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Health and Civil War in Rural Burundi

Research Working Paper 5

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April 2008

Correct citation: Bundervoet, T., Verwimp, P. and Akresh, R. *Health and Civil War in Rural Burundi.* MICROCON Research Working Paper 5, Brighton: MICROCON.

First published in 2008
© Tom Bundervoet, Philip Verwimp and Richard Akresh 2008
ISBN 13: 978 185864 684 7

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Funded by
the European Commission's
Sixth Framework Programme

Health and Civil War in Rural Burundi[1]

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Abstract: We combine household survey data with event data on the timing and location of armed conflicts to examine the impact of Burundi's civil war on children's health status. The identification strategy exploits exogenous variation in the war's timing across provinces and the exposure of children's birth cohorts to the fighting. After controlling for province of residence, birth cohort, individual and household characteristics, and province-specific time trends, we find an additional month of war exposure decreases children's height for age z-scores by 0.047 standard deviations compared to non-exposed children. The effect is robust to specifications exploiting alternative sources of exogenous variation.

JEL codes: I12, J13, O12

Keywords: Child health, economic shocks, stunting, Africa, civil war

[1] The authors would like to thank Jean-Marie Baland, Robert Bates, Tony Addison, Marcel Fafchamps, Olga Shemyakina, Peter Uvin and participants at HiCN's first annual workshop in 2006 in Berlin, at the 2006 CSAE conference, at the 2007 NEUDC, and at seminars in Namur, ECARES-ULB and DIW-Berlin for helpful comments on earlier drafts. The data used in this article can be obtained beginning six months after publication through three years hence from the authors.

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1. Introduction

During the past 30 years, civil conflict affected almost three-fourths of all countries in sub-Saharan Africa (Gleditsch et al. 2002). Recently academic economists and policy makers have begun focusing on this topic, specifically trying to understand the causes of war and its role in reducing growth and development (Collier and Hoeffler 1998; Miguel, Satyanath, and Sergenti 2004; Guidolin and La Ferrara 2007). The nature and magnitude of a conflict's long-term negative economic consequences are debated in the literature (see Davis and Weinstein (2002) for Japan; Brakman, Garretsen, and Schramm (2004) for Germany; Miguel and Roland (2006) for Vietnam; Bellows and Miguel (2006) for Sierra Leone). Despite the suffering and deaths caused by these various wars, there is limited research that examines the microeconomic impacts of conflict for non-combatants, although this is slowly changing as data from war regions becomes available (Shemyakina 2006; Akresh, Verwimp, and Bundervoet 2007).[5]

The 1990s were a particularly violent decade in Central Africa's history.[6] Burundi and Rwanda experienced several episodes of mass murder and genocide, and the regional civil war in the Democratic Republic of Congo created an enormous loss of life and socioeconomic destruction. Most of the recent work on Burundi focuses on the causes of the latest episode of civil conflict

5 Research focusing on soldiers finds large negative impacts on earnings for these individuals, and soldiers exposed to more violence face a harder time reintegrating into civilian society (Angrist 1990; Imbens and van der Klaauw 1995; Humphreys and Weinstein 2005; Blattman and Annan 2007).

6 The number of people killed in direct violence is often less than that killed by a conflict's indirect consequences, such as the breakdown of the economic and health systems and the spread of infectious diseases (WHO 2002; Eck 2003; Roberts et al. 2003). Ghobarah, Huth, and Russett (2003) use cross-country data to assess the impact of civil wars on the loss of life and find that wars "continue to kill people indirectly, long after the shooting stops."

(Nkurunziza and Ngaruko 2000), the progression of the crisis (Chrétien and Mukuri 2000), the year-by-year political dimensions of the conflict (Reyntjens and Vandeginste 1997; Reyntjens 1998), or the possible solutions to it (Ndikumana 2000).

Civil wars often have immediate negative economic impacts through the destruction of productive capacity and the disruption of normal activity. Between 1990 and 2002, per capita income in Burundi fell from $210 to $110 leaving Burundi as the world's poorest country. The proportion of people living below the nationally defined poverty line increased during this period from 35 to 68 percent, and the spread of the civil war starting in 1994 led to double digit inflation rates, which peaked at over 30 percent in 1997 (all figures from IMF (2007)).

In this paper, we examine the impact of the Burundi civil war on children's health status, focusing on early childhood malnutrition and stunting measured by height for age z-scores. We examine if and how shocks, such as conflict, affect childhood health for those exposed children. We combine data from a nationally representative household survey (the 1998 Priority Survey carried out by the World Bank and the Burundi Statistics Institute) with event data on the timing and evolution of the conflict from 1994 to 1998. The empirical identification strategy exploits variation in the timing and duration of conflict across the Burundi provinces and the related variation determining which birth cohorts of children were exposed to the war and for how long (see Suri and Boozer (2007) using a similar identification strategy to explore child labor issues). We find that an additional month of civil war exposure decreases a child's height for age z-score by 0.047 standard deviations, an effect that is robust to including a variety of control variables, time trends, and alternative sample specifications. In calculating the total difference between a child not exposed to the war and one exposed for the average exposure duration, the results imply a one standard deviation reduction in the child's height for age z-score.

Research suggests this finding could have implications for these war-exposed children's future schooling and productivity as adults (see Strauss and Thomas (1998) for a discussion of health and development links). Alderman, Hoddinott, and Kinsey (2006) use Zimbabwe data and find that improvements in childhood malnutrition (measured as height for age) are associated with more completed grades in school. Alderman et al. (2001) estimate the impact of child health on school enrollment in rural Pakistan and find that improvements in preschool height for age z-scores are likely to have substantial long-run productivity effects through inducing more schooling. Maccini and Yang (2006) and Meng and Qian (2006) find that negative early-life environmental conditions (negative rainfall shocks in Indonesia and China's Great Famine, respectively) lead to worse adult health and socioeconomic conditions.[7] Based on the existing literature, it is likely the short-run health impact of the Burundi civil war will have a long-run welfare impact through an adverse effect on future schooling, adult health, and income levels.

The remainder of the paper is organized as follows. Section 2 provides an overview of the history of violence in Burundi and sketches the spatial and temporal event data for the most recent civil war. Section 3 describes the survey data used in the analysis and explains the key variables. Section 4 describes the empirical identification strategy and section 5 presents the main results as well as robustness tests. Section 6 concludes.

7 There is also evidence showing the adverse effects of prenatal health shocks (Stein et al. 2004; Almond 2006).

2. Conflict in Burundi

A. Political History

Civil conflict in Burundi began in 1965, three years after independence from the Belgian colonial administration, when a group of Hutu officers unsuccessfully tried to seize power and overthrow the monarchy. This failed coup led to a purge of Hutu from the army and government and marked the beginning of political exclusion of the Hutu majority by the Tutsi minority. Power became the sole monopoly of the Tutsi, who effectively seized power in 1966 and proclaimed the First Republic, headed by Captain Michel Micombero. During Micombero's regime, power was increasingly concentrated in the hands of the Tutsi Hima clan, a small ethno-regional group from the southern province of Bururi, that the French historian Chrétien calls the Bururi mafia (1997).

In 1972, a Hutu insurgency started in southwestern Burundi resulting in considerable loss of life among the Tutsi residents. The subsequent Tutsi army repression was dramatic. From May to August 1972, all educated Hutus and members of the Hutu elite were systematically eliminated or fled into exile (Lemarchand 1994). This massacre of educated Hutus reduced their status to an oppressed underclass and reduced future Hutu opposition for over a generation.[8]

The next major confrontation was in 1988, when a Hutu insurgency began in the north. As in 1972, army repression was swift and took a heavy toll on local Hutus. However, unlike 1972, the international community condemned the massacres and pressured the Buyoya regime to

8 In 1976, Micombero was ousted in a coup by Colonel Jean-Baptiste Bagaza, another Tutsi Hima from the same district in Bururi as Micombero. Bagaza's reign was characterized by unprecedented socio-economic development despite an increase in ethnic discrimination. No significant violence took place under Bagaza. In 1987, Bagaza was replaced in another coup by his cousin, Major Pierre Buyoya, also from the same district in Bururi.

liberalize its political system. In June 1993, this led to the first free and fair elections in post-independence Burundi.[9] Unfortunately, the democratic transition did not last. In October 1993, Melchior Ndadaye, the first democratically elected president and a Hutu, was assassinated by Tutsi army elements in a failed coup attempt, marking the start of another civil war. As the news spread to the rural provinces, Hutu peasants committed large-scale massacres of Tutsis and Uprona Hutus.[10] Chrétien (1997) describes the massacres saying districts in certain provinces were "almost completely 'cleansed' of all Tutsi elements." Within days, approximately 100,000 Burundians lost their lives in what was later acknowledged as genocide (United Nations 1996). The Tutsi army retaliated against the Hutus, continuing what would become the most severe civil war in Burundi's history, both in terms of human lives and socioeconomic destruction. Unlike prior wars that began with a localized Hutu insurgency followed by severe but random Tutsi army reprisals, this crisis was a more traditional war, with two opposing armed and organized factions and an impact on almost the entire country (Ndikumana 2000).[11]

B. Spatial and Temporal Intensity of the Conflict

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9 The elections resulted in a landslide victory for the opposition party, Frodebu, with 65 of 81 Parliament seats and 64 percent of all votes in the presidential elections (Reyntjens 1993).

