The Health Consequences of the Mozambican Civil War: an Anthropometric Approach[1]

Patrick DOMINGUES[2]

Centre d'Economie de la Sorbonne, University of Paris 1 Panthéon Sorbonne

Thomas BARRE[3]

ERUDITE, University of Paris-Est

April 2012

Abstract: Survivors of a war bear the burden of reconstruction; therefore, understanding the costs of civil conflicts to survivors' health is crucial for the design of post-war economic policies. This paper investigates this issue by examining the Mozambican Civil War using an original geo-referenced event dataset. The results presented here show that fully grown women exposed to the conflict during the early years of their lives have poorer health, as reflected by a lower height-for-age z-score. Using the infancy-childhood-puberty curves, a concept used in the medical literature to study the human growth process, this study demonstrates that this negative effect depends on both age at the time of exposure to the civil war and the number of months spent in the conflict zone. Furthermore, this study finds that the number of months of prenatal civil war exposure has a negative impact on a woman's health, thereby highlighting the importance of prenatal conditions for health outcomes.

Keywords: Civil War, Health, Nutrition, Anthropometry, Mozambique

JEL Classification: H56, I12, O12, O55.

---

[1] We are grateful for access to the Demographic and Health Survey database kindly provided by Macro International, Inc. We would like to thank the following people for their comments and advice: Jean-Louis Arcand, Martine Audibert, Tilman Brück, Raul Caruso, Lisa Chauvet, Philip Verwimp, Finn Tarp. We especially thank Catherine Bros and Karine Marazyan for very useful discussions and two anonymous referees for invaluable comments. All remaining errors are ours.

[2] e-mail: *r.patrick.domingues@gmail.com*

[3] e-mail: *thomas.barre@univ-paris-est.fr*

1. Introduction

A country sinking into civil war experiences a process of self-destruction that damages its economic growth potential and devastates all of the determinants of economic growth within the country[4] to such an extent that Paul Collier (2004) refers to civil war as "development in reverse". The frequency and highly destructive capacity of civil wars have prompted many analyses on the consequences of civil war. [5]However, the impact of civil conflicts on the survivors' health remains under investigated. This paper offers a microeconomic analysis of the impact of the Mozambican Civil War on the health of fully grown women following the recent literature on this topic, such as the work of Akresh, Bundervoet and Verwimp (2009). To capture this impact, this paper focuses on an anthropometric indicator, the height-for-age z-score (HAZ), which measures long-term health. To draw conclusions about this issue, the empirical strategy focuses on a sample of fully grown women who have always lived in the same place of residence where they were born. This restriction of the sample is an important point because the empirical strategy examines variations in the timing and duration of the civil war across the different Mozambican provinces and examines each woman's place of residence at the time she was interviewed to identify which women have faced the conflict, at which age, and for how long they were exposed. The place in which a woman was interviewed and the place where she was exposed to the conflict would only coincide for women who had never moved from their

[4] Brück (1997) analyzes some macroeconomic channels operating in a wartime economy and draws evidence from the Mozambican case.

[5] See Blattman and Miguel (2010) for a recent survey of the theoretical and empirical literature on the determinants and consequences of civil war. Furthermore, Justino (2009, 2012) provides a survey of the micro-level literature on civil conflict.

current location making migration a potential source of measurement bias. However, restricting the sample to non-migrant women could introduce a selection bias in the results; this point will be discussed further later in the paper. Another limitation of our econometric approach might lie in the scarcity of the data, which could result in an omitted variable bias. We include interactions between region fixed effects and 5-year cohort fixed effects that take care of any time invariant heterogeneity across different regions and 5-year cohort of birth, in order to control for unobserved covariates that may confound the results.

Scholars who have analyzed the relationship between civil war and health have focused on individuals who died during the conflict or on those who survived. Analyses based on mortality rates are useful for characterizing the destructive power of civil wars and to stress the need to prevent them and to protect civilians (Guha-Sapir and Degomme, 2006; Tabeau and Bijak, 2005). However, these analyses provide little help to policymakers seeking to design and implement policies during the post-conflict period. For this purpose, it seems appropriate to focus on survivors, who bear the burden of reconstruction.

Survivors have suffered from both the direct and indirect consequences of civil conflicts, and at the end of the war, their health has usually deteriorated to some degree. On this point, Davis and Kuritsky (2002) conclude that the health outcomes of civilians living in conflict-ridden sub-Saharan African countries are worse than those of civilians living in countries that remained at peace. The researchers find that countries experiencing severe conflict have higher infant mortality rates and lower total life expectancy. Similarly, Stewart and Humphreys (1997) find that infant mortality rates are significantly higher in countries that were affected by armed conflict. Moreover, Blattman and Annan (2010) show that among other results, child soldiers are more likely than other children to have persistent injuries. Therefore, civil war survivors' life expectancies will be reduced depending on the degree to which the war has affected their health, and mortality rates may remain high long after the end of the war. Ghobarah et al. (2003, 2004) estimate that the number of deaths and disabilities in 1999 due to the lingering effects of civil wars that occurred between 1991 and 1997 was twice that of the number of deaths and disabilities directly caused by civil wars that occurred in 1999. Finally, Akresh, Bundervoet and Verwimp (2009) highlight the lasting impact of the Burundi Civil War on children's health. In this war, each additional month of war exposure decreased a child's HAZ by .047 standard deviation. Using the same type of anthropometric indicator, Arcand and DjimeuWouabe (2009) found that, in the case of the Angolan Civil War, the intensity of the conflict negatively impacted the children's health.

This paper focuses on the impact of the Mozambican Civil War on health. Individual level information is obtained from the Mozambican Demographic and Health Survey (the fourth phase of DHS, DHS+, from 2003)[6], which provides the height-for-age z-score for adult women. This indicator captures the durable consequences of illness and malnutrition caused by armed conflict. The DHS representative household survey is combined with an original database described in Domingues (2011) and designed to examine the spatial and temporal evolution of the Mozambican Civil War. This paper advances the existing research by focusing on fully grown women rather than young children, who have been the focus of previous studies. This allows us to assess the impact of civil war on the whole growth process

[6] The fourth phase of DHS (DHS+: 2003) is the most recent DHS survey available for Mozambique. Furthermore, as this study focuses on adults, the use of the DHS (2003) allows us to obtain data for a large sample of individuals who were exposed during the war period (1977-1992) and had reached adulthood by the time of the survey. No other survey contains a similar sample.

instead of only during the first stages of life. The results of this paper corroborate those found in the recent literature. Exposure to civil war in the early stages of life was related to significantly lower HAZ. Using the medical concept of Infancy-Childhood-Puberty (ICP) curves[7], the results indicate that this negative effect depends on the duration of war exposure at each growth stage. Furthermore, this study indicates that an additional month of in utero exposure to civil war also has a negative impact on adult health. Therefore, this study highlights the importance of prenatal conditions, as well. Finally, no effect was found for civil war exposure among women who were older than 18 years when they were exposed; this last result strengthens the validity of the empirical methodology used in this paper.

The paper proceeds as follows. Section 2 provides an overview of the political history of the Mozambican Civil War, discusses its impact on the health of the population and describes the database on this conflict. Section 3 explains the empirical framework for the econometric analysis. Section 4 presents the main results and tests their robustness. Section 5 summarizes the main conclusions of the paper and discusses their implications.

2. Historical Overview, Data and Measurement

2.1. The Mozambican Civil War

[7] For an explanation of ICP curves, see Section 3.3 – Empirical framework and preliminary results.

Two years after it gained its independence, Mozambique entered a fifteen-year period of civil war between the *Frente de Libertação de Moçambique* (FRELIMO) and the *Resistência Nacional Moçambicana* (RENAMO) (i.e., from 1977 to 1992).[8]

The Mozambican Civil War originated from two conflicts that occurred in the 1960s and 1970s: the Mozambican War of Independence, which was led by the FRELIMO against the Portuguese colonial forces, and the war in Rhodesia. In 1965, Rhodesia unilaterally declared its independence, but it found itself confronted by internal Zimbabwean resistance, mainly consisting of the Zimbabwe African National Liberation Army (ZANLA), a group whose ideology closely resembled that of the FRELIMO. The FRELIMO welcomed the ZANLA and offered them a haven in northwestern Mozambique from which they could operate in Rhodesia (Smith, 1997). In response to their attacks, Rhodesia formed a counterinsurgency unit, which attacked the FRELIMO's infrastructure inside Mozambican territory (Stiff, 1999).

Some years later, when the FRELIMO came to power in 1975[9], it decided to comply with international requirements and close its borders to Rhodesia. In doing so, the FRELIMO deprived Rhodesia of access to the Beira Corridor, which is a supply road connecting Rhodesia to the Mozambican port of Beira. Among other reprisals, Rhodesia decided to support the Mozambican dissidents who were opposed to the FRELIMO. These dissidents

[8] This information was provided by the UCDP/PRIO Armed Conflict Dataset. Note that according to the Correlates of War (COW) project, the Mozambican Civil War only lasted from 1979 to 1992.

[9] Mozambique became independent on June 25, 1975.

were implanted within the Rhodesian counter-insurgency structures to form the RENAMO and fought against the FRELIMO in Mozambique (Robinson, 2006).

Later, after Zimbabwe gained its independence, the RENAMO lost the support of Rhodesia, but South Africa intervened in an effort to destabilize Mozambique. Finally, after fifteen years of civil war, the twelfth round of the Rome talks led to the resolution of the conflict on October 4, 1992[10].

As highlighted by Figure 1, the historical and geographical patterns show that the spread of the conflict on Mozambican soil was driven by geographical conditions. Indeed, the RENAMO was primarily involved in Rhodesia's counter-insurgency operations. Therefore, the first attacks took place near the Zimbabwean border. The provinces that remained unaffected by the war longest are those located farthest from the Zimbabwean border.

