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Long-term effects of a nutritional shock: the 1980 famine of Karamoja, Uganda

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Long-term effects of a nutritional shock: the 1980 famine of Karamoja, Uganda

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Abstract
This paper uses the 1980 famine in Karamoja, Uganda, as a natural experiment to evaluate its possible long-lasting cognitive and health effects. Results indicate a strong negative impact on the educational attainment of adults exposed to the famine in utero or infancy. They were less likely to be literate and completed less years of education. These negative effects increase (become more negative) when controlling for family-level unobservables. The study exploits the Ugandan 1991 and 2002 censuses provided by the Integrated Public Use Microdata Series - International (IPUMS-I) and conducted by the Uganda Bureau of Statistics. These two unique datasets allow to link the place and date of birth of individuals with the timing and regional variation of the famine.

Keywords : educational attainment, health, fetal origins, famine, Uganda, Africa

JEL Classification : O12, O15, I12, J13, N37, N97.

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1 Introduction

Gestation and childhood are crucial periods for the development of human beings. For instance, the development of the human brain and the central nervous system starts 22 days after conception with the neural tube (Schoenwolf and Smith; 1990). Also, the first five years of life are fundamental for the acquisition of essential cognitive skills (Grantham-McGregor et al.; 2007; Thompson and Nelson; 2001). However, these processes are sensitive to psychosocial, biological and environmental shocks (Cunha and Heckman; 2007; Shonkoff and Phillips; 2000). Therefore, a negative and strong nutritional shock, such as a famine, in the early years of life may cause severe drawbacks on physical and mental development (St Clair et al.; 2005). The main objective of this chapter is to evaluate the possible cognitive and health effects of a famine on young adults who were born in Karamoja, Uganda, during the late seventies.

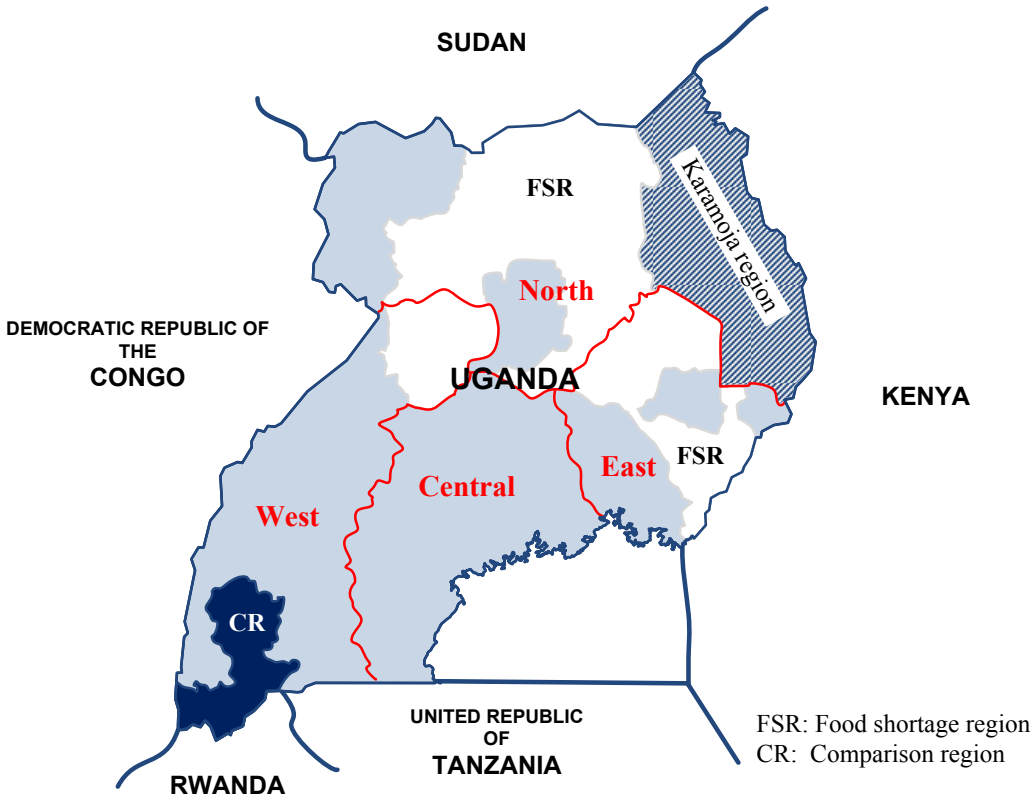
Medical literature has shown that food deprivation during both the fetal and postnatal period retard the growth of the brain and the development of brain neurotransmitter systems (Stoch and Smythe; 1963; Winick; 1969; Wiggins et al.; 1984; Levitsky and Strupp; 1995; Uauy and Dangour; 2006). During pregnancy, for example, the placenta and the fetus development depend on maternal essential fatty acids (EFA), which are provided by a healthy diet. EFA are also essential for the optimum functional maturation of the retina and visual cortex. Infants with higher intakes of EFA have greater mental and psychomotor development scores (Uauy and Dangour; 2006). On the other hand, malnutrition generates permanent alterations in the hippocampus and cerebellum affecting the brain neural receptor function (Levitsky and Strupp; 1995).

Uganda is sub-divided into four regions: Central, East, North and West. Karamoja is located in the eastern part of the North region (Figure 1), and comprises three districts: Kotido, Moroto and Nakapiripirit. This region suffered from a severe famine from January to December 1980. The famine was attributed to various factors such as very low rainfall, violence and political unrest. Some studies suggest that the famine was, in terms of mortality rates, one of the worst in history. Approximately, 20,000 to 50,000 people (14% of the population in Karamoja) died, most of them children (Biellik and Henderson; 1981; Alnwick; 1985).

Karamoja was not the only region affected by the severe drought and the social and political situation in Uganda. According to Okudi (1992), there were also extreme food shortages in the districts of Mbale, Tororo, Lira, Gulu, Kitgum and Masindi. Figure 1 shows the location of these districts, henceforth, food shortage region (FSR) - see the white area.

Using the Ugandan censuses of 1991 and 2002, and the 2006 Demographic and Health Survey (DHS), I evaluate the long-term effects of the famine on the cohort exposed *in utero* and under five years old in Karamoja, 1980. At the time of the 2002 census and the 2006 DHS survey, these people were already adults (22-26 years old or 26-30 years old, respectively). For these

Figure 1: Map of Uganda.



databases, I use measures of cognitive development and health to characterise the impact of the famine. Indicators of cognitive development are: literacy, whether the individual has ever attended school, completion of primary education and total years of education. Measures of health are weight, height, weight-for-height, and whether the individual is under-weight, over-weight or anaemic. The census of 1991 allows the evaluation of famine effects during childhood as the exposed cohort was 10-14 years old at the time of the survey. The cognitive measures for these children are whether the child has ever attended school and whether they were attending school in 1991. I also include two child labour indicators: whether the main activity of the child is working or doing domestic work at home.

This study contributes to the literature on the fetal origins hypothesis (Barker; 1992) and on nutrition and childhood development (Strauss and Thomas; 1998; Glewwe et al.; 2001). In addition, it presents evidence on the long-term effects of a famine in Africa, a continent with frequent spells of food-shortages and food crises. Previous research has mainly focused on famines in Europe (van den Berg et al.; 2007; Roseboom et al.; 2006) or Asia (Almond et al.; 2007; Chen and Zhou; 2007; Meng and Qian; 2009). The only exception is Porter (2009) who explores the long-term impact of the Ethiopian famine on the height of children ten years after the famine. Finally, this study exploits the Ugandan 1991 and 2002 censuses provided by

IPUMS-I[1], two unique datasets which allow to link the place and date of birth of individuals with the timing and regional variation of the famine.

Results indicate that the educational attainment of people who were exposed to the famine *in utero* or infancy (0 to 2 years old) is lower than that of surrounding cohorts born in Karamoja and of people born outside Karamoja (control group). On average, the group who were in the womb during the famine obtained 4.4 months less of education, were 4.2 percentage points (%-points) less likely to complete primary school and 3.1%-points less likely to both ever-attend school and be literate than the control group. The cohort who were exposed to the famine under the age of two, received 3.5 months less of education and were more likely to be illiterate by 1.6%-points.

In the case of adults exposed to the famine when they were between three and five years of age, I find positive effects, although some of them insignificant. In particular, this cohort was 1.1%-points more likely to be literate and (weakly[2]) 2.2%-points more likely to complete primary school. Note that survival selection may play an important role here by over-estimating the coefficients in case that only the stronger/healthier children (at the top of the distribution) were able to survive the famine.

I find significant sex-ratio differences in the cohort exposed between 3-5 years of age. Girls were 3%-points more able to survive the famine, which suggests that girls might be stronger than boys at early stages of life (Stevenson et al.; 2000; Fukuda et al.; 1998).

Regional variation of effects show that the famine also reduced the educational attainment of people who were born in areas where there were extreme food-shortages (FSR). However, those effects were much smaller than in the worst affected area (Karamoja). The cohort exposed in the womb and born in the FSR received almost 2.3 months less of education, were 1.9%-points less likely to complete primary school and 2%-points less likely to be literate. The educational attainment of adults from FSR and exposed in infancy (0-2 years old) was lower by 1.8 less months of education. Their school attendance and literacy rates were also lower by 1.3%-points and 2.2%-points, respectively. Contrary to the findings in Karamoja, the effects on the group people born in this area, and exposed at the age of three to five years old, are negative with lower literacy rates (-1.3%-points). Since the intensity of food shortages in this area was much lower, the mortality incidence is lower and therefore survival selection is less strong here.

The negative effects of the famine[3] increase when I control for family-level unobservables (genetic differences, decision-making process and background characteristics). The size of the school-ever-attendance coefficients are more than three times greater (in absolute terms) than the ones estimated without family fixed effects in Karamoja. This might indicate that family-

[1]Integrated Public Use Microdata Series - International (IPUMS-I) and conducted by the Uganda Bureau of Statistics. The exact date of the censuses was 11 January 1991 and 12 September 2002.

[2]Weakly means significant at 10% only

[3]On the exposed cohorts in the areas most severely affected.

gender fixed effects mitigate the mortality selection effect[4] because frail (strong) exposed children are compared with their frail (strong) unexposed same-sex siblings.

Family fixed effects results indicate that children exposed to the famine under the age of five were between 15%-points and 23%-points less likely to be attending school when they were 10 to 15 years old. Child labour and housework increased among these children. Younger cohorts were more likely to stay at home instead of going to school and older children tended to work more than going to school.

Differences by intensity of the famine show smaller negative effects for children born in the less affected areas (FSR). They were less than 3%-points more likely to have dropped school at the age of 10-12 years and between 2.1%-points and 4.5%-points more likely to work.

I also find some significant effects of the famine on health. Specifically, adults exposed during infancy and early childhood (0-5 years old) tend to weigh between 2.4 and 3.3 kg less and their weight/height ratio decreased by 1.1%-points. However, the drop in weight does not increase the incidence of very low weight.

Monthly variation suggests that the longer the foetus is exposed *in utero*, the stronger the negative cognitive effects are. Cohorts who were in the womb nine months were the most affected with 7 months less of education, more likely to be illiterate, less likely to have ever-attended school and to complete primary education. These effects were less strong or insignificant for adults who were exposed less than nine months.

Migration seems to have alleviated the negative effects of the famine, as they were larger for cohorts exposed under 2 years old and who did not migrate. This is consistent with out-migrants being relatively well-off and, therefore, more able to protect themselves by migrating to better developed regions.

Family fixed effects by gender reveal that the *direct* negative effect of the famine is larger for girls compared to boys. The genetic/innate disadvantage of males (e.g. Stevenson et al.; 2000; Fukuda et al.; 1998) enlarge the negative effects of the famine for the cohort exposed during gestation and so, they seem to be stronger than for girls. However, this effect is mitigated when the heterogeneity at family level is controlled for.

Finally, I conduct two falsification experiments to evaluate the validity of the results. A distant region not affected by the famine (control region, CR, in Figure 1) and cohorts born before 1975 in Karamoja are used as *placebo* to substitute the real affected region and the real cohorts in the main models. Most of the estimated coefficients are positive or insignificant for the false area and cohorts. Therefore, the negative effects of the famine are valid only for people born in Karamoja and exposed to the famine.

[4]Over-estimation of coefficients.

2 Background

2.1 Literature Review

The foetal origins hypothesis, proposed by Barker (1992), suggests that factors that affect the foetus and infants have long lasting effects. They show evidence that low birth weight and retarded infant weight gain might increase the incidence of heart disease, hypertension and limited lung function in adult life. Recent epidemiologic studies also indicate that prenatal exposure to a famine[5] has negative effects on the female reproductive function (Elias et al.; 2005) and increase the risk of antisocial behaviour in adulthood (Neugebauer et al.; 1999).

Parallel nutritional studies have also emphasised the importance of good nourishment at early stages of life for adequate mental development. Hertzig et al. (1972), for example, show that the intelligence quotient (IQ) of children exposed to severe malnourishment in the first two years of life is lower than their siblings'. Similarly, children severely stunted under the age of two yield lower scores in cognitive tests (Mendez and Adair; 1999). Birth weight is a measure of the nutritional status and health of the baby in the womb. Low birth weight has negative long term effects on educational attainment (Royer; 2009; Black et al.; 2007), school performance (Lin and Liu; 2009), pregnancy complications (Royer; 2009), IQ, height and earnings (Black et al.; 2007).

The economics literature has also contributed to the evaluation of the foetal origins hypothesis. Abrupt and unexpected environmental events have been used as natural experiments in economic research. When these events last for a short period of time, they may provide exogenous variation in a genetic or innate endowment (latent factor). Therefore, its role can be isolated from other inputs or technologies (such as family background or health/education investments later in life). Evidence of this has been presented by Almond (2006), Kelly (2009), Barecca (2007) and Bleakley (2007), who have studied the long term effects of epidemics. For instance, the influenza pandemic of 1918 increased physical disability rates and reduced the educational attainment, income and socio-economic status of the cohort exposed *in utero* (Almond; 2006). The Asian flu of 1957 decreased the birth weight of babies who were in the womb during the epidemic outbreak and reduced their tests scores at the age of seven and eleven (long-term effect) (Kelly; 2009). Exposure *in utero* to malaria reduced the educational attainment of adults born in the United States of America (USA) from 1900 to 1930, but did not affect their wage (Barecca; 2007). Likewise, Bleakley (2007) evaluates the effects of the launch of malaria eradication campaigns in USA, Brazil, Colombia and Mexico. He shows that the campaign helped to increase the income of adults who were born and risen in malarious areas, relative to the preceding generation and to non-malarious areas.

[5]Dutch famine of 1944-1945.

Other sudden events that have been explored in the foetal origins literature are armed conflicts/wars (Alderman et al.; 2006; Akresh and de Walque; 2008; Akbulut-Yuksel; 2009), the Chernobyl fallout (Almond et al.; 2009), negative income shocks (Banerjee et al.; 2007), prenatal alcohol intake (Nilsson; 2008) and prenatal fasting (Almond and Mazumder; 2008). Most of these studies agree in finding reductions in educational attainment and performance, measured in total years of education, school entry age, illiterate rates, tests scores and qualifications obtained. Additional negative effects are found in health outcomes, such as, lower birth weight, reduction in the length of pregnancy, higher probability to be disable, lower height and lower health satisfaction in adulthood (Alderman et al.; 2006; Banerjee et al.; 2007; Almond and Mazumder; 2008; Akbulut-Yuksel; 2009). Similarly, lower sex-ratios (lower number of male births) and earnings (Almond and Mazumder; 2008; Nilsson; 2008; Akbulut-Yuksel; 2009) were found.

The most relevant studies to this work are those concerning the long term effects of a famine. Almond et al. (2007), Chen and Zhou (2007) and Meng and Qian (2009) evaluate the effects of the China's great famine (1959-1961) on educational attainment, literacy, health, labour market status, wealth, economic status and gender differences of the survivors. Using the 2000 Chinese Population Census, Almond et al. (2007) find that foetal exposure to the famine increases illiterate rates, the likelihood of being unemployed, of being disable and of living in a smaller house. Their measures of famine intensity are weighted death rates and the average month of birth (mortality is higher during winter). They also find a persistent reduction in sex-ratio of the cohort exposed *in utero* (less male births) and of the following generation (their offspring) by comparing Chinese exposed women with non-exposed women of Hong-Kong (natality microdata).

Chen and Zhou (2007) measure the severity of the Chinese famine by calculating excess death rates from the China Health and Nutrition Surveys (CHNS). Their results suggest that the population exposed in early childhood to the famine was shorter, worked less hours and earned less income than the control group. Meng and Qian (2009) combine four datasets and geographic information system (GIS) data to measure the intensity of the famine and its effects on adulthood. They find that the height, weight, body mass index (BMI), total years of education and number of hours worked per week of the cohorts born between 1954 and 1961 dropped as consequence of famine exposure in early childhood.

The Dutch Potato Famine of 1846-1847 reduced the life expectancy of men exposed during gestation and under the age of three. The study by van den Berg et al. (2007) evaluates the longevity effects of the famine using the Historical Sample of Netherlands. They use average real market prices to measure the intensity of the famine and instrument the economic conditions at birth with historical infant mortality rates and the gross national product.

The only study that examine the long-run effects of a famine in Africa is Porter (2009). She

evaluates the impact of the 1984 Ethiopian famine on the height of children exposed *in utero* or under three years old. Using the Ethiopian Rural Household Survey and mother fixed effects, she finds that 10-12 years old children were on average three centimetres shorter than children who were born two years after the famine or who were 3-5 years old at the time of the shock.

In summary, foetal origins literature has revealed that abrupt environmental changes during the gestation period or at early ages of life may have long-lasting consequences in the well-being of adults. This study, thus, contributes to such literature and expands the evidence by exploring the cognitive and health effects on adults of a deep nutritional shock in infancy, in a region historically and frequently hit by several food shortages. In addition, I use large and unique datasets to estimate causal effects by different methodologies including family-gender fixed effects.