10 Uprona Hutus are Hutus loyal to the former unique state party, Uprona, and are therefore seen as traitors to the Hutu cause. Consult Chrétien and Mukuri (2000) for an overview of the massacres that followed the coup.

11 Burundi's conflict had detrimental effects on the Rwandan situation. The killing of President Ndadaye in October 1993 strengthened the Rwandan extremist Hutu factions in their distrust of Tutsis. The role taken by the local Burundian Hutu administrators to direct the massacres against the Tutsi population as well as the mobilization of the villagers and speed of execution mirrors the modus operandi of the April 1994 Rwandan genocide. Also, many Burundian Hutus who fled army persecution would become perpetrators of the Rwandan genocide (HRW 1999).

In this analysis of child health, the exact timing and location of the civil war plays an important role.[12] We describe the war's evolution through time and space as follows:

- January 1994 to July 1996: Spread of civil war throughout the country (see Figures 1 and 2).
- July 1996 to August 2000: Return of Major Buyoya to power after a bloodless coup. Lower civil war intensity in most provinces and signing of the Arusha Peace Accords in 2000.

Figure 1 sketches a more detailed evolution of the conflict, defined at the province-month level.[13] Fighting began in October 1994 in the northwestern provinces of Cibitoke, Bubanza, Bujumbura Rural and Ngozi. By early 1995, violence spread to the bordering Kayanza province, and by April 1995, massacres of civilians and confrontations between army and rebel forces happened in Karuzi, Bururi, Ruyigi and Muyinga. By late 1995, fighting took place in the central provinces of Gitega and Muramvya and the northern province of Kirundo. Figure 2 depicts the situation at the end of 1995. By then, conflict had spread to almost all of the provinces of Burundi, with the exception of Cankuzo (in the east of the country) and Rutana and Makamba (in the south of the country).[14] In July 1996, former president Buyoya seized power again in a bloodless coup d'état backed by the army. During late 1996 and early 1997, armed conflict continued in Kayanza, Muramvya, Kirundo and Gitega. Meanwhile in April 1997, the Arusha

12 The massacres and ethnic cleansing that occurred during the few weeks immediately following the president's assassination in October 1993 are not the focus of the analysis. Since the oldest child in our sample was born in January 1994, we focus exclusively on the impact of the armed conflict and civil war and not on the genocide.

13 The crisis reconstruction is largely based on work by Chrétien and Mukuri (2000) and the United Nations (1996).

14 By late 1998, Makamba was severely impacted by insurgents operating from neighboring Tanzania. Due to the generalized insecurity in Makamba at the time of the survey, no data were collected (Republic of Burundi 1998).

Peace talks between the principal conflict parties began. As of late 1997, insecurity increased again in Cibitoke, Bubanza and Bujumbura Rural, provinces which remained unsafe until 1999.[15]

The various conflict accounts provide no definitive explanation for why the war affected some provinces earlier than others. However, the conflict's spread was clearly influenced by the rebel base locations in the Democratic Republic of Congo's North Kivu region next to the borders of Cibitoke, Bubanza, and Bujumbura Rural, which explains why these provinces were first to experience conflict. The presence of the Kibira forest bordering these provinces could explain the subsequent spread of war to Kayanza and Ngozi, since rebels passed undetected through the forest. From these initial conflict provinces, the war spread to the rest of the country.

C. Civilian Impacts of the Conflict

According to Human Rights Watch (1998), the civil war in Burundi "has above all been a war against civilians." They were widely used as proxy targets, with both sides targeting civilians deemed supportive of the other group. Between 1994 and 2001, an estimated 200,000 people lost

15 Although the peace negotiations ended in 2000 and a transitional government began in 2002, it was not until 2003 that Burundi entered a period of fragile peace. The 2000 Arusha Accords were not signed by two main rebel groups, CNDD-FDD and FNL, so the accord had no real impact in the field. By 2005, Burundi approved a new constitution and held local and parliamentary elections. In September 2006, the last rebel group, FNL, and the government signed a cease-fire agreement finally ending the civil war. Coupled with this political stability, a series of economic reforms were implemented and post-2000 annual growth averaged 2.7 percent. Despite the post-2000 political and economic improvements, health issues, particularly child health, remain a major concern in post-war Burundi.

their lives in the war, a majority of them civilians (UNFPA 2002).[16] To understand how the war affected the civilian population and subsequently child health, we focus on three critical areas: displacement, looting of household assets, and the theft and burning of crops.

First, the United Nations Population Fund (UNFPA) conducted a demographic household survey in 2001 and found over 50 percent of the rural Burundi population had been displaced from their homes at least once between 1994 and 2000 due to violence (UNFPA 2002). The average displacement duration was just over one year, meaning three agricultural seasons were missed as households could not cultivate or harvest their fields while displaced (UNFPA 2002). Displacement also meant individuals were more likely to contract water and vector-borne diseases while hiding in the forest. As people could not carry significant amounts of food when fleeing their village, adequate nutrition was a problem. Finally, displacement also implied a lack of access to markets or health clinics as roads were unsafe or these structures had been damaged. Later in the war, civilians were forced into local resettlement camps by the government and camp conditions were poor, being overcrowded and with a lack of food supplies, clean water, or waste disposal (HRW 2000).[17] The displacement's impact on aggregate production from 1993 to 1998 showed production declines in cereals of 15 percent, roots and tubers 11 percent, and fruits and vegetables 14 percent, with particularly dramatic declines in 1994 and 1995 (FAO 1997).[18]

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16 This mortality estimate excludes the deaths from the October 1993 ethnic killings.

17 Officially, resettlement camps were set up to protect rural Hutu populations from the Hutu rebel groups, but in reality they were more like prisons (HRW 1998).

18 Note that this massive civilian displacement does not invalidate our identification strategy, which exploits variation in the timing and duration of conflict across provinces (see Section 4 for details), since the UNFPA survey

Second, besides the displacement and killing of civilians, both rebel and government forces engaged in the looting of civilian property, in particular livestock, causing an unprecedented drop in household welfare levels. Aggregate national figures show the number of tropical livestock units in the country declined by 23 percent from 1990 to 1998, a decline that is predominantly due to theft and pillaging (FAO 1997). At the household level, the results of the UNFPA survey show that the average number of tropical livestock units per household fell from 2.37 before the crisis to 0.42 in 2001 (UNFPA 2002).[19]

Third, Human Rights Watch reports (1998) document the theft and burning of household crops. Crops were stolen from the field or granaries and coffee trees were particularly targeted for burning. As coffee is the government's main source of tax revenue, rebels frequently burnt coffee plantations to reduce government revenue, although we cannot quantify the extent of this. Coffee is also an important source of income for small farmers, so by losing their crop, farmers had less income to pay for other expenditures, including purchasing food crops or health care.

When the conflict ended in a given province, households who were displaced could and did return to their homes and fields. However, humanitarian interventions by either the government or non-governmental organizations (NGO) after the fighting ended were practically nonexistent, due to the continued insecurity on all roads linking the capital, Bujumbura, to the countryside.

found that "the overwhelming majority of displacements in rural Burundi did not lead to a change in province," but rather were local and took place within the province of residence (UNFPA 2002, p. 141).

19 Although there is no information in the survey about how much of this decrease was due to theft as opposed to sales, it still indicates a significant drop in household asset holdings.

By early 1995, rebels groups had begun to target and kill foreign NGO workers and journalists who left Bujumbura to visit war regions.[20] Moreover, international development assistance dropped sharply during the crisis, from almost $320 million before 1993 to below $100 million in 1999 (IMF 2007).

