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Poverty Dynamics, Violent Conflict and Convergence in Rwanda

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Abstract: Civil war and genocide in the 1990-2000 period in Rwanda - a small, landlocked, densely populated country in Central Africa - have had differential economic impacts on the country's provinces. The reasons for this are the death toll of the genocide, the location of battles, the waves of migration and the local resurgence of war. As a result, the labour/land and labour/capital ratios at the provincial level changed considerably during that period. Using two cross-sections, we find empirical evidence for convergence between provinces following the conflict shocks: previously richer provinces in the east and in the north of the country experienced lower, even negative, economic growth compared to the poorer western and southern provinces. This has in turn affected significantly the dynamics of household poverty in Rwanda in the same period. Using a small but unique panel of households surveyed before and after the conflict period, we find that households whose house was destroyed or who lost land ran a higher risk of falling into poverty. This was particularly the case for households who were land-rich before the genocide. We do not find this for the loss of household labour. In the latter case the effect depends on the violent or non-violent character of the loss.

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1. Introduction

The analysis of poverty dynamics has figured prominently in recent development economics research (e.g. Bane and Ellwood, 1986; Jenkins, 1998; Layte and Whelan, 2003). The identification of the socio-economic characteristics of individuals and households that move in and out of poverty is critical to the design of effective poverty-alleviating policies. These characteristics are also of considerable importance to the understanding of the impact of socio-economic shocks on household welfare. Shocks such as price changes, sudden climatic changes, loss of work or illness are the subject of an extensive literature in economics.[1] Developing countries are not only vulnerable to economic shocks but also to political shocks, ranging from violent protests and riots to coups, revolutions, civil wars, genocide and international wars. These affect millions of people every year across the world, resulting in lost opportunities in terms of economic growth and human development (Collier, 1999; Stewart et. al., 2001; Fearon and Laitin, 2003). The economic effects of conflict-induced shocks at the household level are, however, under-researched, as the impact of war, genocide or other types of violent conflict is typically analysed in the macro-economic literature and in cross-country studies (e.g. Collier and Hoeffler, 2001).

Conflict-related shocks are likely to have significant effects on the poverty status of households. Wars, violence and genocide kill and injure people, destroy infrastructure, services, assets and livelihoods, displace populations, break social cohesion, institutions and norms and create fear and distrust. These effects are likely to push the worse-effected households into extreme forms of poverty and destitution, even if some of these households were not poor initially (see Alderman, Hoddinott and Kinsey, 2004; Verwimp, 2005; Bundervoet and Verwimp, 2005; de Walque, 2006; Shemyakina, 2006; Justino, 2006). Violence often leads to the simultaneous destruction of assets and serious reductions in individual and household nutritional status (e.g. Alderman, Hoddinott and Kinsey, 2004; Bundervoet and Verwimp, 2005). This may push household into poverty, and possibly create

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[1] On the impact of trade shocks on household poverty dynamics see McCulloch, Winters and Cirera (2001) and Justino and Litchfield (2004). On the impact of weather shocks see, for instance, Paxson (1992) and Rosenzweig and Binswanger (1993). Frankenberg, Smith and Thomas (2003) and Lokshin and Ravallion (2005) examine the micro-level impact of financial crises. Gertler and Gruber (2002) provide empirical evidence on the impact of illness shocks on households' livelihoods.

poverty traps since under those circumstances the household would have little chance of recovering their economic status by resorting to productive means. Only a serious windfall (e.g. aid) would be able to lift the household back into recovery path (Dasgupta and Ray, 1986).

Minimising risky activities is probably the most widely observed effect in times of conflict, in the run-up to a war as well as in post-war coping strategies (e.g. Brück, 2004). Ex-ante, households that predicted occurrence of political violence will tend to hold a lower risk/lower return portfolio of activities in order to minimise their risk of serious income shortfall, even at the price of a lower average return. Morduch (1995) and Dercon (2002) show evidence for such behaviour in the presence of economic shocks. Ex-ante, households may also be able to save or build up assets as a precaution in the anticipation of a crisis, similarly to the mechanisms reported in Binswanger (1981) and Rosenzweig and Wolpin (1993). The literature identifies also several ex-post coping strategies, i.e. strategies followed by households to smooth consumption and nutrition when shocks take place, even when formal credit and insurance markets are not available. These include the use of savings in the form of livestock and other assets (Fafchamps, Udry and Czukas, 1998; Dercon, 1996), attempts to diversify incomes (Barrett, Reardon and Webb, 2001; Dercon and Krishnan, 1996), resort to informal mutual support networks (e.g. family, friends, ethnic groups, neighbours, funeral societies, etc) (Platteau, 1991; Townsend, 1994; Grimard, 1997; Fafchamps and Lund, 2002; Dercon, 2005), or intra-household decisions such as cutting meals and portions, relying on wild foods and moving to feeding camps (Dasgupta, 1993; Jalan and Ravallion, 2001; Dercon, 2005).

Depending on its idiosyncratic or covariant nature of the shock, not all strategies will be effective in preventing more vulnerable households from falling into poverty. Shocks like war and genocide have a covariate character, but households with characteristics that are salient to the conflict may be particularly badly hit by the initial shock. For instance, while a high level of education may be a secure source of income in times of peace, it can become a liability in times of violence as it was the case during the Cultural Revolution in China or the Khmer Rouge regime in Cambodia (e.g. de Walque, 2006). In addition, known household insurance mechanisms may fail in a situation of conflict. According to Verpoorten (2005) Rwandan households did not in general sold cattle in response to conflict as they would do as a response to other shocks. Road unsafety prevented households most targeted by violence from accessing markets where cattle could be sold, at the same time that cattle was seen as an insecure asset,

likely to be targeted by violence. Households less affected by violence sold their cattle but suffered from overall lower prices.

Deaths and injuries are some of the most visible effects of violent conflicts, requiring significant adaptation within the household. Donovan et al (2003) research the effect of adult death on Rwandan households using self-reported coping strategies mentioned in interviews with 1500 rural households. They found that some households sell assets, adjust their crop mix, adjust area planted or/and hire in more labour. The effect on farm labour supply was dominant: 6 out of 10 households reported a reduction in farm labour due to a male adult death and 5 out of 10 for a female adult death. Half of the households reported no effect on other income generating activities for a male death and 80% did so in case of a female adult death. Beegle (2005), researching the effect of adult mortality on the labour supply of Tanzanian households, did not find an increase in hours farmed by surviving household members after an adult death, but found decreased activity in the farming of maize, cassava and beans. She draws attention to the fact that households experiencing decreased income or farm output after an adult death not necessarily experience a reduction of income, production or consumption *per capita*. Beegle links this to low marginal labour productivity in agriculture in the area of the survey (Kagera, northern Tanzania, bordering Rwanda). McKay and Loveridge (2005) make yet another observation: a reduction in income does not necessarily imply a worsening of the nutritional standard when the farm household substituted food crops for cash crops.

