Livestock, Crop Choice and Conflict: Evidence from Burundi.

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Abstract

This paper investigates whether the frequently observed relationship between savings and activity choices holds in the face of violent conflict, when savings are risky and unstable. Standard economic risk theory postulates that households with more savings will engage in higher-risk, more profitable activities since those households can deplete their savings or asset base when things go wrong. Using data from the 1998 household priority survey in Burundi, we estimate the relationship between livestock holdings (accumulated savings) and crop choices (risky vs non-risky crops). Estimating this relationship for the whole of rural Burundi, we find the empirical results to be consistent with theory, in the sense that households with a higher value of livestock significantly reduce allocation to low-risk activities and increase investment in higher-risk, higher value activities. However, limiting the analysis to the three provinces which were most affected by the civil war, this relationship disappears, suggesting that households with higher-valued livestock holdings (more savings) do not significantly reduce their allocation to low-risk, low-value crops nor increase allocation to higher-risk, higher-value crops when they assume a considerable degree of risk in their assets. This finding has important poverty implications. We argue that this result could possibly account (in part) for the massive increase in poverty in the civil war-provinces during the period 1990-1998.

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1 Introduction

It is well documented that rural households in developing countries face considerable risk in their generation of income, an inevitable consequence of engaging in rainfed agriculture on increasingly degraded soils[1]. The extent to which an adverse income shock translates into consumption shortfalls depends, among others, on the savings of the household and the existence and functioning of insurance and credit markets. If these markets are absent or imperfect, households have to deplete accumulated savings to maintain their consumption. Households without sufficient savings are in these curcumstances faced with declining consumption levels, causing them to fall into poverty or become even poorer.

In most of the developing world, formal credit and insurance markets are indeed imperfect or even absent (see for example Hoff and Stiglitz (1990)). In these cases, households have to self-insure through the accumulation of savings or through informal insurance mechanisms at the village - or kinship level. The effectiveness of these informal insurance strategies has been widely studied, and generally it is concluded that these offer a limited insurance only against idiosyncratic income risk (see...). Savings on the contrary can provide an effective insurance against both idiosyncratic and non-idiosyncratic risk and can be de-accumulated to smooth consumption in situations when households are precluded from doing any borrowing at all (i.e. in the absence of credit markets; see Deaton (1990)).

A very relevant form of liquid savings and insurance substitute in many developing countries is the accumulation of livestock (see, for instance, Binswanger and McIntire (1987)). Livestock is a popular productive asset with high expected returns through offspring, sale or consumption of dairy products and use in farming systems, and can be accumulated (bought) in good times and depleted (sold) in bad times for the purpose of consumption smoothing. A large body of mainly anthropologic and economic literature investigates this proposition, and it is generally found that sales of livestock indeed play a crucial role in maintaining consumption following an adverse income shock (see for instance Rosenzweig and Wolpin (1993) for India and Swinton (1998) for south-central Niger)[2].

[1] See, among others, Dercon (1996),Dercon (1998),Czukas et al. (1998) and Alderman and Paxson (1992) for an overview of existing literature

[2] A recent study by Czukas et al. (1998) for Burkina Faso however suggests that livestock transactions are less important for consumption smoothing than is often assumed.

This *ex post* risk coping potential of livestock also influences the *ex ante* risk management choices households make to reduce total income variability[3]. Dercon (1996) examines the impact of the level of livestock holdings on risk-taking behavior by households. The theoretical argument is that households with considerable herds will choose a portfolio of income generating activities (crops) that is more risky (and also has a higher expected return) than households who own little or no livestock, since the former households can deplete their assets to maintain their consumption when things turn out bad. The households with little or no livestock will choose a low risk (low return) portfolio, because they do not dispose of sufficient assets for ex post risk coping. Using data from Western Tanzania, Dercon indeed finds that households with lower livestock values allocate a larger share of their land to the low risk low return crop compared to households with higher livestock holdings[4].

This finding has important poverty implications. It suggests that households with low livestock holdings (usually the poor households) engage in the cultivation of low risk, low return crops, thereby confirming their low income levels, while wealthier households engage in higher risk, higher return activities, allowing them a further accumulation of productive assets, and creating a permanent poverty trap.

One could ask the question whether this relation between savings and activity choices holds if the savings themselves are very risky and unstable, for example during violent conflict[5]. In such circumstances, livestock is a very risky asset which can easily be stolen or killed[6], hereby affecting their demonstrated influence on ex ante risk taking behavior. Stated differently, following the theoretical argument of Dercon, we would expect households in areas heavily affected by conflict to engage in low risk, low return activities, regardless of the household's livestock holdings, since these are considered

[3]Alderman and Paxson (1992) consider 2 broad classifications of risk mitigating strategies: risk management and risk coping. Risk management concerns the ex ante actions by households to reduce total income variability (for example, crop and field diversification, off-farm work,...), while risk coping concerns the ex post strategies to deal with an adverse income shock (for example, the sale of liquid assets).

[4]Dercon considers the proportion of land allocated to sweet potatoes to be a proxy for the low risk, low return activity choice, and the proportion allocated to paddy rice as the higher risk, higher return choice.

[5]This question is very relevant, since approximately one third of the world's population lives in poor conflict-affected countries, with two thirds of these people residing in rural area's (calculation in Bruck (2004))

[6]We will present evidence of this later on in the text.

risky during civil war[7]. This paper has the simple goal of testing this hypothesis by using cross-section household data from Burundi. Section 2 offers a brief overview of climate and agriculture in Burundi, and gives descriptive data on the relationship between welfare, livestock holdings and crop choices, while section 3 sketches the theoretical model developed by Deaton (1991) and adapted by Dercon (1996). In this section, we will consider the theoretical implications of explicitly assuming the assets to be risky. Section 4 estimates the econometric specification, deals with possible econometric problems and discusses the main results. The final section concludes.