Civil war affects survivors' health through various channels. In this respect, the case of the Mozambican Civil War does not differ from other cases of civil war. One hundred thousand Mozambicans were killed by the war directly, and nearly one million people perished as a result of its indirect consequences, including starvation and lack of or disruption to health services (Gersony, 1988). Moreover, the RENAMO's military strategy included the enrollment of child soldiers (Hanlon, 2002), the kidnapping and mutilation of civilians, and the sabotage of power lines, water infrastructure, roads and railways (Wilson, 1992). This strategy of destroying infrastructure and disrupting road and rail traffic deprived Mozambican cities of access to water and food. In particular, Maputo City, the capital of Mozambique, was almost cut off from the main roads to the food production areas in Limpopo Valley. Of all of

[10] See Annex 1 for a more detailed description of the periods and sub-periods of this civil war.

the provinces, the Zambézia province was most affected by the RENAMO during the mid-1980s because the attacks on Zambézia's agricultural production were particularly detrimental to its economy. For example, in 1987, the Zambézia RENAMO's offensive coincided with the region's agricultural planting season. As a result, the RENAMO's attacks deprived as many as 600,000 Mozambican civilians of food and the destruction of farmland by government forces during the counter-offensives certainly contributed to the 1987 famine (Robinson, 2006). Finally, because the Mozambican Civil War led tens of thousands of refugees to flee the fighting and the areas controlled by the RENAMO, the region eventually faced serious humanitarian crises, such as that of 1985 (Robinson, 2006).

2.2. The Spatial and Temporal Evolution of the Mozambican Civil War: an Original Database

This study assesses the impact of the Mozambican Civil War through the use of a spatial and temporal approach to the conflict. The objective of this methodology is to take into account the heterogeneity of the experiences among the Mozambican provinces. Perceiving civil war as an event that homogeneously affects all regions is inappropriate because the reality of civil conflict is usually far more complex. For example, some provinces experience the conflict from the beginning, whereas others experience the conflict only some years later. Therefore, some regions endure several consecutive years of violence, whereas other regions experience the consequences of the war for either a short period of time or intermittently.

Domingues (2011) describes the spatial and temporal evolution of the Mozambican Civil War in accordance with the historical research conducted by Robinson (2006). As

Robinson mentioned, the objective of his study was to present a detailed account of the political and military history of the civil war in Mozambique based on a wide range of sources, including RENAMO's internal documents, the South African Foreign Affairs Archives, the Malawian National Archives, various documents collected from the private archives of Dr. Colin Darch (University of Cape Town), books, journal articles and newspaper/periodical articles. All of the violent events (i.e., attacks or skirmishes) and all of the events related to military strategies or movements that were recorded in Robinson's study have been used to construct the database for this study. Afterwards, to the greatest possible extent, the collected information has been cross-checked against the accounts of the conflict in Vines' (1991) and Cahen's (1994) books.

Following this methodology, [11] Domingues (2011) identified a large array of events, dated by year and month, and determined the locations of each event in the 10 Mozambican provinces. [12] By doing so, it is possible to determine the start and end dates of the conflict for each province. Figure 1 summarizes the conflict's start and end dates for each province, the duration of the conflict and the type of event chosen to indicate its entry into the war. This figure highlights the heterogeneity of the conflict's duration across the Mozambican provinces.

3. Econometric Analysis

---

[11] See Annex 2 for a more detailed explanation of the methodology used to construct this database.

[12] See Figure 2 for the distribution of the 901 events collected throughout the years. As shown in the figure, the distribution of events by year is relevant to these four historical periods.

3.1. The Demographic and Health Survey Database

To investigate the health consequences of the civil war, we combined the database of the Mozambican conflict presented in Domingues (2011) with a DHS representative household survey. Initiated by the U.S. Agency for International Development (USAID), the DHS project provides data on the populations of developing countries. The DHS is based on a representative sample of households, and all of the surveys use standardized household and women's questionnaires. The DHS program collects data on the nutrition and health of women and children every five years, on average, including a set of anthropometric measures. As mentioned by Moradi and Baten (2005), the training and equipment for height measurements followed the WHO guidelines. The DHS program used measuring boards with a headpiece (see also Loaiza (1997)), and heights were recorded to the nearest millimeter.

This article used only the Mozambican data collected during the fourth phase of DHS + (DHS IV: 2003). Table 1, Column 1 presents the data broken down by Mozambican province and the DHS roster (i.e., the number of individuals in the sample). This phase of the DHS program has the advantage of providing a widespread record of anthropometric measures (i.e., height, and weight) for all children younger than five years old and for their mothers, as well as for all women aged 15 to 49 years old who were present in the household during the interview. Previous phases did not include this information. Only the men were not measured. Therefore, the DHS database provides a high-quality set of anthropometric data for 12,144 eligible women.[13] This set of anthropometric data includes three indicators that were calculated according to their standard deviations: height-for-age z-score (HAZ), weight-

[13] Table 1, Column 2 indicates that among these 12,144 eligible women, the DHS contains the province of residence for 11,946.

forage z-score (WAZ) and weight-for-height z-score (WHZ). These indicators enable us to assess the nutritional status of the measured individuals. We merged the household survey data with the data on the timing and location of the Mozambican Civil War, as presented in the preceding section, and we used the survivors' HAZs [14] to examine the impact of the war on their health status.

The use of anthropometric data as a measure of health has several advantages. The height and weight of an individual are non-estimated data that can be easily measured with a high degree of precision. Furthermore, these data are specific to each individual and allow consideration of the possibility of intra-household bias. Finally, as recognized by international health organizations (e.g., WHO and NCHS), presenting anthropometric measures in terms of z-scores is a better strategy than comparing their medians (percentage or percentile) because z-scores allow the anthropometric indices for individuals of different ages and genders to be expressed in terms of "standard deviations" and in comparison with an accepted common reference population. Therefore, this strategy enhances the comparability of the data. Finally, we used HAZ instead of other anthropometric indicators as a dependent variable because HAZ best captures the long-term health effects of events from an individual's past. Indeed, even if an individual's nutritional status is evaluated through various anthropometric indicators, only HAZ can indicate chronic under-nutrition without depending on the collection date, unlike weight and WAZ. However, HAZ and stature should not only be regarded as proxies of nutritional status. HAZ reflects the biological component of human welfare (Komlos, 1999) and illustrates how basic needs were satisfied during the first years of life.

[14] HAZ = [(Observed Height-for-Age) – (Median Height-for-Age from the Reference Population)] / Standard Deviation from the Reference Population.

Most of the women in our database are fully grown (i.e. 18 years of age or older). The DHS categorized all women who were 18 years or older as 18 years of age, and the related means and standard deviations were used to calculate the z-score. In this case, analyzing HAZ is equivalent to analyzing height in centimeters.[15] However, HAZ is used as the dependent variable to maintain consistency with previous studies on this topic and to facilitate the interpretation of the results. We can interpret these results in terms of their standard deviations from the norm, which would not be possible if we used only the women's adult heights. An increase in the distance from the norm is more meaningful than a loss in centimeters.

With the timing database on the Mozambican civil war broken down by region and the region of residence for the women measured in the Mozambican DHS, we can determine which women were exposed to war, at what age, and for how long. The determination of the duration of civil war faced by a woman is based on her region of birth, but the DHS only provides each woman's place of residence at the time she was interviewed. These two locations would only coincide for women who had never moved from their current location. As a result, the exclusion of women who migrated constitutes a potential source of bias. This point will be considered in Section 4-2.

3.2. Preliminary Observations

[15] The proportion of women who are at least 18 years old is 88%. Women who are 15, 16 and 17 years old are still included in the sample, and for these women, their z-scores are calculated according to their ages.

The purpose of this paper is to estimate the impact of the civil war on the health of adult women who lived through it using an anthropometric indicator, the height-for-age z-score (HAZ). In Table 1, Column 3, we break down the average HAZs for the women by province. The average HAZ of the women in Mozambique is -1.308, which means that an average woman in Mozambique has a height-for-age that is 1.308 standard deviations less than that of an average referenced woman. Variations in HAZ exist across the provinces, with the average HAZ varying from -1.753 in Cabo Delgado to -.79 in Maputo City (the capital of Mozambique). Furthermore, the women in rural Mozambique have a lower average HAZ than do the women in urban areas.

We constructed the conflict exposure variables with the information summarized in Figure 1 taken from Domingues (2011), which specifies the period of time during which a province was exposed to the civil war. The conflict dates of each province are cross-referenced with the place of residence and age of the women interviewed, which was collected from the DHS + (DHS: 2003), to determine at what age and for what period of time these women experienced civil war.

The first conflict exposure variable is the dummy variable ONEMONTHCW17A, which takes the value of 1 if a woman was exposed to the civil war for at least one month during her first 17 years of life, and it receives a value of 0 if a woman was not exposed to civil war during her first 17 years. We chose the age of 17 years because researchers agree that a woman's growth is finished at this age (Karlberg et al., 2003). Table 1, Column 4 presents the difference in mean HAZs between the women who were exposed to war (ONEMONTHCW17A = 1) and those who were not exposed to war (ONEMONTHCW17A = 0). For every Mozambican province, the difference in the average HAZ between the women who were exposed to war and those who were not exposed is positive. In other words, on average, the women who were exposed to the civil war within their first 17 years of life have a lower HAZ than those who were not exposed. For most provinces, this positive difference is statistically significant at least at the 10% level. At the country level, this difference is evaluated at .051 and is statistically significant at the 5% level. The difference is larger in rural Mozambique (.078).