This paper draws on the above literature to analyse the impact of the 1994 genocide in Rwanda on household income and poverty dynamics: who stayed poor, who moved into poverty, who moved out of poverty? We model empirically household poverty transitions before and after the 1994 genocide. Our main interest is to uncover potentially important differences between the effects of conflict-induced shocks on household welfare compared to well-known economic shocks: Does the violent death of a household member affect welfare similarly to non-violent death? How will loss of land or the destruction of one's house affect household welfare? We aim to add further insight to the literature understanding the difference between demographic and economic shocks (Pitt and Rosenzweig, 1986; Kochar, 1995; Beegle, 2005).

We start by examining the economic impact of conflict at the provincial level, focussing on the particular process of income convergence that has taken place in Rwanda following the 1990-1994 events. Subsequently, we link these to changes in poverty at the household level. Our

empirical analysis relies on two nationwide cross sectional data sets, one with data collected in 1990, the second with data from 2000, in order to trace changes in poverty at the national level. In addition, we make use of a small but unique household panel data, which followed the same Rwandan households before and after the 1994 genocide in two provinces, Gitarama and Gikongoro (situated in central and south Rwanda). Our empirical strategy is based on the estimation of dynamic poverty transition functions, which in turn will be compared to reduced-form models of changes in income. We address in detail the potential problem of attrition in panel datasets such as the one we use.

The remainder of the paper is structured as follows. Section 2 presents a brief history of conflict in Rwanda. Section 3 shows the differential economic impact the conflict had on Rwanda's provinces and makes the case for convergence. In section 4, we move from the provincial to the household level. We present a poverty and inequality profile of Rwandan households, using two nationwide cross-sectional surveys, one with data collected before the genocide, the other with data collected after the genocide. In section 5, we use a household panel dataset to analyse household poverty dynamics in Rwanda between 1990 and 2002. We discuss and correct for potential attrition problems in our data set. In section 6, we present and analyse results obtained from both dynamic poverty transition functions and reduced-form income models. Section 7 summarises the main results and concludes the paper.

2. A short history of conflict in Rwanda

Between April and July 1994, at least 500 000 Tutsi (Des Forges, 1999)[2] or about 75% of the Tutsi population, together with many Hutu who were known to be opponents of the Habyarimana regime, were killed by the Rwandan military (FAR), local police, national guard and militia called Interahamwe. A few years before, in October 1990, a group of rebels consisting of Tutsi refugees who had left Rwanda during the 1959-1962 revolution, together with their offspring, attacked Rwanda from Uganda. What followed was a civil war between the Rwandan armed forces (Forces Armées Rwandaises, FAR) and the rebel army (Rwandan Patriotic Front, RPF), in which the civilian population in the north of Rwanda was the main victim. While the RPF claimed to fight against the dictatorship of president Habyarimana, the latter claimed to represent the majority of the people. The battles between both armies were paralleled by peace negotiations and third party interventions. In order to understand the drama

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[2] Other scholars, such as Prunier (1995), put the death toll between 500.000 and 800.000.

of this period, it is essential to know its history.

The ethnic composition of the population had been a major issue in Rwandan politics since the time of colonisation. The Belgian colonizer had first favoured the Tutsi ruling class because they were considered racially superior to the Hutu, who were considered a people of cultivators. In the 1950's, with the spread of anti-colonial and independence movements, the ruling Tutsi began to claim the independence of Rwanda. At that time, a Hutu counter-elite was given the chance to study at catholic seminars. With Belgian military and political aid, this new elite of Hutu leaders succeeded in overturning the ruling Tutsi regime and replace it by the leadership of the *Parmehutu*, the party for the emancipation of the Hutu. G. Kayibanda, a seminarian, became the first president. The ethnic divide however remained and was even strengthened. The new rulers, at the national as well as at the local level, established their power by removing all Tutsi from positions of power. Ordinary Tutsi who were not associated with political power became targets of reprisal and murder.[3]

In 1973, a group of army officers close to Juvénal Habyarimana took power via a coup d'état. They were frustrated by the monopolisation of power by the group led by Kayibanda, whose power base was the central prefecture of Gitarama. Habyarimana's support group, originated from northern Rwanda, saw all benefits of power go to the people from Gitarama. After the coup d'état, Habyarimana became the new president. He established the MRND (Mouvement Révolutionnaire National pour le Dévéloppement), the single party to which every Rwandan was supposed to belong to by birth. Aided by high prices for the coffee in the late seventies, the country's main export crop, and generous donor support, Habyarimana was liked, or at least not contested, by a large part of the population. Ethnicity was made a central political issue. Habyarimana maintained a system of ethnic identity cards and forbade officers and soldiers to marry Tutsi wives. In order to control population movements, he set up a detailed system of registration and reporting of demographic changes at the local level. He also had every adult participate in the *Umuganda* (weekly communal labour), and institutionalized weekly animation sessions in honour of himself (Verwimp, 2003).

A key characteristic of the Habyarimana regime was its doctrine on the relation between population and land. The president had never been an advocate of a family planning policy. On

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[3] For detailed treatment of the history of Rwanda, we refer to books written by Prunier (1995), Newbury (1988), De Lame (1996), Reyntjens (1994), among others.

several occasions he declared that children were the wealth of every Rwandan family. Groups set up by the Ministry of the Interior attacked pharmacies that sold condoms. The president was fully supported by the Catholic Church, which was omnipresent in Rwanda. The fertility rate of Rwandan women was among the highest in the world and the average size of cultivated land per family was shrank rapidly from 1.2 ha in 1984 to 0.9 ha in 1990 (National Agricultural Surveys, 1984 and 1989-1991). In that period, many families had not enough land to earn a living and feed their families. In 1986, when discussing the fate of the 1959-1962 refugees, the Central Committee of the MRND said that their return was not possible because the country was overpopulated. After this, the Tutsi refugees in the Diaspora, and especially in Uganda, started to mobilise militarily against Habyarimana.

During the civil war preceding the genocide (1990-1994), a number of local massacres occurred in which a total of 2000 Tutsi were killed. These massacres were not spontaneous outburst of violence from a poor peasant population but were organised by the national power elite. On April 6th 1994, Habyarimana's plane was shot down. After that, the genocide broke out.

A substantial part of the FAR, together with several hundreds of thousands of civilian refugees fleeing the war, was pushed into neighbouring Zaire, Tanzania and Burundi. For two years, a mix of civilian refugees and warrior-refugees (ex-FAR) resided in refugee camps along the border between Zaire, on the one hand, and Uganda, Rwanda and Burundi, on the other hand. In November 1996, the Rwandan patriotic army (RPA, successor of the RPF) attacked the Zairian camps thereby killing both thousands of armed ex-FAR, as well as unarmed civilians. The majority of the surviving refugees then returned to Rwanda. A sizable part of ex-FAR, Interahamwe and genuine refugees fled deeper into Zairian territory. During the subsequent years, 1997-2000, most remaining refugees had either died or were repatriated. These conflicts had considerable impacts on a population already living well below international living standards.