3. 1998 Burundi Priority Survey

A. Data Overview

The Burundi Priority Survey, organized by the Burundi Institute of Statistics and Economic Studies in cooperation with the World Bank, was designed to be nationally representative and took place between October 1998 and March 1999.[21] The survey's main goal was to evaluate the country's socioeconomic situation following five years of civil war in order to design an efficient poverty alleviation policy (Republic of Burundi 1998). The 1,064 rural households in the sample

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20 Rebel groups spread messages prohibiting humanitarian workers from working in the rural provinces and urging foreigners to leave the country. For instance, following repeated deadly attacks on its personnel, the International Committee of the Red Cross decided to cease its activities in Burundi in late 1995 (Chrétien and Mukuri 2000).

21 However, on-going fighting in the entire province of Makamba and certain districts in Bubanza and Bujumbura Rural meant these areas could not be surveyed. Although these regions were excluded, we do not believe it creates a significant bias for the generalizability of our results. The population in these excluded regions only represents 6.1 percent of the country (4.4 percent in Makamba and 1.7 percent in the other two provinces). Examining province level poverty, which could be correlated with child health status, shows that the pre-war headcount poverty rate in Makamba in 1990 was 39.8 percent, comparable to the national average of 36.2 percent for all rural provinces. Finally, we might be concerned that if these excluded regions did not experience conflict and children there were less healthy, we might be overestimating the negative health impact of war, but these regions were excluded precisely because there was on-going conflict that made it unsafe to conduct interviews and that also made it likely the children in those areas were negatively impacted by the war as in the other provinces.

that were randomly selected for the anthropometrics survey and have children under age five provide data on 1,442 children between 6 and 60 months of age. However, there are 214 children that cannot be included in the analysis because of missing height data and 32 children are excluded due to measurement errors in either height or age. These 246 children with missing information potentially pose a selection bias problem. In Appendix 1, we use two alternative approaches to evaluate this problem and find consistent results indicating selection bias is unlikely to be a significant concern. First, we find that along observable dimensions, included and excluded children look similar. Second, using regression analysis similar to Fitzgerald, Gottschalk, and Moffit (1998), we conclude that the civil war does not have a significant impact on the probability of being excluded from the sample and therefore any selection bias is likely to be small. This leaves a final sample of 1,196 children between 6 and 60 months of age.

B. Health and Civil War Variables

Childhood health status has multiple dimensions making it difficult to capture with a single indicator. The relevant literature suggests that child height conditional on age and gender can be objectively measured and is a good indicator of long-run nutritional status as height reflects the accumulation of past outcomes (Martorell and Habicht 1986). The goal of our analysis is to estimate the prior war's impact on a child's health status at the time of the survey, so we focus on the long-run indicator, child height for age.[22] We compute z-scores for each child's height for age, where the z-score is defined as the difference between the child's height and the median height of the same-aged international reference population, divided by the standard deviation of

22 We use the World Health Organization growth charts for the reference population.

the reference population. On average, across households in all of rural Burundi, children were more than two standard deviations below the average height for age of a reference child.

To construct the conflict exposure variables, we examine, based on Figure 1, whether a specific child was directly exposed to the war during his life and the number of months of exposure. The variables are defined at the province times birth cohort level, (*Conflict Province* $_j$ * *Exposure* $_t$), which allows us to exploit variation across two dimensions: spatial (variation across provinces) and temporal (within each province, the timing of birth and the timing of the conflict). The first war exposure variable is a binary measure indicating if a child was ever exposed to the war, so for a given province that experienced war, for a child who was born before or during the conflict, the variable is coded one, while for a child not alive during the war, the variable is coded zero. The second war exposure variable measures the duration (in months) of conflict exposure. Of the 1,196 rural children in the sample, 707 were exposed to the conflict during their lives and the average duration for these exposed children was 14.7 months.

C. Preliminary Observations

Table 1 shows the provincial disparities in nutritional status (average height for age z-score) and the incidence of malnutrition.[23] The first salient factor in Table 1 is the magnitude of malnutrition: 60.6 percent of all children in the sample are malnourished with 33.2 percent experiencing severe malnutrition. There is variation across provinces in the malnutrition level with rates varying from 34.9 percent in Cibitoke to 75.4 percent in Kayanza. The average height-

23 The incidence of malnutrition is divided into 3 groups: not malnourished (z-score $\geq$ -2), moderately malnourished (-3 $\leq$ z-score < -2), and severely malnourished (z-score < -3).

for-age z-score in rural Burundi is -2.32, meaning that an average child in rural Burundi has a height-for-age that is 2.32 standard deviations lower than an average reference child. The data do not contain information about household ethnicity so we are unable to explore this issue, and we do not have any empirical evidence that would allow us to speculate on whether the conflict had differential impacts on children of certain ethnic groups.

In Table 2 Panel A, we present, broken down by province, average height for age z-scores for children who are not exposed to the civil war (column 1), children whose duration of war exposure is less than the 14.7 month mean (column 2), and children who are exposed for more than 14.7 months (column 3). The 489 non-war exposed children have an average height for age z-score of -2.009, while the 295 children with limited war exposure have an average z-score of -2.276. The 412 children with the longest exposure have an average z-score of -2.681. The 0.672 standard deviation difference between non-exposed children and children with long exposures (columns 1 and 3) is statistically significant at the one percent level. For every province, children exposed to the war have lower height for age z-scores than children from that same province who are not exposed to conflict, and for most provinces the difference is at least statistically significant at the ten percent level. Although the results suggest war had an adverse effect on child health, many factors influence health and we cannot yet conclude a causal relationship.

4. Identification and Econometric Specification

A. Potential Threats to Identification Strategy

It is well-known that height for age follows a non-linear pattern in developing countries, with older children having worse z-scores than younger ones (Martorell and Habicht 1986). Since height for age is a stock variable, reflecting current and past health investments, older children accumulate a larger deficit during their lives, resulting in lower height for age compared to younger children. Panel B in Table 2 indicates that children exposed to the conflict are older than non-exposed children (average age of 19.09 months for non-exposed children, 31.40 months for the least war exposed children, and 45.25 months for the most war exposed children). Therefore, the relationship between conflict and height in Panel A may simply reflect that children exposed to the conflict are on average older than non-exposed children. We next present preliminary evidence that the conflict-health relationship is not due to this differential age pattern.

In the second row of Table 2 Panel B, we compare average height for age z-scores for children exposed and not exposed to the civil war but restricted to children less than or equal to 24 months old. The average height for age z-score for young non-exposed children is -2.128, while it is, respectively, -2.310 and -2.677 for young children with limited or extensive war exposure. The difference between non-exposed and extensively exposed young children of 0.549 standard deviations is statistically significant at the one percent level. The same pattern is seen if the data are restricted to children greater than 24 months old. In the third row of Table 2 Panel B, the older most-exposed children have an average height for age z-score of -2.781, the older less-exposed children have an average z-score of -2.100, while the older non-war exposed children have an average z-score of -1.979. There is a difference of 0.802 standard deviations between the most-exposed and non-exposed older children and this difference is significant at the ten percent level. The results provide suggestive evidence that the conflict impact on health is not solely due to older children being more likely to be exposed to the war, as results within each age category show a large significant war impact on children's height for age z-scores. In the subsequent regression analysis, we control for potential age effects by including year of birth fixed effects.

Related to the non-linear age pattern and its relationship with conflict and health is the role of poverty as a potential alternative explanation for the war-health link. Following Duflo's (2003) argument, older children in poor regions (or households) are shorter than older children in non-poor regions because they accumulate a larger poverty-induced height deficit. Conversely, younger children in poor regions will look more similar in height to younger children in non-poor regions because they have not had time to develop large height deficits. Therefore, if the war affected mostly poor provinces, then we would falsely attribute this observed lower height for age z-score to the war, when in fact it is due to the region's poverty status.

In the first row of Panel C in Table 2, we present average height for age z-scores for exposed and non-exposed children in only the poor provinces. A province is defined as being poor if the 1990 pre-war poverty headcount (percentage poor) is above the national average of 36.2 percent.[24] Within the poor provinces, children not exposed to the war have an average height for age z-score of -1.969, while children in poor provinces who have limited or extensive war exposure have an average height for age z-score of -2.097 or -2.580, respectively. The difference between no exposure and extensive war exposure of 0.611 standard deviations is statistically significant at the one percent level. Similarly, within non-poor provinces, children with extensive conflict exposure have 0.828 standard deviations lower height for age z-scores than non-exposed

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24 Table 1 column 6 presents the pre-war poverty headcount for each province with variation ranging from Karuzi with 66.8 percent of the population in poverty to Cibitoke with a 19.6 percent rate (Bundervoet 2006).

children, a difference that is statistically significant at the one percent level. These results suggest that poverty is unlikely to be the driving force behind the observed lower height for age z-scores of children in civil war regions.