2 Crops and livestock in rural Burundi

Burundi is a small, landlocked and mountainous country in Eastern Africa, bounded on the north by Rwanda, on the east and south by Tanzania, and on the west by Lake Tanganyika and the Democratic Republic of Congo. The country has a high tropical climate, on the whole temperate and even cold, with a large number of micro-climates and considerable variation between years. Burundi can be divided in 11 agro-ecological zones(Tessens, 1989)(see table 1).

These zones differ by average temperature, altitude and rainfall, with the biggest difference occuring between the Imbo Ruzizi plain (average annual temperature of 23.9 C and 957.8 mm rainfall) and the Mugamba ridge in the north west of the country (average temperature of 16.2 C and annual average rainfall levels around 1668 mm). Burundi has three agricultural seasons per year, the A season running from September to January and generally accounting for about 35% of total annual production, the main B season between Februari and May (50% of production) and a less important C season from June untill September accounting for the remaining 15% of total production(Ministere de l'Agriculture et de l'Elevage, 2005).

Main food crops grown are bananas, beans, sweet potatoes and cassava, with the latter three accounting for over 50% of total dietary energy supply. Coffee is by far the most important cash crop, accounting for approximately 80 to 85% of total exports in 1998(FAO, 2005). Livestock is widely held in rural Burundi and represents the principal form of capital accumulation for

[7]When determining its activity portfolio, the household would explicitly take account of the fact that its livestock may be pillaged at some point in the near future, which of course affects its ability to act as a buffer stock.

Table 1: Average annual rainfall and temperature in Burundi's 11 natural regions

Natural region	avg rainfall (mm)	avg number of dry months	avg temperature (degrees Celsius)
Bugesera	1000.4	3.25	21.1
Buragane	1276.5	3.95	no observations
Bututsi	1483.4	3.74	17.0
Buyenzi	1348.8	3.11	19.3
Buyogoma	1250.1	3.93	19.8
Bweru	1228.8	3.59	19.9
Imbo	957.8	4.12	23.9
Kirimiro	1301.8	3.49	19.2
Moso	1184.1	3.95	21.7
Mugamba	1668.2	2.78	16.2
Mumirwa	1492.5	3.25	18.7

Source:Tessens (1989)

farmers (Cochet, 2004)[8]. However, as shown by table 1, the livestock sector suffered heavy losses since the onset of the civil war in 1993, mainly due to theft, pillaging and illegal exports (FAO, 1997)[9].

Table 2: Evolution of live animals, 1990-1998 (number of heads)

	1990	1994	1998
Cattle	431839	400000	346000
Goats	927472	910000	659000
Sheep	360633	360000	200000
Pigs	102799	85000	73000
Poultry	4400	4800	4600
Rabbits	110	100	75

Source: FAOSTAT data, 2005; Poultry and rabbits per 1000 heads.

To test the hypothesis stated in the introduction to this paper, we will use

[8]ISABU, the national institute of agronomics in Burundi, describes livestock as *'un carnet d'epargne'* (a savings account) for rural farmers.

[9]In our sample, 19,8% of household reported having lost livestock this way during the 12 months preceding the survey.

data on rural households available from the 1998 Priority Survey(The Republic of Burundi, 1998). During this survey, a total of 6668 households were interviewed, of whom 3908 lived in rural areas. After skipping households for whom the collected data was too incomplete to use, we arrive at a final sample of 3570 households which will be used in the analysis. In the remainder of this section I will use this sample data to sketch the observed relationship between livestock holdings and risk-taking behaviour of households.

Table 2 shows the proportions of households owning different types of livestock in 1998. Generally speaking, the rearing of livestock is rather widespread, with over 63% of all sampled households holding any livestock[10]. The average size of livestock holdings however is relatively small, with only 3,6 heads per household. The average value of livestock holdings amounts to 60925 BIF or 136$ in 1998 prices.

Table 3: Livestock ownership according to poverty status (in %)

	All	**Non-Poor**	**Poor**
livestock	**63,3**	**69,7**	**60,7**
cattle	14,3	21,5	11,3
sheep	10,8	14,8	9,1
goats	30,7	33,7	29,4
pigs	14,8	17,6	13,6
poultry	28,9	31,7	27,7
rabbits	11,5	11,2	11,5
average number of heads	3,6	4,8	3,1
value of total stock (1998 BIF)	60925	96743	46202

To stratify the sample according to poverty status, we estimated an absolute poverty line using consumption data available from the same survey. When assuming a required nutritional intake of 2500 calories per adult equivalent per day, we estimate a rural poverty line (allowing for non-food requirements as well) of 8174 BIF per adult equivalent per month[11]. As expected, live-

[10] Excluding rabbits from the calculations presented in table 2, only 55.5% of rural households own any livestock. A demographic household survey carried out by FNUAP in 2001 estimates this percentage at 62.8 before the crisis and 53.8 in 2001, which indeed suggests a loss of livestock during the crisis.

[11] Expressed in constant October 1998 prices. This translates to 18,25$ using the 1998 official exchange rate of $1USD = 447,8BIF$. Full calculation available on request.

stock ownership corresponds with welfare levels: almost 70% of non-poor households own any livestock, while this figure drops to 60,7% among poor households. The difference in livestock ownership between welfare levels is particularly clear for the higher valued species like cattle and sheep. Richer households thus seem to 'specialize' in higher value livestock. This finding is confirmed by the observation that livestock *holdings* are only 55% higher for richer households, while the total *value* of their stock is more than 109% higher (see table 2). The average value of assets amounts to 216$ for richer households and 103$ for poorer ones.