The war and genocide had an unequal impact on Rwanda's provinces, an impact that can be attributed to four major events that occurred during this period: war in 1990-1993, genocide 1994, mass migration 1994-1998 and (counter) insurgency 1997-1999. The war, the genocide and the (counter) insurgency caused massive losses of population. The mass emigration to Congo also ended in large population losses. This period was also characterised by mass

immigration of former refugees from neighbouring countries. These four events or shocks, together with the high natural growth of Rwanda's population, were the main culprits for the observed differential population changes in the provinces. Later on in the paper, we will discuss the results of field work in two of Rwanda's provinces, Gitarama and Gikongoro. In order to insert these provinces in the context of overall Rwanda, we compare them with other provinces in the next section, using the four shocks mentioned above.

3. Geography of conflict

3.1 The impact of the conflict on Rwanda's provinces

Map 1 shows the progress of the civil war. In the 1990-1993 period, battles were concentrated in the north (Byumba and Ruhengeri). At the start of the genocide, the FPR made a circular move around the capital Kigali. Coming from Byumba, they first captured the eastern provinces of Kibungo and rural Kigali, encircling the capital and moving forward to Gitarama and Butara. In May 1994 , the FPR was prevented to enter Gikongoro, Cyangugu and Kibuye provinces by the French army serving under UN mandate in *Operation Turquoise*. In June and July the FPR captured Gisenyi and Ruhengeri. This war and subsequent events affected considerably the economic position of Rwanda's provinces.

Table 1a depicts the economic impact of the conflict on a series of labour/capital ratios at the provincial level. The differential economic impact of the conflict is illustrated by changes in the labour/land ratio, the labour/cattle ratio, and the percentage of 'villages' (cells) with new settlements (*imidigudu*). In the absence of technological change (which is a safe assumption for rural post-conflict Rwanda), economic growth is determined by the relative scarcity of factors of production. Labour, land and cattle are straightforward indicators to measure the changes in labour to capital ratio in a land-scare, capital poor, densely populated economy. Higher values for the different ratios in Table 1a indicate that the ratio has worsened over time. The number of new settlements is also introduced as an indicator because it captures to a certain degree the need for housing and other infrastructure (destruction of physical capital) during the civil war as well as the level of social capital in these locations. As the spatial structure is remodelled with these new settlements and citizens had to move in these new settlements with many of them former refugees, high values indicate low degrees of social capital. As with other forms

of capital, low levels of social capital impact negatively on economic growth, considering the lack of technological progress and the scarcity of capital.

In addition, table 1b shows the effect of the four shocks: genocide, civil war, immigration and (counter) insurgency. We describe the events in each province in subsequent paragraphs below and in the next section. The shock index in Table 1b is the sum of the effect of each of the shocks on the provincial economy, taking account of the scarcity of capital and the abundance of labour in rural Rwanda.[4]

The provinces of Byumba, Ruhengeri, Kibungo and Rural Kigali situated in the north and east of Rwanda were the scene of the invasion and early advancement of the RPF. Byumba suffered the impact of war in the 1990-1993 period due to battles taking place between both armies. Its population fled to Kigali. Not many Tutsi lived in Byumba before the war and genocide. After 1994, many Tutsi from neighbouring countries (old caseload refugees) resettled in Byumba. Net population growth in Byumba in the period between 1990 and 2002 was 11%. Kibungo and Rural Kigali were the scene of horrific massacres and killings during the genocide as both had a sizeable (but lower then the southern provinces, see below) Tutsi population. They were also the scene of fierce battles between the RPF and the FAR in 1994, accompanied by killings of Hutu civilians. After the genocide, many old case-load refugees resettled in Kibungo. Net population growth in Kibungo was 8% between 1990 and 2002. The provinces of Gisenyi and Ruhengeri did not loose many people in the genocide because very few Tutsi lived there. Both provinces did suffer from the war before the genocide when their population fled to Kigali and especially from the (counter) insurgency in the 1997-1999 period when the RPF was fighting the remains of the FAR who attacked Rwanda from the Congo. Population growth remained high in these provinces, whereas the degree of destruction of the capital stock (in terms of cattle) was higher then average, as is also the case for the number of new settlements.

The provinces of Butare, Gikongoro,[5] Cyangugu and Kibuye in the south and west of the country had the highest number of Tutsi before the genocide. In those provinces, the genocide took its largest toll. Butare also suffered Hutu casualties along its border with Rural Kigali when the FPR approached. Gikongoro, Cyangugu and Kibuye experienced very few Hutu deaths because of the *operation Turquoise* which prevented the FPR from entering these

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[4] The assumptions made and the exact composition of the shock index is explained under table 1b.
[5] This is one of the two provinces in the panel (see section 5).

provinces.[6] Resettlement of old caseload refugees was almost non-existent in these provinces. Net population growth was therefore very low in Kibuye and Gikongoro and even negative in Butare. This testifies the level of population loss during the genocide. As an exception, net population growth is high in Cyangugu is high due to the influx of new caseload refugees from the Congo.

The unfolding of the genocide in the province of Gitarama in Central Rwanda[7] was different from other provinces. More Tutsi were saved in Gitarama compared to other provinces, for historical reasons, such as intermarriage, but also because of the resistance of Hutu and Tutsi at several locations in the province (Des Forges, 1999). Gitarama was the scene of fighting between enemy armies, but fighting was not as fierce as in the east. Killings of Tutsi and Hutu took a lot of casualties, but less compared to the south in the case of Tutsi, and less compared to the east in the case of Hutu (Verwimp, 2003). Few old case load refugees resettled in this province.

3.2 Convergence between poorer and richer provinces

Before 1990, the southern provinces were much poorer compared to the northern and eastern provinces, as shown in table 2. The average income per adult equivalent in Kibungo, the richest province, was three times that in Gikongoro, the poorest province. In 2000, Kibungo was still the richest province, but the average household was only 1.5 times richer than a household in Butare, now the poorest province. Interestingly, Rwanda's high performing provinces prior to the genocide (Kibungo in the east and Ruhengeri in the north) have experienced low economic growth in the conflict decade. Provinces that were poor, prior to the war and genocide, are still poorer than the Rwandan average, but they have experienced much stronger economic growth than the other provinces (see table 2). In real terms, the growth of average income was negative in the two richest provinces and was highest in the three poorest provinces. These figures suggest that income convergence has taken place in Rwanda between poor and rich provinces. Following the convergence literature (Barro and Sala-i-Martin, 1992), Figure 1 plots initial income and the growth rate in one figure, demonstrating convergence.

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[6] In table 1b this means that these provinces get the 0 value for the impact of the civil war shock, on both factors of production.
[7] This is the second province in the panel (see section 5).

The provinces that performed better before the genocide (Kibungo, Rural Kigali, Ruhengeri, Buymba) were the scene of major battles between enemy armies, resulting in serious damage to the capital stock (as illustrated in tables 1a and 1b). Ruhengeri saw battles as recently as 1999 - just before the survey from which the income data are drawn - took place. Many people in this province were displaced during the decade and unlike the other provinces were still living in refugee settlements at the time of the survey. On all accounts, be it increased labour supply, destruction of the cattle stock and the percentage of new settlements, Ruhengeri is on top of the list (meaning negative effect on the economy for all indicators). By 2000, Ruhengeri had not recovered from its war experience.[8] To a lesser degree, the same story applies to the other provinces in north and east Rwanda: increases in labour supply, destruction of the cattle stock and new settlements are higher than average. After 1994, Rural Kigali and Kibungo were the scene of mass resettlement of former refugees and Uganda based exiles, putting strain on land resources.