The second conflict exposure variable is a dummy named BORNduringCW, which takes the value of 1 if a woman was born during the civil war (i.e., she spent her first month of life in a conflict area) or 0 if she did not spend any months exposed to the war during her first 17 years. Finally, all of the women who were not born during the civil war but were exposed to the war during their first 17 years are dropped from this part of the analysis to keep the same reference population for the construction of the ONEMONTHCW17A variables. In other words, BORNduringCW = 1 is a subset of the ONEMONTHCW17A = 1 set, and BORNduringCW = 0 corresponds to the population of ONEMONTHCW17A = 0. The aim of this approach is to consider the impact of the war on the women who were born during the conflict. These women did not necessarily suffer during the duration of the civil war, as they may have been born in the last month of the conflict and, therefore, may have spent only one month in war. However, being born during a conflict is a special case for many reasons, including the possibility that fetal development took place during the conflict. In that case, the war may have impacted these women's health prenatally. Column 5 in Table 1 compares the mean HAZ values of the women who were born during the civil war (BORNduringCW = 1) to those of the women who were not exposed to the war before turning 17 years old (BORNduringCW = 0). For the entire country, the difference in the average HAZ between these two categories of women is positive (.059). That is, on average, the women born during the Mozambican conflict have a lower HAZ than the women who were not exposed to the conflict during their physical growth. Furthermore, the differences found through BORNduringCW are larger than the differences based on ONEMONTHCW17A for almost every province. If we assume that the women who were exposed and the women who were not exposed to war have similar characteristics, then on average, the women born during the civil war have lower HAZs than the women exposed to the civil war in the early years of their lives.

Based on these preliminary observations, exposure to civil war appears to be negatively correlated with long-term health, as shown by a lower HAZ for the women exposed to the conflict during their first few years of life. Furthermore, this correlation appears to be influenced by the woman's age at the time of her exposure to the war. Finally, the mean comparison results by province show variations among the provinces (Columns 4 and 5). One possible explanation for these variations is the difference in the number of years of war experienced by residents of these different provinces. This finding suggests that the duration of the conflict may have influenced the negative correlation between the war and the subjects' long-term health.

3.3. Empirical framework and preliminary results

Based on the information presented above, we can form the following hypotheses:

H1: Civil war has a lasting negative impact on the survivors' health.

H2: This negative impact is influenced by the age at which the survivors were exposed to the civil war and the number of years of exposure to the conflict.

From H1, we determine the following relationship:

$$HAZ_{(o)ijt} = HAZ_{(n)ijt} + \beta_{cw}.CIVILWAR_{ijt} + \varepsilon_{ijt} \qquad (1)$$

where $HAZ_{(o)ijt}$ is the observed height-for-age z-score measured by the DHS for the individual i, born in province j at time t, $\beta_{cw}.CIVILWAR_{ijt}$ is the health effect of the civil war and $HAZ_{(n)ijt}$ represents the natural height-for-age z-score (i.e., the expected HAZ for an adult who has not been exposed to a civil war). $HAZ_{(n)ijt}$ is a function of a set of determinants, including ethnicity, type of childhood residence, region of residence and other variables, that are not observable in this case. Among the most important determinants of $HAZ_{(n)ijt}$ are the heights of the individual's parents. Unfortunately, the DHS does not provide this information. However, in this case, we were interested in variables that may influence the effect of civil war on children's height (e.g., wealthier parents can protect their children against war).Thus, the parents' wealth is a better candidate than the parents' heights for conditioning the effects of civil war. We control for the parents' wealth with province and urban/rural fixed effects to account for the spatial distribution of incomes and wealth.

The emerging consensus in the literature is that ethnicity has a minor influence on height. Anthropometric surveys have found that the differences in height between the socioeconomic elite and the poor of the same ethnicity are greater than the differences observed among the elite of different ethnic groups (Habicht et al*.,* 1974). Moreover, different ethnic groups reach the same average adult height if their environment is optimal for their physical growth (Eveleth and Tranner, 1990). Additionally, length at birth is fairly similar between ethnic groups (Martorell and Habicht 1986). In other words, the influence of environmental conditions is more important than the influence of ethnicity. However, ethnicity may influence nutritional practices, which can result in a correlation between adult height and ethnic group. Consequently, all econometric specifications include 28 dummies for the language spoken as a proxy for ethnicity.

As mentioned above, the literature indicates that the environment plays an important role in the growth process. We capture this influence with two variables: the type of childhood residence, which is broken down into city, town and countryside, and the region of residence. The type of childhood residence captures the effects of the environmental differences that exist between urban and non-urban areas (e.g., access to health and sanitation infrastructure). Studies have demonstrated that growth deficits are larger for infants living in suburban areas than for those in urban areas, and the greatest deficits are found in infants from rural areas (Jalil et al., 1993; Hagekull et al., 1993). The 11 regional dummies are used to capture the differences between the provinces. These differences can include the type of agriculture and stockbreeding or the availability of public health services. Finally, the type of childhood residence and the region of residence can also be regarded as proxies for household wealth (Haddad and Hoddinott 1994; Garrett and Ruel 1999) or parental education (Glewwe 1999; Chen and Li 2009), which also influence children's growth. Indeed, living in an urban area is correlated with wealth and education. In sum, all specifications presented in this paper include the following set of control variables: ethno-linguistic membership, province-fixed effects and the type of childhood residence. Therefore, we can establish the following relationship:

$$HAZ_{(n)ijt} = f(\text{Ethnicity}_i, \text{Type of childhood residence}_i, \text{Region of residence}_i) + \varepsilon_{ijt} \quad (2)$$

For the remainder of this study, the influence of the number of years spent in the civil war on long term health will be estimated taking into account the age at which the individual endured this conflict period. The rationale behind this idea is that environmental conditions affect the human growth process differently over the course of development. This explanation coincides with the concept of the Infancy–Childhood–Puberty (ICP) growth model from the medical literature (Karlberg, 1987, 1989; Karlberg et al., 1976, 1987a, 1987b).

The ICP curves are based on two important pieces of information. First, the factors influencing subjects' growth are not evenly balanced throughout the growth process. Second, the dynamics of physical growth vary during the growth process. By combining these two concepts, one may identify three successive periods that cover the entire growth process and the factors that might cause a downturn in growth.

These three periods are defined as follows:

- Infancy (from birth to two years of age): This phase is marked by fast growth. It is mainly influenced by nutrition and secondarily influenced by growth hormones (GH).

- Childhood (from two years of age to puberty): This phase is characterized by steady growth. It is influenced primarily by GH and secondarily influenced by nutrition.

- Puberty (for girls, the onset of puberty is, on average, between 9 and 11 years of age, and this phase ends at approximately 16 years of age): During this phase, growth accelerates. The determining factors of growth are, in order of importance, sex steroids, growth hormones and nutrition.

Based on these three phases of human growth, we can define three variables to estimate the joint influences of the duration (in months) spent in conflict and of the age at which the individuals experienced the conflict.

DURATIONofCW_Infancy is a variable that captures the impact of the duration of exposure to the civil war during the infancy stage. The infancy stage consists of the first two years of life. Therefore, for all women who experienced the civil war during infancy, this variable assumes a value equal to the number of months of conflict that they faced during this stage of the growth process.

DURATIONofCW_Childhood captures the duration of exposure to the civil war during the childhood stage of the growth process. The childhood stage begins after the child turns two years of age and ends after ten years of age (i.e., it begins after the 24th month and ends after the 132nd month of life). This variable assumes a value equal to the number of months of conflict that the woman faced during her childhood.

DURATIONofCW_Puberty captures the duration of exposure to the civil war that occurred during the puberty stage of the growth process. The puberty stage begins after ten years of age and finishes at over 17 years of age. An age of more than ten years (i.e., the 133rd month of life) is selected to mark the end of childhood and the beginning of early puberty. This age corresponds to the average age at onset of puberty. As we have already mentioned, the beginning of puberty for women occurs between 9 and 11 years of age. Therefore, for all women who experienced the civil war during puberty, this variable takes on a value equal to the number of months of conflict that they faced during this stage of the growth process.

One possible limitation of this set of variables is that they do not distinguish the women who were born during the civil war, despite our previous observation that these women have suffered differently from the other women. The women born during the civil war not only suffered for the number of months that they experienced war, but also for the number of months of war that their mothers experienced prior to their birth. The civil war caused disruptions to the food supply, deprived pregnant women of food and disrupted the sanitation and health systems of the provinces before these women were born. These disruptions should be taken into account, as they may have altered the health of the women who were born during the civil war by affecting the health of their mothers, particularly during pregnancy. Almond and Mazumder (2005) found that fetal injuries compromise adult health. Therefore, another variable must be defined to account for the influence of the number of months of conflict that occurred before a woman's birth. The variable MONTHSofCWatBIRTH captures this influence and is defined as the number of months of civil war that preceded the woman's birth in the province.

In sum, the HAZ of a woman is described by the following specification:

$$\begin{aligned} HAZ_{(o)ijt} = \quad & \beta_0 + \beta_Z.Z_i + \textstyle\sum_{k=(I,\,C,\,P)}(\beta_k.DURATIONofCW_{k,ijt}) \\ & + \beta_N.MONTHSofCWatBIRTRH_{ijt} + \varepsilon_{ijt} \qquad (3) \end{aligned}$$

where the dependent variable for each regression is the women's HAZ, $\sum_{k=(I,C,P)}(\beta_k.\text{DURATIONofCW}_{k,ijt})$ is the sum of the sets of components of the subjects' growth process defined above from the ICP curves, $\text{MONTHSofCWatBIRTRH}_{ijt}$ is the number of month of civil war that preceded the woman's birth, and Z_i is the set of control variables presented in equation (2).[16]

Several potential caveats call into question the validity of the empirical strategy. First, one could think of a reverse causality bias with health causing war. Indeed, it is possible that the rebels had concentrated their attacks in the richest regions, where the population is better fed, and therefore healthier. In this case, health causes war and we face a simultaneity problem. Regarding this point, the pattern displayed by the geographical spread of the civil war on Mozambican soil indicates that the first attacks took place near the Zimbabwean border and that the last Mozambican province to be affected by the conflict was located a significant distance from this border. Therefore, it seems that the spread of civil war was induced by the geographic distance to the Zimbabwean border. However, this latter is likely correlated with many observed and unobserved covariates that may confound the results, thus the empirical strategy needs the inclusion of region fixed effects in order to control for any time invariant heterogeneity across different regions. Second, the scarcity of the data is so that we are unable to observe many characteristics of a Mozambican province that can be linked with the health status of its population, for example, the available health and sanitary infrastructures of each province. Unobservable characteristics of a particular birth cohort can also be linked to the health status of this cohort. These two kinds of unobserved variables (at the province and cohort level) can bias the estimated effect of civil war exposure on the