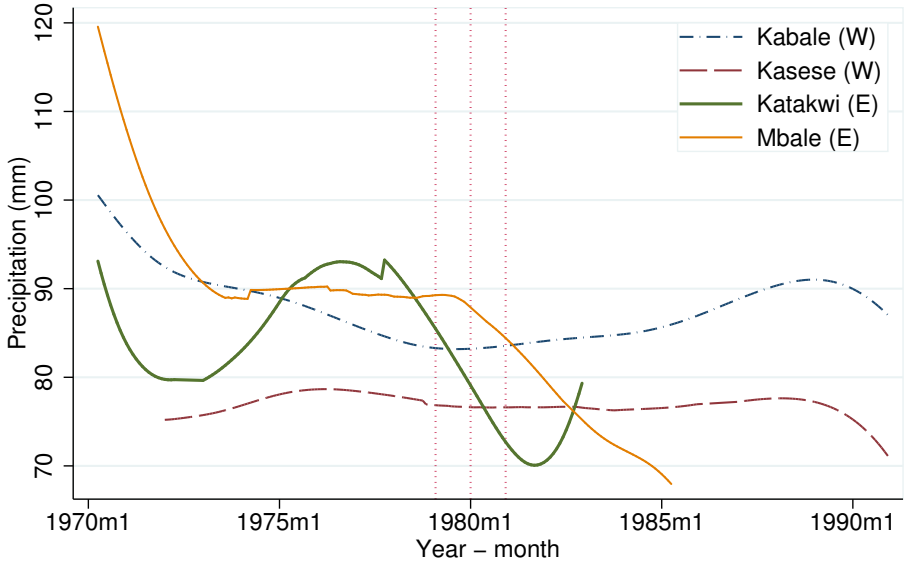
2.2 Famine in Karamoja 1980

Karamoja is a semi-arid region located in northeastern Uganda, along the borders with Sudan and Kenya (Figure 1). This is an area characterised by single year droughts, which hit the region every three to four years, and a multi-year drought happening once in a decade (Knutsson; 1985; Stites et al.; 2007). One of those periods of extended drought occurred between 1979 and 1980, when rainfall was unusually low in most of the north and east regions of Uganda. Figure 2 plots the lowess fit of the monthly precipitation, between 1970 and 1990, in four districts of Uganda (Kabale and Kasese in the west and Katakwi and Mbale in the east). Katakwi and Mbale are located in the East region and are the nearest districts to Karamoja[6] for which rainfall data is available. The affected districts show great reductions in the rainfall levels in 1979-1980, while the west experienced constant historical levels of precipitation (Figure 2).

Traditionally, the population in the region was prepared to cope with those periods of drought by maintaining large herds of livestock (Knutsson; 1985), using communal form of assistance, moving to other agricultural regions in search of food, or by early state intervention (Okudi; 1992). However, in 1980 those coping mechanisms collapsed for various reasons. First, the liberation war of 1979, to overthrow the military dictatorship of Idi Amin, brought the opportunity to Karamoja people of acquiring a large amount of modern weapons and ammunition. This situation transformed the traditional patterns of raiding and social security, which resulted in the intensification of raids and violence in the area. Second, the political unrest deteriorated the macroeconomic conditions. There was a sharp increase in the price of goods and services, and an excessive loss of value of money, which induced the demonetisation of the currency. Finally, in spite of sending a promptly alert to the central government about the food

[6]Katakwi city is 72.5 km south of the Moroto district border and Mbale city is 168.2 km south east of Moroto city.

Figure 2: Monthly precipitation in four districts of Uganda. 1970-1990.



Notes: (W) West Region, (E) East Region.
Data for Katakwi is available until 1982 and for Mbale until 1985.
Source: www.fao.org/nr/climpag

situation in the area, there was not an organised effort to prevent the disaster (Alnwick; 1985; Knutsson; 1985; Okudi; 1992).

Consequently, families started running out of food in early 1980. By May 1980, the situation became critical, and the famine reached its peak in July/August, when the international relief started (Alnwick; 1985; Robinson et al.; 1980). The death toll estimation was approximately 20,000 to 50,000 people, most of them children (Biellik and Henderson; 1981; Alnwick; 1985). Figure A1 plots the cohort size of the population by year and month of birth from 1965 to 1985 using the 2002 Ugandan census. The figure shows a sharp drop in the population born in Karamoja between 1975 and 1980. Subsequent periods of drought have occurred every five years according to The United Nations World Food Programme (2005)[7].

Idi Amin's regime from 1971-1979 resulted in the deterioration of the economic system and social services in Uganda as a whole (Dodge and Wiebe; 1985). After his government was ousted by the Ugandan National Liberation Army in April 1979, three governments held power before the following elections in December 1980. This political turmoil caused confusion, instability and violent episodes across the entire country (Dodge; 1986). In addition, the government was not able to respond to the crisis (Cisternino; 1985; Okudi; 1992). Bureaucracy and corruption under Amin's rule, and political interests and lack of logistics under the new government impeded the immediate distribution of aid (Okudi; 1992). For this reason, aid distribution was coordinated primarily by the World Food Program of the United Nations

[7]http://www.wfp.org/news/news-release/wfp-assists-drought-hit-karamoja-highest-malnutrition-uganda. 16 March 2005

(Cisternino; 1985) although there were important efforts from independent religious missions to provide food and health services (Alnwick; 1985).

3 Methodology

Initially, I investigate the impact of the famine on young adults who were in the womb at the time of the famine (foetal origins hypothesis). The empirical specification to evaluate this effect is:

$$y_{itmd} = \alpha + \beta\, K_{1980} + \gamma_1\, female_{itmd} + \gamma_2\, rural_{itmd} + \eta_d + \delta_t \times \delta_m + \varepsilon_{itmd}, \tag{1}$$

in which y_{itmd} is a cognitive indicator or a health outcome for individual i, born in year t, in month m and in district d. K_{1980} is a dummy variable which indicates if the individual was born in Karamoja[8] between March 1980 and March 1981. March is the relevant month here to ensure that the foetus was exposed *in utero* for at least three months to the famine[9]. β is the parameter of interest. $female$ and $rural$ are dummy variables which indicate whether the individual is female and whether the area of residence at the time of the census was rural. The model controls for district of birth fixed effects, denoted by η_d. $\delta_t \times \delta_m$ are birth year *and* birth month (multiplicative) fixed effects, which control for time unobservables that affected all regions (e.g. 1971-1979 dictatorship and the political unrest and violence after 1979.).

Since famines may also affect the development of infants and young children, under the age of five. I also estimate an alternative model for these cohorts,

$$\begin{aligned} y_{itmd} =& \alpha + \beta_1\, K_{1980} + \beta_2\, K_{1978-1979} + \beta_3\, K_{1975-1977} \\ &+ \gamma_1\, female_{itmd} + \gamma_2\, rural_{itmd} + \eta_d + \delta_t \times \delta_m + \varepsilon_{itmd}, \end{aligned} \tag{2}$$

β_1, β_2 and β_3 are the parameters of interest in this equation. $K_{1978-1979}$ and $K_{1975-1977}$ are dummies which indicate whether the individual was born in the famine region (Karamoja) *and* was 0-2 years old or 3-5 years old[10] at the time of the famine. Controls are the same as for the previous model: gender, current area of residence (rural/urban), year×month and place of birth fixed effects.

As an additional empirical strategy, I also apply family and gender fixed effects to a model in which the exposed cohorts are still children. This is done for two reasons, (i) to remove all the heterogeneity at family level and (ii) to evaluate the effects at different stages in life, as

[8] Three districts: Kotido, Moroto and Nakapiripirit.

[9] Children of women who were six months pregnant in January 1980 were born three months after the onset of the famine (March 1980).

[10] Children born in January 1978 were 2 years 11 months old when the famine finished. Similarly, children born in January 1975 were 5 years 11 months old when the famine ended.

follows,

$$y_{ifgtd} = \alpha + \beta_1 K_{1980} + \beta_2 K_{1978-1979} + \beta_3 K_{1975-1977} + \gamma X_{iftd} + \lambda_{fg} + \delta_t + \varepsilon_{ifgtd}, \qquad (3)$$

in which y_{ifgtd} is an indicator of educational attainment or child labour for child i, of gender g, who belong to family f, born in year t and in district d. As previously described, K_{1980}, $K_{1978-1979}$ and $K_{1975-1977}$ are dummy variables which indicate if the child was born in Karamoja between 1975 and 1980. β_1, β_2 and β_3 are the parameters of interest. X_{iftd} are characteristics of parents, which vary across children. In this case, X_{iftd} includes age of mother at birth. The model controls for year of birth fixed effects denoted δ_t. Month of birth is not available in the data base for children. Therefore, I cannot control for birth month fixed effects in this model (see Section 4).

In model (3) I exploit the fact that children belong to a nuclear family, f, and estimate family-gender[11] fixed effects, denoted by λ_{fg}. Family fixed effects allow to control for unobserved heterogeneity at family level, i.e. children who share same genetics, family care, family decisions, growing environment are compared, and also for observable characteristics of the family such as parental education. Therefore, it is a like-with-like contrast.

4 Data and descriptive statistics

The primary data used in this study is a 10% sample of the 1991 and 2002 Uganda Population and Housing Censuses provided by IPUMS-I. The censuses contain exact information about the place of birth of each member of the household, as well as their citizenship, ethnicity, religion, educational attainment, occupation and disabilities. The 2002 census recorded the exact month and year of birth of each member of the household. In addition, I use the Ugandan DHS, conducted in 2006, since those surveys collect extensive information on population, health and nutrition. Sections 4.1 and 4.2 describe the characteristics of each dataset.

Uganda has three levels of political division: regions, districts and counties. The country is sub-divided into four regions: Central, East, North and West (Figure 1). At the time of the 1991 census, there were 39 districts, which became 56 in subsequent years as some of them were split into two or three. In consequence, by the time of the 2002 census and the 2006 DHS, the number of districts had increased to 56[12]. The Karamoja region comprises three of those 56 districts: Kotido, Moroto and Nakapiripirit[13], which are located in the North region.

[11] These are multiplicative $family \times gender$ fixed effects in one equation and not two individual equations for boys and girls separately. Section 8.3 discusses gender differences in detail. Ugandan families might be large and more than one child of different sex might have been exposed to the famine.

[12] Nowadays, there are 78 districts as new districts were created between 2005 and 2007.

[13] Nakapiripirit was part of Moroto district in 1991 (The independent, 2009 - Evolution of Uganda

4.1 IPUMS-I Data

4.1.1 2002 Ugandan Census

The 10% sample of the 2002 Census of Uganda contains 2.5 million observations of people who were born in Uganda between 1905 and 2002. The exact date (month and year) and place (district) of birth for each household member are available in the census. Birth month was imputed for some individuals (9.15% of the sample), those observations are dropped[14]. For this analysis, I use a sample of the census which only includes people born between 1957 and 1982[15]. The final total number of observations is, therefore, 702,233. 4.5% of these were born in the Karamoja region.

The cohort of interest is the population who was in the womb during the famine (March 1980 - March 1981) or were less than five years old, i.e. young adults born from January 1975 to March 1981 (31.4% of the sample). The group who were born in Karamoja between 1975 and 1980 are 1.4% of the sample. I split this group (exposed under the age of five) in two groups: 0-2 years old and 3-5 years old, to evaluate the famine effects at different stages in early childhood. The census was conducted on the 12th of September 2002. Therefore, individuals who were born between March 1980 and March 1981 were 21-22 years old in 2002. At this age it is expected they have finished their education process.

The control group consists of the cohorts surrounding the individuals who were exposed to the famine, or who were born outside the affected region. Therefore, in order to estimate Model (1), I restrict the data to those born between 1977 and 1982. In this case, the control group includes cohorts born three years before and two years after the famine. For the model evaluating the effects on individuals exposed under five years old (Equation 2), I restrict the data to those born between 1970 and 1982 to include five pre-exposure years to famine and two post-famine years. 1957-1969 cohorts will be used to conduct robustness checks trough falsification experiments, explained in Section 7. Note also that individuals of the same cohort as the exposed individuals, but who were born outside Karamoja are also part of the control group.

The dependent variables are four outcomes of educational attainment: Total years of education, literacy, whether the individual completed primary education and whether the individual

Districts. Source: http://independent.co.ug/index.php/milestones-a-quotes/82-cover-story/1110-evolution-of-ugandas-districts-?format=pdf).

[14]The dataset contains an imputation flag. There are two types of imputations "logical" and "hot-deck". There are cases in wich year of birth was logically imputed; I keep those observations. All birth month imputations were hot-deck, therefore they were dropped.

[15]1982 was selected as the upper limit because people who were born in that year were 20 years old at the time of the census. At this age, it is expected that they have finished their basic education. Primary education is completed in six years and secondary in six additional years (12 years of basic education). Only 3.5% of Ugandan population reach higher education, i.e. secondary education is the highest level of education for the 96.5% of the population.

ever-attended school. In addition, I include a categorical dependent variable indicating if the individual is female to examine possible effects of the famine on the population's sex ratio.

4.1.2 1991 Ugandan Census

I also use a 10% sample of the 1991 Census of Uganda to evaluate the effects of the famine during childhood. Since individuals are organised into households, I exploit the data to estimate the model with family fixed effects. The original sample contains 1.55 million observations of people from 0 to 95 years of age. Month and year of birth are not available in the sample, but as the census was conducted on the 11th of January 1991, year of birth can be calculated quite accurately using age[16]. Birthplace is available at district level[17].

I keep a sample of people born between 1957 and 1982 to be consistent with the 2002 census. The final total number of observations is 302,833. I restrict the sample to those households with at least two own children[18]. The data contains a variable which explicitly links children and their parents. I drop all children for whom such a link is ambiguous or no-parent is present in household. 56.4% of households have three or more children who were born between 1970 and 1982.

The group of interest is the population who was in the womb (born in 1980) or was younger than five years old during the famine. Therefore, individuals who were born between 1975 and 1980 were 10-15 years old in January 1991. The control group is composed of the cohorts surrounding the exposed individuals to the famine and those born during the famine but outside the affected regions. Therefore, the control cohorts in Equation (3) are those born between 1970-1974 and 1981-1982, which include five pre-exposure years and two post-famine years.

The dependent variables are educational outcomes or child labour indicators: whether the child had ever-attended school, whether they were attending school at that moment, whether the child was working at the time of the survey and whether they did housework. Schooling information is available for children older than five years old (inclusive) and employment information is available for children above the age of ten (inclusive).

4.2 DHS 2006

The Ugandan 2006 DHS was collected between April and October 2006, and contains 45,439 observations. Exact place of birth is not available and exact date of birth is known only for selected individuals. For this reason, year of birth was imputed for the 59% of the sample, using the age of individuals. Educational attainment information is available for the full sample. For

[16] $Birthyear = 1991 - age - 1$.

[17] Recall that in 1991 there were 39 districts only, 17 less than in 2002.

[18] 0.13% of households in the sample had more than 10 children. I keep those observations.

consistency, I keep the sample containing people who were born between 1957 and 1982. The final total number of observations is 10,743[19].

The advantage of the DHS surveys is that they contain anthropometric information for a sample of eligible women and men, who were selected during the field-work. They were measured by the interviewer, who collected information about *exact date of birth*, weight, height, anaemia and other health indicators. These indicators are available for 4,379 individuals (women and men) in total[20].

Nine outcomes were selected or constructed using the DHS survey. They are classified in two groups:

1. Education-related: years of education, whether the individual completed primary or ever-attended school. These are very similar to the ones selected in the census data and are used for comparison.

2. Health-related: weight, height, weight-for-height (W/H), whether the person is under- or over-weight[21] and whether the person was anaemic at the time of the survey.

4.3 Descriptive Statistics

Table A1 contains the population means of the selected outcomes (education, child labour and health) of people born in Karamoja for the three data sets. The first three columns show descriptive statistics for the treated groups exposed to the famine *in utero*, 0-2 years old and 3-5 years old, respectively. The fourth column presents the same statistics for the surrounding cohorts (born 1970-1974 and 1981-1982).

A comparison of the first and fourth column shows that the educational attainment of the group exposed *in utero* is always lower than the one of the control cohorts. People born in 1980 completed 1.12 years of education, 14% are literate, 17% attended school and 6% completed primary education; against 1.31 years of education, 15% literacy rate, 17% school ever attendance rate and 7% primary education completion rate of the surrounding cohorts.

Interestingly, the sex-ratio[22] of the treated cohorts (born 1975-1980) is always higher. This might indicate that the survival probability for boys was lower than for girls during the famine.

Columns five and six present descriptive statistics of Karamoja compared with people born in the rest of the country. The figures show a large educational and health gap among both groups. On average, people from Karamoja completed 4.55 less years of education, only 15%

[19] 3.55% of the sample was living in the Karamoja region. People who were born between 1975 and 1980 are 30.9% of the sample and those who were living in Karamoja and were born between 1975 and 1980 are 1.02% of the sample.

[20] 3% of them were living in the Karamoja region, 22.35% belong to the 1975-1980 cohorts and 0.70% were living in Karamoja and were born between 1975 and 1980.

[21] Using the body mass index (BMI). Underweight=1 if BMI¡18.5 and overweight=1 if BMI¿=25.

[22] Expressed as the female proportion= $female/(males + females)$.

were literate (74% rest of Uganda) and 7% finished primary education. The incidence of very low weight and anaemia was higher among people born in Karamoja. 27% of them were underweight while only 9% of the rest of Ugandans fell in this category.

Figure A2 shows the population means of education attainment outcomes of Ugandan people born in Karamoja and outside Karamoja, by year of birth. All four graphs show a consistent fall in the mean of the educational outcomes, which is far from the linear trend[23].

5 Selection

The effects of the famine on cognitive development and health might also be attributable to *fertility selection*, i.e. changes in the type of parents who have live births during a famine. Using the Ugandan census of 1991 it is possible to compare the characteristics of parents who had children during the famine against those who did not. Table A2 shows this comparison for a sample of children born from 1978 to 1982. Parents of children who were born during the famine were, on average, older (39.8 vs. 38.9), had more children (4.05 vs 3.66) and were Muslims (0.9% vs 0.2%). The t-test of population means (columns 4-8, Table A2) shows that there are no significant differences in parents' education (literacy, years or completion rates) or in their employment status, occupation or type of work. These statistics indicate that *fertility selection* is not a potential problem in the estimation of the long-run effects of the famine.

On the other hand, estimates of the famine impact on education and health might be upward biased due to survival selection. The survivors might be the stronger/healthier infants who belong to the top of the outcomes distribution.

6 Results

6.1 Educational Attainment - 2002 Census

Table 1 presents the results of Equation (1), i.e. the impact of the famine on unborn babies. The estimated effect is negative for the four outcomes, although they are not statistically significant. The control group in this equation are people who were born in January 1977 - February 1980 and April 1981 - December 1982 in Karamoja and between January 1977 and December 1982 in regions outside Karamoja. However, this control group might not be suitable as people who were under five years old during the famine were also exposed and probably affected by it.

Results in Table 2 add the impact on the cohort of people who were less than two years old

[23]Note that there is a generational fall in all four cases, as there were other regions affected by extreme food-shortages, but the drop is deeper for the treated group in Karamoja.

at the time of the famine[24]. The effects of the famine on education attainment are all negative and become significant as the control group is better identified. On average, the cohort of people born in Karamoja, and who were in the womb during the famine outbreak, completed 2.6 months less of education and were 3.9%-points less likely to complete primary education than the control group. Similarly, the cohort group who were under two years of age at the time of the famine received 1.8 less months of education than the control group and were 1.1%-points less likely to finish primary education.

Table 1: Cognitive effects of the famine on 1980 cohort - 2002 Census.