The opposite story can be told for the poor provinces in the south and in the west. *First*, these provinces did not suffer directly from displacement and battles in the 1990-1993 period, as these were restricted to the northern provinces. *Second*, these provinces had the largest percentage of Tutsi in Rwanda, resulting in unprecedented loss of population. Population loss in these provinces in 1994 is estimated around 10 to 15% of the population (or 75% of the Tutsi population). *Thirdly*, these provinces were not the scene of intense battles between the FPR and the FAR in 1994, meaning that the capital stock was not damaged to the degree it was damaged in the north and the east. And *fourthly*, there was no mass resettlement of former refugees from Uganda in these provinces. As a result the labour/land and labour/capital ratios remained more or less unaffected after the conflict (see tables 1a, 1b and 2).[9] Importantly, the average rank of the poor provinces, when taking the three ratios into account, is well below the average rank of the rich provinces (higher rank indicating a comparatively worsening situation).

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[8] For a review of existing sources on displacement in northern Rwanda we refer to a report by the Global IDP Project, "*Ensuring durable solutions for Rwanda's displaced people: a chapter close to early*, July 2005

[9] It is not the case that *all* ratios for *all* provinces in the north have deteriorated more than average and it is equally so not the case that *all* ratios for *all* provinces in the south have performed above average. What we want to demonstrate, with the few data points that we have, is that *on average*, the economies of the northern and eastern provinces have suffered more (increases in labour supply and destruction of capital) from the decade of conflict compared to the economies in the southern and western provinces.

Table 1c shows the degree of rank correlation between the income in 1990 (in adult equivalent), the growth rate over the conflict period, the changes in the labour/capital ratios and the shock index of the authors. The Spearman correlation coefficient is statistically significant on all indicators and supports the story explained above and depicted in Figure 2: the impact of a decade of conflict on the rural economy has been such that the poor provinces have grown more than the rich.[10] This effect is likely to have affected profoundly poverty patterns and economic structures of Rwandan households.

4. Poverty profile for 1990 and 2000

4.1. Poverty and extreme poverty lines

The previous section showed a picture of national economic convergence across Rwandan provinces following the 1994 genocide. How did these changes affect the poor? According to the 2002 Poverty Profile of Rwanda, a government approved document published by the Ministry of Finance, 60.3% of the Rwandan population was poor in that year with 65.7% in rural areas, 19.4% in urban areas outside the capital and 12.3% in Kigali. As for extreme poverty (measured by a food-only poverty), the 2002 Profile sets the number at 41.6% countrywide, 45.8% in the rural areas, 10% in urban areas outside the capital and 4.5% in Kigali.[11]

The calculation of the above Poverty Profile was based on a nationwide household survey, the EICV (Enquête Intégrale des Conditions de Vie), conducted by the Department of Statistics of the Ministry of Finance in the period July 2000-July 2001 in rural Rwanda and October 1999-July 2000 in urban Rwanda. The EICV is a nationwide, multiple purpose household survey with 6240 rural and urban households. One generally uses income or (food) consumption as indicators of poverty and extreme poverty. Both have advantages and disadvantages (e.g. Kanbur and Squire, 1999). The 2002 Profile uses consumption as its indicator of poverty and extreme poverty, but the EICV contains also data on income.

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[10] We are interested in the relative position (the ranking) of each province on the different indicators, not in the Pearson correlation coefficient of the indicators.

[11] The 2000 poverty line was set at 64.000 RwF per adult equivalent per year, based on a daily food intake of 2.500 Kcal (resulting in a 45.000 RwF food poverty line) and 29.4% non-food expenditures (see section 4.2 for details). Ministry of Finance, *a Poverty Profile for Rwanda*, Kigali, February 2002

In this paper, we compare poverty and extreme poverty in Rwanda over time. In addition to the rural 2000-2001 EICV data, we make use of the 1989-1991 DSA (Département de Statistiques Agricole). The latter survey was implemented by Ministry of Agriculture in the 1989-1991 period. The DSA data were collected from 1248 rural households in all prefectures (now called provinces). In order to get a sample that was representative for Rwanda as a whole, for each of the 10 prefectures and for each of the 5 agro-ecological zones, a stratified random sampling procedure was used. This resulted in the selection of 78 sectors where each sector represented a cluster of 16 households. The smaller prefectures were represented by 6 clusters, the larger by 10 clusters. Since data collection for the 1991a and the 1991b crop seasons were disrupted by the war in northern Rwanda, the most complete data are for crop year 1990. This is the year we will use in our comparison with the EICV. Below we describe the steps taken to ensure comparability between the two surveys. McKay and Loveridge (2005) in their exploratory analysis have used the same data and write that the income data from both surveys can be fruitfully compared.

4.2. The approach taken

We use an income variable to compare levels of poverty and extreme poverty across the two surveys. Since the 1990 survey did not collect data on non-food consumption, we have to restrict our comparison to income poverty and extreme income poverty. In order to compare the two cross-sections, we had to make sure we could derive similar welfare variables in the two years. Starting from the 2002 Profile, we looked for all consumption variables that were included in the 2000 as well as in the 1990 surveys. The food poverty line set by the Ministry of Finance in 2000 was 2500 calories per adult equivalent per day. This was done by taking the consumption basket of the poorest 60% of the population, which contained information on what quantities the poor consume for each key product. By inputting a caloric value to the consumption of each food item, one could ultimately derive the monetary value of a basket of 2500 calories per day per adult. However, neither the EICV nor the DSA had complete quantity and price information on all the consumption items in this basket.

As the 2000 survey was the most complete, we looked for all food consumption items in the 1990 survey that were also in the 2000 survey. We then calculated the caloric value of each those items and arrived at 2088 calories per day per adult. This means that we found information on prices and quantities in both surveys for 83.5% of the calories set as the food

poverty line in the 2002 Poverty Profile. The reason for this is that Rwandans derive a large part of the calories from a few crops like beans, bananas, potatoes, sweet potatoes, sorghum and manioc. Production and consumption data for such main crops is present in both surveys. The monetary value of this reduced food poverty line was 95.5 RwF per day in 2000 and 25.7 RwF in 1990. On an annual basis, this food poverty line for 2000 then equals 35.000 RwF and 9.400 RwF in 1990. These two lines will form the basis of our comparison. The 2002 Poverty Profile found that households around the food poverty line devote on average 29.4% of their budget to non-food items. This is then considered as a minimum of non-food expenditures to escape poverty. For the poverty line, we then arrive at 49.575 RwF per adult per year (35.000 / (1-0.294) for 2000 and 13.300 RwF (9400 / (1-0.294) for 1990.