[16] See Table 2, for descriptive statistics for the variables used in the econometric analysis.

individual's health status downward or upward because of an omitted variable bias. These two threats are accounted for by the use of province- and cohort-fixed effects and all of their interactions. Third, as previously mentioned, we designed the conflict exposure variables based on the assumption that the household's current region of residence coincides with the region in which its members had lived during the period of war exposure. However, civil wars are a cause of migration. Consequently, migrations may lead us to misattribute the duration of civil war exposure, and introduces a measurement error bias to the analysis. Therefore, we restricted the sample to women who indicated that they had always lived in the same place of residence. With this restricted sample, the duration of civil war exposure can be estimated with more accuracy. Nevertheless, the use of this restricted sample of women could lead to a selection bias because women who migrated could have particular wealth/anthropometric characteristics. There is thus a tradeoff between control for the exact duration of exposure to civil war and the potential bias induced by the restriction of the sample of study. To address this issue, section 4.2 provides the results using the entire sample of women (i.e., both migrant and non-migrant) and discusses the distribution of HAZ in these two groups. Furthermore, since this selection issue is related to the potential heterogeneity of the effect of civil war exposure among taller and shorter women, we performed quantile regressions that could account for this heterogeneity. Indeed OLS coefficients only capture an average effect between the outcome variable of interest and a set of regressors. For this purpose, Section 4.2 presents the result of quantile regressions that allow us to estimate the effect of civil war exposure for each quantile of the HAZ distribution.

4. Estimation Results and Robustness Checks

4.1. Results

Height-for-age z-score is a long-term indicator of health status. As defined by Moradi (2002), "final adult height is a function of conditions in youth, especially of the nutritional quality and quantity as well as the epidemiological environment, which the individuals have faced during their period of growth." Consequently, if the civil war has an impact on health, which is measured here as a lower HAZ, then the war will have a greater influence on the growth stages that are more sensitive to nutrient intake. The brief description of the different stages of human growth presented earlier provides us with some ability to anticipate the results. Therefore, we expect that infants will be most affected by the civil war because growth is mainly influenced by nutrition during this stage. For the same reason, we expect that the negative effects of the civil war will decrease throughout the physical-growth process.

Table 3 presents the OLS regression results for Equation (3) for the subsample of fully grown women who have always lived in the same place. Column 1 shows the estimation results of the decomposition of the subjects' growth process, as described by the ICP curves. The results indicate a negative relationship between civil war exposure and the long-term health of fully grown women who have always lived in the same place. This impact is attenuated according to the stage at which the woman was exposed to the conflict. We show that an additional month of civil war exposure suffered during infancy leads to a larger decrease in the final HAZ than an additional month of civil war exposure during the other two stages of the growth process. These results confirm the soundness of decomposing the subjects' growth process based on the ICP curves.

Column 2 provides the results of the estimation for specification (3), which introduces the variable MONTHSofCWatBIRTH together with the set of variables generated by the decomposition of the growth process. This variable considers the influence of the number of months of civil war prior to birth to analyze the particular case of women who were born during the conflict. This result allows us to conclude that the inclusion of the variable MONTHSofCWatBIRTH does not contest the logic of the aforementioned ICP curves. The negative relationship between the civil war exposure and the women's long-term health remains. In addition, the effect of war on health depends on the growth stage the war was experienced, similarly to our previous results where the months of warfare during the early years of life are more important than the months of war suffered later. This finding confirms our argument that the civil war has a decreasing impact throughout the stages of growth in accordance with the sensitivity of these stages to nutrient intake.

Columns 3, 4, and 5 in Table 3 respectively include a time trend, a 5-year cohort fixed effect, and the interaction between the region and the cohort fixed effects to control for the potential bias introduced by the variation in health conditions throughout the period of analysis. The results from these last three columns display the same pattern as previously described. The civil war still has a negative and significant effect on the HAZ. Furthermore, the magnitude of this negative effect still decreases throughout the growth process.

The most relevant specification among these last three estimations appears to be the results indicated in Column 5 because the introduction of interaction terms between region and cohort fixed effects adds flexibility. We show that one additional month of civil war exposure during a woman's infancy reduces her final HAZ by .012 standard deviations. In contrast, her final HAZ decreases by only .006 standard deviations for one additional month of civil war exposure during her childhood.[17] Finally, one additional month of civil war exposure during puberty decreases her final HAZ by only .003 standard deviations, which is a non-significant result.[18] These results confirm the arguments presented above. The stages of human growth that are most affected by civil war are those that are primarily influenced by nutrition. These results are consistent with the findings of Martorell and Habicht's (1986) research, which shows that the first two years of life are decisive for growth.

Focusing on the variable MONTHSofCWatBIRTH, we note that an additional month of civil war exposure before birth decreases the final HAZ by .005 standard deviations, which is roughly the same as the effect of one additional month of civil war exposure sustained during childhood. This result highlights the importance of the prenatal conditions for women who were born during the civil war and shows that the women born during the war are the most negatively affected by the conflict.[19] Since women may have responded to civil war by changing their fertility behavior, this effect could be a mix of a direct impact on women effectively born during the civil war and a selection effect due to women postponing the birth of their next child. Indeed, richer/taller women could decide to postpone births while poorer/smaller women are not able to do so. In this case, children born during the civil war

[17] These two results are statistically significant at the 1% level.

[18] The total impact during infancy is -.012*24 = -.288, and it is -.006*108 = -.648 during childhood. The non-decreasing effect between the first two stages of human growth is due to the fact that these two stages have different durations.

[19] Because the prenatal period of life is short (i.e., 9 months), the total effect of exposure to civil war during this period is small, resulting in a loss of approximately 4 percent of the standard deviation (.005*9=.045).

would be smaller than other birth cohorts. Data limitations prevent us from controlling for such bias, so that this result should be interpreted with caution.

We now calculate the total average decrease of the HAZ due to the Mozambican Civil War. On average, the cumulative effect of civil war is a decrease in the HAZ of .53 standard deviations, and for a woman exposed to the war from before her birth to childhood, the total impact is a decrease of .98 standard deviations. Using the formula for HAZ, we find that these variations in terms of centimeters lost in adulthood are 3.553 cm for the average loss and 6.558 cm for the total loss.[20] This decrease in adult height must be considered in comparison with the secular trend in adult height (i.e., the intergenerational increase in height). The literature on this topic tends to show that the secular trend in adult height is a 1-cm increase per decade (Garn, 1987; Hauspie et al., 1997; Eveleth and Tanner, 1990). Consequently, considering that the average duration of the conflict sustained by an individual woman is approximately 9 years (109 months), the Mozambican Civil War resulted in more than a reversal of the secular trend in adult height.[21] Therefore, we concur with Paul Collier's affirmation (2004) that civil war is "development in reverse".

---

[20] For a woman who is 17 years of age (i.e., 204 months), Δheight (in cm) = ΔHAZ * 6.6917. The number 6.6917 is the standard deviation from the NCHS/FELS/CDC reference population for women aged 204 months. These results account for the fact that the effect of exposure to civil war during puberty is insignificant. Therefore, we calculate the average and total losses only using the coefficients of exposure to civil war during infancy, childhood and the prenatal period.

[21] Because adult height increases by 1 cm per decade across generations and the average estimated loss induced by the civil war is 3.5 centimeters, we can conclude that the Mozambican population has lost more than 30 years of secular growth in adult height.

4.2. Robustness

The most relevant specification among the previously presented results appears to be that used in Table 3, Column 5, which presents the most flexible specification. Using this specification, we can perform several robustness tests. First, the use of a restricted sample of fully grown women who have always lived in the same place can introduce selection bias. Second, there may be parameter heterogeneity in the civil war exposure-HAZ relationship. Third, the threshold of 204 months of life as the age at which a woman reaches her final height may be too restrictive. Fourth, the results may vary depending on the region. Fifth, the choice of the age at which puberty begins may not be correct.

Column 1 of Table 4 provides the results for specification (3) using the whole sample including migrant women. The results are consistent with those shown in Table 3. However, the estimated coefficients are lower than those presented in Table 3, Column 5. Unfortunately, data on the women's anthropometric characteristics prior to migration are unavailable. Therefore, we cannot conclude that this decrease in the size of the coefficients is induced by particular characteristics of women who migrated or that it results from the fact that women who migrated successfully fled from the adverse consequences of the civil war, thereby resulting in an higher HAZ for migrant women at the end of the conflict, as shown in Figure 3.[22] In conclusion, it seems difficult to make an assumption about the direction of the

[22] The results of a variance-comparison test between migrant and non-migrant women ($Pr(F < f) = .274$) indicate that even if there is a difference in the average HAZ between migrants and non-migrants, the dispersion of the distribution of the HAZ between these two samples is the same.

potential bias induced by the use of a restricted sub-sample of non-migrant women. However, our results could be upwardly biased and must be taken with caution.

Regarding the second point, we studied the question of parameter heterogeneity in the civil war exposure-HAZ relationship using a quantile regression analysis based on the preferred specification. This strategy allows us to identify possible differences in the effect of civil war exposure for taller and shorter individuals. In Figure 4, the solid line represents point estimates; with the lines on either side depicting a point-wise confidence band computed using bootstrapped standard errors (100 replications). The superimposed horizontal dashed line refers to the OLS estimate and its confidence intervals. As indicated by this Figure, the quantile results for the effect of civil war exposure are not statistically different from the OLS results. The impact of civil war is not statistically different among taller and shorter individuals for each conflict-exposure variable used in this paper, meaning that we do not find evidence of parameter heterogeneity among the higher and lower quantiles.