	Years of education	**Completed primary**	**literate**	**Ever-attended school**	**Female**
	(1)	(2)	(3)	(4)	(5)
in utero Karamoja 1980	-0.081	-0.024	-0.014	-0.01	0.008
	[0.106]	[0.016]	[0.017]	[0.013]	[0.005]
Female	-1.316	-0.121	-0.146	-0.11	
	[0.133]*	[0.012]*	[0.014]*	[0.010]*	
Rural	-2.779	-0.311	-0.165	-0.111	0.011
	[0.152]*	[0.015]*	[0.007]*	[0.006]*	[0.008]
Constant	10.749				
	[0.190]*				
Observations	245,890	245,887	245,887	245,887	245,890
R-squared	0.22				
Dependent variables descriptive statistics:					
Mean	5.79	0.30	0.74	0.81	0.54
standard deviation	4.15	0.46	0.44	0.39	0.50

Robust standard errors in brackets. Clustered at district of birth level.
* significant at 5%; + significant at 10%.
Columns 2-5 present marginal effects from the probit model.
Control group: people who were born between January 1977 - February 1980 and April 1981 - December 1982 in Karamoja and between January 1977 - December 1982 in regions outside Karamoja.
54% of the population are women, 83% live in rural areas and 1.03% were *in utero* in Karamoja 1980.
Coefficients of district of birth fixed effects and birth year × birth month fixed effects are not reported but available upon request.

Medical and nutritional studies (Grantham-McGregor et al.; 2007; Thompson and Nelson; 2001; Strauss and Thomas; 1998) suggest that the first five years of life are crucial for human development. Therefore, the control group in Table 2 might still not be well identified as it includes cohorts which belong to the treated group.

Table 3 contains the estimates of Equation (2) in which the control group comprises: (i) people from Karamoja who were six or more years old in December 1979 or were born after

[24]Therefore, the control group here are those who were born in 1974 - 1977 and from April 1981 to December 1982 in Karamoja and between 1974-1982 in the rest of the country.

Table 2: Cognitive effects of the famine on 1978-1980 cohorts - 2002 Census.

	Years of education	**Completed primary**	**Literate**	**Ever-attended school**	**Female**
	(1)	(2)	(3)	(4)	(5)
in utero Karamoja 1980	-0.220	-0.039	-0.0210	-0.015	-0.003
	[0.094]*	[0.013]*	[0.017]	[0.014]	[0.005]
Born Karamoja 1978-79	-0.147	-0.011	-0.007	-0.001	0.010
	[0.026]*	[0.004]*	[0.005]	[0.004]	[0.007]
Female	-1.374	-0.120	-0.153	-0.115	
	[0.137]*	[0.011]*	[0.014]*	[0.010]*	
Rural	-2.896	-0.321	-0.172	-0.116	0.017
	[0.154]*	[0.015]*	[0.007]*	[0.006]*	[0.008]*
Constant	10.779				
	[0.195]*				
Observations	347,679	347,676	347,676	347,676	347,679
R-squared	0.22				
Dependent variables descriptive statistics:					
Mean	5.72	0.29	0.73	0.81	0.53
standard deviation	4.19	0.45	0.44	0.39	0.50

Robust standard errors in brackets. Clustered at district of birth level.
* significant at 5%; + significant at 10%.
Columns 2-5 present marginal effects from the probit model.
Control group: people who were born between January 1974 - December 1977 and April 1981 - December 1982 in Karamoja and between January 1974 - December 1982 in regions outside Karamoja.
The number of observations increased here as the control group was expanded.
53% of the population are women, 83.1% live in rural areas, 0.73% were *in utero* in Karamoja 1980 and 1.08% were born in Karamoja 1978-79.
Coefficients of district of birth fixed effects and birth year × birth month fixed effects are not reported but available upon request.

the famine finished (between March 1981 - December 1982), and (ii) all cohorts of people born in the rest of the country.

On the one hand, results suggest that the educational attainment and school attendance of cohorts who were less than two years old in 1980 are highly affected by the famine. Their coefficients become even more negative after adding cohorts exposed at 3-5 years old in the treated group (Table 3, rows one and two). On average, the group who were *in utero* during the famine obtained 4.4 months less of education, were 4.2%-points less likely to complete primary school and 3.1%-points less likely to have ever-attended school than the control group. Similarly, the cohorts who were exposed to the famine under the age of two, received 3.5 months less of education and were more likely to be illiterate by 1.6%-points.

On the other hand, coefficients for those exposed between three and five years old are positive, although some of them insignificant. In particular, this cohort is 1.1%-points more

likely to be literate and (weakly) 2.2%-points more likely to complete primary school. These results suggest that if only the stronger/healthier children (at the top of the dristribution) were able to survive the famine, survival selection may play an important role, by over-estimating the coefficients. It is worth noticing that these positive coefficients are relatively smaller (in absolute value) than the negative effect found on people expose under the age of two.

Interestingly, I find significant sex-ratio differences in the cohort exposed between 3-5 years of age. Results indicate that girls were 3%-points more able to survive the famine, which suggest that girls might be stronger than boys at early stages of life (Stevenson et al.; 2000; Fukuda et al.; 1998). The estimated sex-ratio effect for the cohort born in Karamoja between 1978 and February 1980 is also positive, but not significant.

Table 3: Cognitive effects of the famine on 1975-1980 cohorts - 2002 Census.

	Years of education	**Completed primary**	**Literate**	**Ever-attended school**	**Female**
	(1)	(2)	(3)	(4)	(5)
in utero Karamoja 1980	-0.364	-0.042	-0.031	-0.031	-0.001
	[0.056]*	[0.007]*	[0.016]+	[0.015]*	[0.010]
Born Karamoja 1978-79	-0.289	-0.015	-0.016	-0.014	0.012
	[0.060]*	[0.011]	[0.007]*	[0.008]+	[0.013]
Born Karamoja 1975-77	0.027	0.022	0.011	0.004	0.03
	[0.073]	[0.011]+	[0.005]*	[0.007]	[0.010]*
Female	-1.491	-0.123	-0.169	-0.131	
	[0.137]*	[0.011]*	[0.015]*	[0.011]*	
Rural	-2.969	-0.324	-0.179	-0.124	0.024
	[0.152]*	[0.015]*	[0.007]*	[0.006]*	[0.007]*
Constant	10.997				
	[0.197]*				
Observations	472,025	472,025	472,016	472,025	472,025
R-squared	0.22				
Dependent variables descriptive statistics:					
Mean	5.56	0.27	0.72	0.79	0.53
standard deviation	4.20	0.44	0.45	0.41	0.50

Robust standard errors in brackets. Clustered at district of birth level.

* significant at 5%; + significant at 10%.

Columns 2-5 present marginal effects from the probit model.

Control group: people who were born between January 1970 - December 1974 and April 1981 - December 1982 in Karamoja and between January 1970 - December 1982 in regions outside Karamoja.

The number of observations increased here as the control group was expanded.

54% of the population are women, 83.7% live in rural areas, 0.54% were *in utero* in Karamoja 1980, 0.80% were born in Karamoja 1978-79 and 0.84% were born in Karamoja 1975-77.

Coefficients of district of birth fixed effects and birth year $\times$ birth month fixed effects are not reported but available upon request.

6.2 Intensity of the famine

Karamoja was not the only region affected by the rainfall decrease in 1980. There were also extreme food shortages in the districts of Mbale, Tororo, Lira, Gulu, Kitgum and Masindi (Okudi; 1992) - **FSR** in Figure 1. Table 4 presents the estimates of Equation (2) adding categorical variables which identify the cohorts born in the FSR between 1975 and 1980, as follows

$$\begin{aligned} y_{itmd} =& \alpha + \beta_1 K_{1980} + \beta_2 K_{1978-1979} + \beta_3 K_{1975-1977} \\ &+ \lambda_1 FSR_{1980} + \lambda_2 FSR_{1978-1979} + \lambda_3 FSR_{1975-1977} \\ &+ \gamma_1 female_{itmd} + \gamma_2 rural_{itmd} + \eta_d + \delta_t \times \delta_m + \varepsilon_{itmd}, \end{aligned} \tag{4}$$

in which β_1, β_2 and β_3 and λ_1, λ_2 and λ_3 are the parameters of interest. These coefficients show regional differences according to the intensity of the famine, and their estimates are presented in rows 1 to 6 of Table 4.

I find negative cognitive effects on people who were in the womb in the FSR. They received almost 2.3 months less of education, were 1.9%-points less likely to complete primary school and 2%-points less likely to be literate than the control group. In addition, the educational attainment, school attendance and literacy rate of adults born in the FSR and exposed between zero and two years old, were lower by 1.8 less months of education, 1.3%-points and 2.2%-points, respectively. Results show significant negative effects on the literacy rate (-1.3%-points) of the group exposed in the FSR at the age of 3-5 years old.

The most outstanding result is that although there were negative effects for age of exposure under two years old in both affected regions (Karamoja and FSR), they were much stronger in Karamoja, which was the worst affected area. Also, notice that the coefficients of people from Karamoja, born between 1978 and 1980, become more negative when the FSR is included as part of the treatment group. In addition, the literacy rate of the cohort exposed in the womb (3.7%-points) and ever-attendance to school (1.8%-points) of the group exposed under two years old turn to be significant at the 5% level of significance.

The finding that long term effects of the famine are negative for the cohort exposed from three to five years old in low intensity regions, while positive at this age in high intensity regions, suggests that the positive effect may arise due to fertility or survival selection. Descriptive statistics in Section 5 suggest that fertility selection was limited. However, survival selection may bias the coefficient upwards, as explained in Section 6.1, especially in the most affected areas where the mortality was high. The infant (under one year old) mortality rate of Karamoja in 1980, calculated by Biellik and Henderson (1981), was 607 per 1,000 live births, which represented a four to five-fold increase in infant mortality with respect to the 1969 census

estimate of 139 per 1,000 live births[25].

Table 4: Cognitive effects of the famine on 1975-1980 cohorts by intensity - 2002 Census.

	Years of education	**Completed primary**	**Literate**	**Ever-attended school**	**Female**
	(1)	(2)	(3)	(4)	(5)
in utero Karamoja 1980	-0.410	-0.046	-0.037	-0.033	0.002
	[0.057]*	[0.007]*	[0.016]*	[0.015]*	[0.011]
Born Karamoja 1978-79	-0.324	-0.016	-0.022	-0.018	0.011
	[0.061]*	[0.011]	[0.007]*	[0.008]*	[0.013]
Born Karamoja 1975-77	0.008	0.021	0.008	0.002	0.032
	[0.073]	[0.012]+	[0.005]	[0.007]	[0.010]*
in utero food-shortage region 1980	-0.191	-0.019	-0.020	-0.010	0.012
	[0.065]*	[0.005]*	[0.009]*	[0.008]	[0.007]
Born food-shortage region 1978-79	-0.149	-0.008	-0.022	-0.013	-0.006
	[0.067]*	[0.007]	[0.008]*	[0.005]*	[0.006]
Born food-shortage region 1975-77	-0.082	-0.005	-0.013	-0.005	0.006
	[0.054]	[0.006]	[0.005]*	[0.004]	[0.005]
Female	-1.491	-0.123	-0.169	-0.131	
	[0.137]*	[0.011]*	[0.015]*	[0.011]*	
Rural	-2.969	-0.324	-0.179	-0.124	0.024
	[0.152]*	[0.015]*	[0.007]*	[0.006]*	[0.007]*
Constant	10.98				
	[0.196]*				
Observations	472,025	472,025	472,016	472,025	472,025
R-squared	0.22				

Robust standard errors in brackets. Clustered at district of birth level.
* significant at 5%; + significant at 10%.
Columns 2-5 present marginal effects from the probit model.
Control group: people who were born between January 1970 - December 1974 and April 1981 - December 1982 in both Karamoja and the FSR. Also, people born in the rest of the country between January 1970 - December 1982.
Coefficients of district of birth fixed effects and birth year × birth month fixed effects are not reported but available upon request.
Full results are presented in the appendix, Table A5

The following section presents the estimations of the family-gender fixed models using the 1991 census.

6.3 Family-gender fixed effects. The 1991 census

The advantage of the 1991 census is that the cohorts exposed to the famine under the age of five were ten to fifteen years old at the time of data collection. The census is organised by households, and families are fully identified. Since children normally belong to a nuclear family in which parents and siblings live together, the long-run effects of the famine can be estimated

[25]Under-five mortality rates are not available.

using family fixed effects. In addition, the 1991 census allows to examine the incidence of the famine at different stages of life.

I restrict the sample to those households with at least two own children. 42.6% of the households with chidren born in Karamoja had two or more children exposed to the famine, and 85.4% had at least one famine-exposed child and one unexposed child[26]. In this section, I compare the exposed children with their unexposed siblings, rather than with all children in the cross section, due to family fixed effects. However, the best scenario is to compare same-sex siblings. For this reason, I do not add simple family fixed effects but **family×gender fixed effects** to distinguish males and females within families. Gender differences will be discussed in Section 8.3.

Results indicate strong negative effects on school attendance for all children who were exposed to the famine under the age of five (Table 5). This effect is greater for the cohorts who were exposed in the womb or under the age of two, which is consistent with the results in adulthood (Table 3). Specifically, unborn babies or children under the age of five at the time of the famine, were from 9.7%-points to 13.5%-points less likely to have attended school ever by the age of 10-15. Similarly, the probability of attending school at the time of the census was smaller (-23 to -15.1%-points) for this group of children.

In terms of child labour, children seem to had been more prone to be working or doing housework at the time of the survey, when they were exposed to the famine in infancy (0-5). Younger children were more likely to stay at home (22.1%-points) instead of going to school (-20%-points), while older children tended to work more (17 to 18%-points) than going to school (-23 to -15%-points) - columns two, three and four in Table 5.

Table 6 contains the estimates of the family fixed effects model, omitting the restriction of comparing same-sex siblings only. The results are significant and of the same sign as in Table 5. However, the magnitude of the effect is smaller for school attendance (columns one and two) and housework (column four), but larger for child labour (column three).

Differences by intensity of the famine are presented in Table 7. In general, negative effects are much smaller for children born in the FSR. They were less than 3%-points more likely to have dropped school at 10-12 years old and between 2.2%-points and 4.5%-points more likely to work. Children born in this region do not tend to stay at home doing domestic work. These results indicate that a severe negative nutritional shock might widen gaps on the wellbeing and development of malnourished children, compared to well nourished children.

The negative effects of the famine on the exposed cohorts in the most severely affected

[26]Note that the percentages are for the sub-sample of families with children born in Karamoja. In 55.8% of households from the whole sample there were two or more children born from 1975 to 1980 (treatment cohort) and potentially exposed to the famine. 82.7% of households, in the final sample, had at least one potentially-exposed child and one unexposed child to the famine.

Table 5: Family-gender fixed effects results - 1991 census.

		Main activity of child		
	Ever-attended school	**attending school** (currently)	**Working**	**house-work**
	(1)	(2)	(3)	(4)
in utero Karamoja 1980	-0.103	-0.199	0.053	0.221
	[0.014]*	[0.011]*	[0.027]*	[0.028]*
Born Karamoja 1978-79	-0.135	-0.230	0.178	0.150
	[0.013]*	[0.012]*	[0.023]*	[0.022]*
Born Karamoja 1975-77	-0.097	-0.149	0.167	0.053
	[0.012]*	[0.012]*	[0.020]*	[0.019]*
Age of mother at birth	-0.025	0.023	-0.036	-0.006
	[0.001]*	[0.001]*	[0.001]*	[0.000]*
Constant	1.197	-0.061	1.072	0.261
	[0.118]*	[0.065]	[0.051]*	[0.055]*
Observations	192,113	192,113	180,377	180,377
Number of fam-gen groups	105,776	105,776	102,373	102,373
R-squared	0.126	0.149	0.157	0.014
Descriptive statistics of dependent variables:				
mean	0.80	0.65	0.20	0.08
standard deviation	0.40	0.48	0.40	0.28

Robust standard errors in brackets

* significant at 5%; + significant at 10%.

Control group: children who were born from 1970 to 1974 and 1981 - 1982 in Karamoja and from 1970 to 1982 in regions outside Karamoja.

Children who were born from 1975 to 1980 were 10 to 15 years old at the time of the 1991 Ugandan census.

0.26%, 0.35% and 0.42% of children were *in utero* in Karamoja 1980, born in Karamoja 1978-1979 and in 1975-1977, respectively.

Coefficients of birth year fixed effects are not reported but available upon request.

areas increase when I control for family-level unobservables (genetic differences, decision-making process and background characteristics). The size of the school ever attendance coefficients are more than three times smaller[27] than the ones estimated without family fixed effects in Karamoja. This might indicate that family-gender fixed effects mitigate the mortality selection effect because siblings have shared frailty.

In contrast, the negative effect on school ever attendance of the 1978-79 cohort (-1.3%-points in Table 4) vanishes in the less affected areas (FSR). However, I still find significant negative effects on school current attendance and child labour, which are consistent with lower educational attainment and literacy in adulthood of the cohorts born in 1978-1980 in the FSR

[27]Greater in absolute terms. -3.3%-points vs -10.1%-points for the cohort in womb, -1.8%-points vs -13.2%-points for 0-2 years old cohort and -9.6%-points vs 0.2%-points for 3-5 years old cohort.

(columns 1-3, Table 4). It is worth noticing that the effect on the cohorts born in the FSR is much lower than the effect on children born in Karamoja after estimating family-gender fixed effects.

Table 6: Family fixed effects results - 1991 census.

		Main activity of child		
	Ever-attended school	**attending school** (currently)	**Working**	**house-work**
	(1)	(2)	(3)	(4)
in utero Karamoja 1980	-0.074	-0.187	0.097	0.175
	[0.012]*	[0.010]*	[0.025]*	[0.026]*
Born Karamoja 1978-79	-0.116	-0.214	0.187	0.12
	[0.011]*	[0.011]*	[0.021]*	[0.021]*
Born Karamoja 1975-77	-0.095	-0.138	0.166	0.051
	[0.011]*	[0.010]*	[0.019]*	[0.019]*
Age of mother at birth	-0.025	0.022	-0.036	-0.005
	[0.001]*	[0.001]*	[0.001]*	[0.000]*
Constant	1.187	-0.094	1.08	0.226
	[0.097]*	[0.076]	[0.049]*	[0.043]*
Observations	192,113	192,113	180,377	180,377
Number of households	63,235	63,235	63,108	63,108
R-squared	0.113	0.136	0.145	0.01

Robust standard errors in brackets

* significant at 5%; + significant at 10%.

Control group: children who were born from 1970 to 1974 and 1981 - 1982 in Karamoja and from 1970 to 1982 in regions outside Karamoja.

Coefficients of birth year fixed effects are not reported but available upon request.

6.4 Cognitive and health effects of the famine

As a negative nutritional shock might also have consequences on the health status of exposed children, I now examine the long-run health effects of the famine on the treated group in adulthood.