Income contains crop consumption from own production (main crops such as beans, bananas, sorghum, manioc, potatoes, sweet potatoes and rice). The income variable also includes the sales of all crops, sales of beer and juice, off-farm income, sales of livestock, milk and eggs, and transfers received. Items that were not included in the income variable are income from renting out livestock, renting out land, sharecropping out land, income from some livestock products (buttermilk, butter, cheese, leather and skin, manure), income from renting out equipment, income from other agricultural products and the sales of some home processed products (sales of maize flour, sorghum flour, cassava flour, soya flour, peanut flour) and finally miscellaneous incomes. As said, these items were left out because this data was not collected in the 1990 survey. Inevitable this leads to an underestimation of income, in 2000 as well as in 1990.[12]

Items not included in our income variable for 2000 represent, on average, 1.6% of total household income. In table 3b, we investigate whether or not the left out income sources are concentrated among the rich or the poor. This may give us a better idea of the impact of the underestimation of income on our poverty statistics. Underestimation was largest for the poorest income quintile (averaging 3.2% of income), but even in this quintile, income was not underestimated for over 90% of the households. Given that all the households in this quintile fall below the extreme poverty line and given the marginal underestimation of income when leaving out certain income categories not measured in 1990, we believe underestimation not to be an important issue for our analysis.

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[12] Income is commonly under-recorded in household surveys as it is usually difficult to record all sources of income and all forms of income (see Deaton, 1997).

4.3. Profile of poverty for rural Rwanda

The poverty profile for rural Rwanda using sample characteristics in 1990 and 2000 is presented in table 3a and 3b. In the whole of the rural areas, poverty increased by 2.3%.[13] The small increase of the headcount over time is not a country-wide phenomenon; it is marked by large differences across provinces. Poverty decreased substantially in Gikongoro, Cyangugu and Kibuye. It increased substantially in rural Kigali, Kibungo and Byumba. Smaller changes occurred in the other provinces. The head count remained the same for households with a male head, but increased for female-headed households. It also increased across the education spectrum, with the most educated having the lowest headcount. Poverty decreased for agricultural labourers and businessmen and women, and increased for government officials, the latter having the lowest head count among all occupations. The poverty gap and squared poverty gap (not shown in the tables but available upon request) yield similar trends over time, i.e. 2000 fared worse than 1990, both with strong provincial differences. The indices for extreme poverty show similar tendencies for overall poverty.

As the two surveys we are using are cross-sections, they do not allow a dynamic analysis of poverty over time. That task will be taken up through the use of a smaller household panel data in the next section. The provincial level changes of poverty and extreme poverty are not independent of the major events that hid Rwanda in the nineties, as described above. In a cross-section it is however difficult to determine the cause(s) of such profound changes. Suffice here to note the extent of the changes and their compatibility with the convergence story in section 3: provinces which experienced a decline (increase) in poverty in 2000 are exactly those provinces which were poorer (richer) in 1990.

Together with the geographic profile of poverty, we examined also the distribution of income. As table 3b clearly shows, average income increased over time, but this increase only benefited the richest income quintile. McKay and Loveridge (2005), working with quartiles, report a similar trend. The worsening of the income distribution was already visible in table 3a, where we computed the Gini coefficient for income distribution in rural Rwanda as well as per province. Thus, following the political events in Rwanda in the 1990s, poor provinces have

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[13] Only the EICV has data on urban poverty, making a comparison of urban poverty over time not possible. 10% of the population lived and lives in urban areas. Poverty in the urban areas is lower then in the rural areas. The poverty head count for Rwanda overall is then a few percentage point lower then the head count for the rural areas only.

become richer and richer provinces have become poorer, but all provinces have become more unequal.

5. Evidence from a panel dataset 1990-2002

5.1 Description of the data

In the first months of 2002, one of the authors of this paper (Verwimp) collected household demographic, economic and agricultural data from a subset of the households interviewed in the 1989-1991 survey, thus constituting a panel data set which spans the period of the war and genocide.[14] This survey, the Post-Conflict Survey on the Rural Household Economy, was in itself the second stage of a tracing exercise undertaken in 2000 (Verwimp, Genocide Transition Survey, 2003 and 2005). In 2002, 258 households were interviewed in 16 clusters in Gikongoro and Gitarama, covering all the clusters in these two provinces that were included in the DSA. The first is a poor province in the south of Rwanda, heavily affected by the genocide and the second is located in central Rwanda (see section 3.1). The data do not cover the new immigrants after 1994, only households that were already residing in Rwanda in 1990.

We define a household to be part of the panel if the head of the household in 2002 was a member of the household in the 243 household sample interviewed in 1990. This was the case for 186 of the 258 households interviewed in 2002. In further eight cases, data on income sources or other important variables were missing in either 2002 or 1990. This gave us a final panel of 178 households, or 73% of the original 1990 sample. Although this is a smaller data set compared to other panel surveys, it is the only data set that spans the period before and after the genocide in Rwanda, thus constituting a unique panel. The panel data sample is not representative for the whole of Rwanda, but contains invaluable information on Rwandan households during a key episode in world affairs. These data cover two entire prefectures, Gikongoro and Gitarama.

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[14] This fieldwork was organised and undertaken by P.Verwimp in cooperation with M.Verpoorten, a PhD student from the KU Leuven. This research was financed by the Belgian Department for International Cooperation. Berlage, L, Verpoorten, M, Verwimp, Ph. (2003) provides the first results from this dataset. See Berlage a.o., Rural Households under extreme stress, report for the Flemish Interuniversity Council and the Belgian Depertment of International Cooperation, September. Available at www.hicn.org

As with the cross-sectional analysis, our analysis is based on an income variable that is the same for both rounds of the survey. In both surveys, household income is the sum of production for own consumption, crop sales, sales of home manufactured beverages (banana and sorghum beer), wages from off-farm work and sales of livestock products.[15] The data collected apply to the period October 2001-March 2002, in effect only one year after the rural EICV. Since we work have panel data for one season, we divided the poverty lines calculated for the two cross-sections in half. For both years we used the same equivalence scales.

5.2 Attrition in the household panel

The possibility that estimates may be biased as a consequence of selective sample attrition is a major concern in the panel data literature. Alderman and his colleagues (IFPRI, 2000), studied the extent and implications of attrition for three longitudinal household surveys from Bolivia, Kenya and South Africa. They found that the means for outcome and family background variables differed significantly between attritors and non-attritors. Multivariate estimates of behavioural relations however were not significantly affected by attrition. Fitzgerald et al. (1998) studied attrition in the Michigan Panel Study on Income Dynamics (PSID) and found a 50% sample loss between 1968 and 1989. Despite the large amount of attrition, they do not find strong evidence that attrition distorted the representativeness of the PDID. Maluccio (IFPRI, 2000), working with panel data for an income study in Kwazulu Natal, used Heckman selection procedures to study attrition bias. Using a Hausman test, he rejects the equality of coefficients between the corrected and the uncorrected models, suggesting the importance of attrition bias. Alderman, Hoddinot and Kinsey (2004) in a paper on the long term consequences of early childhood malnutrition, find that the initial health status does not explain attrition once they control for other child and household characteristics.

In our sample, the main concern is that observable or non-observable characteristics of households that dropped from our sample are significantly different from the panel households. There can be several reasons for selective sample attrition in our data. First, households who dropped from the analysis may be poorer in 1990, resulting in a panel whose average income in

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[15] There are two differences between the income variable used in the cross-sections and in the small panel data analysis. For the panel, the second round only collected data for one season and does not have data on transfers received from others. Using the first wave, which did have transfer data, we know that the latter leads to an underestimation of income of on average 2.7%. Since we use the same season in both years, seasonality is not an issue in the panel data analysis.