Column 2 of Table 4 provides the results for specification (3) in which we included a new variable: DURATIONofCW_AfterPuberty_205_360. This variable captures the duration of the women's exposure to the civil war after they had passed the puberty stage and before they turned 30 years old (i.e., 360 months). We can predict that civil war exposure does not affect the health of these women. The results confirm this assumption; they indicate that exposure to the civil war after puberty has no effect on the HAZ. Furthermore, they are consistent with the pattern shown in Table 3. This last result strengthens the validity of the empirical methodology used in this paper.

To account for the fourth point, we restricted the province sample to control for the robustness of the results across regions. Column 3, Table 4 includes all of the provinces, except for the province with the shortest period of conflict, Niassa. Additionally, Column 4 excludes Gaza, the province with the longest period of war. The estimation results are robust for these alternative sample specifications.

To address the potential bias introduced by incorrectly selecting the age at which puberty begins, Column 5 provides the estimation results for specification (3) with the same identification strategy used for the results given in Table 3 but with a different age for the onset of puberty. In Column 5, puberty has been determined to begin at the end of the tenth year of life (i.e., 120 months), whereas it had previously been set at over ten years of age (i.e., 132 months of life). Changing the timing of the onset of puberty does not contradict the logic of the ICP curves or the previously described results.

Finally, as Bertrand et al. (2004) mentioned, certain papers employing differences-in-differences estimation ignore the possible inconsistency in the standard errors due to the serial correlation among observations. Therefore, we performed a Monte Carlo exercise with the sample of non-migrant women as a robustness test in the spirit of Bertrand et al. (2004). We generated random placebo exposure dates for the non-migrant women in each province. The dates range between 1954 and 1989, which means that this placebo exposure may coincide with a true period of civil war exposure. Because these placebo exposures are fictitious, a significant effect at the 5 percent level should be found roughly 5 percent of the time. This Monte Carlo exercise has been performed using 500 replications; for each replication, the dates of the placebo exposure have been randomly generated. The result, which is shown in Table 5, confirms that only a few replications are significantly different from zero. We find that less than 5% of the coefficients are statistically significant at the 5% level. We can conclude that the autocorrelation bias mentioned by Bertrand et al. (2004) does not challenge the estimation described in this paper.

5. Conclusion

The aim of this paper is to determine the impact of a civil war on the long-term health of fully grown women who survive it, including the extent to which civil war impacts their health, the duration of this impact on health, and the factors that determine its magnitude. These issues are crucial for the development and implementation of assistance policies for the survivors and for reconstruction policies during the postwar period.

This paper explored these issues for the case of the Mozambican Civil War with a new and original database described in Domingues (2011) specifically designed for this study to examine the spatial and temporal evolution of this conflict. This empirical strategy accounts for the variations in the timing and duration of the war across the different Mozambican provinces. Combining this information with a DHS representative household survey allows us to identify the individuals who were exposed to the conflict, the age at which they were exposed and for how long they were exposed.

Focusing on the height-for-age z-score (an anthropometric indicator of long-term health) of adult women, we found a negative relationship between civil war exposure and the long-term health of women who have always lived in the same place and who survived the conflict. This relationship depends on the age at which the individual was exposed to the conflict and on the number of months she spent enduring the civil war. The paper finds that women who were born during the conflict are the most affected by the civil war because they also suffered from adverse effects prenatally. These results indicate that an additional month of civil war before birth has an impact on the HAZ. Therefore, our findings highlight the importance of prenatal conditions to later health. Furthermore, as established by Martorell et al. (1994), women who grow up in a stunting environment are unlikely to obtain the expected growth rate later in life.

Moreover, the Mozambican survivors' poor health status, which in itself is a tragic consequence of the conflict, induces additional adverse effects in the long run. As recent studies have shown, poor health status, particularly due to malnutrition during childhood, ultimately reduces survivors' welfare (Behrman and Rosenzweig, 2004), the number of completed school grades (Alderman et al., 2006), post-school productivity (Alderman et al., 2001), labor productivity (Behrman, 1993) and income level (Bleakley, 2007).

All of these adverse effects must be considered when measuring the considerable consequences to a population whose health status has been damaged by armed conflict. These effects demonstrate the importance of preventing civil wars. Furthermore, given that the effect of civil war on the survivors' health is enduring and accumulates throughout the years of war, an intervention to end ongoing conflicts will greatly benefit the long-term welfare of a nation and its people. Finally, survivors would benefit from a special education program to offset the negative effects on adult productivity and education level induced by their poor health status. This kind of program may increase their productivity and income in adulthood, thereby increasing the country's level of development.

References

Akresh, Richard, Tom Bundervolt, and Phillip Verwimp. 2009. "Health and Civil War in Burundi." *Journal of Human Resources* 44, no. 2:536-63

Alderman, Harold, John Hoddinott, and Bill Kinsey. 2006. "Long Term Consequences of Early Childhood Malnutrition." *Oxford Economic Papers* 58, no. 3:450-74.

Alderman, Harold, Jere Behrman, Victor Lavy, and Rekha Menon. 2001. "Child Health and School Enrollment: A Longitudinal Analysis." *Journal of Human Resources* 36, no. l:185-205.

Almond, Douglas, and Bhashkar Mazumder. 2005. "The 1918 Influenza Pandemic and Subsequent Health Outcomes: An Analysis of SIPP Data". *American Economic Review* 95, no. 2:258-62

Arcand, Jean-Louis, and Eric Djimeu Wouabe. 2009. "Households in a Time of War: Instrumental Variables Evidence for Angola" Unpublished manuscript, Departement of Economics, Centre d'Etudes et de Recherches sur le Développement International.

Behrman, Jere. 1993. "The Economic Rationale for Investing in Nutrition in Developing Countries", *World Development* 21, no. 11:1749-72.

Behrman, Jere, and Mark Rosenzweig. 2004. "The Returns to Birth Weight", *Review of Economics and Statistics* 86, no. 2:586-601.

Blattman, Christopher, and Jeannie Annan. 2010. “The Consequences of Child Soldiering.” *Review of Economics and Statistics* 92, no. 4:882-98

Blattman, Christopher, and Edward Miguel. 2010. “Civil War.” *Journal of Economic Literature* 48, no. 1:3–57

Bleakley, Hoyt. 2007. “Disease and Development: Evidence from Hookworm Eradication in the American South”, *Quarterly Journal of Economics* 122, no. 1:73-117.

Brück, Tilman. 1997. “Macroeconomic Effects of the War in Mozambique” In *Report to ODA*, ed. E.V.K. FitzGerald and F. Stewart Queen Elizabeth House, Oxford.

Cabrita, João M. 2000. *Mozambique: The Tortuous Road to Democracy*. ed. Palgrave Macmillan, St. Martin’s Press, Nova Iorque

Cahen, Michel. 1994. *Les Bandits. Un historien au Mozambique.* Publications du Centre culturel Calouste Gulbenkian, Paris

Chen, Yuyu, and Hongbin Li. 2009. “Mother's education and child health: Is there a nurturing effect?” *Journal of Health Economics* 28, no. 2:413-26.

Collier, Paul. 1999. “On the economic consequences of civil war.” *Oxford Economic Papers* 51, no. 1:168-83.

Collier, Paul. 2004. “Development and Conflict.” Unpublished manuscript, Centre for the Study of African Economies Centre for the Study of African Economies, Department of Economics, Oxford University

Davis, David, and Joel Kuritsky. 2002. “Violent conflict and its impact on health indicators in Sub-Saharan Africa, 1980 to 1997”. Paper presented at the annual meeting of the International Studies Association, New Orleans, LA.

Davies, Robert. 1989. “The SADF’s Covert War Against Mozambique”, in *War and Society: The Militarisation of South Africa*, ed. Jacklyn Cock and Laurie Nathan, David Philip Publisher.

Domingues, Patrick. 2011. "A Database on the Mozambican Civil War," *Peace Economics, Peace Science and Public Policy* 17, no. 1:84–113

Eveleth, Phyllis B, and James M. Tanner. 1990. *Worldwide Variation in Human Growth*. ed. Cambridge, Cambridge University Press,

Garn, Stanley M. 1987. “The Secular Trend in Size and Maturational Timing and Its Implications for Nutritional Assessment”, *The Journal of Nutrition* 117, no. 5:817-23.

Garrett, James, and Marie T. Ruel. 1999. “Are Determinants of Rural and Urban Food Security and Nutritional Status Different? Some Insights from Mozambique.” *World Development* 27, no. 11:1955-75.

Gersony, Robert. 1988. "*Summary of Mozambican Refugee Accounts of Principally Conflict-Related Experience in Mozambique"*, Washington D.C.: Bureau for Refugee Programs, US Department of State

Ghobarah, Hazem, Paul Huth, and Bruce Russett. 2003. "Civil Wars Kill and Maim People - Long after the Shooting Stops." *American Political Science Review* 97, no. 2:189-202.

Ghobarah, Hazem, Paul Huth, and Bruce Russett. 2004. "The post-war public health effects of civil conflict". *Social Science & Medicine* 59, no. 4:869–84.

Glewwe, Paul. 1999. "Why Does Mother's Schooling Raise Child Health in Developing Countries? Evidence from Morocco." *The Journal of Human Resources* 34, no. 1:124-59

Guha-Sapir, Debarati, and Olivier Degomme. 2006. "Counting the Deaths in Darfur: estimating Mortality from Multiple Survey Data", Working Paper no. 15, Households in Conflict Network, Institute of Development Studies at the University of Sussex, Brighton

Habicht, Jean-Pierre, Charles Yarbrough, Reynaldo Martorell, Robert M. Malina, and Robert E. Klein. 1974. "Height and Weight Standards for Preschool Children: How Relevant Are Ethnic Differences?" *Lancet* 303, no. 7858:611-15.

Haddad, Lawrence, and John Hoddinott. 1994. "Women's income and boy-girl anthropometric status in the Cote d'Ivoire." *World Development* 22, no. 4:543-53.