In this section, I use the 2006 Ugandan DHS as it contains anthropometric information for a sample of eligible individuals. It also contains information on education, which can be used to cross-check the results obtained from the census. People born in Uganda in 1975-1980 were 26 to 31 years old in 2006. Unfortunately, the exact place of birth is not available in the DHS data. For this reason, I estimate the Models (1) and (2) with place of residence instead of place of birth fixed effects. Migration rates in Uganda are low. According to the 2002 Ugandan census, 94.5% of people who were born in Karamoja were still living there (98.4% in Kotido,

94.3% en Moroto and 80% in Nakapiripirit). Migration rates in other regions are slightly higher than in Karamoja. 90.3% of the population from the East, 90.7% from the North (excluding Karamoja), 87.1% from the West and 95.5% from the Center, were living in their region of birth in 2002.

Estimated famine effects on educational attainment and health are summarised in Table 8. The first panel of the table contains the coefficients of the Model (1), in which the treatment group is the cohort who was in the womb at the time of the famine only. Most of the coefficients are negative and insignificant, as the results presented in Table 1. The impact of the famine on the education outcomes (those comparable) is similar as in Table 1 (columns 1-3).

The lower panel of the table presents the results of Model (2), in which further potential treatment groups are added. Famine effects on education are mostly negative and significant for the 1978-1980 cohorts, and positive for the 1975-1977 cohorts, which is consistent with the results in Table 3. The magnitude of the coefficients is, however, higher especially for the cohort exposed between three and five years old.

The educational effects seem to be comparable using both samples (DHS and Census). Consider now the impact of the nutritional shock on health. Columns four to nine, in Table 8, show the estimated effects on weight, height, weight-for-height, whether the individual is under or overweight or has anaemia at the time of the survey.

I find significant effects of the famine on some of the health outcomes (anthropometric measures) of the treated groups. Adults exposed during infancy and early childhood (0-5 years old) tend to weigh between 2.4 and 3.3 kg less (column four) than the surrounding cohorts who live in Karamoja or/and people living in other regions (control group).

Height is a measure of long-term nutritional status, health investments over the life and welfare. I do not find significant effects of the famine on height, but the coefficients are negative for the adults exposed during gestation and under two years old (column five). The coefficient for adults born in 1975-1977 is positive (insignificant), but this might be the effect of survival selection, as discussed in previous sections.

Columns six suggests that the decrease in weight is relatively stronger than the decline in height since the weight-for-height coefficients are negative for all three treated cohorts. This effect is especially stronger for the cohort exposed to the famine during infancy (0-2 years old) as their weight/height ratio decreased by 1.1%-points. However, the drop in weight does not increase the incidence of very low weight (column seven). In contrast, adults exposed under the age of 2 are 5.3%-points less likely to be underweight.

Finally, the treated cohorts seem to be more likely to be anaemic compared to the control group (positive coefficients - column nine).

Table 7: Famine Intensity - Family-gender fixed effects results. 1991 census.

		Main activity of child		
	Ever-attended school	**attending school** (currently)	**Working**	**house-work**
	(1)	(2)	(3)	(4)
in utero Karamoja 1980	-0.101	-0.204	0.062	0.224
	[0.014]*	[0.011]*	[0.027]*	[0.028]*
Born Karamoja 1978-79	-0.132	-0.236	0.188	0.151
	[0.013]*	[0.012]*	[0.023]*	[0.022]*
Born Karamoja 1975-77	-0.096	-0.150	0.172	0.054
	[0.012]*	[0.012]*	[0.020]*	[0.019]*
in utero food-shortage region 1980	0.005	-0.028	0.045	0.011
	[0.009]	[0.010]*	[0.008]*	[0.007]
Born food-shortage region 1978-79	0.013	-0.024	0.044	0.008
	[0.006]*	[0.007]*	[0.006]*	[0.004]+
Born food-shortage region 1975-77	0.003	-0.002	0.021	0.005
	[0.006]	[0.007]	[0.006]*	[0.004]
Age of mother at birth	-0.025	0.023	-0.036	-0.006
	[0.001]*	[0.001]*	[0.001]*	[0.000]*
Constant	1.198	-0.063	1.078	0.262
	[0.118]*	[0.066]	[0.052]*	[0.055]*
Observations	192,113	192,113	180,377	180,377
Number of fam-gen groups	105,776	105,776	102,373	102,373
R-squared	0.126	0.149	0.158	0.014

Robust standard errors in brackets

* significant at 5%; + significant at 10%.

Control group: children who were born from 1970 to 1974 and 1981 - 1982 in both Karamoja and the FSR, and from 1970 to 1982 in the rest of the country.

2.51%, 4.43% and 5.89% of children were *in utero* or born in the FSR in 1980, 1978-1979 and in 1975-1977, respectively.

Coefficients of birth year fixed effects are not reported but available upon request.

Full results are presented in the appendix, Table A6

Table 8: Cognitive and health effects of the famine on 1975-1980 cohorts. 2006 DHS.

	Cognitive outcomes[1/]			Health outcomes					
	Years of education	**Completed primary**	**Ever-attended school**	**Weight**	**Height**	**Weight--for-height**	**Under-weight**	**Over-weight**	**Anaemic**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Womb									
in utero Karamoja 1980	-0.05	-0.041	0.012	-1.708	-1.383	-0.005	-0.007	0.067	-0.058
	[0.358]	[0.063]	[0.053]	[2.879]	[2.408]	[0.013]	[0.085]	[0.102]	[0.122]
Female	-1.76	-0.155	-0.096	-3.971	-10.321	-0.001	-0.027	0.183	0.366
	[0.183]*	[0.017]*	[0.014]*	[1.114]*	[0.402]*	[0.006]	[0.031]	[0.016]*	[0.027]*
Rural	-2.659	-0.26	-0.081	-4.242	-1.723	-0.022	-0.023	-0.187	0.252
	[0.479]*	[0.048]*	[0.027]*	[1.498]*	[1.172]	[0.008]*	[0.077]	[0.088]*	[0.066]*
Constant	8.804			60.415	170.581	0.355			
	[0.486]*			[2.678]*	[1.925]*	[0.014]*			
Observations	3,510	3,528	3,494	1,072	1,068	1,067	588	743	1,037
R-squared	0.28			0.24	0.52	0.23			
Womb and 0-5 years old									
in utero Karamoja 1980	-0.652	-0.049	-0.054	-1.923	-1.039	-0.005	-0.024	0.062	0.101
	[0.378]+	[0.025]*	[0.056]	[3.623]	[2.709]	[0.016]	[0.050]	[0.086]	[0.123]
Born Karamoja 1978-79	-0.943	-0.102	-0.097	-2.376	-0.06	-0.011	-0.053	[2/]	0.212
	[0.196]*	[0.058]+	[0.060]	[1.210]+	[1.709]	[0.005]*	[0.015]*		[0.148]
Born Karamoja 1975-77	1.075	0.187	0.023	-3.286	0.056	-0.021	-0.056	[2/]	0.347
	[0.513]*	[0.076]*	[0.010]*	[1.941]+	[1.074]	[0.013]	[0.029]+		[0.185]+
Female	-1.958	-0.15	-0.126	-3.34	-9.955	0.002	-0.02	0.169	0.331
	[0.154]*	[0.015]*	[0.011]*	[0.724]*	[0.312]*	[0.004]	[0.015]	[0.013]*	[0.020]*
Rural	-2.461	-0.252	-0.066	-4.813	-1.368	-0.026	0.033	-0.137	0.2
	[0.493]*	[0.042]*	[0.029]*	[1.715]*	[0.771]+	[0.009]*	[0.032]	[0.065]*	[0.046]*
Constant	7.614			61	167.325	0.365			
	[0.529]*			[2.442]*	[1.349]*	[0.013]*			
Observations	6,966	7,023	6,993	2,155	2,149	2,148	1,594	1,624	2,101
R-squared	0.26			0.24	0.5	0.25			
Dependent variables descriptive statistics:									
mean	5.70	0.25	0.85	58.19	163.02	0.36	0.09	0.12	0.38
standard deviation	4.27	0.44	0.35	9.57	8.31	0.05	0.29	0.33	0.48

Robust standard errors in brackets. Clustered at district of residence level. * significant at 5%; + significant at 10%.
Probit results are presented in columns 2,3 and 7-9, since the dependent variable is dichotomous. Models are estimated with sample weights.
[1/] Year of birth fixed effects estimation only, since month of birth is not available for 60% of the sample as explained in Section 4.2. Birth year×birth month fixed effects results for the 40% of the sample are available upon request.
[2/] There were no overweight people in these cohorts.

7 Robustness checks

This section conducts a series of falsification experiments to test the validity of the results described in the previous section. Ideally, the education outcomes of people who were born in a famine-unaffected region should not have been affected by the famine. Similarly, people born in the famine region, but who belong to cohorts not exposed to it, should not show any similar effects as the treated group. Next, I present the results of those falsification exercises using the same specifications described in Equations (2) and (3).

7.1 Districts not affected by the famine

7.1.1 2002 census

The most affected regions by food shortages in 1980 were the North and East (Figure 1). For this reason, four districts in the West region of Uganda were selected as *placebo* to examine whether the famine effects found for Karamoja are robust. Kisoro, Kabale, Ntugamo and Bushenyi districts are located 600-700 km, approximately, to the south-west of Karamoja. They are marked as CR (black area) in Figure 1.

Table 9 presents the regression results of Model (2), in which K_{1980}, $K_{1978-1979}$, $K_{1975-1977}$ are categorical variables indicating whether the individual was born in one of the four selected western districts, and they were either *in utero*[28] or from 0-5 years old[29] in 1980. All people born in Karamoja or in the FSR were dropped from the control group. Most of the estimated effects are positive and significant, and opposite to the effects found in Karamoja. The exception is the educational attainment (years of education and completion of primary school) of the cohort born in Bushenyi between 1978-1979.

7.1.2 1991 census

The government of Uganda has repeatedly reformed the political organisation of Uganda since 1974[30]. Kisoro district was split from Kabale in 1991, and Ntugamo district was formed by taking parts of Bushenyi and Mbarara in 1994[31]. For this reason, Table 10 presents the family-gender fixed effects results (Equation 3) for Kabale and Bushenyi districts, which comprise 89%[32] of the CR in Figure 1, using the Ugandan census of 1991.

[28] Between March 1980 and March 1981.

[29] Born from January 1975 to February 1980.

[30] "Can Uganda's economy support more districts?", New Vision, 8 August, 2005. http://www.newvision.co.ug/D/8/26/449320.

[31] The independent (2009) - Evolution of Uganda Districts. http://independent.co.ug/index.php/milestones-a-quotes/82-cover-story/1110-evolution-of-ugandas-districts-?format=pdf).

[32] Ntungamo has three administrative units: Kajara, Rushenyi and Ruhaama (Ntungamo District Report 2002. The Uganda Participatory Poverty Assessment Process. http://www.finance.go.ug/docs.). Karaja and

Nearly all the estimated coefficients are of the opposite sign to the results obtained for Karamoja. The only exception is that children 10-12 years old form Kabale were more likely to do domestic work at the time of the census. However, the size of these coefficients is very small compared to the ones estimated for Karamoja (Table 5).

7.2 Cohorts not exposed to the famine

7.2.1 2002 census

As explained above, people born in the famine region but who belong to cohorts not exposed to it should not show any similar effects as the treated group. Thus, I estimate Equation (2) for cohorts born in Karamoja between 1962 and 1971. Although those cohorts were already born when the famine occurred, they were older than the critical age period (0-5 years old). Table 11 contains the regressions results of a similar model as the one described by Equation (2), but in which the treated cohorts (K_{1980}, $K_{1978-1979}$ and $K_{1975-1977}$) are replaced interactively by false treated cohorts (K_s, $K_{s-1,s-2}$ and $K_{s-3,s-4,s-5}$),

$$\begin{aligned} y_{itmd} =& \alpha + \beta_1 K_s + \beta_2 K_{s-1,s-2} + \beta_3 K_{s-3,s-4,s-5} \\ &+ \gamma_1 female_{itmd} + \gamma_2 rural_{itmd} + \eta_d + \delta_t \times \delta_m + \varepsilon_{itmd}, \end{aligned} \tag{5}$$

in which s is the reference year (or false famine year) from which the exposed cohorts are drawn, and takes values of 1967, 1968, 1969, 1970 and 1971. Therefore, K_s, $K_{s-1,s-2}$ and $K_{s-3,s-4,s-5}$ are dummy variables which indicate whether the individual was in the womb in year s, or was born in Karamoja in years $s-1$, $s-2$, $s-3$, $s-4$ and $s-5$. Hence, if the reference year is s =1967, $K_s = K_{1967}$, $K_{s-1,s-2} = K_{1965-1966}$ and $K_{s-3,s-4,s-5} = K_{1962-1964}$. The control cohorts also change interactively, ensuring that they always include five *pre-* and two *post-treated cohort* years. Therefore, the control group of the Karamoja cohorts born in 1962-1967 (s =1967 in Equation 5), includes people born in Karamoja from 1957 to 1961 (five years) and from 1968 to 1969 (two years), and all cohorts 1957-1969 born outside Karamoja.

Results in Table 11 show that the coefficients are mostly of the opposite sign (or insignificant) to those found for the cohorts born in Karamoja between 1975 and 1980. The only exception is the reduction in years of education of people born between 1968-1970. According to Alnwick (1985) there was a small famine in 1969 in Karamoja due to a very unusual rain pattern and poor yields.

Rushenyi were part of Bushenyi in 1991 and Ruhaama belonged to Mbarara (Ugandan Censuses 1991 and 2002). The population of Ruhaama is 11% of the population in the CR according to the 2002 census (author calculations).

7.2.2 1991 census

Using a similar specification described by Equation (3) and the interactive technique explained above (Equation 5), I estimate family-gender fixed effects for the same group of cohorts (1962-1971) using the 1991 census. All the results are insignificant or of the opposite sign to the ones obtained for the real treated group (Tables 12 and 5). Family fixed effects show that the small famine of 1969 only had a effect on the cohort born in 1969, by reducing their school attendance (-15.1%-points) and increasing the probability of working (12.7%-points).

The following section explore heterogeneous effects by the number of months of exposure in the womb, by gender and migration status.

Table 9: Famine effects for same cohorts in districts where there was no famine - 2002 Census.

	Years of education	**Completed primary**	**Literate**	**Ever-attended school**	**Female**
	(1)	(2)	(3)	(4)	(5)
in utero 1980 - Kisoro	0.092	0.023	0.018	0.000	-0.040
	[0.033]*	[0.004]*	[0.003]*	[0.003]	[0.012]*
born 1978-1979 - Kisoro	0.328	0.032	0.031	0.026	-0.200
	[0.035]*	[0.005]*	[0.003]*	[0.002]*	[0.009]*
born 1975-1977 - Kisoro	-0.067	-0.009	0.003	-0.003	-0.065
	[0.025]*	[0.003]*	[0.002]	[0.002]	[0.006]*
in utero 1980 - Kabale	0.090	0.003	0.011	0.018	-0.134
	[0.035]*	[0.004]	[0.003]*	[0.003]*	[0.011]*
born 1978-1979 - Kabale	0.204	0.016	0.020	0.021	-0.059
	[0.034]*	[0.004]*	[0.002]*	[0.002]*	[0.009]*
born 1975-1977 - Kabale	-0.046	-0.004	0.008	0.009	-0.041
	[0.026]+	[0.003]	[0.002]*	[0.002]*	[0.006]*
in utero 1980 - Ntungamo	0.256	0.021	0.025	0.030	0.034
	[0.031]*	[0.003]*	[0.003]*	[0.002]*	[0.013]*
born 1978-1979 - Ntungamo	0.292	0.025	0.031	0.017	-0.059
	[0.033]*	[0.004]*	[0.002]*	[0.002]*	[0.009]*
born 1975-1977 - Ntungamo	0.110	0.001	0.016	0.015	-0.043
	[0.026]*	[0.004]	[0.002]*	[0.002]*	[0.006]*
in utero 1980 - Bushenyi	0.004	-0.004	0.012	0.003	-0.032
	[0.035]	[0.004]	[0.003]*	[0.003]	[0.013]*
born 1978-1979 - Bushenyi	-0.120	-0.027	-0.007	-0.002	-0.024
	[0.034]*	[0.004]*	[0.003]*	[0.003]	[0.010]*
born 1975-1977 - Bushenyi	-0.085	-0.030	0.018	0.011	0.024
	[0.026]*	[0.003]*	[0.002]*	[0.002]*	[0.006]*
Female	-1.309	-0.113	-0.129	-0.101	
	[0.145]*	[0.012]*	[0.013]*	[0.010]*	
Rural	-2.832	-0.316	-0.144	-0.101	0.050
	[0.181]*	[0.017]*	[0.006]*	[0.005]*	[0.021]*
Constant	10.855				0.033
	[0.245]*				[0.031]
Observations	344,499	344,499	344,490	344,499	344,499
R-squared	0.19				
Descriptive statistics of dependent variables:					
mean	5.88	0.29	0.77	0.83	0.52
standard deviation	4.15	0.45	0.42	0.38	0.50

Robust standard errors in brackets. Clustered at district of birth level.
* significant at 5%; + significant at 10%.
Columns 2-5 present marginal effects from the probit model.
The number of observations is smaller than in Table 3 because all people born in Karamoja and in the FSR are not included in the control group.
52.1% of the population are women, 82.2% live in rural areas. The proportion of people who were in the womb in 1980 in Kisoro, Kabale, Ntungamo and Bushenyi are 0.17%, 0.37%, 0.25% and 0.47%, respectively. 0.25%, 0.64%, 0.43% and 0.88% of people were born in 1978-1979 in Kisoro, Kabale, Ntungamo and Bushenyi, respectively. 0.40%, 0.88%, 0.55% and 1.07% of people were born in 1975-1977 in Kisoro, Kabale, Ntungamo and Bushenyi, respectively.

Table 10: Famine effects for same cohorts in districts where there was no famine. Family fixed effects. 1991 Census.

		Main activity of child		
	Ever-attended school	**attending school** (currently)	**Working**	**house-work**
	(1)	(2)	(3)	(4)
in utero 1980 - Kabale	-0.024	-0.001	-0.020	0.040
	[0.015]	[0.016]	[0.015]	[0.011]*
born 1978-1979 - Kabale	0.037	0.059	-0.057	0.022
	[0.011]*	[0.013]*	[0.012]*	[0.008]*
born 1975-1977 - Kabale	0.024	0.029	-0.017	0.010
	[0.010]*	[0.012]*	[0.011]	[0.007]
in utero 1980 - Bushenyi	0.028	0.075	-0.046	-0.013
	[0.013]*	[0.015]*	[0.014]*	[0.008]+
born 1978-1979 - Bushenyi	-0.003	0.027	-0.032	0.012
	[0.010]	[0.012]*	[0.012]*	[0.005]*
born 1975-1977 - Bushenyi	0.022	0.023	-0.022	0.009
	[0.009]*	[0.011]*	[0.011]*	[0.005]+
Age of mother at birth	-0.025	0.024	-0.037	-0.006
	[0.001]*	[0.001]*	[0.001]*	[0.000]*
Constant	1.155	-0.052	1.117	0.205
	[0.133]*	[0.075]	[0.060]*	[0.019]*
Observations	144,837	144,837	136,536	136,536
Number of fam-gen groups	79,062	79,062	76,765	76,765
R-squared	0.124	0.156	0.168	0.013
Descriptive statistics of dependent variables:				
mean	0.81	0.65	0.20	0.08
standard deviation	0.39	0.48	0.40	0.27

Robust standard errors in brackets.