1990 is biased upward. This would cause bias in our analysis as we are particularly interested in poverty dynamics. Second, households who dropped from the analysis may have had an older head in 1990 making it more likely that he/she will die and that the household will be less likely to be traced again. As households with older heads are in general wealthier, such selective sample selection may result in a panel whose average income in 1990 is biased downward. Third, households were dropped from the analysis because they were targeted in the genocide. The main reason for this would be that they had a Tutsi head of the household because the genocide mainly killed Tutsi. And fourth, apart from ethnicity, age of the head or income, there can be other observed and unobserved household characteristics responsible for selective sample attrition.

In tables 4a and 4b, we present an analysis of a potential attrition problem in our panel data set. Attrition in our sample is at 27% of the original 1990 sample. This is relatively high compared to other surveys (see Thomas, Frankenberg and Smith, 2000 for a review), but not surprisingly high given the extent of the genocide and the war in Rwanda. The Government of Rwanda estimated in 2003 that 1 million people (13.3 % from 7.5 million) died in 1994. Households who dropped from our analysis had a smaller size in 1990, had more female heads of households, had less land to cultivate, had a smaller income and were more likely to reside in Gikongoro province. When we account for the smaller size of the household – as we do in our analysis by using income per adult equivalents – table 4a shows that there is no significant difference anymore between the households in and out the panel on land size and income. Households in our panel are larger, have more income and more land, but the t-statistic is not significant anymore when we compare these characteristics in terms of adult equivalents.

Given the fact that the genocide particularly affected the Tutsi population of Rwanda, one would expect that households with a Tutsi head would drop out of the survey. It is indeed estimated that 75% of the entire Tutsi community living in Rwanda before the genocide was killed. However, as Des Forges (1999) and Verwimp (2003) show, the death rate per ethnic group differs substantially per province, with Butare and Gikongoro in the south particularly hard hit and Kibungo and Gitarama counting fewer Tutsi victims. The main reason for this is that the genocide in Gitarama and Kibungo was not completely carried out. In Gitarama, this was because of the initial passive and active resistance against the genocide whereas in Kibungo it was due to the early arrival of the RPF. Since most of the Tutsi households in the 1990 sample reside in Gitarama, they had a comparatively higher survival chance. As a result,

our panel counts less households with a Tutsi head of the household then the original 1990 sample, but the difference is statistically not significant.

The remaining, statistically significant differences between panel and attrited households at the univariate level are the sex of the head of the household, the age of the head, the number of cattle, the province of residence and the loss of female adults. In table 4b, we perform a probit analysis following Fitzgerald, Gottschalk and Moffitt (1998) in order to investigate further whether these variables are able to explain attrition.

Table 4b presents three probit models. The first model shows that household income and household size are statistically significant in the attrition regression, as expected from the results in table 4a. The Chi-square test however does not indicate a good fit. In the second model, we used income per adult equivalent together with household characteristics that proved significantly different between attrited and non-attrited households from table 4a (age, sex, land size, cattle, residence) or characteristics we expect to be relevant to explain attrition given the nature of the conflict (ethnicity). Income per adult equivalent is not statistically significant and the fit only improves slightly. The third model adds two shocks to the regression – violent and non-violent death of adult females – the relevance of which was also visible in table 4a. This exercise shows improvement in the fit of the regression. It leaves household size, land size, the age of the head of the household, together with both shocks, as the variables that significantly matter in explaining attrition. In our subsequent empirical analysis in section 6 we will correct for attrition bias on observables using a Heckman sample selection model to correct for attrition in income regressions.

5.3 Poverty profiles in Gikongoro and Gitarama

The number of households below the poverty line in the two provinces included in the sample increased from 73.1% in 1990 to 75.3% in 2002. Moreover, the increase in poverty in the two provinces between these two years is robust to the choice of poverty line: Figure 3 shows that poverty was always higher in 2002 than in 1990 in Rwanda up to a very large poverty line. These estimates hide considerable variations across the sample. Increases in the number of poor (and extremely poor) households in 2002 were particularly noticeable amongst smaller Hutu households headed by younger males. In 2002, education keeps a household out of poverty, but less compared to 1990.

Table 5 shows also that the number of poor households decreased quite significantly in the province of Gikongoro in that time period, whereas it increased from 62.4% to around 80% in Gitarama province. Estimates using a lower food poverty line illustrate a similar picture: the number of extremely poor households decreased in Gikongoro from 83.3% to 56.7%, whereas it increased from 44.9% to 72% in Gitarama. The difference in the income and poverty path for Gikongoro in our small panel is similar to the path in the cross-sections, but more outspoken. For Gitarama province, the path of extreme poverty is similar in the small panel and the cross-sections, but poverty in Gitarama in the small panel is higher than in the cross-section. We recall here that the small panel includes only households that lived in the same location before the genocide. Recall that, in contrast to the cross-sections, the small panel does not offer a representative sample of households residing in the provinces in the year 2002 due to drop-out rates from the survey and immigration.

As in the cross-sections, both provinces in the small panel registered an increase in income inequality between the two years (table 5). Increases in income inequality in Rwanda were more or less visible across all population groups analysed in table 5. Interestingly, as table 6 shows, the main sources of inequality in Rwanda in 2002 were education of the head of the household, household size and land size. This is comparable to the situation in 1990, but then location of residence was among the top sources of inequality, not land size. The lesser importance of the province of residence as source of inequality relates closely to our convergence story. The result for land size in table 6 points at the increased importance of land ownership as a source of inequality in Rwanda in 2002.

Table 7 presents static results of the probability of being poor or very poor, comparing the full sample with the panel households in 1990 on the hand one and one logit model for 2002 including the conflict shocks on the other hand. Larger households, land-poor households and female headed households are more likely to be poor or very poor in the full sample as well as for both years in the panel. The statistical significance of several explanatory variables differs between the full sample and the panel, but not the magnitude of the effects. Remark that, in 2002, the death of male adults reduces a household's probability to be poor. The loss of land increases the probability to be very poor. These static effects will be explored further in the next sections.

5.4 Poverty dynamics profiles

Tables 8 and 9 present our analysis of the movement in and out of poverty between the two rounds of the survey. Table 8 illustrates changes in household poverty dynamics across several household characteristics such as location, household size, age, sex, education and occupation of the head of the household, and size of land owned by the household. Table 9 shows changes in poverty dynamics across the different conflict-related shocks observable at the household level. These include the ethnic characteristics of the household (an important element of the Rwandan genocide and surrounding conflicts), the number of male and female adults that died in the 1990-1996 period and in the 1997-2002 period (we include two periods to distinguish between a potential difference in long term and short term effects), whether or not a household saw its house been destroyed in those two periods, the amount of land lost in the two periods (in most cases because of distress sales or intergenerational transfer), or whether or not the household had any member in prison during the survey period (after the genocide, approximately 100 000 people were imprisoned).