Several additional pieces of evidence indicate that children exposed to the war were not living in predominantly worse-off provinces. First, a higher percentage of children were exposed to the conflict in non-poor provinces (69.03) compared to poor provinces (53.49), and the difference across regions is statistically significant at the one percent level. Second, provinces that experienced fighting earlier had lower average poverty headcount rates than provinces that became involved in the war later (31.16 versus 37.99 percent). Third, when the war started in 1994, the first affected provinces (Cibitoke, Bubanza, and Bujumbura Rural) were among the richest in Burundi and were ranked first, second, and fifth respectively in a 1990 pre-war welfare ranking (Republic of Burundi, 2003). Taken together, the evidence strongly suggests children exposed to the war were not predominantly in worse-off provinces and that conflict may have had a negative causal impact on their health. In the subsequent regressions, we include province fixed effects to control for any potential province differences.

The conflict-height relationship in Panel A could also reflect that exposed and non-exposed children have different characteristics or come from different types of households. To examine this possibility, in Table 3, we present tabulations of the child's gender, head of household's education, presence, literacy, occupation, age, and marital status broken down by the exposure duration of the child. For most characteristics, there are no significant differences between exposed and non-exposed children. The exception to this is for the marital status for the head of households with exposed children. These head of households are significantly less likely to be married and are more likely to be widowed, a direct impact of the civil war. In the regression analysis, we include child and household controls to capture any potential differences.

B. Econometric Specification

The empirical identification strategy can be illustrated by examining the nonparametric relationship between height for age z-scores and the number of months of exposure to the civil war. In Figure 3, we estimate a kernel-weighted local polynomial regression of height for age z-scores on months of war exposure using an Epanechnikov kernel. For those children not exposed to the civil war, months of war exposure takes the negative value of the child's age in months minus six months, so that the youngest non-exposed child is considered to have zero months of war exposure (note that only children older than six months were included in the anthropometrics survey). For non-exposed children, the figure shows the previously discussed expected relationship between age and height for age z-scores with older children having lower z-scores than younger children. More importantly, the figure shows a considerable drop in average height for age z-scores for children exposed to additional months of conflict.

To build on Figure 3 and the previous tabulations, we first estimate the following baseline province and birth cohort fixed effects regressions:

(1) $HAZ_{ijt} = \alpha_j + \delta_t + \beta_1 (Conflict\ Province_j * Exposure_t) + \varepsilon_{ij}$

where HAZ_{ijt} is the height for age z-score for child i in province j who was born in time period t, α_j are the province fixed effects, δ_t are birth cohort fixed effects that are defined by the year in which the child is born, and ε_{ijt} is a random, idiosyncratic error term.[25] We calculate the *Conflict Province* $_j$ * *Exposure* $_t$ variable first as a binary measure to indicate a child born in a province that experienced conflict and who was alive during the war, and second, as a continuous measure to indicate for a child born in a province that experienced conflict the duration (in months) of exposure to the war. In regressions only including the binary exposure variable, β_1 measures the impact of war on children's health for children who were alive during the conflict and living in regions that experienced this negative shock. In regressions only including the continuous exposure duration variable, β_1 measures the impact on children's health of an additional month of war exposure. Including all provinces in the regressions allows us to exploit both temporal variation in the timing of the conflict and regional variation across provinces that did not experience war to identify the war's causal impact on children's height. We evaluate whether children born in conflict provinces in years when fighting took place have lower height for age z-scores than their peers born after them, relative to those who are born in other regions in the same year. In the robustness specifications in which we restrict the sample to only those provinces that experienced conflict, identification of the impact comes from comparing, within a given province, children who were alive during the war with those not yet born, and therefore only the timing of the conflict is exploited.

The identification strategy is valid as long as changes over time in average height for age z-scores would be similar across provinces in the absence of the war. Specifically, the strategy

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25 Correlation among the error terms of children in a given province experiencing the same shocks might bias the OLS standard errors downward, so in all regressions we cluster the standard errors by birth province (Moulton 1986; Bertrand, Duflo, and Mullainathan 2004).

might be flawed if the timing or duration of the conflict followed a particular pattern in terms of province-level characteristics that are related to changes in height for age z-scores. For instance, if the provinces that experienced the fighting earlier had less educated households and education is correlated with children's height for age, then we would wrongly find an effect of the war, when the negative health impact was actually due to education differences across provinces. In Table 4, we assign provinces into three categories based on Figure 1 (provinces that did not experience civil war, provinces where the war began early and provinces where the war began late) and find that along observable dimensions, these three groups of provinces do not appear to be significantly different.[26] There are no statistically significant differences across the three groups in household-level characteristics (head of household education, present in the household, literate, age and marital status) or child-level characteristics (child's gender, age, and percentage exposed to the civil war). The exception to these results is seen in the early war provinces, which had a lower fraction of household heads whose main occupation was farming, which is consistent with those provinces being richer as previously discussed.

To address these potential differential time trends across provinces, we estimate the following equation that includes a province specific time trend in addition to province and birth cohort fixed effects (for a similar empirical strategy see Banerjee et al, 2007):

(2) $HAZ_{ijt} = \alpha_j + \delta_t + \beta_1 (Conflict\ Province_j * Exposure_t) + Province\ Trend_{jt} + \varepsilon_{ijt}$

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26 The division between early and late civil war provinces is based on the Figure 1 groupings. Bubanza, Bujumbura Rural, Cibitoke, Ngozi and Kayanza (groups 1 and 2 in Figure 1) are considered early civil war provinces since the war started there by January 1995. Ruyigi, Karuzi, Muyinga, Bururi, Muramvya, Kirundo, and Gitega (groups 3 and 4 in Figure 1) are considered late civil war provinces as the war did not begin there until mid-1995.

where the variables are as previously defined and *Province Trend* $_{jt}$ is defined as a province specific time trend to capture potentially different time patterns in each province. The inclusion of this time trend buttresses the argument that changes in average height for age z-scores in these provinces would have been similar in the absence of the civil war.

5. Empirical Results

A. Baseline Regressions

Table 5 presents the regression results for equations 1 and 2. Each regression includes province dummies, year of birth cohort dummies, and the interaction of child gender and year of birth cohort dummies. All regressions are weighted using survey sampling weights. The variables of interest are the binary civil war conflict shock and the continuous months of exposure measure. Results in column 1 show a negative impact of the binary civil war variable on children's health. Those children exposed to the war have a height for age z-score 0.348 standard deviations lower than non-exposed children, a reduction that is statistically significant at the five percent level.[27]

27 Our analysis likely underestimates the conflict's true health impact for several reasons. First, we do not have data for children who died prior to the 1998 survey and these deceased children were likely the weakest and smallest. The reported effects should be interpreted as the war's impact on a child's health, conditional on the child surviving to be recorded in the survey. Second, children's age could be mismeasured, and if this occurred, it would likely mean our estimates are lower bounds for the true impact, as parents would probably underreport the age of short children making their malnutrition seem less severe than it actually is. The likelihood of mismeasurement is reduced since the household roster collected the exact dates of birth of all the household's children and misreporting on one child would be more difficult as such misreporting would influence the dates of birth of all the household's other children. Third, if a child was in utero during the conflict but born after the war ended, this child is not considered exposed to the conflict, but to the extent the child was negatively affected in utero (mother's pregnancy nutrition could have been worse), we will underestimate the true impact, as some of the 'control' group was negatively

This baseline regression provides evidence of a negative impact of conflict on children's height for age, controlling for province and birth cohort times gender fixed effects, but these results could be due to omitted province specific time trends or household characteristics. In column 2, we include additional household controls in the regression, such as whether the household head is educated, female, or a farmer and the household head's age and marital status. We also include a province specific time trend to control in a flexible manner for the potentially differential time trend in each province. Adding these controls yields consistent results, with exposed children experiencing 0.525 standard deviations lower height for age z-scores, and the coefficient is significant at the five percent level. In addition, children in households with educated heads have better height for age z-scores.[28]

In columns 3 and 4 we replicate the previous analysis using the continuous months of war exposure variable. The duration of war exposure has a strong negative impact on children's height for age z-scores and is significant at the one percent level in both specifications. An additional month of war exposure reduces a child's height for age z-score by 0.057 standard

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impacted by war yet we still find a significant effect. Fourth, to the extent the war has long-lasting impacts (health, market, and road infrastructure are not immediately rebuilt when the war ends), then children born after the war ended in a conflict region could still be affected by the war, meaning we would underestimate the true conflict impact.