* significant at 5%; + significant at 10%.

The number of observations is smaller than in Table 5 because all people born in Karamoja and in the FSR are not included in the control group.

The age of women at birth is on average 26 years old. The proportion of children who were in the womb in 1980 in Kabale and Bushenyi are 1.07% and 1%, respectively. 1.6% and 1.7% of children were born in 1978-1979 in Kabale and in Bushenyi, respectively. 2.3% and 2.2% of children were born in 1975-1977 in Kabale and in Bushenyi, respectively.

Table 11: Famine effects for other cohorts born in Karamoja - 2002 census.

Born in Karamoja in year	**Years of education** (1)	**Completed primary** (2)	**Literate** (3)	**Ever-attended school** (4)	**Female** (5)
1967	0.344	0.139	0.114	0.122	0.02
	[0.134]*	[0.021]*	[0.053]*	[0.082]	[0.019]
1965-1966	0.014	-0.019	-0.013	-0.082	0.03
	[0.037]	[0.041]	[0.015]	[0.020]*	[0.021]
1962-1964	0.351	0.077	0.126	0.115	-0.001
	[0.076]*	[0.038]*	[0.036]*	[0.032]*	[0.011]
Observations	240,922	240,922	240,912	240,922	240,922
1968	-0.249	-0.04	0.004	-0.009	0.02
	[0.090]*	[0.059]	[0.048]	[0.035]	[0.011]+
1966-1967	0.141	0.08	0.035	0.003	0.005
	[0.058]*	[0.033]*	[0.024]	[0.044]	[0.011]
1963-1965	-0.067	-0.065	-0.015	-0.045	0.014
	[0.090]	[0.075]	[0.043]	[0.025]+	[0.004]*
Observations	257,076	257,076	257,066	257,076	257,076
1969	-0.191	0.105	0.059	0.002	0.045
	[0.117]	[0.080]	[0.043]	[0.035]	[0.013]*
1967-1968	-0.016	0.042	0.056	0.062	0.014
	[0.050]	[0.034]	[0.028]*	[0.026]*	[0.008]+
1964-1966	0.006	0.007	0.029	-0.012	0.009
	[0.110]	[0.091]	[0.050]	[0.044]	[0.010]
Observations	263,508	263,508	263,497	263,508	263,508
1970	-0.225	-0.022	-0.049	-0.049	0.021
	[0.142]	[0.071]	[0.070]	[0.065]	[0.013]
1968-1969	-0.293	0.011	0.001	-0.021	0.034
	[0.046]*	[0.023]	[0.027]	[0.029]	[0.003]*
1965-1967	-0.046	-0.009	-0.019	-0.037	0.02
	[0.038]	[0.055]	[0.021]	[0.031]	[0.013]
Observations	301,822	301,822	301,808	301,822	301,822
1971	-0.122	0.093	-0.034	-0.108	0.049
	[0.112]	[0.077]	[0.072]	[0.069]	[0.021]*
1969-1970	-0.201	0.023	-0.021	-0.029	0.022
	[0.072]*	[0.038]	[0.044]	[0.041]	[0.006]*
1966-1968	-0.032	0.025	0.003	0.006	0.002
	[0.072]	[0.024]	[0.048]	[0.048]	[0.006]
Control variables					
female	-2.061	-0.525	-0.696	-0.673	
	[0.133]*	[0.033]*	[0.047]*	[0.043]*	
Rural	-3.284	-1	-0.7	-0.626	0.048
	[0.156]*	[0.040]*	[0.031]*	[0.033]*	[0.007]*
Constant	12.132	1.168	2.444	2.569	0.422
	[0.210]*	[0.058]*	[0.052]*	[0.058]*	[0.015]*
Observations	307,133	307,133	307,119	307,133	307,133

Robust standard errors in brackets. Clustered at district of birth level.
* significant at 5%; + significant at 10%.
Note: Female, Rural and Constant coefficients are very similar for each year regressions. Exact results are available upon request.
Columns 2-5 present marginal effects from the probit model.
Table A3 contains the mean and standard deviation of the dependent variables for each estimation.

Table 12: Famine effects for other cohorts born in Karamoja. Family fixed effects. 1991 Census.

		Main activity		
Born in Karamoja in year	**Ever-attended school** (1)	**attending school** (currently) (2)	**Working** (3)	**house-work** (4)
1967	0.091	-0.012	-0.098	0.048
	[0.039]*	[0.026]	[0.058]+	[0.053]
1965-1966	-0.007	0.053	-0.069	0.001
	[0.033]	[0.024]*	[0.045]	[0.034]
1962-1964	0.041	0.105	-0.102	-0.018
	[0.033]	[0.025]*	[0.046]*	[0.036]
Observations	20,080	20,080	20,133	20,133
Number of fam-gen groups	15,080	15,080	15,101	15,101
R-squared	0.02	0.16	0.07	0.01
1968	0.015	-0.058	-0.024	0.045
	[0.046]	[0.032]+	[0.061]	[0.046]
1966-1967	0.002	0.022	-0.080	0.020
	[0.026]	[0.020]	[0.039]*	[0.032]
1963-1965	-0.019	0.084	-0.092	-0.028
	[0.029]	[0.020]*	[0.040]*	[0.032]
Observations	25,096	25,096	25,493	25,493
Number of fam-gen groups	18,342	18,342	18,424	18,424
R-squared	0.01	0.13	0.09	0.01
1969	-0.051	-0.151	0.127	0.024
	[0.042]	[0.037]*	[0.060]*	[0.065]
1967-1968	-0.008	-0.022	-0.073	0.056
	[0.030]	[0.022]	[0.041]+	[0.034]+
1964-1966	-0.047	0.079	-0.088	-0.008
	[0.024]*	[0.019]*	[0.035]*	[0.028]
Observations	30,085	30,085	30,535	30,535
Number of fam-gen groups	21,613	21,613	21,702	21,702
R-squared	0.01	0.16	0.1	0.01
1970	-0.014	-0.004	0.009	0.007
	[0.027]	[0.025]	[0.036]	[0.030]
1968-1969	-0.019	0.006	-0.021	0.010
	[0.027]	[0.026]	[0.038]	[0.032]
1965-1967	-0.001	0.090	-0.118	0.017
	[0.019]	[0.022]*	[0.032]*	[0.026]
Observations	40,271	40,271	41,397	41,397
Number of fam-gen groups	28,250	28,250	28,764	28,764
R-squared	0.01	0.18	0.12	0
1971	0.040	-0.065	0.116	-0.068
	[0.032]	[0.039]	[0.051]*	[0.049]
1969-1970	-0.012	-0.004	0.003	0.019
	[0.022]	[0.022]	[0.029]	[0.025]
1966-1968	0.028	0.078	-0.086	0.003
	[0.021]	[0.023]*	[0.032]*	[0.026]
Observations	47,415	47,415	48,743	48,743
Number of fam-gen groups	32,667	32,667	33,204	33,204
R-squared	0.01	0.2	0.14	0.01

Robust standard errors in brackets. * significant at 5%; + significant at 10%.
Note: year of birth and constant coefficients are available upon request
Table A4 contains the mean and standard deviation of the dependent variables for each estimation.

8 Extensions

8.1 Effects by month of exposure *in utero*

Table 13 summarises the monthly variation of the famine effects by the time of exposure in the womb. Severe food shortages in Karamoja started in January 1980, but the famine reached its peak in July/August, when international relief started (Alnwick; 1985; Robinson et al.; 1980). Table 13 presents the estimates of Equation (2), in which the term K_{1980} has been replaced by 3 dummy variables indicating how long (in months) the individual was exposed *in utero* to the famine.

Results suggest that the longer the foetus is exposed *in utero* the stronger the negative cognitive effects are. Cohorts who were in the womb nine months were the most affected. They had 7 months less of education, were 6.4%-points less likely to be illiterate, 5.6%-points less likely to have attended school ever and 6.3%-points less likely to complete primary education. The magnitude of these effects are twofold the effects of any other exposed group (Table 13, columns 1-4).

8.2 Effects of migration

A possible consequence of the famine is that people might migrate as a result of the critical situation. Depending upon whether the better or worse off socio-economic groups left Karamoja, the results might be over- or under-estimated. I cannot control for current area of residence due to its endogeneity. For this reason, Table 14 presents the results of Equation (2) for the sample of people who did not migrate, i.e individuals who reported having been born in the same district as the one of residence at the time of the census. According to this definition, migration is very low among people who were born in the districts of Kotido and Moroto, where 98.6% and 94.3% of people from these districts were living there at the time of the 2002 census. A higher proportion of the population who was born in Nakapiripirit district were living in other districts outside Karamoja (19.4%).

Migration seems not to be relevant for the treated group who were in the womb at the time of the famine. The estimated coefficients for this group are very similar to those presented in Table 3. However, the effect of the famine seems to be stronger for the group who were exposed at 0-2 years old and did not migrate. The latter group completed 4.1 months less of education and were 1.8%-points less likely to complete primary school than the control group. This is consistent with out-migrants being relatively well off and, therefore, more able to protect themselves by migrating to better developed regions.

Table 13: Cognitive effects of the famine on 1975-1980 cohorts. Effects by month of exposure in womb. 2002 census.

	Years of education	**Completed primary**	**Literate**	**Ever-attended school**	**Female**
	(1)	(2)	(3)	(4)	(5)
9 months *in utero* Karamoja 1980	-0.567	-0.063	-0.064	-0.056	0.002
	[0.051]*	[0.004]*	[0.021]*	[0.005]*	[0.013]
6-8 months *in utero* Karamoja 1980-81	-0.266	-0.041	-0.014	-0.016	0.002
	[0.084]*	[0.014]*	[0.019]	[0.017]	[0.013]
3-5 months *in utero* Karamoja 1980	-0.206	-0.009	-0.013	-0.019	-0.008
	[0.104]+	[0.010]	[0.032]	[0.026]	[0.028]
Born Karamoja 1978-79	-0.289	-0.015	-0.016	-0.014	0.012
	[0.060]*	[0.011]	[0.007]*	[0.008]+	[0.013]
Born Karamoja 1975-77	0.027	0.022	0.011	0.004	0.03
	[0.073]	[0.011]+	[0.005]*	[0.007]	[0.010]*
Female	-1.491	-0.123	-0.169	-0.131	
	[0.137]*	[0.011]*	[0.015]*	[0.011]*	
Rural	-2.968	-0.324	-0.179	-0.124	0.024
	[0.152]*	[0.015]*	[0.007]*	[0.006]*	[0.007]*
Constant	10.997				
	[0.197]*				
Observations	472,025	472,025	472,016	472,025	472,025
R-squared	0.22				

Robust standard errors in brackets. Clustered at district of birth level.
* significant at 5%; + significant at 10%.
Columns 2-5 present marginal effects from the probit model.
Individuals born from September to December 1980 were exposed 9 months to the famine, from June to August 1980 and January to March 1981 were exposed 6-8 months, and from March to May 1980 were exposed 3 to 5 months to the famine.

8.3 Gender differences

8.3.1 2002 Ugandan Census

The effects of the famine might differ between men and women. Epidemiology studies suggest that males are more frail than females in the womb and in infancy (Stevenson et al.; 2000; Fukuda et al.; 1998). Results in Table 15 indicate that the negative effects of the famine were stronger for males than females exposed *in utero*. Men from this cohort completed six months less of education, were 6.4%-points less likely to complete primary education, 4%-points less likely to be literate and 3.1%-points less likely to have ever attended school. In comparison, women (from the same cohort) attended four months less of education, were just 1.5%-points less likely to finished primary school and were not significantly more likely to be illiterate or skip school in life. These results might indicate that the cognitive damage on the frail group in the womb (men) may be bigger.

On the other hand, the negative impact on the cohorts exposed between zero and five years

Table 14: Cognitive effects of the famine on 1975-1980 cohorts. Sample of people who did not migrate.

	Years of education	**Completed primary**	**Literate**	**Ever-attended school**	**Female**
	(1)	(2)	(3)	(4)	(5)
in utero Karamoja 1980	-0.348	-0.036	-0.022	-0.021	-0.002
	[0.037]*	[0.005]*	[0.014]	[0.012]+	[0.011]
Born Karamoja 1978-79	-0.346	-0.018	-0.027	-0.020	0.020
	[0.049]*	[0.007]*	[0.014]+	[0.012]+	[0.013]
Born Karamoja 1975-77	0.031	0.026	0.007	-0.004	0.031
	[0.053]	[0.012]*	[0.006]	[0.007]	[0.010]*
Female	-1.519	-0.118	-0.183	-0.144	
	[0.146]*	[0.010]*	[0.016]*	[0.012]*	
Rural	-2.572	-0.28	-0.158	-0.11	0.009
	[0.129]*	[0.013]*	[0.011]*	[0.010]*	[0.006]
Constant	9.955				
	[0.175]*				
Observations	352,302	352,302	352,302	352,302	352,302
R-squared	0.22				
Descriptive statistics of dependent variables:					
mean	5.21	0.23	0.69	0.78	0.51
standard deviation	4.05	0.42	0.46	0.41	0.50

Robust standard errors in brackets. Clustered at district of birth level.
* significant at 5%; + significant at 10%.
Columns 2-5 present marginal effects from the probit model.
52% of non-migrants are women, 90% live in rural areas, 0.69% were *in utero* in Karamoja 1980, 1.0% were born in Karamoja 1978-1979 and 1.0% were born in Karamoja in 1975-1977, respectively.

old is greater for women than for men. This is consistent with the fact that boys are more fragile during infancy (mortality selection). A larger number of boys could have died during the famine compared with the proportion of deaths among girls. If this is the case, male survivors were stronger than female survivors and the effects of the famine were milder for them as the results indicate.

8.3.2 1991 Ugandan Census

Table 16 contains the family fixed effects estimates for boys and girls separately[33]. The negative impact of the famine on girls seems to be stronger than for boys when controlling for unobservable individual characteristics. The school attendance (current) of girls decreased by 23%-points compared to 17%-points of boys exposed *in utero* (column two). This pattern is similar for cohorts exposed at older ages (0-2 and 3-5) and for school ever attendance (column one). Female child labor increased by 9.8%-points, 22.6%-points and 17%-points for cohorts

[33]Notice here that it is not necessary to estimate family×gender fixed effects as I am splitting the sample by gender.

exposed in the womb, at 0-2 years old and 3-5 years old, respectively. However, I do not find relevant effects on boys' child labour for the cohort who had not been born at the time of the famine and the coefficient is very small compared to girls. The increase in the chance of working for boys born in Karamoja between 1978 and 1979 is smaller compared to girls (14.2%-points vs. 22.6%-points), and similar for children born in 1975-1977. The probability to stay at home doing housework is similar for both boys and girls.

Two conclusions can be drawn from these results. First, the *direct* effect of the famine is larger for girls compared to boys. And second, the genetic/innate disadvantage of males (e.g. Stevenson et al.; 2000; Fukuda et al.; 1998) enlarge the negative effects of the famine for the cohort exposed during gestation and so, they appear stronger than for girls. This effect is mitigated when heterogeneity at family level is controlled for using family fixed effects.

9 Conclusions

This study aims to evaluate the long-term cognitive and health effects for adults who were in gestation or exposed under five years old during the 1980 famine in Karamoja, Uganda.

Results indicate that the literacy, school attendance and educational attainment of cohorts exposed to the famine are lower than the ones of those who were not exposed or exposed at older ages. I also find significant sex-ratio differences which suggest that girls might be stronger than boys at early stages of life (Stevenson et al.; 2000; Fukuda et al.; 1998).

Regional variation of effects show that food shortages also reduced the educational attainment of people who were born in less affected areas (FSR). However, those effects were much smaller than in Karamoja.

The negative effects of the famine in Karamoja increase when I control for family-level unobservables, but decrease for children born in less affected areas (FSR). I also find significant variation of the famine effects with duration of exposure *in utero*. The negative effect of the famine seems to be larger for the exposed cohort who did not migrate. This is consistent with out-migrants being relatively well off and, therefore, more able to protect themselves by migrating to better developed regions. Family fixed effects by gender reveal that the *direct* negative effect of the famine is larger for girls compared to boys.

Two falsification experiments, in which Karamoja and the exposed cohorts are replaced by a false,distant region and older cohorts (born 1962-1971 in Karamoja), reveal that the negative effects of the famine are valid only for people born in Karamoja and exposed to the famine.

Finally, this work provides evidence of the importance of good nutrition at early stages of life. There are numerous children in the world who are extremely malnourished. They are the most in need of nutritional policies which may help them to improve their quality of life. The socio-economic gaps generated by extreme food shortages during childhood might be narrowed

by key nutritional interventions and quick reactions to natural catastrophes.

Future work will explore in more detail the effects of the famine on health outcomes. In particular, the four rounds of the Ugandan DHS surveys (1988, 1995, 2000 and 2006) provide a good opportunity to explore those effects at different stages of life and also allow to control for unobserved heterogeneity at family level in childhood.

Table 15: Gender differences of the impact of the famine.

	Years of education	**Completed primary**	**Literate**	**Ever-attended school**
	(1)	(2)	(3)	(4)
		A. Females		
in utero Karamoja 1980	-0.306	-0.015	-0.009	-0.022
	[0.042]*	[0.003]*	[0.020]	[0.019]
Born Karamoja 1978-79	-0.383	-0.013	-0.02	-0.025
	[0.077]*	[0.016]	[0.014]	[0.010]*
Born Karamoja 1975-77	-0.06	0.01	0.013	0.006
	[0.042]	[0.007]	[0.009]	[0.004]
Rural	-2.969	-0.298	-0.224	-0.162
	[0.178]*	[0.018]*	[0.009]*	[0.008]*
Constant	10.42			
	[0.194]*			
Observations	245,909	245,906	245,906	245,906
R-squared	0.24			
Descriptive statistics of dependent variables:				
mean	4.83	0.22	0.64	0.73
standard deviation	4.14	0.41	0.48	0.44
		B. Males		
in utero Karamoja 1980	-0.479	-0.064	-0.04	-0.031
	[0.107]*	[0.014]*	[0.013]*	[0.013]*
Born Karamoja 1978-79	-0.215	-0.014	-0.01	-0.005
	[0.061]*	[0.011]	[0.005]+	[0.007]
Born Karamoja 1975-77	0.073	0.033	0.009	0.002
	[0.132]	[0.018]+	[0.012]	[0.010]
Rural	-2.926	-0.339	-0.13	-0.084
	[0.136]*	[0.012]*	[0.006]*	[0.005]*
Constant	9.977			
	[0.169]*			
Observations	226,116	226,116	226,110	226,116
R-squared	0.18			
Descriptive statistics of dependent variables:				
mean	6.36	0.33	0.80	0.86
standard deviation	4.13	0.47	0.40	0.35

Robust standard errors in brackets. Clustered at district of birth level.