Hanlon, Joseph. 2002. “Are Donors to Mozambique Promoting Corruption?”, Paper submitted to the conference ‘Towards a New Political Economy of Development’, Sheffield 3-4 July

Hagekull, Berit, Rozina Nazir, Fehmida Jalil, and Johan Karlberg. 1993. “Early child health in Lahore, Pakistan. III. Maternal and family situation.” *Acta Paediatrica* 82, suppl. 391:27-37.

Hauspie, Roland, Martine Vercauteren, and Charles Susanne. 1997. “Secular changes in growth and maturation: an update”. *Acta Paediatrica* 86, suppl. 423:20-27

Jalil, Fehmida, Bo S. Lindblad, and Lars Å. Hanson. 1993. “Early child health in Lahore, Pakistan. I. Study design.” *Acta Paediatrica* 82*,* suppl. 390:3-16

Justino,Patricia. 2009. “The Impact of Armed Civil Conflict on Household Welfare and Policy Responses,” Research Working Papers 12, MICROCON - A Micro Level Analysis of Violent Conflict.

Justino, Patricia. 2012. “Poverty and Violent Conflict: A Micro Level Perspective on the Causes and Duration of Warfare,” *Journal of Peace Research* 49, no. 3:129-45

Karlberg, Johan. 1987. “On the modelling of human growth”. *Statistics in Medicine* 6, no. 2:185–92.

Karlberg, Johan. 1989. “A biologically-oriented mathematical model (ICP) for human growth.” *Acta Paediatrica* 78, suppl. 350:70–94.

Karlberg, Johan, Inga Engström, Petter Karlberg, and John G. Fryer. 1987a. “Analysis of linear growth using a mathematical model. I. From birth to three years”. *Acta Paediatrica* 76, no. 3:478–88.

Karlberg, Johan, John G. Fryer, Inga Engström, and Petter Karlberg. 1987b. “Analysis of linear growth using a mathematical model. II. From 3 to 21 years of age.” *Acta Paediatrica* 76*,* suppl. 337:12–29.

Karlberg, Petter, John Taranger, Inga Engström, Johan Karlberg, Tova Landstrom, Henrik Lichtenstein, B. Lindstrom, and I. Svennberg-Redegren. 1976. “I. Physical growth from birth to 16 years and longitudinal outcome of the study during the same age period.” *Acta Paediatrica* 65, suppl. 258:7–76

Karlberg, Johan, Chi-wai Kwan, Lars Gelander, and Kerstin Albertsson-Wikland. 2003. “Pubertal Growth Assessment.” *Hormone Research* 60, supp. 1: 27-35

Komlos, John. 1999. “On the Biological Standard of Living in Russia and the Soviet Union.” *Slavic Review* 58, no. 1:71-79.

Loaiza, Edilberto. 1997. Maternal Nutritional Status. *DHS Comparative Studies No. 24.* Calverton, Maryland, Macro International Inc.

Martorell, Reynaldo, Katerine L. Khan, and Dirk G. Schroeder. 1994. “Reversibility of Stunting: Epidemiological Findings in Children from Developing Countries”, *European Journal of Clinical Nutrition* 48, supp. 1:45-57.

Martorell, Reynaldo, and Jean-Pierre Habicht. 1986. *“Growth in early childhood in developing countries”. In*: Falkner F, Tanner JM, editors. *Human growth: a comprehensive treatise, vol. 3.* 2nd ed. New York: Plenum Press, pp.241–62

Moradi, Alexander. 2002, “Height and Health of Women in Sub-Saharan Africa and South-Asia 1950-1980”. Paper presented at the XIII Congress of the International Economic History Association, Buenos Aires, Argentina.

Moradi, Alexander, and Joerg Baten. 2005. “Inequality in Sub-Saharan Africa: New Data and New Insights from Anthropometric Estimates,” *World Development* 33, no. 8:1233-65

Robinson, David Alexander. 2006. “Curse on the Land: A History of the Mozambican Civil War”, PhD diss., School of Humanities, University of Western Australia

Saul, John S. 1999. “Inside from the Outside? The Roots and Resolution of Mozambique’s Un/Civil War”, in *Civil Wars in Africa: Roots and Resolution*, ed. Taisier M. Ali and Robert O. Matthews, McGill-Queen’s University Press, Montreal

Serapião, Luís Benjamin. 1990. “Mozambique’s National Interest in the Regional Conflict of Southern Africa”, *Conflict* 9, no. 4:341-56.

Smith, Ian. 1997. *The Great Betrayal, the memoirs of Africa's most controversial leader,* Blake Publishing, London

South African Foreign Affairs Archives *"Staatkundlge Komitee: Voorgestelde Wysings Tov Strategie NR 19: Mosambiek"*

Stewart, Frances, and Frank P. Humphreys. 1997. "Civil conflict in developing countries over the last quarter century: an empirical overview of the economic and social consequences." *Oxford Development Studies* 25, no. 1:11-31.

Stiff, Peter. 1999. "*The Silent War: South African Recce Operations 1969-1994*," Galago Books Publisher, Alberton

Tabeau, Ewa, and Jakub Bijak, 2005. "War-related Deaths in the 1992-1995 Armed Conflicts in Bosnia and Herzegovina: A Critique of Previous Estimates and Recent Results", *European Journal of Population* 21, no. 2-3:187-215

Vines, Alex. 1991. *RENAMO: Terrorism in Mozambique*, ed. James Currey, Indiana University Press

Vines, Alex. 1996. *RENAMO: From Terrorism to Democracy in Mozambique?* ed. James Currey, Center for South African Studies and University of York

Wilson, Ken. 1992. "Cults of Violence and Counter-Violence in Mozambique", *Journal of Southern African Studies* 18, no 3:527-82

TABLE 1
DESCRIPTIVE STATISTICS AND PRELIMINARY OBSERVATIONS

	1	2	3	4	5
Provinces	DHS Roster	Number of mesured women	Average height-for-age z-score of mesured women	ONEMONTHCW17A At least one month of conflict during the first 17 years: Dif (mean 0 - mean 1)	BORNduringCW Born during the Civil War : Dif (mean 0 - mean 1)
Niassa	4,396	647	-1.589	.000	.008
				(.087)	(.110)
Cabo Delgado	4,796	837	-1.753	.171	.221
				(.080) **	(.118) **
Nampula	6,449	1,226	-1.667	.115	.254
				(.066) **	(.084) ***
Zambezia	6,671	1,266	-1.638	.104	.171
				(.068) *	(.087) **
Tete	5,399	1,072	-1.25	.256	.248
				(.087) ***	(.092) ***
Manica	5,493	851	-1.39	.253	.301
				(.120) **	(.129) ***
Sofala	6,297	1,200	-1.449	.078	.161
				(.091)	(.100) *
Gaza	6,511	1,372	-1.074	.116	.218
				(.063) **	(.071) ***
Inhambane	6,819	1,614	-1.019	.035	.150
				(.064)	(.070) **
Maputo Province	4,426	906	-.962	.078	.160
				(.084)	(.094) **
Maputo City	5,184	955	-.79	.073	.119
				(.099)	(.102)
Maputo P& C	9,610	1,861	-.874	.050	.104
				(.064)	(.068) *
Mozambique	62,441	11,946	-1.308	.051	.059
				(.024) **	(.027) **
			De facto place of residence		
Urban	26,559	5,160	-1.131	.046	.085
				(.037) *	(.040) **
Rural	36,937	6,984	-1.439	.078	.097
				(.030) ***	(.035) ***
			Childhood type of residence		
City	4,003	3,016	-1.042	-.004	.054
				(.057)	(.060)
Town	1,715	1,255	-1.298	.021	.054
				(.073)	(.081)
Countryside	5,718	7,397	-1.410	.123	.148
				(.028) ***	(.034) ***

Note. Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Columns 4 and 5 present the results for a mean comparison test. In Column 4, women exposed to the civil war from age 0 to 17 years are coded 1, and women exposed after age 17 are coded 0. In Column 5, women born during the civil war are coded 1, women who were exposed during their first 17 years but were not born during the civil war are not included in the analysis, and women exposed after age 17 years are coded 0.

TABLE 2
DESCRIPTIVE STATISTICS

Variable	Obs	Mean	Std. Dev.	Min	Max
Height-for-Age Z-score (HAZ)	11,946	-1.308	1.030	-5.97	5.52
Women's age in year	11,946	28.512	9.490	15	49
15 years	453				
16 years	507				
17 years	482				
18 years old and over	10,504				
DURATIONofCW_Infancy	11,946	8.52	11.144	0	24
DURATIONofCW_Childhood	11,946	42.295	38.971	0	108
DURATIONofCW_Puberty	11,946	21.963	28.037	0	72
MONTHSofCWatBIRTH	11,946	15.605	28.656	0	120
Childhood place of residence					
city	2,982			0	1
town	1,224			0	1
countryside	7,269			0	1
Region of residence					
Niassa	647			0	1
Cabo Delgado	837			0	1
Nampula	1,226			0	1
Zambezia	1,266			0	1
Tete	1,072			0	1
Manica	851			0	1
Sofala	1200			0	1
Inhambane	1,372			0	1
Gaza	1,614			0	1
Maputo Province	906			0	1
Maputo City	955			0	1
language spoken (proxy for ethnicity)					
portuguese	1,269			0	1
emakhuwa	2,047			0	1
xichangana	2,276			0	1
elomxe	450			0	1
cisena	819			0	1
echuwabo	282			0	1
shona	58			0	1
chibarue	101			0	1
bitonga	257			0	1
chichewa	421			0	1
nhungue	519			0	1
chitswa	758			0	1
coti	7			0	1
chigorogonza	94			0	1
naconde	141			0	1
ndau	579			0	1
ronga	228			0	1
chimanica	76			0	1
chitewe	20			0	1
chope	284			0	1
jaua	205			0	1
kimuani	28			0	1
chiute	236			0	1
kikakwe	13			0	1
nhanja	70			0	1
suaili	12			0	1
other	245			0	1