The tables show that the percentage of young heads of household decreased significant between the two years (more than halved). In 2002, the majority of households are headed by someone over 60 years old. This is due to the fact that the same households were observed 12 years after the first interview, but also to the loss of young male adults in the conflict. Changes in the gender of the head of household support this: there was a large decrease in number of male-headed households between the two years. The number of female-headed households in Gikongoro and Gitarama more than doubled between 1990 and 2002. The tables show also slight changes in the number of adult equivalents.

The number of non-educated heads of household decreased by around 10 percentage points between 1990 and 2002. In the same time period, the number of heads with incomplete and complete primary school increased, while there was no change in the number of household heads with more than primary school education. This indicates that the heads of households in 2002 who were not head in 1990 (mostly women) were better educated than those that they replaced. We observe a slight increase in number of household heads employed in farming activities, accompanied by decreases in non-farm employment. This is consistent with the first observations: women are generally more likely to be employed in farming.

The number of households with smaller land holdings increased significantly between 1990 and 2002, while the number of larger land holdings decreased. The problems of population growth and land scarcity have not stopped with the genocide.[16] After 1994, households have continued to sell (parts of) their land, to rent it out and to give parts of it to their sons. At the time of the survey, there was no policy of land consolidation. Over time and generations, this leads to smaller and smaller land sizes per household. The Gini coefficient on land inequality rose from 0.44 in 1990 to 0.59 in 2000.[17]

55.1% of all households in our sample remained poor in both years, while 18% moved out of poverty and 20.2% became poor in 2002. Only 6.7% of all households remained non-poor in both 1990 and 2002. As with the headcount estimates, these values cover important differences across the sample. A large number of households from our panel in Gitarama (27.4%) fell below the income poverty line in 2002. Poverty dynamics estimates for Gikongoro show a reverse picture: only 8.3% of households in this province fell into poverty, while a substantial 33.3% became non-poor 12 years later. These results are closely replicated when using the lower food-only poverty line.

Households that owned large land holdings (> 1 hectare) in 1990 were more likely to fall into poverty in 2000, but not households owning between 0.66 and 1 hectare in 1990. André and Platteau (1998) and Verwimp (2003) have demonstrated that land-rich households had a higher probability to fall victim to deadly violence (murder) compared to land-poor households. What we now see is that such targeting also has long-term economic consequences: owners of relatively large plots of land before the genocide were worse of after the genocide compared to before.

Movement into and out of poverty were more frequent for Tutsi heads of households compared to Hutu heads. Falls into poverty and extreme poverty were most notably among households headed by a young male with incomplete primary school, employed in farming activities. Tutsi households that were poor in 1990 were more likely to be non-poor in 2002. The same is true for households headed by an older, educated male, employed in non-farming work. Estimates based on the food poverty line show slight differences: movements out of extreme poverty were highest for Tutsi households headed by older females (not males) employed in low-

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[16] For an analysis of land issues, we refer to a briefing paper by The African Centre for Technology Studies, *Land Reform, Land scarcity and post-conflict reconstruction, Eco-Conflicts*, Volume 3, Number 3, October 2004.
[17] Authors' own calculations from the 1990 and 2000 cross section data.

skilled off-farm activities. This would be consistent with female-headed households being typically found amongst the very poor. Poverty changes between 1990 and 2002 in the two provinces seemed to have lifted some of these households out of extreme forms of poverty. Off-farm low-skilled employment seems to have been an important motor for such changes. In the next section, we analyse in further detail the determinants of these changes in poverty status amongst Rwandan households between 1990 and 2002.

6. Determinants of poverty dynamics in Rwanda

6.1 Empirical approach

Several models have been proposed in the literature to analyse the impact of economic shocks on changes in household consumption expenditure, income or earnings (e.g. Rosenzweig and Wolpin, 1993; Townsend, 1994; Dercon, 2004). There is, however, a scarcity of models that estimate directly the effects of conflict-related changes on poverty or on poverty dynamics. The objective of this section is to estimate the direct impact of shocks directly related to the 1994 Rwandan genocide on household poverty dynamics between 1990 and 2002. To that effect, we make use of multinomial logit models,[18] and reduced-form models of changes in income. Multinomial logit regressions are commonly used to model processes that involve a single outcome among several alternatives that cannot be ordered (for example, choices between modes of travelling, occupational choices, etc). Poverty dynamics between two periods can be divided into four mutually exclusive outcomes: (i) being poor in both periods, (ii) being non-poor in the first period and poor in the second period, (iii) being poor in the first period and non-poor in the second period and (iv) being non-poor in both periods. Independence between the four outcomes is tested using a Hausman chi-squared statistic (Greene, 2000).[19]

The multinomial logit model determines the probability that household i experiences one of the j outcomes above. This probability is given by:

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[18] Glewwe, Gragnolati and Zaman (2002) and Justino and Litchfield (2004) use a similar model to estimate the impact of trade shocks on household poverty dynamics in Vietnam during the 1990s.
[19] The hypothesis of no independence is rejected for all models reported in table 10.

$$P(Y_i = j) = \frac{e^{\beta_j' x_i}}{1 + \sum_{k=1}^{J} e^{\beta_k' x_i}}, \text{ for } j = 1, 2, ..., J \text{ and } P(Y_i = 0) = \frac{1}{1 + \sum_{k=1}^{J} e^{\beta_k' x_i}}. \tag{5}$$

In the equations above, Y_i is the outcome experienced by household i, β_k are the set of coefficients to be estimated and x_i includes aspects specific to the individual household as well as to the choices. β_0 has been set to zero (i.e. β_0 has been defined as the base category) in order to identify the model (Greene, 2000). All other β_k are estimated in relation to this benchmark.

From the model above, we can compute J log-odds ratios $\ln[P_{ij}/P_{i0}] = \beta_j' x_i$. The log-odds ratios (also called relative risk ratios) can be normalised on any other probability, which will yield $\ln[P_{ij}/P_{i0}] = x_j'(\beta_j - \beta_k)$ (Greene, 2000). For convenience, we have calculated in tables 8 and 9 $\ln[P(Y_{i1} = 2)/P(Y_{i0} = 0)]$ and $\ln[P(Y_{i1} = 1)/P(Y_{i0} = 3)]$. These models represent, respectively, the risks of a household escaping and falling into poverty.[20] Results for these models are presented in table 10. Explanatory variables are those outlined in the previous section: household characteristics plus changes in poverty transitions attributed directly to specific conflict shocks observable at the household level.

Discrete poverty functions of the one described above tend, however, to be criticised on the grounds that they introduce measurement errors by using arbitrarily defined poverty lines (see Deaton, 1997 for discussion). This is a particularly serious problem in analyses that use developing countries data sets, since large numbers of households may be concentrated around the poverty line. On the other hand, more conventional income or earnings functions will impose constant parameters across the entire consumption distribution. This feature may, in turn, limit their application to the analysis of the impact of shocks on household poverty transitions if the determinants of household welfare yield different returns to the poor and the non-poor (Appleton, 2002). In fact, it is possible to have situations in which some households may experience decreases in consumption expenditure without becoming poor, and vice-versa.

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[20] $e^{\beta_j' x_i}$ is the relative risk ratio for a unit change in the variable x: a relative risk ratio (*rrr*) of less than one means that the variables decreases the probability of the household to be in the base category, whereas an *rrr* of more than one increases the probability of the household being in the alternative state.