* significant at 5%; + significant at 10%.

Columns 2-5 present marginal effects from the probit model.

84% of women and 83% of men live in rural areas. 0.57%, 0.83% and 0.89% of women and 0.51%, 0.76% and 0.80% of men were *in utero* in Karamoja 1980, born in Karamoja 1978-1979 and in 1975-1977, respectively.

Table 16: Gender Differences. Family fixed effects results - 1991 census.

		Main activity of child		
	Ever-attended school	**attending school** (currently)	**Working**	**house-work**
	(1)	(2)	(3)	(4)
		A. Females		
in utero Karamoja 1980	-0.103	-0.229	0.098	0.235
	[0.015]*	[0.013]*	[0.037]*	[0.038]*
Born Karamoja 1978-79	-0.142	-0.253	0.226	0.159
	[0.014]*	[0.014]*	[0.030]*	[0.032]*
Born Karamoja 1975-77	-0.102	-0.152	0.169	0.075
	[0.013]*	[0.014]*	[0.027]*	[0.028]*
Age of mother at birth	-0.017	0.029	-0.036	-0.012
	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Constant	1.086	-0.072	1.002	0.343
	[0.058]*	[0.053]	[0.044]*	[0.034]*
Observations	89,304	89,304	82,364	82,364
Number of households	51,333	51,333	49,147	49,147
R-squared	0.095	0.172	0.169	0.029
Descriptive statistics of dependent variables:				
mean	0.76	0.61	0.21	0.12
standard deviation	0.43	0.49	0.40	0.32
		B. Males		
in utero Karamoja 1980	-0.111	-0.169	0.018	0.227
	[0.025]*	[0.019]*	[0.038]	[0.040]*
Born Karamoja 1978-79	-0.121	-0.200	0.142	0.153
	[0.022]*	[0.021]*	[0.036]*	[0.029]*
Born Karamoja 1975-77	-0.087	-0.135	0.168	0.042
	[0.020]*	[0.020]*	[0.030]*	[0.025]+
Age of mother at birth	-0.031	0.017	-0.036	-0.002
	[0.001]*	[0.001]*	[0.001]*	[0.000]*
Constant	1.333	0.069	1.056	0.149
	[0.174]*	[0.075]	[0.065]*	[0.064]*
Observations	102,809	102,809	98,013	98,013
Number of households	54,443	54,443	53,226	53,226
R-squared	0.159	0.146	0.152	0.013
Descriptive statistics of dependent variables:				
mean	0.83	0.69	0.19	0.05
standard deviation	0.37	0.46	0.39	0.23

Robust standard errors in brackets

* significant at 5%; + significant at 10%.

Control group: children who were born from 1970 to 1974 and 1981 - 1982 in Karamoja and from 1970 to 1982 in regions outside Karamoja.

0.30%, 0.38% and 0.50% of girls and 0.22%, 0.31% and 0.36% of boys were *in utero* in Karamoja 1980, born in Karamoja 1978-1979 and in 1975-1977, respectively.

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Appendix

Figure A1: Uganda population by region and date of birth (year-month).

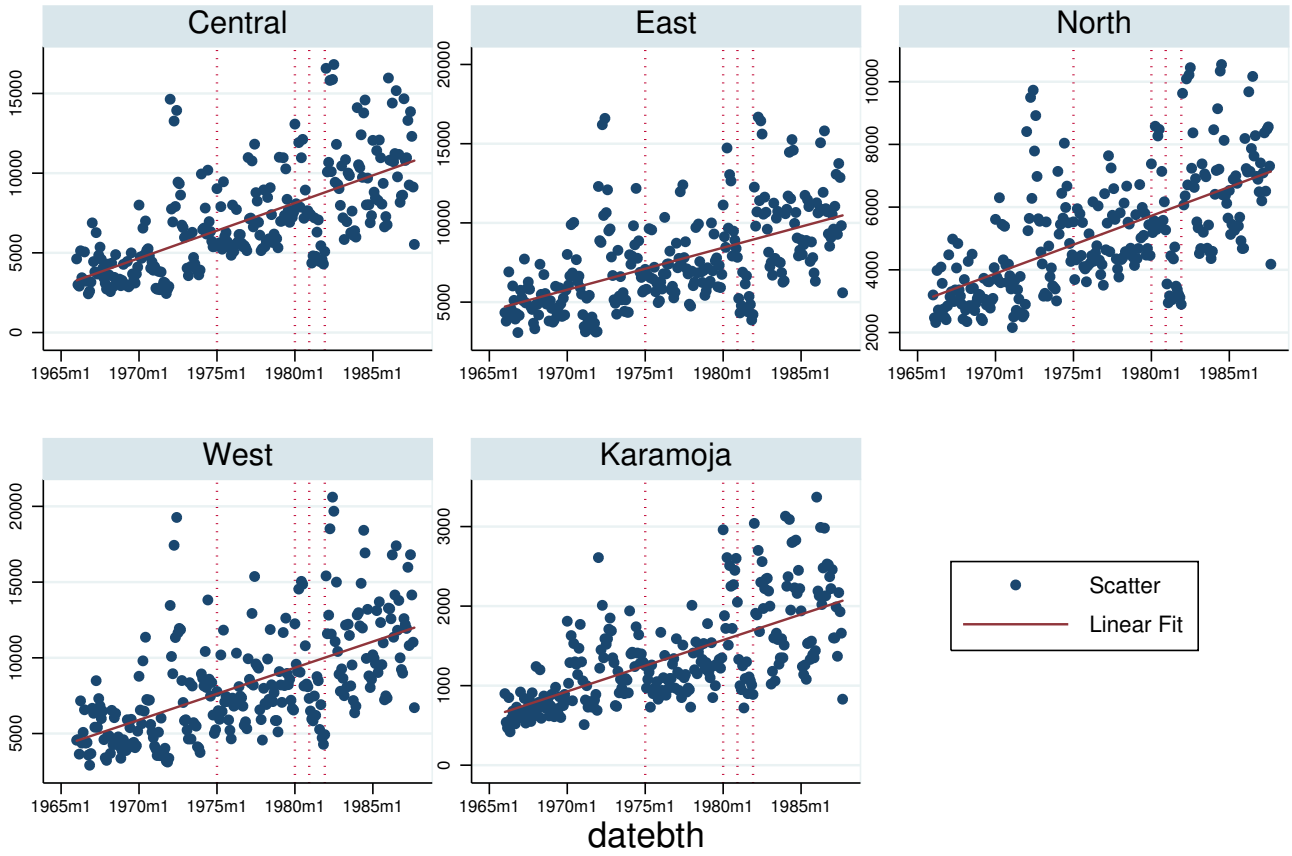


Table A1: Outcome means.

Education or health Outcome	**Born in Karamoja**					Born **rest of Uganda**
	1980	**1978 -1979**	**1975 -1977**	**Surrounding cohorts**[1]	**Total**	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A - 2002 Census						
Years of education	1.12	1.29	1.31	1.19	1.22	5.77
Completed Primary	0.06	0.07	0.07	0.07	0.07	0.28
Literate	0.14	0.15	0.15	0.15	0.15	0.74
Ever-attended school	0.17	0.19	0.18	0.17	0.18	0.82
Female	0.55	0.55	0.55	0.52	0.53	0.52
Observations	*2,544*	*3,756*	*3,979*	*11,375*	*21,654*	*450,371*
Panel B - 1991 Census						
Ever-attended school	0.13	0.16	0.20	0.16	0.17	0.81
Attending school	0.12	0.14	0.16	0.10	0.13	0.65
Observations	*842*	*1,200*	*1,528*	*2,627*	*6,197*	*193,584*
Working	0.38	0.45	0.49	0.47	0.46	0.19
House-work	0.48	0.39	0.33	0.30	0.36	0.08
Observations	*817*	*1,181*	*1,536*	*1,404*	*4,938*	*182,726*
Panel C - DHS 2006						
Years of education	1.54	0.89	3.55	2.12	1.99	5.83
Completed Primary	0.07	0.04	0.24	0.09	0.11	0.26
Ever-attended school	0.29	0.24	0.46	0.39	0.34	0.87
female	0.62	0.71	0.51	0.60	0.61	0.53
Observations	*51*	*76*	*85*	*182*	*423*	*6,543*
Weight	57.5	52.8	55.4	56.5	55.7	58.3
Height	165.6	165.7	168.7	167.6	167.1	162.9
Weight-for-height	0.35	0.32	0.33	0.34	0.33	0.36
Under-weight	0.27	0.28	0.20	0.31	0.27	0.09
Over-weight	0.19	0.00	0.00	0.07	0.07	0.12
Anemic	0.38	0.52	0.53	0.36	0.43	0.38
Observations	*19*	*28*	*23*	*54*	*124*	*2,024*

[1] Born in 1970-1974 or 1981-1982.

Table A2: Parents characteristics by year of birth of their children - Population means and t-tests.

	Birth year of children[1/]			means	t- test of means			
	1978-79, 1981-82	**1980**	**Total**	**diff**	t	p-value	obs	pop size
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
%	67.4	32.6	100					
Observations	3,551	1,718	5,269					
Individual characteristics								
Age	38.9	39.8	39.2	-0.889	-2.39*	0.017	5,267	33,370
number of kids	3.66	4.05	3.79	-0.389	-7.32*	0.000	5,269	33,378
Muslim	0.002	0.009	0.004	-0.008	-2.51*	0.012	5,266	33,347
Christian	0.51	0.54	0.52	-0.029	-1.69	0.090	5,266	33,347
rural	0.96	0.94	0.95	0.014	1.72	0.085	5,266	33,357
Education								
literate	0.09	0.09	0.09	-0.004	-0.44	0.661	5,269	33,378
years of education	0.64	0.67	0.65	-0.027	-0.36	0.720	5,268	33,374
Completed secondary	0.06	0.07	0.06	-0.006	-0.76	0.446	5,268	33,374
Ever-attended school	0.10	0.11	0.10	-0.002	-0.15	0.878	5,269	33,378
Employment status[2/]								
house-work	0.30	0.30	0.30	-0.007	-0.45	0.655	5,259	33,273
working	0.67	0.66	0.67	0.008	0.49	0.626	5,259	33,273
Type of worker								
self-employed	0.72	0.72	0.72	-0.005	-0.27	0.787	3,310	22,295
paid employee	0.09	0.08	0.08	0.002	0.16	0.872	3,310	22,295
unpaid worker	0.20	0.20	0.20	0.003	0.19	0.846	3,310	22,295
Occupation								
agricultural	0.65	0.65	0.65	-0.004	-0.19	0.850	3,277	22,056

* Significant at 5%.

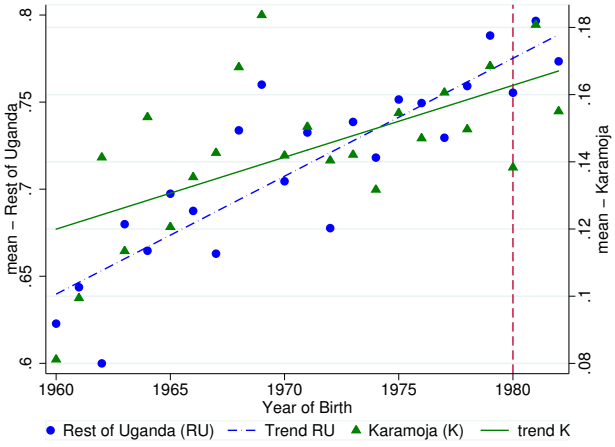
Note: sample includes all parents (fathers and mothers) of children who were born in Karamoja between 1978-1982. Population means and t-tests were also calculated for mothers and fathers separately. The results are very similar and are available upon request.

[1/] 67.9% of parents had one child between 1978 and 1982, 28.3% had two children and 3.8% had three. In this table, I separate parents who had a child in 1980 from those who did not, but they could also have one or two more children in the period 78-82. Population means and t-tests were also calculated for three exclusive groups of parents, those who had only one child in: (1) 1978-1979, (2) 1980 and (3) 1981-1982. Age and Muslim were the only categories statistically different between group (2) and groups (1) and (3). Parents who had children in 1980 are predominantly more Muslims, older than group (3) and younger than group (1). The full set of results is available upon request.

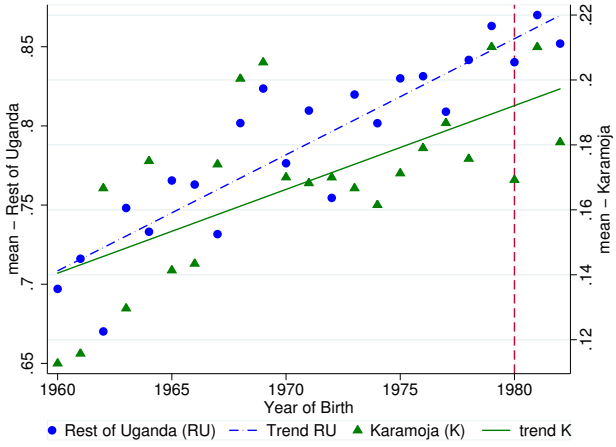
[2/] in 1991.

Figure A2: Cognitive outcomes by year of birth - Uganda Census 2002.

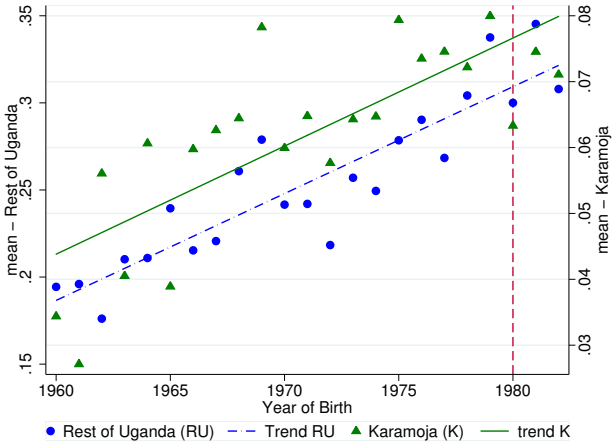
(a) Literate.



(b) Ever-attended School.



(c) Completed Primary.



(d) Years of Education.

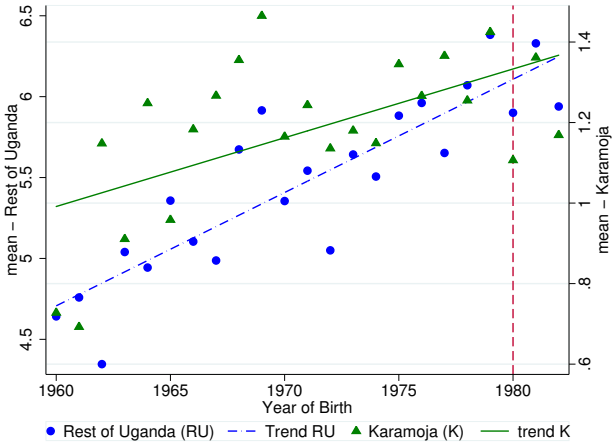


Table A3: Descriptive statistics dependent variables. Different cohorts born in Karamoja - 2002 census.

Reference year ($s =$)	Years of schooling	Completed primary	Literate	Ever-attended school	Female
1967					
mean	4.83	0.21	0.64	0.71	0.48
s.d.	4.30	0.41	0.48	0.45	0.50
1968					
mean	4.90	0.21	0.65	0.72	0.48
s.d.	4.30	0.41	0.48	0.45	0.50
1969					
mean	4.93	0.21	0.66	0.72	0.48
s.d.	4.30	0.41	0.48	0.45	0.50
1970					
mean	4.93	0.21	0.66	0.72	0.48
s.d.	4.28	0.41	0.48	0.45	0.50
1971					
mean	5.00	0.22	0.66	0.73	0.49
s.d.	4.27	0.41	0.47	0.44	0.50

s.d. standard deviation.

Table A4: Descriptive statistics dependent variables. Different cohorts born in Karamoja - 1991 census.

Reference year ($s =$)	Ever-attended school	attending school	Working	house-work
1967				
mean	0.78	0.11	0.69	0.12
s.d.	0.41	0.32	0.46	0.33
1968				
mean	0.80	0.15	0.66	0.12
s.d.	0.40	0.36	0.48	0.33
1969				
mean	0.81	0.19	0.62	0.12
s.d.	0.39	0.40	0.49	0.32
1970				
mean	0.82	0.24	0.58	0.12
s.d.	0.38	0.43	0.49	0.32
1971				
mean	0.84	0.29	0.53	0.12
s.d.	0.37	0.45	0.50	0.32

s.d. standard deviation.

Table A5: Cognitive effects of the famine on 1975-1980 cohorts by intensity - 2002 Census. Full results.

	Years of education	**Completed primary**	**Literate**	**Ever-attended school**	**Female**
	(1)	(2)	(3)	(4)	(5)
in utero Karamoja 1980	-0.410	-0.046	-0.037	-0.033	0.002
	[0.057]*	[0.007]*	[0.016]*	[0.015]*	[0.011]
Born Karamoja 1978-79	-0.324	-0.016	-0.022	-0.018	0.011
	[0.061]*	[0.011]	[0.007]*	[0.008]*	[0.013]
Born Karamoja 1975-77	0.008	0.021	0.008	0.002	0.032
	[0.073]	[0.012]+	[0.005]	[0.007]	[0.010]*
in utero food-shortage region 1980	-0.191	-0.019	-0.02	-0.01	0.012
	[0.065]*	[0.005]*	[0.009]*	[0.008]	[0.007]
Born food-shortage region 1978-79	-0.149	-0.008	-0.022	-0.013	-0.006
	[0.067]*	[0.007]	[0.008]*	[0.005]*	[0.006]
Born food-shortage region 1975-77	-0.082	-0.005	-0.013	-0.005	0.006
	[0.054]	[0.006]	[0.005]*	[0.004]	[0.005]
Female	-1.491	-0.123	-0.169	-0.131	
	[0.137]*	[0.011]*	[0.015]*	[0.011]*	
Rural	-2.969	-0.324	-0.179	-0.124	0.024
	[0.152]*	[0.015]*	[0.007]*	[0.006]*	[0.007]*
January 1970	-1.212	-0.11	-0.164	-0.164	-0.117
	[0.109]*	[0.008]*	[0.016]*	[0.017]*	[0.011]*
February 1970	-1.237	-0.113	-0.17	-0.179	-0.079
	[0.135]*	[0.010]*	[0.017]*	[0.017]*	[0.015]*
March 1970	-1.265	-0.122	-0.17	-0.172	-0.075
	[0.116]*	[0.008]*	[0.015]*	[0.018]*	[0.013]*
April 1970	-1.379	-0.129	-0.178	-0.177	-0.089
	[0.121]*	[0.008]*	[0.016]*	[0.018]*	[0.013]*
May 1970	-1.23	-0.118	-0.162	-0.156	-0.091
	[0.112]*	[0.008]*	[0.016]*	[0.018]*	[0.013]*
June 1970	-1.338	-0.122	-0.172	-0.168	-0.095
	[0.101]*	[0.007]*	[0.014]*	[0.016]*	[0.010]*
July 1970	-1.109	-0.104	-0.159	-0.157	-0.074
	[0.123]*	[0.009]*	[0.017]*	[0.018]*	[0.015]*
August 1970	-1.188	-0.11	-0.156	-0.164	-0.07
	[0.097]*	[0.006]*	[0.018]*	[0.019]*	[0.012]*
September 1970	-1.156	-0.107	-0.164	-0.175	-0.067
	[0.116]*	[0.009]*	[0.015]*	[0.015]*	[0.008]*
October 1970	-1.109	-0.096	-0.159	-0.163	-0.092
	[0.118]*	[0.009]*	[0.014]*	[0.017]*	[0.012]*
November 1970	-0.976	-0.101	-0.144	-0.155	-0.057
	[0.129]*	[0.010]*	[0.016]*	[0.020]*	[0.015]*
December 1970	-0.68	-0.074	-0.11	-0.119	-0.052
	[0.141]*	[0.012]*	[0.016]*	[0.017]*	[0.014]*
January 1971	-0.915	-0.105	-0.118	-0.11	-0.128
	[0.128]*	[0.010]*	[0.018]*	[0.016]*	[0.014]*
February 1971	-1.231	-0.126	-0.157	-0.14	-0.081
	[0.155]*	[0.013]*	[0.021]*	[0.017]*	[0.015]*
March 1971	-0.918	-0.104	-0.119	-0.111	-0.104
	[0.101]*	[0.010]*	[0.018]*	[0.018]*	[0.014]*
April 1971	-1.169	-0.128	-0.149	-0.135	-0.075

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Table A5: Cognitive effects of the famine on 1975-1980 cohorts by intensity - 2002 Census. Full results.