TABLE 3

ICP DECOMPOSITION OF CIVIL WAR INFLUENCES ON HEIGHT-FOR-AGE Z-SCORES

Dependent variable: Women's Height-for-Age Z-Score (HAZ)					
	1	2	3	4	5
	OLS	OLS	OLS	OLS	OLS
DURATIONofCW_Infancy_1_24	-.008***	-.004**	-.004*	-.005**	-.012***
	(.001)	(0.002)	(.002)	(.002)	(.003)
DURATIONofCW_Childhood_25_132	-.001***	-.001***	-.002*	-.003*	-.006***
	(.000)	(.000)	(.001)	(.001)	(.002)
DURATIONofCW_Puberty_133_204	-.001**	-.001**	-.001*	-.002	-.003
	(.000)	(.000)	(.001)	(.002)	(.002)
MONTHSofCWatBIRTH		-.001**	-.001	-.002	-.005**
		(.001)	(.001)	(.001)	(.002)
Constant	-1.227***	-1.226***	-2.339	-1.150***	-.397
	(.114)	(.113)	(8.901)	(.119)	(.294)
Region-fixed effects	yes	yes	yes	yes	no
Time trend (year of birth)	no	no	yes	no	no
5-year cohort-fixed effects	no	no	no	yes	no
Interaction of region and 5-year cohort-fixed effects	no	no	no	no	yes
Observations	6,536	6,536	6,536	6,536	6,536
R-squared	.106	.106	.106	.107	.115

Note. Robust standard errors in parentheses and clustered at the province level. * significant at 10%; ** significant at 5%; *** significant at 1%. All provinces are included in the regressions. All regressions include ethno-linguistic dummies, type-of-childhood-residence fixed effect, and province dummies. This table uses a restricted sample of women who have always lived in the same place.

TABLE 4
ROBUSTNESS SPECIFICATION OF THE ICP DECOMPOSITION OF CIVIL WAR INFLUENCES ON HEIGHT-FOR-AGE Z-SCORES

Dependent variable: Women's Height-for-Age Z-Score (HAZ)					
	1	2	3	4	5
	OLS	OLS	OLS	OLS	OLS
DURATIONofCW_Infancy_1_24	-.009***	-.012***	-.0100***	-.0103***	-.0109***
	(.003)	(.003)	(.004)	(.004)	(.004)
DURATIONofCW_Childhood_25_132	-.003**	-.006***	-.006***	-.005**	
	(.001)	(.002)	(.002)	(.002)	
DURATIONofCW_Puberty_133_204	-.000	-.003	-.002	-.002)	
	(.001)	(.002)	(.002)	(.002)	
DURATIONofCW_AfterPuberty_205_360	-.002	-.000			
	(.002)	(.001)			
MONTHSofCWatBIRTH		-.005**	-.005**	-.003	
		(.002)	(.002)	(.002)	
DURATIONofCW_Childhood_25_120					-.006***
					(.002)
DURATIONofCW_Puberty_121_204					-.003*
					(.002)
MONTHSofCWatBIRTH					-.005**
					(.002)
Constant	-.697***	-1.150***	-.413	-.568*	-.415
	(.224)	(.204)	(.299)	(.314)	(.293)
Interaction of region and 5-year cohort-fixed effects	yes	yes	yes	yes	yes
Observations	11,467	6,536	6,056	5,891	6,536
R-squared	.1095	.1153	.1168	.1092	.1151

Note. Robust standard errors in parentheses and clustered at the province level. * significant at 10%; ** significant at 5%; *** significant at 1%. All regressions include ethno-linguistic dummies and a type-of-childhood-residence fixed effect. Column 1 uses the whole sample of women; the other columns use a restricted sample of women who have always lived in the same place. Column 2 provides the results for a restricted sample excluding the province of Niassa, which was exposed to the civil war for the shortest time. Column 3 provides the results for a restricted sample, excluding the province of Gaza, which suffered from the Civil War for the longest time. Column 4 provides the results using an alternative age for the onset of puberty..

TABLE 5
ESTIMATION THROUGH A MONTE CARLO SIMULATION USING 500 REPLICATIONS

	Average estimated effect	% significant and negative at .10 level	% significant and negative at .05 level	% significant and negative at .01 level
DURATIONofCW_Infancy_1_24	.00401	0%	0%	0%
DURATIONofCW_Childhood_25_132	.00167	0%	0%	0%
DURATIONofCW_Puberty_133_204	.01094	4%	2%	1%
MONTHSofCWatBIRTH	.00181	0%	0%	0%
Constant	-1.36012			
Observations	500			
R-squared	.10229			

Note. All of the provinces are included in the regressions. Standard errors are clustered at the province level. All of the regressions include ethno-linguistic dummies, a type-of-childhood-residence fixed effect, and the interaction between the region and the 5-year cohort fixed effects. This table uses a restricted sample of women who have always lived in the same place.

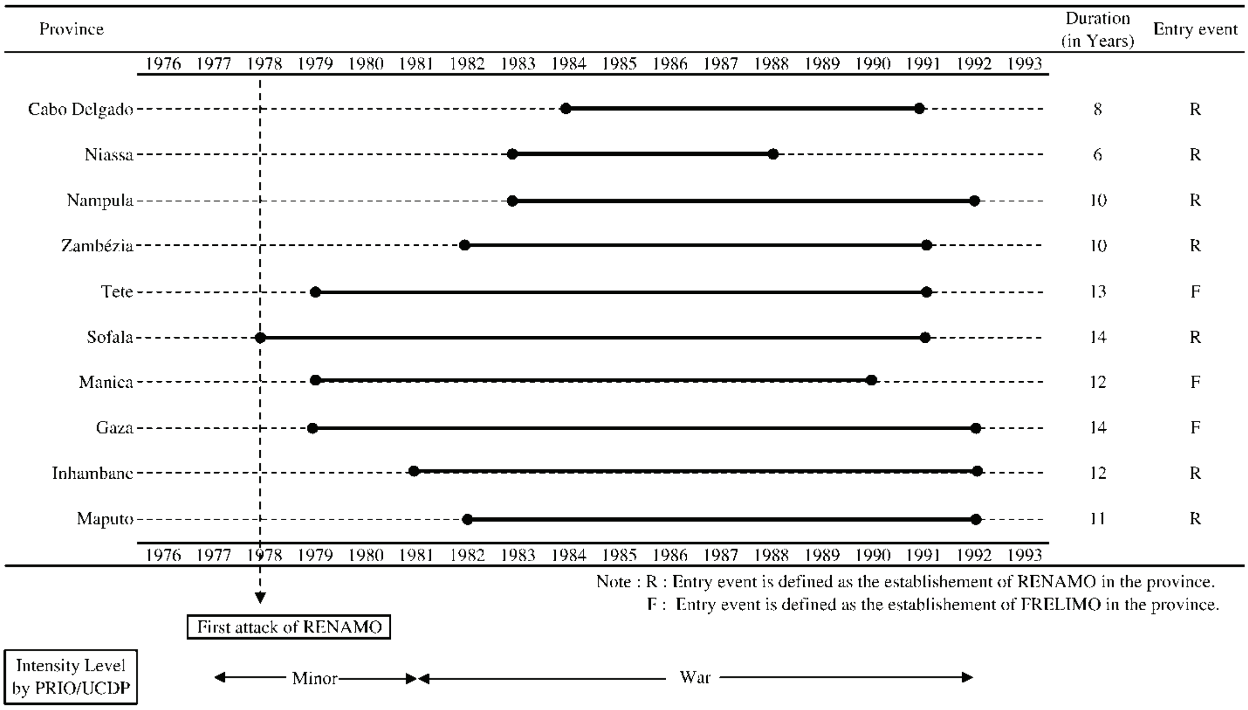

Figure 1. Chronology of civil war at the province level. Source: Domingues (2011)

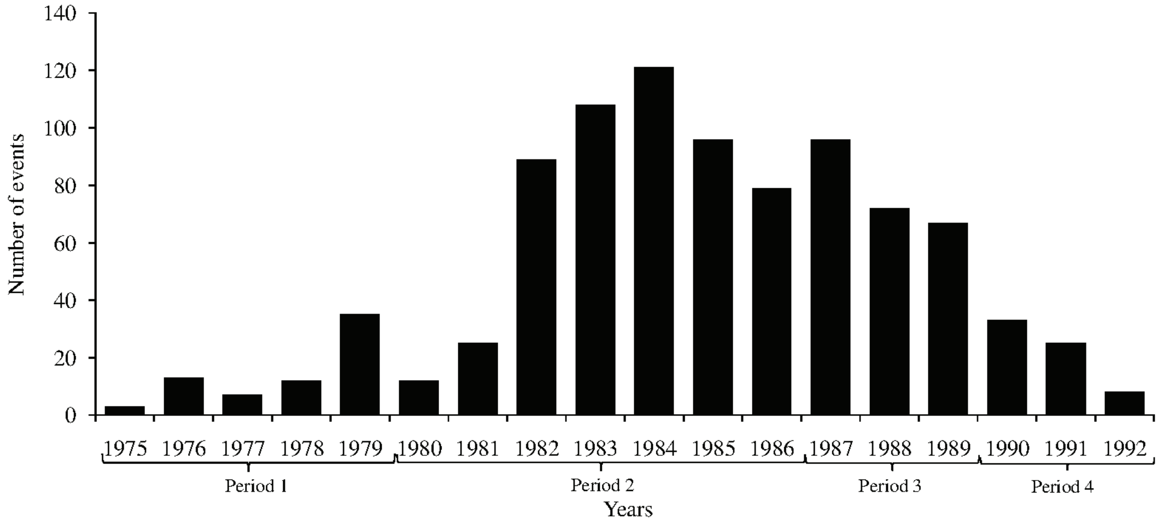

Figure 2. Number of recorded events related to the Mozambican civil war.