Table 4 describes labor supply characteristics and connects the value of livestock holdings with crop production decisions. Mean labor supply figures show little difference across poverty groups, with poor households having a somewhat higher supply of adult labor, while the quality of labor is substantially higher within the non-poor subgroup. The proportional crop productions given in the table seem to correspond roughly with the theoretical argument that households with more livestock are willing to invest more in riskier, higher-return crops compared to households with less livestock available. Cassava for instance is considered to be a very low risk crop in the highlands of tropical Africa, given its strong resistance to both extended droughts and excessive rains and the fact that it can grow on soils of poor quality (Nyabyenda, 2005), and represents a larger part in total production for poorer households with less livestock. The cultivation of cassava in Burundi plays a very important alimentary role, but its economic value is limited: cassava and sweet potatoes are so-called *cultures de soudure* which serve to feed the farmer and its family during the period between two harvests. Both crops (especially the cassava crop) can be kept in the soil and harvested according to the nutritional needs of the household. As such, these two crops are the pillars of food security in Burundi and act as a relatively riskless reserve stock (see for instance Janssens (2001a) and Janssens (2001b)). The relatively low economic value of cassava (and sweet potatoes) can be seen in table 3: prices of both crops are low, and *decrease* rather than increase over the course of the conflict. This observed reduction in the real prices of these crops between 1993 and 1998 could actually point towards a regression into low-risk crops during the crisis. At this stage however, this is purely hypothetical[12].

[12] Although this point is indeed hypothetical, it seems to be confirmed by FAOSTAT data: the total area devoted to the cultivation of cassava rose from 65000 hectares before the crisis in 1992 to 70000 in 1998. Also, the French historian Jean-Pierre Chrétien writes in relation to the crisis in Burundi(Chrétien and Mukuri, 2000): *'Negative evolutions*

In contrast to cassava, the less drought-resistant maize occupies a larger part in total production among the richer households with higher livestock holdings (see table 4). Although maize can be grown on practically all types of soils and on high altitudes (0 - 2500 m), its production is constrained by various requirements (Nyabyenda, 2005): First, a good harvest requires sufficient rainfall, which has to be spread evenly during the vegetation period. Long dry spells between rains considerably reduce yields and, hence, returns. Second, excessive rains inevitably destroy part of the plantation and, finally, upon maturation, maize is also seriously affected by praying birds. An additional constraint to maize production is that its cultivation requires considerable entry costs (fertilizers, hybrid seeds,...), for which poor farmers often lack the revenues. As can be seen in table 3, maize is a rather high value food crop: in 1993, the price of maize is 65% higher than the price of sweet potatoes and 22% than that of cassava, while in 1998, after 5 years of civil war, these figures have risen to 113,5% and 58% respectively. Hence, it is safe to say that maize is a relatively high value food crop in 1998[13].

Table 4: Deflated prices of four crops, 1993-1998 (base year 1990); BIF/kg

	1993	1994	1995	1996	1997	1998
Cassava	18,04	23,02	21,33	13,49	15,52	17,06
Potatoes	13,34	14,47	11,97	9,52	10,58	12,62
Maize	21,97	21,71	19,25	17,46	23,99	26,95
Rice	39,23	39,47	35,38	30,95	35,27	45,72

Source: ISTEEBU; authors calculations.

Paddy rice is considered the highest value crop in the region, though its cultivation is risky and is restricted, due to the lack of irrigation, to specific soils near rivers and areas with higher rainfalls. In our sample, only 8%

can be observed at the production level: the cultivation of food crops has grown relative to that of coffee, the cultivation of cassava has become more important than other food crops.'(authors translation from french).

[13]FAOSTAT data shows a decline in area cultivated by maize in the course of the crisis: 124000 hectares in 1992 compared to 115000 hectares in 1998. Production of maize dropped from 176300 metric tons in 1992 to 131830 metric tons in 1998. This, together with the previous figures on cassava, seems to suggest that farmers reduced their allocation to the more risky crop during the crisis. However, the area cultivated with paddy increased, allbeit very moderately (with 700 hectares).

Table 5: Livestock, crop choice and labour supply characteristics for different welfare groups

	All	Non-Poor	Poor
labor and land endowments			
number of adults	2,4	2,21	2,48
male adults	1,07	0,98	1,11
female-headed households (%)	23,2	18,8	25,1
household's head educated (%)	32,8	40,8	29,6
female adult literate (%)	30,7	41,4	26,3
total production (in kg)	1580,0	2121,2	1357,5
livestock values and crop allocations			
livestock value	60925	96743	46202
sweet potatoes	18,8	20,6	18,1
maize	5,5	6,1	5,3
cassava	11,5	9,8	12,2
paddy	1,3	1,4	1,2
beans	7,0	5,9	7,5
coffee	4,6	4,8	4,5
consumption exp per adult equivalent	6670	12154	4498

of households grow paddy, and its production accounts for a mere 1,3% of total production, these figures being moderately higher for richer households (with respectively 9,1% and 1,4%).

Finally, the outcome for sweet potatoes is surprising, as it seems to contradict the theoretical argument: sweet potatoes are, like cassava, widely believed to be a low risk food crop, and as such we would expect it to be more important in the portfolio of poor households, which is contradicted by the data in table 4. Of course, the decision to invest in particular crops will be affected by other factors besides livestock holdings, so these descriptive results cannot be treated independently from the analysis that will follow in section 4.

The figures mentioned above concern *all* sampled households in rural Burundi[14]. The goal of this paper however, is to examine whether or not the relationship between savings and activity choices changes in areas with (or during times of) violent conflict, when livestock holdings are risky. To test

[14]These sampled households represent 14 rural provinces. 1 rural province, Makamba, was not included in the 1998 survey due to widespread insecurity.

this hypothesis for Burundi, we have to take account of the fact that the conflict varried in spatial and temporal intensity. We need to be very careful and select *only* those households for whom violent conflict and its consequences can plausibly be assumed to be a genuine and relevant variable in the crop-production decision process. In other words, we must only consider those households who can reasonably be assumed to take account of the civil war in determining their crop or activity choices.