28 The positive correlation between parent education and child health is among the most persistent findings in the empirical literature on child health production functions (see Strauss and Thomas (1998) for an overview).

deviations (based on the regression that includes a province specific time trend and household characteristics).[29]

In column 6 we present the results of our preferred specification that includes both the binary exposure to any conflict variable and the continuous months of conflict exposure variable. We include province fixed effects, year of birth cohort fixed effects, the interaction of child gender and year of birth cohort fixed effects, household characteristics, and a province specific time trend.[30] An additional month of war exposure decreases a child's height for age z-score by 0.047 standard deviations and the coefficient is significant at the one percent level. The impact of the exposure to any conflict variable is still negative and similar in magnitude to the earlier regressions, but it is no longer significant. This regression that includes both the exposure to any conflict variable (acting as an 'intercept' term) and the months of conflict variable (acting as a 'slope' term) indicates that much of the war's negative impact on child health is cumulatively built up over time as the months of exposure increases and is not a level effect of only being exposed to the war. Using these coefficients, children exposed to the conflict for the average duration of 14.7 months will have 0.314 standard deviations lower height for age z-scores due to a level effect and an additional decrease of 0.691 standard deviations due to an exposure duration effect. These results provide the strongest evidence that children exposed to the civil war experience a negative impact of the conflict that lowers their height for age z-scores.

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29 We discuss the household fixed effects regression in column 5 in the robustness check section 5.2.

30 We also estimate this regression using two alternative province specific trends, one that controls for a differential time trend across poor and non-poor provinces and one that controls for a differential time trend across the war regions based on the Figure 1 groupings. Results are consistent.

B. Robustness Checks

To confirm the war effect's robustness, we discuss the results of three alternative specifications. First, we estimate a household or sibling fixed effects model and present the results in column 5 in Table 5. Results are consistent with our preferred specification indicating an additional month of war exposure lowers height for age z-scores by 0.048 standard deviations. The sibling difference model is able to control for time invariant household characteristics that are common to all children in the household (for instance parent's preferences, discount rate, or ability), but note that identification in this regression is driven only by the 176 households that have multiple children with at least one child exposed to the war and one child not exposed to the war.

Second, we test if results are consistent if only the temporal variation in the timing and duration of the conflict is exploited by restricting analysis to alternative province samples. This is done because the two provinces (Cankuzo and Rutana) that did not experience civil war and therefore had no exposed children and the three provinces (Bubanza, Bujumbura Rural, and Cibitoke) in which all children were exposed to the war might be systematically different than the provinces in which only some children were exposed to conflict. Identification of the impact in this robustness check comes from comparing, within a given province, children who were alive during the war with those not yet born, and therefore only the time of the conflict is exploited. Results that drop the no-children exposed war provinces or the all-children exposed war provinces are consistent with our preferred specification indicating an additional month of war exposure reduces height for age z-scores by 0.044 or 0.040 standard deviations, respectively. These results provide strong evidence of the validity of the baseline identification strategy to measure the causal impact of civil war on children's health status and the lack of any province-level selection bias in exploiting both the variation across provinces (spatial variation) and the variation within each province of the timing and duration of conflict (temporal variation).

Third, the child development literature suggests child stunting usually occurs between 0 and 24 months of age and is considered permanent, with minimal catch-up growth at older ages (Martorell 1999; Shrimpton et al. 2001). As a robustness check to our preferred regression, we use an alternative conflict shock definition in which only children aged 0 to 24 months old when the conflict occurred in their province are considered exposed to the shock, and children older than 24 months in a province that experienced conflict are not considered exposed to the war. Using this critical age restriction to replicate the Table 5 regressions yields consistent results.

C. Discussion of War Impact Mechanisms

Understanding the specific mechanisms by which the war impacts child health is critical for developing adequate policy responses to protect children from the negative conflict effects. Unfortunately, this study's data are not sufficiently rich to disentangle these channels and conclude which mechanism exclusively drove worse child health for children exposed to the war. To convincingly answer this question, one would need detailed household level data on crop production and assets (including the timing and magnitude of thefts), information about the extent and duration of displacement (including changes in nutrition and exposure to disease or resettlement camps), as well as detailed conflict event data at the household and village level to measure war exposure, and child anthropometrics at multiple points in time to capture changes in short and long-run health indicators. Despite the inability to completely disentangle these mechanisms, based on our empirical results and localized case studies conducted by NGOs during and immediately after the war ended, we can begin to speculate on which mechanisms were qualitatively more important in the context of the Burundi civil war.

Our results suggest that looting of household assets, particularly livestock, is unlikely to be the main channel through which war impacts child height for age z-scores. Recent research sheds doubt on the ability of households to use buffer stocks for consumption smoothing during crisis times such as drought (Kazianga and Udry 2006) or war (Verpoorten 2008), implying that even households who had livestock holdings would have experienced difficulty protecting their children's health during the war. The theft of livestock during war would make a household poorer, but such a loss would likely negatively affect all children (those born during as well as after the conflict) as it takes time and money to rebuild herds, and this is not consistent with our empirical results in columns 1 and 2 in Table 5 in which only children born during the conflict are impacted. However, this is only suggestive evidence against the asset theft mechanism, as the results in our preferred specification (column 6) that include the binary exposed to any conflict variable and the months of exposure variable suggest there is a level effect between exposed and non-exposed children but the coefficient is not significant at standard levels, meaning we cannot entirely exclude this mechanism.[31]

Our results seem to offer more support for two other channels through which conflict may affect child health: violence-induced displacement and the theft and burning of crops. Both

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31 Finally, the asset theft mechanism, by making households poorer, means exposed children would accumulate more poverty-induced height deficit (as discussed previously), which is consistent with our empirical results, but it is unlikely that the continuous months of exposure variable would show such an impact in response to asset theft.

mechanisms negatively affect nutrition and displacement also makes exposed children more vulnerable to water and vector-borne diseases. A child exposed to these events would be worse-off compared to a child who did not experience these shocks and we would expect the adverse impact to be larger the longer the child is exposed to it. The results in columns 1 to 4 in Table 5 are compatible with this reasoning, while the results of our preferred specification are also suggestively consistent with it.[32] Moreover, these mechanisms are consistent with the observations of human rights organizations that found that malnutrition was most prevalent among people who had been displaced and were therefore unable to farm (HRW 1998).

6. Conclusions

In this paper, we combine detailed event data about the timing and location of armed conflict with household survey data to examine the impact of the civil war in Burundi on the health status of young children who were exposed to it. The empirical identification strategy exploits variation in the timing of the civil war across Burundi's provinces and the related variation in which birth cohorts of children were exposed to the fighting and the duration of their exposure. We estimate a child health status regression including cohort of birth fixed effects, province of residence fixed effects, and province specific time trends and find that the civil war had a significant adverse effect on height for age z-scores. Research by non-governmental organizations (Doctors Without Borders 2004) finds that children are among the most affected by conflict and the identification strategy used in this paper allows us to empirically confirm and quantify the magnitude of this

32 However, the effect is unlikely to be solely due to a lack of food as related Rwanda research (Akresh, Verwimp, and Bundervoet 2007) shows a markedly different effect on children's health due to crop failure as opposed to conflict.

negative war impact on children. Children exposed to the conflict during their lives have a height for age z-score that is reduced by 0.047 standard deviations for each additional month of war exposure compared to non-exposed children, and for children exposed to the war for the average exposure duration they will have one standard deviation lower height for age z-scores than non-exposed children. This causal effect of war on children's health is robust to the inclusion of a variety of household level control variables, province time trends, different definitions of conflict exposure, sibling fixed effects estimation, and alternative sample specifications that exploit only variation in the timing of the crisis.

The empirical results show that exposure to war during early childhood significantly affects children's health outcomes and the longer the exposure, the larger the impact. The negatively impacted health status of Burundian children could lead to adverse welfare effects in the long-run. Recent research has shown that chronic malnutrition during childhood (measured by height for age) is associated with substantially less schooling during adolescence, worse adult health, and lower adult productivity. Hence, it is likely that the civil war, by negatively affecting child health, will reduce the future welfare levels of these children.

To speculate on the magnitude of this long-run impact, we use the estimated coefficients from the Alderman, Hoddinott, and Kinsey (2006) paper on Zimbabwe that links child health and schooling and the Appleton (2001) paper on Uganda that calculates individual returns to primary education combined with our measurements of the size of the negative war impact on Burundian children's health. A Burundi child exposed to the conflict for the average duration will have a 0.314 standard deviation lower height for age z-score due to a level effect and an additional decrease of 0.691 standard deviations due to an exposure duration effect. Using the estimates from the Zimbabwe paper (Alderman, Hoddinott, and Kinsey 2006), this total one standard deviation reduction in height effect will translate into 0.678 fewer grades completed and an increase of 4.8 months in the age at which children start school. Using the individual returns to primary education based on data from Uganda (Appleton 2001), this foregone schooling due to the Burundi civil war will translate into a 20.5 percent reduction in expected adult wages. Following the end of conflict, improved child health should be a tangible peace dividend, although there will still be a generation of children who were exposed to the conflict and it is likely that the civil war in Burundi (and civil wars in general) will continue to have adverse effects for these children long after the fighting ends.