	Years of education	Completed primary	Literate	Ever-attended school	Female
	(1)	(2)	(3)	(4)	(5)
	[0.140]*	[0.010]*	[0.019]*	[0.021]*	[0.013]*
May 1971	-0.702	-0.095	-0.101	-0.083	-0.087
	[0.124]*	[0.011]*	[0.017]*	[0.013]*	[0.016]*
June 1971	-1.303	-0.13	-0.144	-0.139	-0.101
	[0.133]*	[0.008]*	[0.014]*	[0.018]*	[0.013]*
July 1971	-0.969	-0.105	-0.135	-0.13	-0.096
	[0.144]*	[0.012]*	[0.019]*	[0.020]*	[0.012]*
August 1971	-0.99	-0.108	-0.136	-0.123	-0.084
	[0.120]*	[0.010]*	[0.018]*	[0.021]*	[0.018]*
September 1971	-0.881	-0.091	-0.14	-0.127	-0.057
	[0.141]*	[0.010]*	[0.022]*	[0.019]*	[0.016]*
October 1971	-1.031	-0.115	-0.118	-0.131	-0.091
	[0.110]*	[0.008]*	[0.020]*	[0.021]*	[0.013]*
November 1971	-0.892	-0.1	-0.124	-0.131	-0.093
	[0.153]*	[0.011]*	[0.020]*	[0.023]*	[0.017]*
December 1971	-0.639	-0.085	-0.09	-0.084	-0.067
	[0.107]*	[0.010]*	[0.016]*	[0.019]*	[0.015]*
January 1972	-1.419	-0.124	-0.194	-0.191	-0.077
	[0.105]*	[0.007]*	[0.013]*	[0.016]*	[0.010]*
February 1972	-1.408	-0.122	-0.184	-0.174	-0.069
	[0.101]*	[0.006]*	[0.016]*	[0.018]*	[0.012]*
March 1972	-1.486	-0.133	-0.187	-0.193	-0.05
	[0.106]*	[0.008]*	[0.015]*	[0.015]*	[0.010]*
April 1972	-1.63	-0.143	-0.21	-0.203	-0.038
	[0.105]*	[0.007]*	[0.013]*	[0.017]*	[0.011]*
May 1972	-1.362	-0.123	-0.186	-0.181	-0.04
	[0.119]*	[0.007]*	[0.016]*	[0.016]*	[0.009]*
June 1972	-1.669	-0.143	-0.209	-0.198	-0.06
	[0.094]*	[0.006]*	[0.013]*	[0.014]*	[0.011]*
July 1972	-1.497	-0.13	-0.201	-0.199	-0.037
	[0.107]*	[0.006]*	[0.015]*	[0.016]*	[0.012]*
August 1972	-1.431	-0.133	-0.183	-0.182	-0.028
	[0.099]*	[0.007]*	[0.015]*	[0.017]*	[0.010]*
September 1972	-1.51	-0.132	-0.196	-0.186	-0.029
	[0.093]*	[0.007]*	[0.015]*	[0.018]*	[0.011]*
October 1972	-1.265	-0.12	-0.169	-0.17	-0.057
	[0.106]*	[0.007]*	[0.016]*	[0.016]*	[0.010]*
November 1972	-1.078	-0.105	-0.145	-0.15	-0.047
	[0.088]*	[0.007]*	[0.016]*	[0.016]*	[0.010]*
December 1972	-0.608	-0.078	-0.107	-0.101	-0.019
	[0.075]*	[0.007]*	[0.014]*	[0.014]*	[0.011]+
January 1973	-0.949	-0.095	-0.132	-0.132	-0.063
	[0.105]*	[0.009]*	[0.015]*	[0.016]*	[0.013]*
February 1973	-1.058	-0.113	-0.14	-0.115	-0.059
	[0.118]*	[0.009]*	[0.014]*	[0.015]*	[0.013]*
March 1973	-0.965	-0.103	-0.119	-0.116	-0.082
	[0.129]*	[0.009]*	[0.016]*	[0.016]*	[0.015]*
April 1973	-1.259	-0.13	-0.149	-0.136	-0.063
	[0.109]*	[0.007]*	[0.015]*	[0.019]*	[0.013]*

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Table A5: Cognitive effects of the famine on 1975-1980 cohorts by intensity - 2002 Census. Full results.

	Years of education	Completed primary	Literate	Ever-attended school	Female
	(1)	(2)	(3)	(4)	(5)
May 1973	-0.93	-0.109	-0.103	-0.09	-0.053
	[0.112]*	[0.009]*	[0.015]*	[0.014]*	[0.015]*
June 1973	-1.077	-0.114	-0.114	-0.112	-0.059
	[0.134]*	[0.009]*	[0.016]*	[0.019]*	[0.010]*
July 1973	-0.883	-0.092	-0.126	-0.108	-0.036
	[0.120]*	[0.010]*	[0.018]*	[0.016]*	[0.014]*
August 1973	-0.903	-0.1	-0.124	-0.099	-0.015
	[0.122]*	[0.009]*	[0.017]*	[0.017]*	[0.012]
September 1973	-0.866	-0.094	-0.13	-0.111	-0.048
	[0.127]*	[0.010]*	[0.017]*	[0.017]*	[0.013]*
October 1973	-0.82	-0.093	-0.11	-0.096	-0.036
	[0.121]*	[0.012]*	[0.017]*	[0.014]*	[0.015]*
November 1973	-0.68	-0.082	-0.1	-0.093	-0.036
	[0.132]*	[0.010]*	[0.019]*	[0.017]*	[0.017]*
December 1973	-0.267	-0.046	-0.065	-0.057	-0.007
	[0.106]*	[0.009]*	[0.017]*	[0.014]*	[0.016]
January 1974	-1.063	-0.105	-0.146	-0.14	-0.052
	[0.093]*	[0.007]*	[0.014]*	[0.015]*	[0.012]*
February 1974	-1.209	-0.114	-0.168	-0.151	-0.052
	[0.100]*	[0.008]*	[0.017]*	[0.015]*	[0.013]*
March 1974	-1.329	-0.125	-0.175	-0.146	-0.022
	[0.119]*	[0.009]*	[0.015]*	[0.014]*	[0.014]
April 1974	-1.185	-0.115	-0.152	-0.142	-0.04
	[0.111]*	[0.008]*	[0.014]*	[0.014]*	[0.012]*
May 1974	-1.112	-0.113	-0.158	-0.135	-0.005
	[0.100]*	[0.008]*	[0.015]*	[0.016]*	[0.012]
June 1974	-1.221	-0.123	-0.153	-0.126	-0.028
	[0.111]*	[0.008]*	[0.014]*	[0.014]*	[0.010]*
July 1974	-0.958	-0.102	-0.138	-0.107	-0.02
	[0.105]*	[0.009]*	[0.013]*	[0.016]*	[0.013]
August 1974	-0.923	-0.101	-0.13	-0.115	-0.02
	[0.104]*	[0.009]*	[0.015]*	[0.015]*	[0.012]
September 1974	-0.88	-0.091	-0.127	-0.122	-0.026
	[0.107]*	[0.009]*	[0.016]*	[0.016]*	[0.011]*
October 1974	-0.939	-0.098	-0.134	-0.126	-0.027
	[0.109]*	[0.010]*	[0.016]*	[0.016]*	[0.012]*
November 1974	-0.524	-0.069	-0.088	-0.094	-0.006
	[0.133]*	[0.011]*	[0.016]*	[0.015]*	[0.013]
December 1974	-0.27	-0.055	-0.057	-0.071	-0.007
	[0.117]*	[0.012]*	[0.018]*	[0.017]*	[0.011]
January 1975	-0.852	-0.09	-0.134	-0.114	-0.062
	[0.108]*	[0.010]*	[0.015]*	[0.016]*	[0.011]*
February 1975	-0.835	-0.091	-0.123	-0.106	-0.071
	[0.104]*	[0.009]*	[0.015]*	[0.015]*	[0.012]*
March 1975	-0.863	-0.1	-0.124	-0.097	-0.048
	[0.112]*	[0.009]*	[0.015]*	[0.016]*	[0.013]*
April 1975	-0.982	-0.106	-0.114	-0.101	-0.059
	[0.096]*	[0.008]*	[0.014]*	[0.016]*	[0.011]*
May 1975	-0.569	-0.081	-0.085	-0.087	-0.041

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Table A5: Cognitive effects of the famine on 1975-1980 cohorts by intensity - 2002 Census. Full results.

	Years of education	Completed primary	Literate	Ever-attended school	Female
	(1)	(2)	(3)	(4)	(5)
	[0.111]*	[0.009]*	[0.016]*	[0.019]*	[0.013]*
June 1975	-0.925	-0.11	-0.123	-0.104	-0.044
	[0.121]*	[0.010]*	[0.014]*	[0.015]*	[0.011]*
July 1975	-0.683	-0.088	-0.099	-0.086	-0.058
	[0.114]*	[0.011]*	[0.014]*	[0.014]*	[0.012]*
August 1975	-0.681	-0.09	-0.097	-0.088	-0.025
	[0.108]*	[0.009]*	[0.014]*	[0.014]*	[0.012]*
September 1975	-0.575	-0.068	-0.107	-0.099	-0.042
	[0.104]*	[0.010]*	[0.016]*	[0.015]*	[0.010]*
October 1975	-0.663	-0.075	-0.098	-0.103	-0.058
	[0.117]*	[0.012]*	[0.016]*	[0.016]*	[0.012]*
November 1975	-0.529	-0.072	-0.087	-0.095	-0.039
	[0.118]*	[0.011]*	[0.016]*	[0.017]*	[0.015]*
December 1975	0.138	-0.008	-0.027	-0.034	-0.011
	[0.096]	[0.011]	[0.011]*	[0.013]*	[0.011]
January 1976	-0.802	-0.077	-0.125	-0.12	-0.058
	[0.110]*	[0.010]*	[0.013]*	[0.015]*	[0.012]*
February 1976	-0.731	-0.08	-0.107	-0.094	-0.047
	[0.109]*	[0.010]*	[0.015]*	[0.015]*	[0.014]*
March 1976	-0.798	-0.085	-0.117	-0.101	-0.035
	[0.108]*	[0.009]*	[0.016]*	[0.015]*	[0.015]*
April 1976	-0.986	-0.106	-0.13	-0.118	-0.044
	[0.090]*	[0.007]*	[0.013]*	[0.012]*	[0.010]*
May 1976	-0.552	-0.069	-0.107	-0.076	-0.048
	[0.121]*	[0.011]*	[0.018]*	[0.017]*	[0.012]*
June 1976	-0.5	-0.069	-0.101	-0.082	-0.052
	[0.121]*	[0.013]*	[0.015]*	[0.013]*	[0.011]*
July 1976	-0.672	-0.085	-0.103	-0.082	-0.029
	[0.122]*	[0.010]*	[0.015]*	[0.015]*	[0.012]*
August 1976	-0.607	-0.083	-0.109	-0.085	-0.027
	[0.117]*	[0.010]*	[0.015]*	[0.015]*	[0.013]*
September 1976	-0.652	-0.079	-0.1	-0.09	-0.032
	[0.118]*	[0.011]*	[0.015]*	[0.015]*	[0.017]+
October 1976	-0.57	-0.077	-0.097	-0.087	-0.046
	[0.114]*	[0.010]*	[0.014]*	[0.016]*	[0.014]*
November 1976	-0.505	-0.064	-0.085	-0.088	-0.047
	[0.114]*	[0.010]*	[0.016]*	[0.015]*	[0.012]*
December 1976	-0.126	-0.036	-0.059	-0.051	-0.008
	[0.113]	[0.011]*	[0.014]*	[0.014]*	[0.014]
January 1977	-0.949	-0.088	-0.14	-0.137	-0.056
	[0.120]*	[0.009]*	[0.016]*	[0.016]*	[0.011]*
February 1977	-1.004	-0.097	-0.145	-0.128	-0.038
	[0.121]*	[0.010]*	[0.014]*	[0.015]*	[0.014]*
March 1977	-1.135	-0.116	-0.145	-0.134	-0.033
	[0.115]*	[0.009]*	[0.015]*	[0.015]*	[0.011]*
April 1977	-1.143	-0.108	-0.147	-0.131	-0.027
	[0.104]*	[0.008]*	[0.013]*	[0.013]*	[0.012]*
May 1977	-0.901	-0.096	-0.124	-0.118	-0.038
	[0.121]*	[0.010]*	[0.016]*	[0.017]*	[0.011]*

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Table A5: Cognitive effects of the famine on 1975-1980 cohorts by intensity - 2002 Census. Full results.

	Years of education	Completed primary	Literate	Ever-attended school	Female
	(1)	(2)	(3)	(4)	(5)
June 1977	-1.176	-0.117	-0.152	-0.125	-0.043
	[0.109]*	[0.008]*	[0.015]*	[0.015]*	[0.013]*
July 1977	-0.714	-0.08	-0.13	-0.113	-0.064
	[0.109]*	[0.010]*	[0.013]*	[0.016]*	[0.011]*
August 1977	-0.855	-0.096	-0.111	-0.095	-0.015
	[0.084]*	[0.007]*	[0.014]*	[0.014]*	[0.012]
September 1977	-0.894	-0.091	-0.134	-0.128	-0.016
	[0.128]*	[0.010]*	[0.016]*	[0.016]*	[0.012]
October 1977	-0.692	-0.081	-0.104	-0.098	-0.031
	[0.109]*	[0.010]*	[0.015]*	[0.015]*	[0.013]*
November 1977	-0.65	-0.071	-0.111	-0.11	-0.03
	[0.104]*	[0.010]*	[0.016]*	[0.016]*	[0.012]*
December 1977	-0.096	-0.037	-0.035	-0.043	0.003
	[0.126]	[0.013]*	[0.016]*	[0.013]*	[0.013]
January 1978	-0.595	-0.062	-0.108	-0.097	-0.027
	[0.116]*	[0.010]*	[0.017]*	[0.015]*	[0.013]*
February 1978	-0.689	-0.081	-0.101	-0.083	-0.035
	[0.112]*	[0.010]*	[0.015]*	[0.015]*	[0.016]*
March 1978	-0.71	-0.083	-0.116	-0.086	-0.029
	[0.112]*	[0.011]*	[0.016]*	[0.016]*	[0.017]+
April 1978	-0.745	-0.089	-0.108	-0.082	-0.02
	[0.101]*	[0.009]*	[0.014]*	[0.013]*	[0.014]
May 1978	-0.505	-0.06	-0.098	-0.075	-0.021
	[0.098]*	[0.009]*	[0.014]*	[0.014]*	[0.013]
June 1978	-0.772	-0.087	-0.11	-0.092	-0.034
	[0.103]*	[0.009]*	[0.015]*	[0.015]*	[0.011]*
July 1978	-0.551	-0.069	-0.099	-0.079	-0.008
	[0.113]*	[0.009]*	[0.017]*	[0.017]*	[0.011]
August 1978	-0.392	-0.065	-0.065	-0.056	-0.035
	[0.124]*	[0.011]*	[0.015]*	[0.017]*	[0.012]*
September 1978	-0.371	-0.054	-0.077	-0.064	-0.021
	[0.126]*	[0.011]*	[0.014]*	[0.016]*	[0.014]
October 1978	-0.337	-0.052	-0.077	-0.061	-0.013
	[0.115]*	[0.011]*	[0.017]*	[0.016]*	[0.011]
November 1978	-0.255	-0.034	-0.056	-0.063	-0.006
	[0.113]*	[0.013]*	[0.013]*	[0.014]*	[0.009]
December 1978	0.073	-0.011	-0.031	-0.033	-0.016
	[0.085]	[0.011]	[0.013]*	[0.013]*	[0.011]
January 1979	-0.314	-0.044	-0.069	-0.059	-0.057
	[0.123]*	[0.012]*	[0.016]*	[0.016]*	[0.011]*
February 1979	-0.512	-0.068	-0.095	-0.069	-0.041
	[0.113]*	[0.010]*	[0.015]*	[0.014]*	[0.012]*
March 1979	-0.411	-0.057	-0.081	-0.053	-0.034
	[0.106]*	[0.008]*	[0.015]*	[0.015]*	[0.013]*
April 1979	-0.508	-0.062	-0.079	-0.066	-0.033
	[0.118]*	[0.010]*	[0.016]*	[0.015]*	[0.011]*
May 1979	-0.23	-0.04	-0.068	-0.047	-0.032
	[0.110]*	[0.011]*	[0.014]*	[0.012]*	[0.011]*
June 1979	-0.544	-0.065	-0.083	-0.058	-0.019

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Table A5: Cognitive effects of the famine on 1975-1980 cohorts by intensity - 2002 Census. Full results.