Readings of detailed accounts of the evolution of the crisis and various UN documents reporting on the security situation in Burundi suggest very clearly that three north-western provinces of the country were particularly hard-hit by the conflict: Bubanza, Bujumbura-Rural and Cibitoke[15]. This is supported by a FAO document which says that out of a estimated total population of 6 200 000 in 1998, 572 462 people or 9% were living in regroupment camps[16]. This figure increased to 10% in Bujumbura Rural, 22% in Cibitoke and 54% in Bubanza (FAO, 1998). Overall, this three provinces (out of a total of 16) accounted for over 47% of total regrouped population. One paragraph of the Interim Poverty Reduction Strategy Paper of November 2003 is worth quoting to support our point:

> *[...] the provinces that have seen the highest increase in poverty are those that suffered most from the conflict [...]. Many provinces that were doing relatively well in 1990 found themselves with higher poverty levels following the crisis: the provinces of Bubanza, Cibitoke and Bujumbura Rural fell from fifth, first and fourth place, respectively, in 1990 [...] to places 14, 12 and 8 in the national ranking for 1998, with poverty levels of between 50 and 75 percent.* (The Republic of Burundi, 2003)

Table 5 shows livestock values and proportional crop productions for the provinces of Bubanza, Cibitoke and Bujumbura Rural. Compared to the figures reported in table 2 (the whole of rural Burundi), the households in the war-affected provinces devote a larger part of their production portfolio to the riskier crops such as maize (12,5% vs 5,5%) and paddy (9,7% vs 1,3%), a smaller part to sweet potatoes (8,2% vs 18,8%) and a larger part to

[15]Chrétien and Mukuri (2000) provide an exceptionally rich and detailled account of the spatial and temporal evolution of the conflict between its onset in October 1993 and its official end with the signing of the Arusha Peace Agreements in August 2000. Relevant reports of the UN Security Council are S/1996/660 and S/1996/682.

[16]These camps were set up in all but one provinces, supposedly to protect the civilian population from the fighting going on in their province (FAO, 1998).

cassava (20,5% vs 11,5%). This is not surprising however, given the specific topography and climatic conditions of these provinces: the territories of Bubanza, Cibitoke and Bujumbura rural largely coincide with the Mugamba and Mumirwa natural regions, which enjoy a much higher average rainfall than the other regions (see table 1), making the rainfed cultivation of maize and rice an attractive option. Moreover, the presence of the Ruzizi river in this part of the Imbo plain makes the irrigated cultivation of rice possible, especially in the area located between two side rivers of the Ruzizi, the Ninga and the Mpanda[17].

Table 5 shows a roughly similar pattern of crop production as table 2: non-poor households have higher-valued livestock holdings and invest relatively more in high risk crops (maize, paddy rice) and relatively less in low risk crops (cassava) compared to their poorer neighbours. As in table 4, the exception is given by sweet potatoes, which accounts for a larger part in total production for non-poor households. At this stage, the figures for the worst conflict-affected provinces in table 5 rather support the overall theoretical argument than the hypothesis we wish to test in this paper. Households with more savings seem more likely to engage in the production of high-risk crops, regardless of the stability or security of the savings[18].

Labor supply characteristics in the war-affected provinces follow roughly the same pattern as for the whole of Burundi (table 4), with poor households having a higher adult labor supply. The results on the quality of male labor however are surprising: the percentage of households with an educated head is higher within the poor subgroup than in the non-poor group, which suggests that households within the civil war-region have no observable returns to education.

Finally,note that the average value of livestock holdings per household is approximately the same as in the whole of rural Burundi (61007 BIF vs 60925BIF)[19].

[17]For a more elaborate discussion, consult Nkikabahizi et al. (1986)
[18]Of course, this will be tested more formally later on.
[19]An independent samples t-test could not reject equality of means at 99%.

Table 6: Livestock, crop choice and labour supply characteristics in the war-affected provinces

	All	Non-Poor	Poor
labor and land endowments			
number of adults	2,45	2,09	2,59
male adults	1,14	0,97	1,20
female-headed households (%)	21,5	8,8	25,9
household's head educated (%)	41,8	41,2	42,0
female adult literate (%)	30,3	47,8	23,7
total production (in kg)	1160,6	1556,2	1021,2
livestock values and crop allocations			
livestock value (1998 BIF)	61007	88029	51487
sweet potatoes	8,2	10,4	7,4
maize	12,3	13,6	11,8
cassava	20,5	15,4	22,3
paddy	9,7	13,8	8,2
beans	7,3	4,5	8,3
coffee	1,7	1,9	1,6
consumption exp per adult equivalent	6860	13438	4543

3 Theoretical framework

To explain risk-taking behaviour by households on the basis of their asset holdings, we will use a model of consumption under liquidity constraints developed by Deaton (1991) and adapted by Dercon (1996). In this model, it is assumed the household can choose between the cultivation of two crops with different mean returns and different degrees of risk. The household allocates its total available labor time (L) to these two activities, according to its own objectives. A priori, we expect households with considerable asset holdings (i.e. with considerable options for ex-post risk coping) to invest a higher proportion of their labor time in the cultivation of higher-risk crop which also has the higher expected returns, while households without any assets would specialize in the cultivation of the low-risk crop with the lower returns.

To capture this in a stylized fashion, let p_t be the proportion of labor allocated to the low-risk crop in period t, r_1 the return per unit of labor of crop 1 (the low-risk crop) and r_2 the return per unit of labor of crop 2. Income in period t from the cultivation of crop 1 is given by $p_t L r_1$, and is assumed to be certain (Dercon, 1996). Returns on the cultivation of the second crop however are risky, and equal $(1-p_t)Lr_{21}$ with a probability of q and $(1-p_t)Lr_{22}$ with a probability of $(1-q)$. Dercon (1996) further assumes that $r_{21} < r_1 < r_{22}$ and that the expected return per unit of labor of crop 2, $E(r_2) = qr_{21} + (1-q)r_{22}$ is greater than r_1 [20]. Each household maximizes intertemporal expected utility given by

$$u = E_t \sum_{t=0}^{T} (1+\delta)^{-t} c_t^{\rho} \tag{1}$$

where T is the time horizon of the household, δ its rate of time preference, c_t its consumption in period t and $(1-\rho)$ the (constant) coefficient of relative risk aversion. We assume that $\rho < 1$, that is, the households are considered to be risk-averse.