Appendix 1: Potential Selection Bias for Missing Children

The 1064 rural households in the Priority Survey that were randomly selected for the anthropometrics survey and have children under age five provide data on 1442 children between 6 and 60 months of age. There are 214 children who cannot be included in the child health analysis because of missing height data.[33] An additional 32 children are excluded from the analysis due to measurement errors in either height or age (for instance a height of 775 cm or an age of 326 months).[34] These 246 children with missing information potentially pose a selection bias problem. We use two alternative approaches to evaluate this problem and find consistent results indicating selection bias is unlikely to be a significant concern.

The first approach is to compare the 1196 children who were included in the analysis with the 246 excluded children along as many observable dimensions as possible. Results for this comparison are presented in Appendix Table 1, Panel A, which shows the mean differences in covariates for the included and excluded children. The children appear to come from similar types of households, with the percentage of household head's education level, occupation, presence, literacy, age, gender, and marital status not showing any significant differences across the two groups. Average age and gender of the child also appear to be similar for both groups of children. Finally, the excluded children are no more likely to have been exposed to the civil war shock. Since none of the covariates are significantly different across the two groups of children,

33 The survey does not provide any reason for this non-measurement of certain children.

34 We adopt the approach of Alderman, Hoddinott, and Kinsey (2006) in excluding all children with a height for age z-score of less than -6 or greater than 6, as these extreme scores are probably due to measurement errors.

this suggests that, at least along observable dimensions, selection effects are likely to be minimal or absent.

The second approach modifies the method proposed by Fitzgerald, Gottschalk, and Moffit (1998) to analyze attrition in a panel data setting. In Appendix Table 1, Panel B, we present results of a probit regression analysis where the dependent variable is the probability of being included in the sample. For the 1196 children included in the health analysis, the variable is coded one and for the 246 excluded children, it is coded zero. We examine whether the civil war shock influences the probability of being included in the sample. If the shock has a significant impact on the probability of being included, then the parameter estimates in our subsequent analysis are likely to be biased. In column 1, we estimate the probability of being included in the sample as a function only of the civil war shock, and the resulting coefficient is small and insignificant. In column 2, we add province and year of birth cohort fixed effects, as in Table 5, and the coefficient for the civil war shock remains insignificant. Finally, in column 3, in addition to province and year of birth cohort fixed effects, we include a province specific time trend. The civil war coefficient remains insignificant. From these results, we conclude that the civil war does not have a significant impact on the probability of being excluded from the sample and therefore any selection effects are likely to be small.

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Table 1
Overview of Nutritional Status and Poverty, By Province

Province	N (1)	Average Height for Age Z-Score (2)	Not Malnourished (Percentage) (3)	Moderately Malnourished (Percentage) (4)	Severely Malnourished (Percentage) (5)	Poverty Headcount in 1990 (Percentage Poor) (6)
Bubanza	9	-2.28	43.8	26.8	29.4	22.4
Bujumbura Rural	9	-3.15	35.0	7.2	57.7	25.7
Bururi	106	-1.67	62.6	21.6	15.8	37.7
Cankuzo	43	-2.18	37.2	28.7	34.1	25.1
Cibitoke	34	-1.54	65.1	21.2	13.7	19.6
Gitega	165	-2.44	34.1	32.3	33.6	35.2
Karuzi	85	-2.29	42.1	19.4	38.5	66.8
Kayanza	146	-2.72	24.6	33.3	42.1	44.9
Kirundo	87	-2.40	35.1	35.3	29.5	34.0
Muramvya	110	-2.03	49.3	25.6	25.1	24.0
Muyinga	123	-2.25	39.3	25.0	35.7	27.8
Ngozi	149	-2.58	29.4	31.6	39.1	42.5
Rutana	65	-1.99	48.5	25.2	26.2	58.0
Ruyigi	65	-2.43	39.7	24.4	35.8	41.0
Rural Burundi	1196	-2.32	39.4	27.4	33.2	36.2

Notes: The incidence of malnutrition is divided into three separate groups: not malnourished in which height for age z-scores are greater than -2, moderately malnourished in which height for age z-scores are between -3 and -2, and severely malnourished in which height for age z-scores are less than -3. The poverty headcount measures the percentage poor in that province using 1990 pre-war data. Data source for health status: World Bank and Burundi Statistics Institute 1998 Priority Survey. Data source for poverty headcount measures: Republic of Burundi and World Bank (1995).

Table 2
Height for Age Z-Scores, By Province, Age Distribution, Poverty Levels, and Civil War Exposure

Average Height for Age Z-scores	Child Not Exposed to Civil War (n=489)	Child With Months of Civil War Exposure Below Mean (n=295)	Child With Months of Civil War Exposure Above Mean (n=412)	Mean Difference
	(1)	(2)	(3)	(1)-(3)
Panel A: By Province				
Bururi	-1.176	-2.085	-1.842	0.666*
	[0.223]	[0.270]	[0.271]	[0.351]
Gitega	-2.068	-2.466	-2.672	0.603**
	[0.218]	[0.247]	[0.159]	[0.270]
Karuzi	-1.898	-2.022	-2.863	0.965
	[0.342]	[0.368]	[0.515]	[0.619]
Kayanza	-2.703	-2.263	-3.145	0.442*
	[0.181]	[0.196]	[0.186]	[0.260]
Kirundo	-2.329	-1.995	-2.751	0.423
	[0.201]	[0.231]	[0.243]	[0.315]
Muramvya	-1.369	-2.144	-2.463	1.094***
	[0.240]	[0.280]	[0.225]	[0.329]
Muyinga	-1.824	-2.056	-2.869	1.045***
	[0.203]	[0.493]	[0.200]	[0.285]
Ngozi	-2.199	-2.784	-3.083	0.884***
	[0.178]	[0.199]	[0.198]	[0.266]
Ruyigi	-1.881	-2.487	-3.285	1.404**
	[0.252]	[0.295]	[0.626]	[0.675]
All Rural Provinces Burundi	-2.009	-2.276	-2.681	0.672***
	[0.074]	[0.094]	[0.097]	[0.122]
Panel B: Age Distribution				
Child’s Age (in months)	19.09	31.40	45.25	-26.16***
	[0.495]	[0.761]	[0.668]	[0.832]
Average Height for Age Z-Scores for Young Children	-2.128	-2.310	-2.677	0.549***
	[0.153]	[0.102]	[0.099]	[0.183]
Average Height for Age Z-Scores for Old Children	-1.979	-2.100	-2.781	0.802*
	[0.084]	[0.230]	[0.461]	[0.469]
Panel C: Province-level Poverty				
Average Height for Age Z-scores, Poor Provinces	-1.969	-2.097	-2.580	0.611***
	[0.102]	[0.151]	[0.115]	[0.154]
Average Height for Age Z-scores, Non-poor Provinces	-2.036	-2.426	-2.863	0.828***
	[0.102]	[0.114]	[0.175]	[0.203]

Notes: Robust standard errors in brackets. *** significant at 1%; ** significant at 5%; * significant at 10%. For children exposed to the war, the average months of war exposure is 14.7

months. In Panel A, Cankuzo and Rutana are not separately reported since no children in those provinces were exposed to the war and Bubanza, Bujumbura Rural and Cibitoke are not separately reported since all children in those provinces were exposed to the war. In Panel B, children less than or equal to 24 months are considered young. Provinces are defined as poor if the province's poverty headcount (using 1990 pre-war data) is greater than the national average of 36.2 percent. Data source: World Bank and Burundi Statistics Institute 1998 Priority Survey.