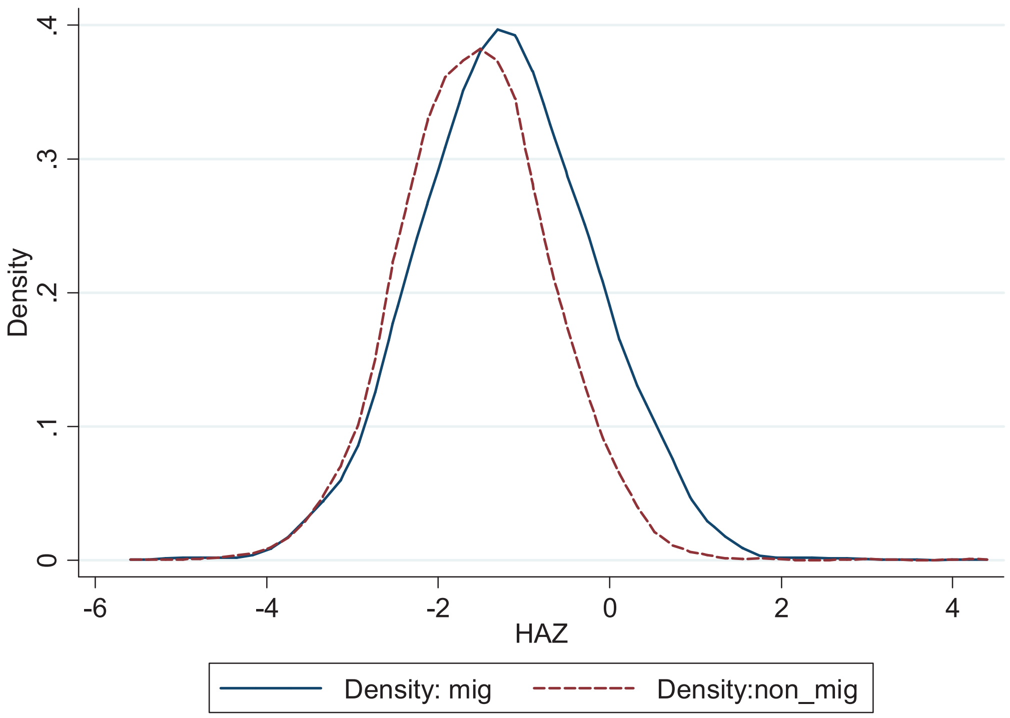

Figure 3. Height-for-age z-score distributions for migrants and non-migrants.

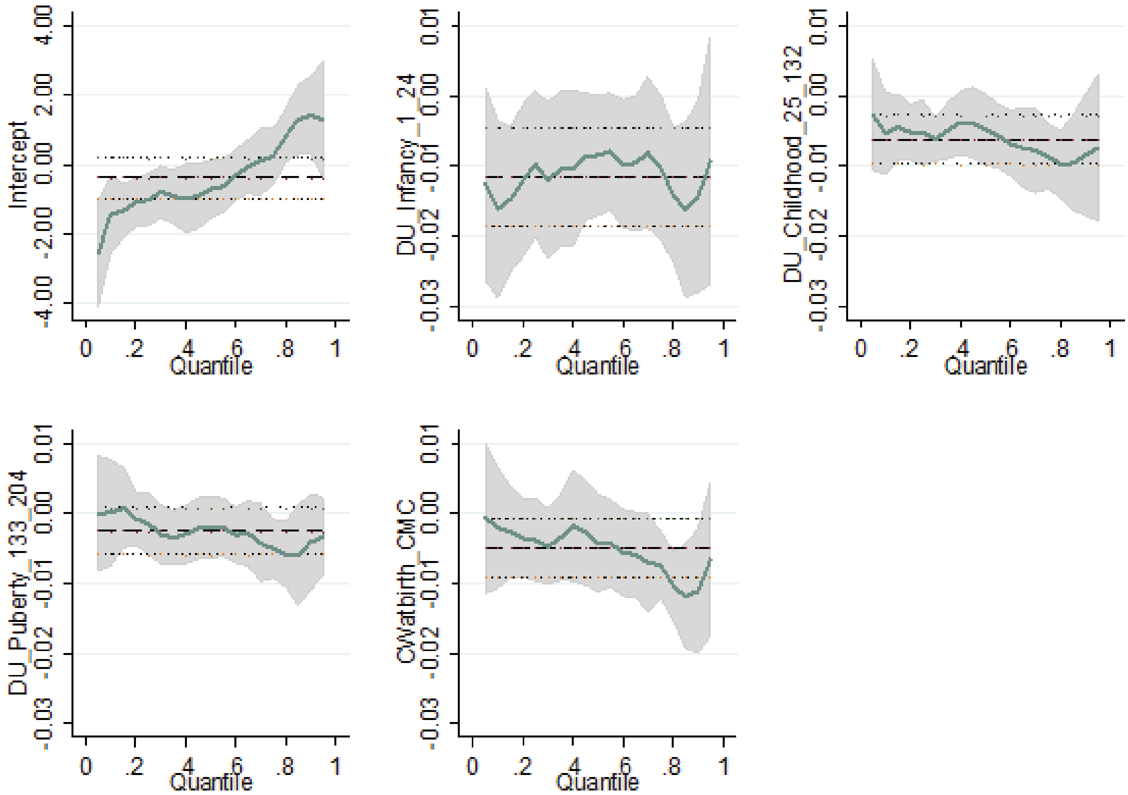

Figure 4. Quantile regression results.

Annex 1: The Mozambican Civil War

This conflict can be divided into four periods:

1977-1980: The RENAMO is controlled by Rhodesia and launched its first attacks on Mozambican soil. These attacks mainly took place in Central Mozambique near the border with Rhodesia and spread gradually toward the south. At that time, the RENAMO, which included a heterogeneous group of opponents of the Mozambican government, targeted both ZANLA camps involved in the Rhodesian counter-insurgency and the infrastructure of the FRELIMO (Serapião, 1990; Smith, 1997).

1980-1986: Following Zimbabwean independence, the RENAMO lost the support of Rhodesia, but South Africa stepped in to support the RENAMO in an effort to destabilize Mozambique. The RENAMO began to build strength in Mozambique (Davies, 1989; Cabrita 2000), and the fighting intensified, first in the south (especially during the RENAMO's offensive towards Maputo in 1982-83), and subsequently in the north (with FRELIMO's offensive, which led to the downfall of the RENAMO base at Gorongosa in the central province of Inhambane in 1985 and with the RENAMO's offensive in the province of Zambezia in 1986-87) (Cabrita, 2000).

1987-1990: This period featured a high level of violence perpetrated by the RENAMO against civilians, especially in the south (Robinson, 2006), despite the decline of South Africa's support. In 1989, South Africa began to change its opinion regarding the optimal strategy regarding Mozambique. In fact, the continuation of a conflict on its borders proved to be a significant source of inconvenience for South Africa, due to the illegal influx of refugees fleeing the conflict (South African Foreign Affairs Archives).

1990-1992: This period of negotiations during the Rome talks led to the resolution of the conflict on October 4, 1992 (Vines, 1996; Saul 1999), but fighting continued in most provinces during this period of negotiations.

Annex 2: Methodology used for the design of the timing geo-referenced database

As mentioned in the paper, the design of the geo-referenced database on the Mozambican Civil War is mainly based on the historical research conducted by Robinson (2006). Next, to the extent possible, the collected information was cross-checked against accounts of the conflict in the books by Vines (1991) and Cahen (1994).

This methodology identified 1,153 attacks and 251 sabotages or other military operations, with each event being dated by year and month. Next, the locations of each of these 1,404 military activities in the 10 Mozambican provinces were identified. Localization data were obtained from www.maplandia.com. At the district level, only 620 of these events were successfully located. For the province of Maputo, the events that occurred in the capital, Maputo City, were separated from those that occurred in Maputo province. Events could not be localized at this level when the accounts left doubt as to the exact location or when information on the geographical location where the event took place was too vague. Finally, these 1,404 military activities were aggregated into 901 events (one event can include a set of simultaneous military activities in the same province). Figure 2 shows the distribution of the 901 events that took place throughout the years.

Approaching the conflict from both a temporal and a spatial perspective highlights the heterogeneity between Mozambican provinces in their experience of the conflict. Indeed, the conflict did not begin and end at the same time in every province. The starting and ending dates of the conflict for each province were determined as follows. We have chosen not to select the date of the first event located in each province as the start date for that province. Indeed, the date of this first event rarely reflects the province’s entry into the war accurately.

Regardless of its nature (most often it is an ambush or sabotage), the event is usually local and does not determine the province's entry into the conflict. Thus, the start date of the conflict for each province was taken as the earliest date of an event that clearly indicates that the province has entered the civil war. Start dates were only assigned for events that indicate that a major share of a province's territory began to suffer the consequences of the conflict.

The date of establishment of the RENAMO within a province (i.e., the installation of bases or headquarters) was used as the date of entry into the war for provinces where this information was available, that is, Cabo Delgado, Inhambane, Nampula, Sofala, Zambezia, Niassa and Maputo. These events can be used as start dates because the RENAMO would only have established itself in an area where it was safe, and its presence gave rise to additional attacks in the province from this military position. Maputo province is unusual because the conflict start date was chosen as the date of the great RENAMO offensive in this region (in 1982), which began RENAMO's activity in this province. For the provinces where the establishment of RENAMO could not be dated, the conflict start date was chosen as the date that FRELIMO placed the province under military command because a province in such a situation is clearly involved in a civil war. This was the case in the provinces of Gaza, Manica and Tete. The RENAMO was established in Manica province in November 1978, but it was only in 1979 that the RENAMO's military operations reached a significant scale, thereby leading FRELIMO to place the province under military command; therefore, 1979 was selected as the date of Manica's entry into the war. Finally, the date of the last event located in each province was chosen as the conflict end date for that province. Periods of one year or more during which a province experienced no events were ignored. Consequently, each province has a single conflict starting date and a single conflict ending date. Figure 1 summarizes the conflict starting and ending dates for each province, the duration of the conflict and the type of event chosen to indicate entrance into the war.