Dercon (1996) first considers the case in which the household has no acces to credit or assets. Consumption in each period simply equals income, and the maximization problem becomes

$$\max u = E_t \sum_{t=0}^{T} (1+\delta)^{-t} [p_t L r_1 + (1-p_t) L r_2]^{\rho} \tag{2}$$

It can be shown that, if the first-order condition of this problem holds with strict equality, the household will find the optimal allocation of labor to crop 1 as

$$p_t = \frac{B}{D(r_1 - r_{21}) + (r_{22} - r_1)} \tag{3}$$

with

$$D = \left(\frac{(1-q)(r_{22} - r_1)}{q(r_1 - r_{21})}\right)^{1/(1-\rho)}$$

and

$$B = r_{22} - D r_{21}$$

From these results, it can easily be seen that households diversify by allocating some labor to the safe crop. The greater the *riskyness* of crop 2 (which would mean a larger spread between r_{22} and r_{21}), the larger the risk premium and the larger the labor allocation to the safe crop and vice versa.

[20] Otherwise, no risk-averse farmer would choose to cultivate the risky crop, see Newberry and Stiglitz (1981).

Dercon continues by introducing the possibility of savings. These can be accumulated in good times and de-accumulated when times are bad. In this situation, the problem becomes

$$\max u = E_t \sum_{t=0}^{T} (1+\delta)^{-t} c_t^{\rho} \tag{4}$$

subject to

$$A_{t+1} = (1+i)(A_t + y_t - c_t) >= 0 \tag{5}$$

$$y_t = p_t L r_1 + (1-p_t) L r_2 \tag{6}$$

where A_t is the total stock of liquid assets at the beginning of period t and i the certain rate of return on savings. In this situation, the household has to make two decisions based on the current income outcome y_t and its present asset holdings A_t: how much to consume in period t, and what proportion of total labor time to invest in the cultivation of the low-risk crop in the coming period (p_{t+1})(Dercon, 1996). This proportion can be found as

$$p_{t+1} = \frac{B}{D(r_1 - r_{21}) + (r_{22} - r_1)} - \frac{(D-1)A_{t+1}}{L[D(r_1 - r_{21}) + (r_{22} - r_1)]} \tag{7}$$

with B and D defined as above. From this equation it can be seen that households with larger asset holdings and thus more available means for consumption smoothing will, ceteris paribus, choose to invest less in the cultivation of the low-risk crop and, consequently, more in the high-risk crop.

What would happen to this result if we would introduce some degree of risk in the liquid asset A? Suppose that there is a probability of the asset being stolen or killed, and that the household explicitly takes this probability into account when determining p_{t+1}[21]. In this case, the expected asset stock in period $t+1$ becomes

$$E(A_{t+1}) = (1-l)(1+i)(A_t + y_t - c_t) + l(1+i)[(1-z)(A_t + y_t - c_t)] \tag{8}$$

with l being the probability and z the proportion of productive assets being stolen or killed. These two variables are to be determined by the household. If $l = 0$, the household assumes no risk in the asset; $E(A_{t+1}) = A_{t+1}$ and nothing changes in equation 7. Whenever l and consequently also z become strictly positive, $E(A_{t+1})$ becomes smaller than A_{t+1}, the more so the higher

[21] We believe this assumption can be plausible in circumstances of intensive violent conflict.

the values of l and/or z. Consequently, the household will limit its reduction in allocation to the safe crop induced by the asset holdings when the risk associated with the asset increases. In this situation, the proportion of labor allocated to the safe crop in period $t+1$ is given by

$$p_{t+1} = \frac{B}{D(r_1 - r_{21}) + (r_{22} - r_1)} - \frac{(D-1)[(1-l)(1+i)(A_t + y_t - c_t) + l(1+i)[(1-z)(A_t + y_t - c_t)]]}{L[D(r_1 - r_{21}) + (r_{22} - r_1)]}$$

which will be higher compared to $pt+1$ in equation 7. In the next section, we will test if there is empirical support for the theoretical implication of equation 9. (9)

4 Empirical analysis

In this section, we will at first focus our attention to the complete sample (the whole of rural Burundi), and test whether or not the data confirm the standard economic risk argument that households with considerable savings devote a smaller part of their labor to low-risk, low-return activities. In a second part, we will narrow the analysis to the three provinces which were most affected by the conflict to see whether we can find some evidence for our hypothesis.

At the outset of this section, we have to mention that the analysis suffers one major drawback resulting from data limitations. To examine labor allocations to different crops, ideally we should dispose of detailed data on crop-specific labor input. That kind of data is however very rarely collected during surveys. Dercon (1996) deals with this problem by using the proportion of land allocated to the low-risk crop as a proxy for the crop labor input. Unfortunately, the 1998 Priority Survey does not contain information on land holdings. The only way to proceed with the data available to us was to calculate, for each household, the total production of all crops (in kilograms), and to use the proportion of each individual crop in total production as a (allbeit rather crude) proxy for crop-specific labor inputs.

To estimate the effect of asset holdings on the investement in the low-risk crop, we will use the econometric model proposed by Dercon (1996), to which we add a series of provincial dummy variables to capture the regional differences in average rainfall levels, temperature and other exogenous factors which possibly affect the household's decision to invest in particular crops:

$$p_i = \beta_0+\beta_1\frac{A_i}{L_i}+\beta_2 edu_i+\beta_3 age_i+\beta_4 sex_i+\beta_5 ma_i+\beta_6 fa_i+\beta_7 farsiz_i+\beta_8 ll_i+\sum_j \beta_j D_{ij}+u_i \quad (10)$$

with edu, age and sex being the education, age and sex of the household's head, ma and fa being the number of male adults and female adults in the household,$farsiz_i$ the size of the farm as crudely approximated by total crop production (in 10000 kg) and ll being the land-labor ratio which accounts for differences in technology. $\frac{A_i}{L_i}$ is the total value (in 100000 BIF) of livestock holdings per adult in the household, while D_{ij} captures 13 provincial dummy variables[22]. Finally, p_i, the dependent variable, represents the allocation of labor to the low-risk crop. This model thus explains the household's investment in the low-risk crop based on its endowments in terms of two production factors (both quality and quantity of labor; quantity of land), the value of its assets and the natural environment in which the household lives.