Table 3
Household and Child Characteristics, By Civil War Exposure

Variables	Child Not Exposed to Civil War (n=489)	Child With Months of Civil War Exposure Below Mean (n=295)	Child With Months of Civil War Exposure Above Mean (n=412)	Mean Difference	Mean Difference
	(1)	(2)	(3)	(1)-(2)	(1)-(3)
Female Children	53.57	53.62	49.94	-0.05	3.63
	[2.63]	[3.53]	[3.12]	[4.40]	[4.07]
Household Head Is Educated	36.34	34.28	32.37	2.06	3.97
	[2.46]	[3.24]	[2.86]	[4.07]	[3.77]
Household Head Not Present	2.43	4.25	2.50	-1.82	-0.07
	[0.65]	[1.26]	[0.70]	[1.42]	[0.95]
Household Head Is Literate	50.55	43.55	45.54	7.00	5.01
	[2.67]	[3.42]	[3.08]	[4.34]	[4.07]
Farming Is Household Head's Occupation	88.06	82.85	85.48	5.22	2.58
	[1.54]	[3.42]	[2.61]	[3.75]	[3.03]
Household Head's Age	37.54	39.28	39.64	-1.74	-2.10*
	[0.57]	[1.38]	[1.02]	[1.49]	[1.17]
Household Head Is Married	92.28	85.27	86.78	7.01***	5.50**
	[1.34]	[2.28]	[1.87]	[2.65]	[2.30]

Notes: Robust standard errors in brackets. *** significant at 1%; ** significant at 5%; * significant at 10%. For children exposed to the war, the average months of war exposure is 14.7 months. Data source: World Bank and Burundi Statistics Institute 1998 Priority Survey.

Table 4
Observable Characteristics Across Regions

Variables	No Civil War Provinces (n=108) (1)	Early Civil War Provinces (n=347) (2)	Late Civil War Provinces (n=741) (3)	Mean Difference (1)-(2)	Mean Difference (2)-(3)
Female Child	47.34	50.22	53.99	-2.88	-3.77
	[5.05]	[3.31]	[2.24]	[6.04]	[3.99]
Child's Age (in months)	30.67	31.26	32.03	-0.60	-0.77
	[1.44]	[1.11]	[0.69]	[1.82]	[1.30]
Household Head Is Educated	39.95	32.40	34.69	7.55	-2.30
	[4.99]	[2.92]	[2.10]	[5.79]	[3.60]
Household Head Not Present	4.00	2.06	3.22	1.94	-1.16
	[1.97]	[0.66]	[0.66]	[2.08]	[0.93]
Household Head Is Literate	50.63	48.45	45.72	2.18	2.73
	[5.06]	[3.29]	[2.22]	[6.03]	[3.97]
Farming Is Household Head's Occupation	86.71	79.18	89.20	7.53	-10.02***
	[3.46]	[3.52]	[1.22]	[4.93]	[3.72]
Household Head's Age	38.67	39.47	38.36	-0.80	1.11
	[1.19]	[1.48]	[0.45]	[1.90]	[1.55]
Household Head Is Married	90.55	87.85	88.62	2.70	-0.77
	[3.21]	[1.93]	[1.30]	[3.75]	[2.33]
Civil War Conflict Shock (Percentage Exposed)	0.00	60.24	64.54	N/A	-4.31
	[0.00]	[2.96]	[2.19]		[3.68]

Notes: Robust standard errors in brackets. *** significant at 1%; ** significant at 5%; * significant at 10%. Cankuzo and Rutana are the provinces that did not experience civil war. The division between early and late civil war provinces is based on the groupings in Figure 1. Bubanza, Bujumbura Rural, Cibitoke, Ngozi and Kayanza (groups 1 and 2 in Figure 1) are considered early civil war provinces since the war started there by January 1995. Ruyigi, Karuzi, Muyinga, Bururi, Muramvya, Kirundo, and Gitega (groups 3 and 4 in Figure 1) are considered late civil war provinces as the war did not start there until mid-1995. Results are robust to alternatively moving the group 3 provinces (where the war started in mid-1995) to the early civil war category. Civil war conflict shock indicates a child born in a province that experienced conflict and who was alive during the war. In calculating the percentage exposed to the civil war for the early civil war provinces, the 52 children in Bubanza, Bujumbura Rural, and Cibitoke are excluded as all children were exposed to the war. Data source: World Bank and Burundi Statistics Institute 1998 Priority Survey.

Table 5
Determinants of Anthropometric Outcomes in Rural Burundi

Dependent variable: Children's Height for Age Z-Score	(1)	(2)	(3)	(4)	(5)	(6)
Months of Civil War Exposure			-0.035***	-0.057***	-0.048**	-0.047***
			[0.011]	[0.014]	[0.022]	[0.017]
Civil War Conflict Shock	-0.348**	-0.525**			-0.162	-0.314
	[0.174]	[0.211]			[0.330]	[0.237]
Household Head Is Educated		0.250**		0.237**		0.241**
		[0.102]		[0.103]		[0.104]
Female Child		0.330		0.303		0.309
		[0.360]		[0.370]		[0.369]
Female-Headed Household		0.038		0.044		0.056
		[0.337]		[0.330]		[0.331]
Farming Is Household Head's Occupation		-0.078		-0.078		-0.086
		[0.125]		[0.131]		[0.130]
Household Head's Age		-0.001		-0.001		-0.001
		[0.003]		[0.003]		[0.003]
Household Head Is Married		-0.121		-0.092		-0.097
		[0.336]		[0.326]		[0.324]
Province Fixed Effects?	Yes	Yes	Yes	Yes	No	Yes
Year of Birth Cohort Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes
Female*Year of Birth Cohort Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes
Province Specific Time Trend?	No	Yes	No	Yes	No	Yes
Household Fixed Effect?	No	No	No	No	Yes	No
Number of children	1196	1196	1196	1196	1196	1196

Notes: Robust standard errors in brackets, clustered at province level. *** significant at 1%, ** significant at 5%, * significant at 10%. All provinces are included in the regressions. All regressions include province dummies, year of birth cohort dummies, and the interaction of child gender and year of birth cohort dummies. Regressions are weighted using survey sampling weights. Civil war conflict shock indicates a child born in a province that experienced conflict and who was alive during the war. Months of civil war exposure measures the number of months a child was alive during the war. In columns 2, 4, and 6, province specific time trends are included to capture potentially different time trends in each province. Data source: World Bank and Burundi Statistics Institute 1998 Priority Survey.

Appendix Table 1
Exploring Potential Selection Bias

Variables	Children Included In Analysis (n=1196) (1)	Children with No Height Recorded or Measurement Error in Height for Age Z-score (n=246) (2)	Mean Difference (1)-(2)
Panel A: Observable Differences			
Female Child	52.76	54.07	-1.31
	[1.44]	[3.18]	[3.50]
Child's Age (in months)	31.59	30.17	1.41
	[0.42]	[0.99]	[1.03]
Household Head Is Educated	34.95	37.40	-2.45
	[1.38]	[3.09]	[3.35]
Household Head Not Present	3.68	1.63	2.05
	[0.54]	[0.81]	[1.26]
Household Head Is Literate	49.00	49.59	-0.60
	[1.45]	[3.19]	[3.50]
Farming Is Household Head's Occupation	86.54	89.84	-3.30
	[0.99]	[1.93]	[2.35]
Household Head's Age	38.09	37.36	0.73
	[0.31]	[0.74]	[0.77]
Household Head Is Married	88.88	90.24	-1.36
	[0.91]	[1.90]	[2.18]
Civil War Conflict Shock (Percentage Exposed)	59.11	58.13	0.98
	[1.42]	[3.15]	[3.45]

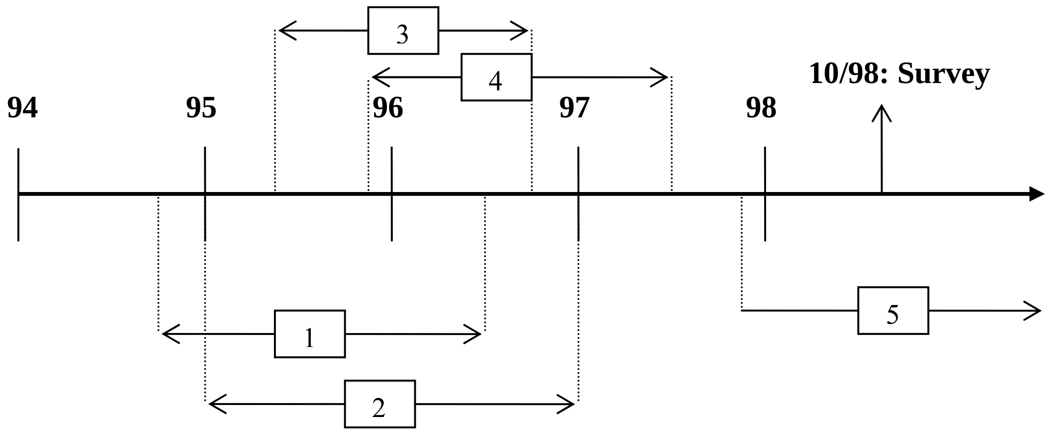
Panel B: Probit Regressions Estimating Probability To Be Included in the Sample, Using Fitzgerald-Gottschalk-Moffit Regression Method

Dependent Variable: Probability To Be Included In Sample	(1)	(2)	(3)
Civil War Conflict Shock	0.023	0.015	-0.060
	[0.123]	[0.126]	[0.136]
Province Fixed Effects?	No	Yes	Yes
Year of Birth Cohort Fixed Effects?	No	Yes	Yes
Province Specific Time Trend?	No	No	Yes
Number of children	1442	1442	1442

Note: Robust standard errors, clustered at province level. *** significant at 1%; ** significant at 5%; * significant at 10%. See Appendix A for additional details on Fitzgerald, Gottschalk, and

Moffit (1998) regression method. Data source: World Bank and Burundi Statistics Institute 1998 Priority Survey.