	Years of education	Completed primary	Literate	Ever-attended school	Female
	(1)	(2)	(3)	(4)	(5)
	[0.104]*	[0.010]*	[0.014]*	[0.011]*	[0.013]
July 1979	-0.355	-0.051	-0.062	-0.05	-0.021
	[0.117]*	[0.012]*	[0.015]*	[0.014]*	[0.012]+
August 1979	-0.242	-0.04	-0.052	-0.035	-0.01
	[0.088]*	[0.010]*	[0.011]*	[0.012]*	[0.010]
September 1979	-0.124	-0.024	-0.05	-0.046	-0.031
	[0.119]	[0.012]*	[0.015]*	[0.014]*	[0.009]*
October 1979	-0.221	-0.028	-0.053	-0.054	-0.023
	[0.113]+	[0.012]*	[0.013]*	[0.015]*	[0.009]*
November 1979	-0.115	-0.026	-0.048	-0.053	-0.019
	[0.118]	[0.012]*	[0.016]*	[0.016]*	[0.013]
December 1979	0.455	0.022	0.02	0.019	0.004
	[0.095]*	[0.012]+	[0.011]+	[0.011]+	[0.010]
January 1980	-0.624	-0.06	-0.095	-0.085	-0.03
	[0.103]*	[0.010]*	[0.013]*	[0.014]*	[0.010]*
February 1980	-0.644	-0.071	-0.084	-0.066	-0.019
	[0.091]*	[0.008]*	[0.013]*	[0.013]*	[0.012]+
March 1980	-0.696	-0.067	-0.1	-0.077	-0.01
	[0.099]*	[0.009]*	[0.012]*	[0.012]*	[0.012]
April 1980	-0.64	-0.074	-0.087	-0.069	-0.018
	[0.095]*	[0.009]*	[0.014]*	[0.013]*	[0.010]+
May 1980	-0.526	-0.058	-0.074	-0.056	0.006
	[0.101]*	[0.008]*	[0.013]*	[0.013]*	[0.011]
June 1980	-0.854	-0.084	-0.116	-0.082	-0.007
	[0.102]*	[0.008]*	[0.015]*	[0.013]*	[0.011]
July 1980	-0.785	-0.075	-0.101	-0.08	0.002
	[0.095]*	[0.008]*	[0.014]*	[0.013]*	[0.010]
August 1980	-0.189	-0.025	-0.052	-0.038	-0.019
	[0.102]+	[0.011]*	[0.013]*	[0.013]*	[0.013]
September 1980	-0.625	-0.059	-0.088	-0.074	-0.005
	[0.104]*	[0.008]*	[0.015]*	[0.015]*	[0.012]
October 1980	-0.432	-0.046	-0.078	-0.066	-0.015
	[0.098]*	[0.011]*	[0.012]*	[0.013]*	[0.010]
November 1980	-0.454	-0.042	-0.074	-0.07	0.001
	[0.109]*	[0.010]*	[0.014]*	[0.013]*	[0.013]
December 1980	-0.068	-0.009	-0.047	-0.044	-0.008
	[0.084]	[0.011]	[0.015]*	[0.011]*	[0.011]
January 1981	-0.25	-0.017	-0.053	-0.044	-0.043
	[0.132]+	[0.012]	[0.015]*	[0.016]*	[0.015]*
February 1981	-0.348	-0.046	-0.047	-0.038	-0.016
	[0.091]*	[0.008]*	[0.015]*	[0.017]*	[0.015]
March 1981	-0.447	-0.045	-0.072	-0.058	-0.024
	[0.117]*	[0.012]*	[0.015]*	[0.014]*	[0.013]+
April 1981	-0.305	-0.035	-0.051	-0.041	0.001
	[0.093]*	[0.010]*	[0.012]*	[0.012]*	[0.009]
May 1981	-0.254	-0.036	-0.055	-0.035	-0.011
	[0.102]*	[0.011]*	[0.016]*	[0.013]*	[0.013]
June 1981	-0.587	-0.059	-0.069	-0.054	-0.016
	[0.100]*	[0.009]*	[0.017]*	[0.014]*	[0.012]

Continued on next page

Table A5: Cognitive effects of the famine on 1975-1980 cohorts by intensity - 2002 Census. Full results.

	Years of education	Completed primary	Literate	Ever-attended school	Female
	(1)	(2)	(3)	(4)	(5)
July 1981	-0.42	-0.043	-0.062	-0.039	-0.025
	[0.085]*	[0.009]*	[0.012]*	[0.011]*	[0.011]*
August 1981	-0.185	-0.01	-0.041	-0.022	-0.018
	[0.099]+	[0.011]	[0.015]*	[0.013]+	[0.013]
September 1981	-0.258	-0.029	-0.042	-0.028	0.006
	[0.108]*	[0.014]*	[0.013]*	[0.013]*	[0.013]
October 1981	-0.009	0.005	-0.031	-0.025	-0.014
	[0.111]	[0.013]	[0.014]*	[0.013]+	[0.012]
November 1981	-0.085	-0.003	-0.034	-0.029	0.005
	[0.108]	[0.011]	[0.017]*	[0.015]*	[0.013]
December 1981	0.181	0.019	0.015	0.011	-0.005
	[0.099]+	[0.013]	[0.013]	[0.012]	[0.011]
January 1982	-0.741	-0.062	-0.096	-0.085	-0.004
	[0.076]*	[0.008]*	[0.010]*	[0.012]*	[0.008]
February 1982	-0.508	-0.051	-0.059	-0.039	-0.006
	[0.088]*	[0.009]*	[0.012]*	[0.012]*	[0.011]
March 1982	-0.72	-0.07	-0.09	-0.075	0.007
	[0.094]*	[0.009]*	[0.014]*	[0.014]*	[0.011]
April 1982	-0.76	-0.069	-0.088	-0.064	0.007
	[0.090]*	[0.009]*	[0.013]*	[0.013]*	[0.009]
May 1982	-0.48	-0.049	-0.07	-0.05	0.007
	[0.088]*	[0.011]*	[0.012]*	[0.012]*	[0.010]
June 1982	-0.75	-0.072	-0.077	-0.065	0.012
	[0.100]*	[0.008]*	[0.014]*	[0.014]*	[0.009]
July 1982	-0.763	-0.074	-0.091	-0.066	0.023
	[0.079]*	[0.007]*	[0.012]*	[0.011]*	[0.009]*
August 1982	-0.292	-0.025	-0.042	-0.032	0.012
	[0.071]*	[0.009]*	[0.012]*	[0.012]*	[0.010]
September 1982	-0.561	-0.058	-0.067	-0.054	-0.001
	[0.080]*	[0.009]*	[0.012]*	[0.011]*	[0.009]
October 1982	-0.422	-0.037	-0.056	-0.048	0.002
	[0.071]*	[0.010]*	[0.010]*	[0.010]*	[0.010]
November 1982	-0.363	-0.032	-0.049	-0.044	0.005
	[0.081]*	[0.010]*	[0.012]*	[0.011]*	[0.010]

Continued on next page

Table A5: Cognitive effects of the famine on 1975-1980 cohorts by intensity - 2002 Census. Full results.

	Years of education	Completed primary	Literate	Ever-attended school	Female
	(1)	(2)	(3)	(4)	(5)
Kampala	1.052	0.122	0.063	0.062	0.036
	[0.078]*	[0.007]*	[0.005]*	[0.004]*	[0.004]*
Kiboga	-1.505	-0.113	-0.109	-0.071	0.016
	[0.020]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Luwero	-0.764	-0.066	-0.035	-0.004	0.033
	[0.010]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Masaka	-0.493	-0.061	0.033	0.035	0.034
	[0.006]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Mpigi	-0.262	-0.022	0.012	0.021	0.038
	[0.009]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Mubende	-0.977	-0.082	-0.04	-0.011	0.023
	[0.016]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Mukono	-0.386	-0.019	-0.028	0.008	0.028
	[0.009]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Nakasongola	-1.089	-0.093	-0.092	-0.022	0.015
	[0.026]*	[0.001]*	[0.001]*	[0.001]*	[0.002]*
Rakai	-1.088	-0.116	-0.026	-0.001	0.006
	[0.026]*	[0.001]*	[0.001]*	[0.001]	[0.002]*
Sembabule	-2.031	-0.159	-0.118	-0.096	-0.003
	[0.033]*	[0.001]*	[0.002]*	[0.002]*	[0.002]
Kayunga	-1.252	-0.094	-0.146	-0.075	0.029
	[0.018]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Wakiso	1.408	0.152	0.12	0.094	0.006
	[0.021]*	[0.002]*	[0.001]*	[0.000]*	[0.001]*
Bugiri	-1.909	-0.124	-0.281	-0.158	0.039
	[0.035]*	[0.002]*	[0.002]*	[0.002]*	[0.002]*
Busia	-1.017	-0.08	-0.206	-0.04	0.014
	[0.038]*	[0.003]*	[0.004]*	[0.003]*	[0.003]*
Iganga	-1.387	-0.081	-0.207	-0.119	0.058
	[0.029]*	[0.002]*	[0.001]*	[0.002]*	[0.002]*
Jinja	0.051	0.029	-0.061	0.001	0.029
	[0.010]*	[0.001]*	[0.001]*	[0.001]	[0.001]*
Kamuli	-1.544	-0.088	-0.232	-0.136	0.045
	[0.037]*	[0.002]*	[0.002]*	[0.002]*	[0.002]*
Kapchorwa	0.294	0.027	-0.192	0.03	0
	[0.038]*	[0.003]*	[0.002]*	[0.001]*	[0.002]
Katakwi	-1.667	-0.113	-0.244	-0.117	0.025
	[0.045]*	[0.003]*	[0.004]*	[0.003]*	[0.003]*
Kumi	-1.254	-0.103	-0.211	-0.035	0.027
	[0.034]*	[0.002]*	[0.002]*	[0.002]*	[0.002]*
Mbale	-0.452	-0.049	-0.153	0.009	0.014
	[0.037]*	[0.003]*	[0.004]*	[0.002]*	[0.003]*
Pallisa	-1.804	-0.111	-0.297	-0.129	0.041
	[0.044]*	[0.003]*	[0.004]*	[0.003]*	[0.003]*
Soroti	-1.028	-0.084	-0.186	-0.042	0.028
	[0.034]*	[0.002]*	[0.004]*	[0.002]*	[0.002]*
Tororo	-1.492	-0.097	-0.277	-0.12	0.038
	[0.039]*	[0.003]*	[0.004]*	[0.003]*	[0.003]*
Kaberamaido	-0.91	-0.1	-0.119	0.015	0.034

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Table A5: Cognitive effects of the famine on 1975-1980 cohorts by intensity - 2002 Census. Full results.

	Years of education	Completed primary	Literate	Ever-attended school	Female
	(1)	(2)	(3)	(4)	(5)
	[0.038]*	[0.002]*	[0.002]*	[0.001]*	[0.002]*
Mayuge	-1.914	-0.122	-0.24	-0.159	0.034
	[0.037]*	[0.002]*	[0.002]*	[0.002]*	[0.002]*
Sironko	-0.883	-0.088	-0.185	-0.004	0.009
	[0.041]*	[0.003]*	[0.004]*	[0.002]+	[0.003]*
Adjumani	-1.462	-0.091	-0.205	-0.068	0.037
	[0.026]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Apac	-1.024	-0.129	-0.087	-0.002	0.018
	[0.034]*	[0.002]*	[0.002]*	[0.001]+	[0.002]*
Arua	-1.632	-0.124	-0.181	-0.092	0.039
	[0.031]*	[0.001]*	[0.002]*	[0.002]*	[0.002]*
Gulu	-1.944	-0.146	-0.264	-0.16	0.042
	[0.028]*	[0.002]*	[0.003]*	[0.003]*	[0.002]*
Kitgum	-1.882	-0.137	-0.256	-0.164	0.029
	[0.032]*	[0.002]*	[0.004]*	[0.003]*	[0.002]*
Kotido	-5.474	-0.228	-0.691	-0.722	0.037
	[0.039]*	[0.001]*	[0.002]*	[0.003]*	[0.005]*
Lira	-1.188	-0.114	-0.166	-0.069	0.011
	[0.041]*	[0.003]*	[0.004]*	[0.003]*	[0.003]*
Moroto	-5.591	-0.225	-0.701	-0.746	0.027
	[0.045]*	[0.001]*	[0.002]*	[0.003]*	[0.006]*
Moyo	-0.831	-0.034	-0.178	-0.065	0.022
	[0.030]*	[0.002]*	[0.001]*	[0.001]*	[0.002]*
Nebbi	-2.614	-0.179	-0.285	-0.163	0.03
	[0.023]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Nakapiripirit	-4.785	-0.204	-0.629	-0.646	0.028
	[0.041]*	[0.001]*	[0.002]*	[0.004]*	[0.005]*
Pader	-2.05	-0.124	-0.279	-0.217	0.025
	[0.049]*	[0.003]*	[0.004]*	[0.004]*	[0.003]*
Yumbe	-2.61	-0.115	-0.319	-0.309	0.039
	[0.034]*	[0.002]*	[0.001]*	[0.002]*	[0.002]*
Bundibugyo	-2.294	-0.121	-0.268	-0.205	0.034
	[0.033]*	[0.002]*	[0.001]*	[0.002]*	[0.002]*
Bushenyi	-0.98	-0.107	-0.031	-0.024	0.032
	[0.029]*	[0.001]*	[0.001]*	[0.001]*	[0.002]*
Hoima	-0.988	-0.073	-0.091	-0.039	0.022
	[0.019]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Kabale	-1.686	-0.132	-0.133	-0.108	0.028
	[0.030]*	[0.001]*	[0.001]*	[0.002]*	[0.002]*
Kabarole	-1.67	-0.124	-0.115	-0.085	0.02
	[0.014]*	[0.000]*	[0.001]*	[0.001]*	[0.001]*
Kasese	-0.879	-0.055	-0.12	-0.063	0.019
	[0.024]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Kibaale	-1.47	-0.116	-0.096	-0.047	0.012
	[0.033]*	[0.002]*	[0.002]*	[0.001]*	[0.002]*
Kisoro	-3.107	-0.176	-0.328	-0.31	0.03
	[0.032]*	[0.001]*	[0.001]*	[0.002]*	[0.002]*
Masindi	-1.462	-0.098	-0.225	-0.115	0.005
	[0.033]*	[0.002]*	[0.004]*	[0.003]*	[0.002]*

Continued on next page

Table A5: Cognitive effects of the famine on 1975-1980 cohorts by intensity - 2002 Census. Full results.

	Years of education	**Completed primary**	**Literate**	**Ever-attended school**	**Female**
	(1)	(2)	(3)	(4)	(5)
Mbarara	-1.317	-0.113	-0.091	-0.084	0.028
	[0.026]*	[0.001]*	[0.001]*	[0.001]*	[0.002]*
Ntungamo	-1.925	-0.147	-0.14	-0.127	0.032
	[0.032]*	[0.001]*	[0.001]*	[0.002]*	[0.002]*
Rukungiri	-0.731	-0.092	-0.016	0.009	0.026
	[0.024]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Kamwenge	-2.367	-0.18	-0.183	-0.152	0.028
	[0.033]*	[0.001]*	[0.002]*	[0.002]*	[0.002]*
Kanungu	-1.726	-0.15	-0.104	-0.036	0.03
	[0.033]*	[0.001]*	[0.001]*	[0.001]*	[0.002]*
Kyenjojo	-2.403	-0.164	-0.163	-0.132	0.01
	[0.028]*	[0.001]*	[0.001]*	[0.001]*	[0.002]*
Foreign country	-1.787	-0.097	-0.242	-0.193	0.051
	[0.016]*	[0.001]*	[0.001]*	[0.001]*	[0.001]*
Constant	10.98				
	[0.196]*				
Observations	472025	472025	472016	472025	472025
R-squared	0.22				

Robust standard errors in brackets. Clustered at district of birth level.
* significant at 5%; + significant at 10%.
Columns 2-5 present marginal effects from the probit model.
Control group: people who were born between January 1970 - December 1974 and April 1981 - December 1982 in both Karamoja and the FSR. Also, people born in the rest of the country between January 1970 - December 1982.

Table A6: Famine Intensity - Family-gender fixed effects results. 1991 census. Full results.

		Main activity of child		
	Ever-attended school	**attending school** (currently)	**Working**	**house-work**
	(1)	(2)	(3)	(4)
in utero Karamoja 1980	-0.101	-0.204	0.062	0.224
	[0.014]*	[0.011]*	[0.027]*	[0.028]*
Born Karamoja 1978-79	-0.132	-0.236	0.188	0.151
	[0.013]*	[0.012]*	[0.023]*	[0.022]*
Born Karamoja 1975-77	-0.096	-0.15	0.172	0.054
	[0.012]*	[0.012]*	[0.020]*	[0.019]*
in utero food-shortage region 1980	0.005	-0.028	0.045	0.011
	[0.009]	[0.010]*	[0.008]*	[0.007]
Born food-shortage region 1978-79	0.013	-0.024	0.044	0.008
	[0.006]*	[0.007]*	[0.006]*	[0.004]+
Born food-shortage region 1975-77	0.003	-0.002	0.021	0.005
	[0.006]	[0.007]	[0.006]*	[0.004]
Age of mother at birth	-0.025	0.023	-0.036	-0.006
	[0.001]*	[0.001]*	[0.001]*	[0.000]*
1971	0.045	0.086	-0.031	0.001
	[0.007]*	[0.010]*	[0.010]*	[0.006]
1972	0.069	0.136	-0.049	0
	[0.006]*	[0.008]*	[0.007]*	[0.005]
1973	0.102	0.175	-0.073	0.002
	[0.006]*	[0.008]*	[0.007]*	[0.005]
1974	0.12	0.217	-0.098	0.003
	[0.005]*	[0.007]*	[0.006]*	[0.004]
1975	0.135	0.252	-0.113	-0.01
	[0.005]*	[0.006]*	[0.006]*	[0.004]*
1976	0.178	0.332	-0.142	-0.015
	[0.005]*	[0.006]*	[0.005]*	[0.003]*
1977	0.194	0.347	-0.136	-0.015
	[0.005]*	[0.006]*	[0.005]*	[0.003]*
1978	0.203	0.348	-0.124	-0.006
	[0.004]*	[0.005]*	[0.004]*	[0.003]*
1979	0.183	0.3	-0.084	0.01
	[0.005]*	[0.006]*	[0.004]*	[0.003]*
1980	0.163	0.243	-0.041	0.04
	[0.005]*	[0.005]*	[0.004]*	[0.003]*
1981	0.1	0.13	-0.036	-0.01
	[0.006]*	[0.006]*	[0.004]*	[0.003]*
1982	0	0	0	0
	[0.000]	[0.000]	[0.000]	[0.000]
Constant	1.198	-0.063	1.078	0.262
	[0.118]*	[0.066]	[0.052]*	[0.055]*
Observations	192,113	192,113	180,377	180,377
Number of fam-gen groups	105,776	105,776	102,373	102,373
R-squared	0.126	0.149	0.158	0.014

Robust standard errors in brackets. * significant at 5%; + significant at 10%.
Control group: children who were born from 1970 to 1974 and 1981 - 1982 in both Karamoja and the FSR, and from 1970 to 1982 in the rest of the country.
2.51%, 4.43% and 5.89% of children were *in utero* or born in the FSR in 1980, 1978-1979 and in 1975-1977, respectively.