditions de Vie des Ménages au Rwanda) conducted between October 1999 and July 2001 by the Statistics Department of the Ministry of Finance and Economic Planning. Data collection took place between October 1999 and December 2000 in urban areas, and July 2000 to July 2001 in rural areas. Since 90% of the population lives in rural areas, we will consider that the survey took place in 2000-2001, and we will compare poverty with and without the Genocide using observed and simulated levels of GDP per capita in 2001.

Household consumption was adjusted for price differences across regions and time using a monthly cost of living index by locality. To account for differences in needs, the number of adult equivalents was computed within each household. A food poverty line was estimated in order to capture the resources needed to meet basic nutritional needs by assessing the cost of a food basket providing 2500 kcal per adult per day. The non-food component of the poverty line was estimated by assessing how much was spent on non-food items by households whose food consumption was close to the food poverty line (plus or minus 10%). On average, these households allocated 29.4% of their total consumption to non-food expenditures. Taking into account such a provision for non-food consumption, the poverty line was set at FRw 64,000 per adult equivalent per year.

**Assumptions.** In Rwanda, as in many other countries, poverty measures have been estimated by comparing adult equivalent household consumption to a poverty line representing the cost of food and non-food basic needs. In order to use the results from our GDP per capita simulations for poverty measurement, a first necessary assumption is therefore that GDP per capita growth as measured in the National Accounts is essentially correlated perfectly with average growth in consumption per adult equivalent at the household level. That is, we use our estimates of the impact of the conflict on per capita GDP as our best bet for the impact of the conflict on mean per-adult equivalent household consumption.

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**Figure 1: Impact of the Genocide on Per Capita GDP**

![Figure 1: Impact of the Genocide on Per Capita GDP](image)

Source: Authors’ estimates (3 methods for counterfactual).
A second assumption is that we can rely on the poverty lines used for measuring poverty in the 1999-01 household survey in order to assess the impact of the Genocide. The fact that we do not change the poverty lines for our counterfactual poverty measures without the conflict means that we assume that the conflict did not affect relative prices and consumption patterns in such a way that other poverty lines would have had to be used in the absence of conflict.

A third assumption is that inequality in per-adult equivalent consumption has not been affected by the Genocide, so that we only need to incorporate the impact of the conflict on mean consumption for our poverty simulations. With only one survey in Rwanda without pre-Genocide comparable household level data, we cannot assess the impact of the conflict on inequality, so it is best to assume that inequality has remained unchanged.

If we accept these assumptions, the procedure for assessing the impact of the conflict on poverty is straightforward. We first compute poverty in the traditional way using the 1999-01 household survey data. Then we compute our counterfactual poverty measures after scaling up the adult equivalent consumption aggregate for all households in the survey by a factor equal to the ratio of the estimated per capita GDP without the conflict to the observed per capita GDP at the time of the survey. The poverty measures used here are the headcount, the poverty gap, and the squared poverty gap.

Results. According to the methodology used in Rwanda’s Poverty Reduction Strategy, 60.3% of the population was poor in 2001, i.e., with a level of consumption per equivalent adult below the poverty line capturing the cost of basic food and non-food needs. The share of the population in extreme poverty, i.e., not able to meet basic food needs, is 41.6%.

If the Genocide had not taken place, so that per capita GDP would have been higher by close to 30 percentage points, poverty would be much lower, around 45-47%, instead of 60.3%, while the share of the population in extreme poverty could be at 26-28%, instead of 41.6% (see Figure 2). The impact in proportional terms is even larger for the poverty gap and the squared poverty gap than for the headcount. For extreme poverty for example, the squared poverty gap could have been about only half of what it is today if the conflict had not taken place.

Conclusion. We estimated the economic cost of armed conflict in Rwanda and the impact of the conflict on poverty using a methodology for the identification and correction of outliers in time series. Our estimates indicate that without the Genocide of 1994, Rwanda’s per capita GDP could have been between 25 and 30% higher in 2001. In turn, under a number of simplifying assumptions, this suggests that one fourth of the population in poverty in 2001 could have been non-poor if the Genocide had not taken place, and more than 40% of the extreme poor could have avoided extreme poverty.

These results suggest that the economic losses due to armed conflict are long-lasting even though some other social indicators, such as the rates of enrollment in primary school or the rate of child mortality can rebound fairly rapidly after conflict. While our results demonstrate the highly negative economic impact of conflicts on standards of living, they may be underestimated given that our econometric methodology did not account for the longer-term economic costs associated, among others, with the losses in human and social capital in the country.

Figure 2: Impact of the Genocide on Poverty

Source: Authors’ estimates (3 methods for counterfactual).

References


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