Figure 1
Spatial and Temporal Intensity of the Conflict

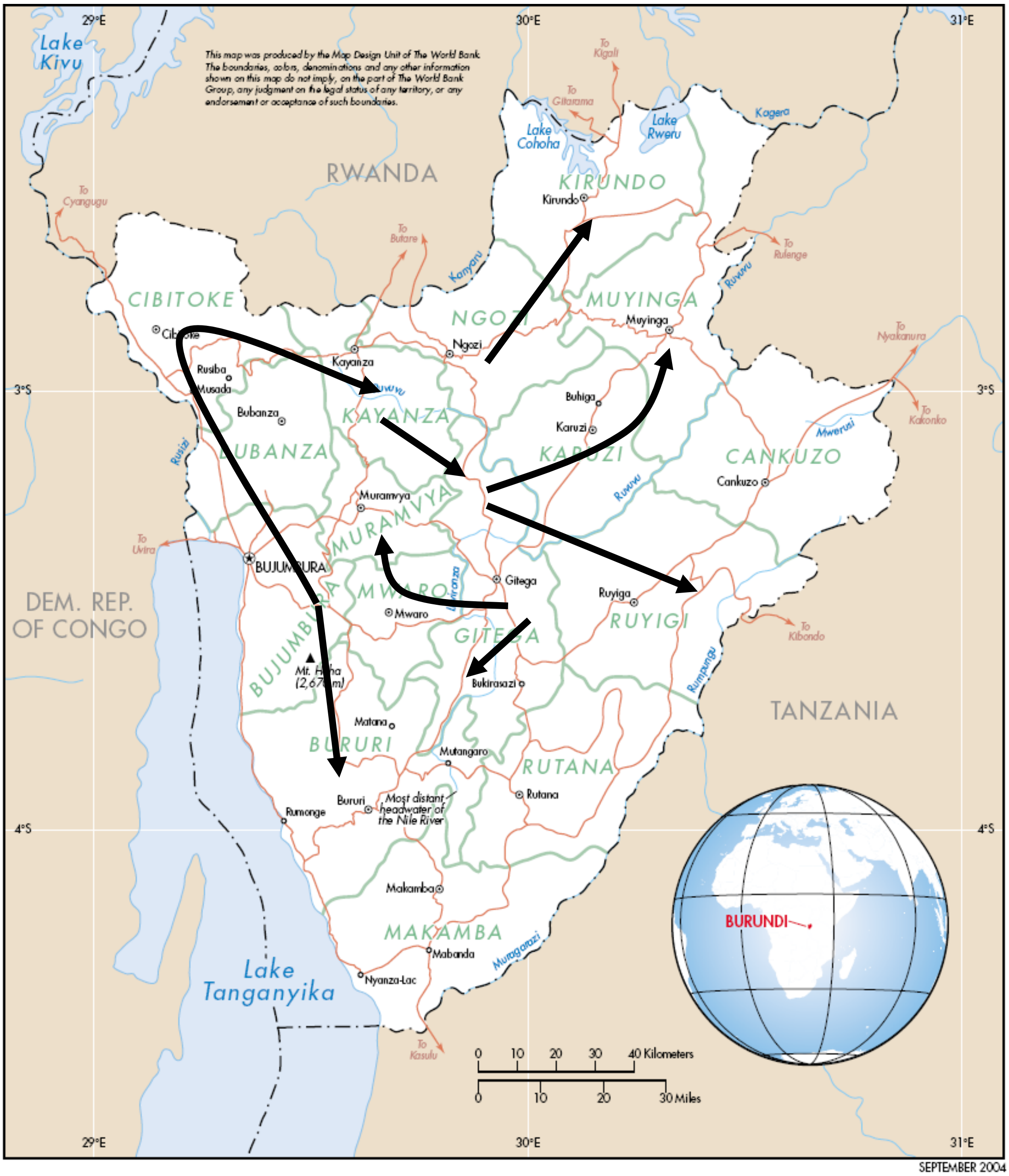


1	Bubanza, Bujumbura Rural, Cibitoke, Ngozi
2	Kayanza
3	Ruyigi, Karuzi, Muyinga, Bururi
4	Muramvya, Kirundo, Gitega
5	Bubanza, Bujumbura rural, Cibitoke

Notes: The provinces of Cankuzo and Rutana (not listed in this figure) did not experience any fighting and therefore no children in these two provinces were exposed to the civil war. Source of the information used to construct the figure is Chrétien and Mukuri (2000).

Figure 2

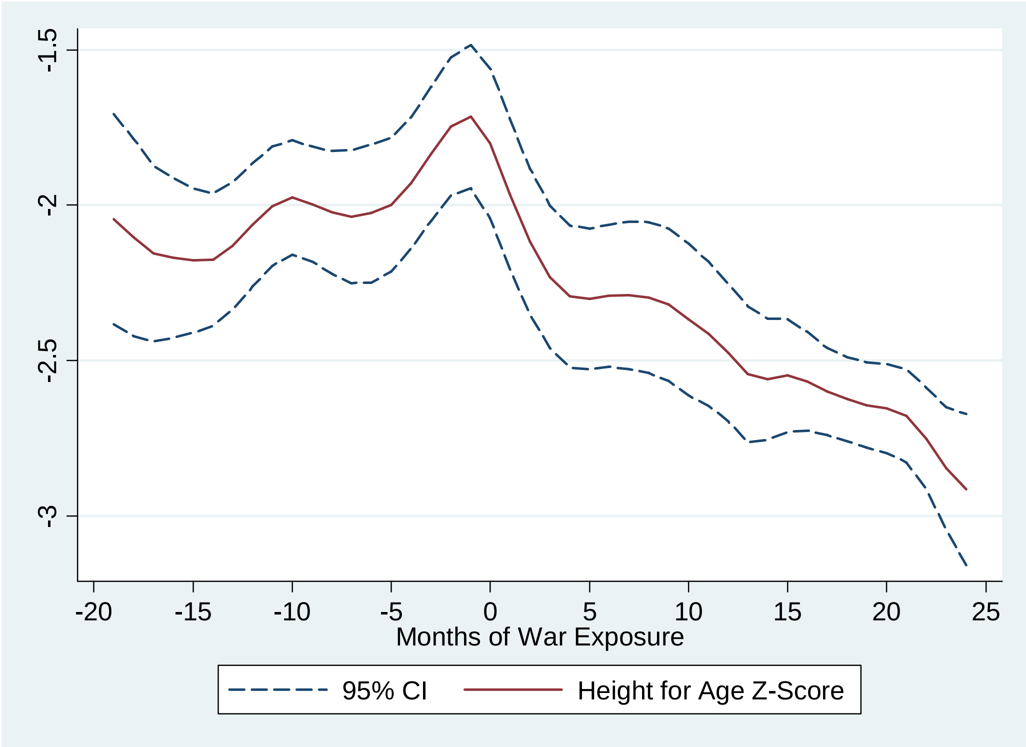
Spread of the Civil War Across the Provinces of Burundi



Notes: The arrows represent the spread of the civil war at the end of 1995 across the provinces of Burundi. Details to construct the spread of the war are from Chrétien and Mukuri (2000).

Figure 3

Height for Age Z-Scores, By Months of War Exposure, Treating Non-Exposed Children as Having Negative Exposure Equal to a Child's Age



Notes: Kernel-weighted local polynomial regression (using Epanechnikov kernel) of height for age z-score on months of civil war exposure. For those children not exposed to the civil war, months of war exposure takes the negative value of the child's age in months minus six months, so that the youngest non-exposed child is considered to have zero months of war exposure (note that only children older than six months were included in the anthropometrics survey). Dashed lines represent the 95 percent confidence bounds, using a bootstrap simulation with 1000 repetitions to estimate the standard errors. Data source: World Bank and Burundi Statistics Institute 1998 Priority Survey.