The labor allocation to the low risk crop (p_i) will be proxied by the proportion in total production of cassava and sweet potatoes. These two crops seem to be equally low-risk, low-return crops in Burundi and will be used alternatively as dependent variable[23]. Equation 10 will also be estimated using the investment in a riskier, higer value crop as dependent variable, in which case we expect a *positive* sign of the coefficient of the value of assets. As shown in table 3, paddy rice is clearly the highest value crop in Burundi. However, only 7,8% of all households grow paddy, and its production accounts for a mere 1,25% of total production. Therefore, we choose to use the production of maize as an indicator for the investment in the riskier, higher value crop. Maize is by far the most important cereal in Burundi and has a relatively high value compared to other food crops. Almost 65% of households cultivate maize, and its production accounts for 5,5% of total production (which probably makes is more suitable as dependent variable compared to paddy rice).

Table 6 shows the results of the OLS estimation of this equation for the whole of rural Burundi.

As can be seen from the first column (OLS1), the value of assets appears to

[22]We use the province of Ruyigi as reference.

[23]ISABU, the national institute of agronomics in Burundi, makes a distinction between roots and tubers as safe crops (*des plantes sres*) and maize and rice as risky crops (*des plantes risques*.

Table 7: Savings and crop choice: Empirical results

	OLS(1)	OLS(2)	OLS(3)
Constant	.131***	.263***	.025**
	(.024)	(.019)	(.012)
Assets per adult	-.010**	-.009***	.008***
	(.004)	(.003)	(.002)
Male adults	-.013**	-3.3E-5	.004*
	(.005)	(0.000)	(.002)
Female adults	-.002	-.001	.004
	(.005)	(.004)	(.002)
sexhead	.021**	-.010	.011***
	(.009)	(.007)	(.004)
eduhead	-.012**	-.010**	.003
	(.006)	(.005)	(.003)
agehead	-.001**	-8.5E-5	.000***
	(.000)	(.000)	(.000)
total production	.026	-.005	-.044**
	(.036)	(029)	(.017)
land/labor	-.097	.004	.061*
	(.074)	(.060)	(.036)
Provincial dummies			
Bubanza	.045	-.109***	.105***
	(.031)	(.025)	(.015)
Buja rural	.039	-.217***	.149***
	(.031)	(.025)	(.015)
Bururi	.167***	-.204***	.090***
	(.018)	(.015)	(.009)
Cankuzo	.014	-.077***	.012
	(022)	(.018)	(.011)
Cibitoke	-.041**	.055***	.056***
	(.021)	(.017)	(.010)
Gitega	.110***	-.124***	.023***
	(.017)	(.014)	(.008)
Karuzi	.060***	-.098***	.000
	(.018)	(.015)	(.009)
Kayanza	.196***	-.139***	-.017**
	(.017)	(.014)	(.008)
Kirundo	.090***	-.048***	-.021**
	(.018)	(.014)	(.009)
Muramvya	.208***	-.175***	.042***
	(.017)	(.014)	(.008)
Muyinga	.011	-.134***	-.018**
	(.018)	(.014)	(.009)
Ngozi	.081***	-.120***	-.018**
	(.017)	(.014)	(.008)
Rutana	.012	-.101***	.043***
	(.020)	(.016)	(.010)
F-joint	28,65***	29,57***	34.57***
N	3570	3570	3570

have a significant negative effect on the investment in sweet potatoes, a finding which supports the overall theoretical argument. Households with large asset holdings thus significantly reduce their allocation to sweet potatoes. Further, both a higher household supply of labor (especially male labor) and a higher quality of labor (as proxied by the education level of the household's head) seem to be associated with a smaller investment in the low risk crop, the same being true for the age of the household's head (which picks up potential farming experience effects). Finally, female-headed households are found to invest more in the low risk crop.

OLS(2) estimates the same equation as OLS(1) with the investment in cassava, an alternative to sweet potatoes as a low risk low value crop, as dependent variable. As such, OLS(2) can be seen as a type of robustness check for the results obtained in OLS(1). As can be seen from table 6, the results are indeed broadly similar: the value of assets per adult has a negative influence on the investment in cassava, significant at the 1% level; both labor quantity and quality reduce the allocation to the low risk crop, as does a higher age of the household's head. The covariates for which the sign of the coefficient differs (sexhead, total production and land/labor) turn out to be completely insignificant in OLS(2).

The results of these two separate regressions suggest that households with large asset holdings significantly reduce their allocation to low-risk, low-value crops: if harvests fail, these households can deplete their assets to buy food on local markets. However, at this stage, the results in table 6 have to be treated with caution: as can be seen from equation 5, the value of assets in period $t+1$ depends upon the chosen level of consumption in the previous period (c_t), making A_{t+1} in fact endogenous to the household. Hence, OLS estimation of equation 10 with disregard to this possible endogeneity problem could result in biased and inconsistent estimates of the coefficient of $\frac{A_i}{L_i}$ (Gujarati, 2003). To test for endogeneity of assets, we performed the Hausman specification test using an auxiliary regression model to explain the value of assets per adult in the household(Hausman, 1976). The model we use is the one proposed by Dercon (1996). In short, this model explains asset holdings based on the household's endowments in terms of labor and land and the length of the asset-accumulation process[24]. The econometric specification is:

$$\frac{A_i}{L_i} = \delta_0 + \delta_1 farsiz_i + \delta_2 size + \delta_3 sex_i + \delta_4 edu_i + \delta_5 age_i + \sum_j \delta_j D_{ij} + v_i \quad (11)$$

[24]For a full description of the model, consult the appendix of Dercon (1996).

with *size* being the size of the household in adult equivalents[25] . The results of ordinary least squares estimation of this equation are presented in the appendix as OLS(1bis). We see that endowments in the form of quantity of land (total production) and quality of labor (education of the household's head) add positively and significantly to the value of assets per adult. The length of the asset-accumulation process, proxied by the age of the household's head, also contributes positively to the present value of assets. The household supply of labor however has a negative though insignificant effect on asset holdings, and female-headed households appear to have higher-valued asset holdings compared to male-headed ones.

In the spirit of the Hausman test, we add the predicted values of assets per adult (obtained by equation 11) to equation 10. Running this regression shows a completely insignificant coefficient of predicted value of assets per adult ($p. = .953$), hereby rejecting the hypothesis of endogeneity of assets at 99%. Consequently, there is no endogeneity problem and we can proceed with the OLS estimates of table 6[26].

OLS(3) shows the results of equation 10 with the allocation to the higher risk, higher value crop (maize) as dependent variable. As expected, the value of assets per adult now adds significantly *positive* to the investment in rainfed maize, as does the male labour supply, the age of the household's head and the land/labor ratio. As an alternative to maize, we also estimated equation 10 using the fraction of paddy as dependent variable, in which case the coefficient of assets per adult shows up positive but insignificant. However, as already explained, the fraction of paddy is probably not a good choice as dependent variable.

In summary, the results presented in table 6 suggest that households with larger asset holdings reduce allocation to the low risk crop in favour of the higher risk, higher value crop, enabling those households to further accumulate wealth, while households with few assets increase allocation to low risk activities, hereby reproducing their poverty.

The analysis presented so far focuses on the complete sample of rural Burundi. Now, we will narrow the analysis to the three provinces which were most affected by the civil war, both during the whole course of the conflict and during the time of the survey.

Table 7 shows the results of OLS estimation of equation 10 for the three

[25]Calculated using the equivalence scales set forth by WHO (1985).

[26]We performed endogeneity tests for OLS(2) and OLS(3) as well, rejecting the hypothesis of endogeneity in both cases.

civil war-provinces. OLS(4) shows a negative influence of assets per adult on the investment in sweet potatoes, though the coefficient is not statistically significant. In fact, not one covariate, except for a provincial dummy, turns out to be significant in regression 4[27].

OLS(5) estimates the same equation with the allocation to cassava as dependent variable and can once again be seen as a robustness check for the results of OLS(4). The outcome of OLS(5) confirms the results of OLS(4): the value of assets appears to have absolutely no substantial effect on the investment in cassava ($p. = .902$). In short, it seems that households within the civil war-region do not substiantially reduce their alocation to low-risk, low-value crops as their asset holdings increase.

A second striking difference between the outcomes of both analyses is the influence of the education of the household's head: while a higher level of education is associated with a significantly lower investment in the low-risk crops for the complete sample, this effect completely disappears in the civil war-subregion (the coefficients of education turn positive though insignificant). This finding could in fact be interpreted as a verification for the tested hypothesis: educated households fully realize the riskyness of their assets in the circumstances in which they live and therefore do not reduce allocation to the safe crops.

Similar to the previous analysis for the complete sample, we also estimate equation 10 using the allocation to maize as regressand. As can be seen in table 7, the results confirm the findings of the two previous regressions: the value of assets per adult has a positive though completely insignificant effect on the investment in the higher-risk, higher-value crop maize ($p. = 715$). Using the fraction of paddy rice as dependent variable shows similar results: the coefficient of assets is positive (.004 with standard error of .013) though insignificant ($p. = .747$)[28].

Comparing the results for the complete sample with those for the civil war sub-region, we note that the coefficients of assets/adult show up with the same sign (negative for sweet potatoes and cassava, positive for maize and paddy) in both analyses, and, second, while the coefficients are systematically *significant* for the complete sample, the coefficients are consistently

[27] We tested for endogeneity of assets/adult using the auxiliary regression reported as OLS(4bis) in the appendix. Using the Hausman specification test, the hypothesis of endogeneity was rejected at 99%.

[28] Within the civil war-region, 16% of households grow paddy, and the cultivation accounts for 9,7% of total production, which makes it more appropriate as dependent variable compared to the complete sample of rural Burundi.

Table 8: Savings and crop choice in civil war: Empirical results

	OLS(4)	OLS(5)	OLS(6)
Constant	.184***	-.105	.118*
	(.058)	(.095)	(.071)
Assets per adult	-.015	-.002	.004
	(.009)	(.015)	(.011)
Male adults	-.016	.069***	.013
	(.014)	(0.024)	(.018)
Female adults	.004	-.017	.001
	(.014)	(.023)	(.017)
sexhead	-.007	.097**	.036
	(.024)	(.040)	(.030)
eduhead	.006	.002	.016
	(.015)	(.024)	(.018)
agehead	-.001	.000	-.001
	(.001)	(.001)	(.001)
total production	-.123	-.267	-.014
	(.113)	(.184)	(.138)
land/labor	.291	.772	-.213
	(.291)	(.475)	(.357)
Provincial dummies			
Buja rural	.005	-.051	.059
	(.032)	(.053)	(.040)
Cibitoke	-.090***	.191***	-.050*
	(.024)	(.040)	(.030)
F-joint	2,58***	6.51***	1.99**
N	261	261	261

insignificant for the civil war-region. Except for sweet potatoes, the size of the coefficient is always smaller in the second analysis.

Overall, the results seem to support the hypothesis we wish to test in this paper and which is formalized in equation 9: households living in regions heavily affected by the conflict seem to take account of the increased riskyness of their assets in making decisions about crop-specific allocations[29]. Contrary to the standard economic risk argument, the empirical results suggest that in those circumstances of increased risk, households with higher-valued assets do not significantly reduce their allocation to low-risk, low-value crops (or, similarly, do not significantly increase their allocation to higher value crops). That is, although the households in the civil war-region have approximately the same average value of assets per adult as all other households, the former households assume a higher risk in their assets and therefore precautionary limit their reduction in allocation to the safe crop which would normally have been induced by their asset holdings.

This finding can probably partly explain the observed welfare reduction in the three civil war-provinces between 1990 and 1998[30]. It is possible that in those provinces higher livestock holdings were not associated with a higher degree of risk-taking by households, which had important poverty implications: households with larger livestock values did not significantly reduce their allocation to low-risk food security crops (such as cassava and sweet potatoes) and did not significantly increase allocation to higher risk, higher value crops (such as maize and paddy) because of the high risks associated with livestock during violent conflict. Those households chose food security instead of wealth accumulation, a perfectly logical choice in conflict, but one with high welfare costs in the longer run[31].

5 Conclusions

Before summarizing the main findings of this paper, we would like to mention its shortcomings. In my opinion, these are two-fold. First, the number of surveyed households within the civil war-region is rather limited: 261

[29] In the logic of equation 9, they assume a higher value of l.

[30] As noted in the introduction to this paper, the civil war-provinces of Cibitoke, Bujumbura rural and Bubanza fell from first, fourth and fifth place in the welfare ranking of 1990 to respectively twelfth, eight and fourteenth place in 1998.

[31] This reasoning however, is entirely hypothetical, since we do not have time-series data to formally test this hypothesis.

households in a total of 3570. Widespread insecurity in the provinces of Bubanza and Bujumbura rural during the period of the survey negatively influenced the number of surveyed households (60 and 50, respectively), which cast doubts on the generelizability of the results. Second, and more important, is the construction of the dependent variable: we use the proportion of a specific crop in the total production of all crops as a proxy for crop-specific labor input. This is potentially problematic. While we are fundamentally interested in the relationship between asset holdings and input decisions (the decision of the household to allocate certain proportions of their time and labor to specific crops given the value of their assets), we in fact estimate the relationship between asset holdings and output outcomes, assuming crop-specific output to be a good indicator for crop-specific input. Clearly, this is a simplification as there are other factors besides labor input that determine crop output: quality of land and labor (especially productivity), use of fertilizers, spatial differences in climatic conditions,... However, I think it it safe to assume that crop-output is in general a fairly good, although non-linear, indicator of crop labor-input.

In the previous analysis, we assumed the absence of formal credit in rural Burundi. This assumption seems to correspond closely to reality, since only 11 of the 391 surveyed sous-collines (2,8%) in 1998 reported to have access to some sort of agricultural credit. We also assumed no alternative to livestock as a liquid asset.

Keeping the limitations and assumptions in mind, we now jump to the main conclusions. The very simple goal of this paper was to test whether or not the relationship between savings and activity choices holds during violent conflict, when the savings are very risky. Using the accumulation of livestock as the main form of savings, we showed that savings were indeed very risky during the conflict period in Burundi: aggregate figures show that the total number of livestock heads declined with 30% during the period 1990-1998[32], and 19,8% of households in our sample reported to have lost livestock due to theft or pillaging during the conflict.

Based on detailed agricultural studies for Burundi, we identified two alternative low-risk activity choices: the cultivation of sweet potatoes and that of cassava. We tested the relationship between savings and crop choices for the whole of rural Burundi, and found it to be consistent with theory: households with higher-valued livestock holdings indeed reduce their allocation to those low-risk, low-value crops, and increase their allocation to

[32]Calculation based on table 1, only considering cattle, sheep, goats and pigs.

higher-risk, higher-value crops, such as maize and paddy rice. In case of a bad weather shock adversely affecting their rainfed harvests, for example, those households can sell assets to buy food.

Estimating the same relationship for those provinces which were most affected by the civil war shows far less convincing results: although the effect of assets on crop choice has the predicted sign, its influence is generally smaller and never significant. The empirical results suggest that when assets are risky, households do not substantially reduce their allocation to low-risk, low-value crops as the value of their assets increases, nor do they increase allocation to higher-value crops. In other words, when assets are risky, households do not seem to 'count' on their assets to eventually smooth consumption ex post if harvests fail (since their assets can be pillaged or killed by then).

This finding has potentially important poverty implications: if households do not reduce their investment in low-risk activities as asset holdings increase, they are not able to accumulate wealth or escape poverty. Poverty would just be reproduced throughout the years. Following this logic, it is possible that the massive increase in poverty in the civil war-provinces over the period 1990-1998 can partly be accounted for by the empirical findings in this paper. However, in order to be more confident in the results, similar analyses would have to be carried out for other conflict-affected countries.

A Testing for endogeneity

Table 8 presents results of the auxiliary regression 11 (see main text) for the complete sample (OLS1bis) and for the civil war sub-sample (OLS4bis). For the complete sample, we see a mixed effect of production factor endowments: while the value of assets is positively influenced by the quantity of land and the *quality* of labor, the *supply* of labor seems to have an opposite effect. We also find a marginally significant life-cycle effect, meaning that households with an older head have a higher value of assets: those households have accumulated assets during more years compared to younger households. Finally, female-headed households have higher valued asset holdings.

Ols(4bis) reports the results for the civil war sub-sample. The signs of the coefficients are always the same as in OLS(1bis), though some determinants win or loose importance: the education of the household's head looses all significance, while the simple life-cycle effect becomes very important. The quantity of land does no longer add significantly to the value of assets, while the quantity of labor significantly reduces the value of assets per adult in the household. The gender effect remains, but only is marginally significant for the civil war-subregion.

Table 9: Explaining assets/adult

	OLS(1bis)	OLS(4bis)
Constant	-.189*	-.776**
	(.102)	(.384)
sexhead	.152***	.277*
	(.035)	(.158)
eduhead	.067**	.100
	(.028)	(.099)
agehead	.002*	.017***
	(.001)	(.005)
size	-.009	-.087**
	(.009)	(.036)
total production	.258***	.003
	(.069)	(.325)
Provincial dummies		
Bubanza	-.126	
	(.140)	
Buja rural	1.118***	1.176***
	(.136)	(.209)
Bururi	.727***	
	(.080)	
Cankuzo	.125	
	(.099)	
Cibitoke	-.064	.104
	(.091)	(.168)
Gitega	.029	
	(.075)	
Karuzi	-.099	
	(.082)	
Kayanza	-.058	
	(.076)	
Kirundo	-.032	
	(.079)	
Muramvya	.290***	
	(.076)	
Muyinga	-.012	
	(.079)	
Ngozi	-.022	
	(.076)	
Rutana	.378***	
	(.089)	
F-joint	22,02***	11.16***
N	3570	261

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Figure 1: Civil war provinces