Due to the advantages and disadvantages entailed by the two models, we compare and contrast both in what follows.

The model is an adaptation of the models used by Dercon (2004) and Justino and Litchfield (2004) to analyse the impact of economic reforms household poverty using, similarly to us, micro-level panel data. The base model used is the following:

$$\ln y_{it} - \ln y_{it-1} = \alpha + \upsilon_i + \gamma \ln k_{it-1} + \eta \ln h_{ct-1} + \theta(\ln S_{it} - \ln S_{it-1}) + \delta X_{it} + \varepsilon_{it}.$$ (3)

where y_{it} is the level of income per adult equivalent in year t, α is a common source of income growth across all households, υ_i represents the household-specific fixed effects, k_i represents the household level of capital per capita and h_c is a vector of commune or region level of capital (infrastructure, institutions and so forth), S_{it} is a multiplicative risk resulting from specific shocks that affects the technology coefficient. This risk can be idiosyncratic or common to all households in a particular commune or region (see Dercon, 2004). Finally, X_{it} are household variables that vary across time and ε_{it} is a stochastic error term with zero mean. Results are given in table 11. Table 11 includes several different variations of model (3). In columns 1 and 2, we present the estimation results of model (3) using change in the logarithmic function of household income per adult equivalent (in real terms). Columns 1 and 3 show the results for the estimation of model (3) using total change in household log income as the dependent variable. We use the two estimation procedures in order to assess how corrections for household size impact on our estimation results. Columns 5 and 6 re-estimate the results in column 1 by separating the sample into households that were poor and non-poor in 1990. The objective of this exercise is to examine further the differential impact of household characteristics and conflict shocks on the poor and non-poor (see Appleton, 2002).

Referring to our discussion on attrition in section (5.2) and tables (4a) and (4b), the model in (3) is likely not to be estimated properly. We have therefore corrected for these problems using the Heckman procedure. The first stage of this procedure is exactly the same as the Probit model presented in the last column of table 4b. Selection instruments are those variables that came out significantly different between attrited and non-attrited households as well as variables that were expected to be relevant given the nature of the conflict. The Heckman procedure then constructs and estimate of the inverse Mills ratio and produces an OLS

regression on the income variable with estimates corrected for sample attrition.[21] For a formal presentation of the sample selectivity correction model, we refer to Heckman (1979) and Vella (1998). Examples of applied work are in Heckman (1980), Sahn and Alderman (1988).

6.2. Results

The effect of household characteristics and commune variables

The results in table 10 (columns 1, 2, 5 and 6 – model 1) illustrate interesting effects of household and commune characteristics on the dynamics of poverty amongst Rwandan households in the 1990-2002 period. In general, household size in 1990 did not determine significantly the chances of Rwandan households escaping or falling into poverty. The variable, however, increases significantly the probability of any given household having a higher income in 2002. Land size in 1990 impacted only on the probability of any given household falling into poverty: households with larger land holdings had increase probability (1%) of falling below both general and food poverty lines. This result is replicated in table 11: one more unit of land decreased household incomes by 0.2% in 2002 (0.1% in the corrected model). The result is statistically significant amongst households that were above the poverty line in 1990 (column 6, table 11). As stated before, what is driving these results is that land-rich households were targeted in the genocide.

Female headed households fare worse than male-headed households, a result in line with other findings in the development economics literature. The level of education and the type of employment held by the head of the household did not seem to influence significantly the likelihood of a given household escaping poverty. However, they do affect the likelihood of falling into poverty: households with more educated heads and with heads employed outside farming activities are less likely to fall below the poverty line between 1990 and 2002. The effect of these variables on food poverty is not statistically significant. The most significant impact relates to household ethnicity: Tutsi households had a high probability of escaping poverty. Ethnicity did not affect household movements into poverty. Referring to our discussion of tables 8 and 9, we already noticed that more Tutsi than Hutu moved into poverty or escaped poverty. The effect of ethnicity proves to be statistically significant and positive for

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[21] At least one variable in the selection equation does not turn up in the subsequent income estimation.

the escape from poverty but not for the movement into poverty in the multinomial logit analysis (table 10). When we correct for selectivity in the income regression (table 11) this effect disappears.

Commune level variables have some, though not large impact on poverty dynamics of Rwandan households. Distance to market seems only to affect the probability of households falling into poverty: the larger the distance of any given household to local markets, the higher the probability of that household having fallen below the food poverty line between 1990 and 2002. This result is again strengthened by the results in table 11. Households living in higher altitudes had a 1% increase in the probability of escaping general and food poverty. Higher levels of altitude also impact positively on income changes between 1990 and 2002, in particular for households that were poor (table 11, column 5). The interpretation of the effect of altitude is not straightforward. It could be that this variable picks up unobserved commune level effects. High altitude may have served as a protection for some of the (worst) effects of the conflict, not accounted for by our household or individual level covariates.

The effect of land losses

A large number of Rwandan households were affected by land losses between the two survey years. In the 1990-1996 period, 14% of the households included in our sample lost land, whereas 21.8% households loss some percentage of their land holdings between 1997 and 2002 (table 9). The main reasons for the loss of land are the transfer of land to a son and the sale of land out of need for cash. Given the importance of land amongst assets of Rwandan households, it is not surprising that this variable has affected the levels of poverty amongst our sample households (see model 1, table 10, columns 1, 2, 5 and 6). Land losses between 1990 and 1996 or between 1997 and 2002 resulted in large decreases in the probability of a given household moving out of poverty. In addition, the loss of any land between 1997 and 2002 increased the probability of a household to fall into absolute poverty by over 170%, and to fall below the food poverty line by around 4%. It also contributes towards the decrease in incomes per adult equivalent by 36% (table 11), in particular for those households that were not poor in 1990 (column 6, table 11). The impact of recent losses appears to be more severe then the impact of older losses.

The effect of death of household members

One the most visible impact of the Rwandan genocide was its death toll. This has had significant effects on changes in households' welfare status. The estimates in table 10 (model 1) show that the death of adult male in period between 1990 and 1996 increased considerably the probability of a household escaping poverty. We obtained a similar result for death of adult male and female between 1997 and 2002 when using food poverty line. However, death of adult female in the 1990-1996 period decreased probability of escaping poverty.

In order to try to understand these effects further, we have run a second model (model 2 in table 10), which disaggregates the variables above into violent and non-violent deaths. The results show that both non-violent and violent deaths of adult males impact on the probability of households escaping poverty. These non-violent deaths are almost all caused by disease. For women, the deaths in the 1997-2002 period - of which 90% caused by disease – also have a positive and statistically significant effect on the escape from poverty for the affected households. The female deaths during the period of the genocide and civil war, be it violent or non-violent, had a negative effect on the escape from poverty. Caution is warranted in the interpretation of these results as we did not correct for sample selectivity in table 10, an issue we now turn to.

These results are only partially repeated in the OLS regressions on the change in income in table 11. The loss of an adult male has a positive and significant effect on income per adult equivalent (models 1 and 2), but only for non-violent male deaths and only in the most recent period. Exactly the same effect shows up in the case of female adult death: only non-violent death and only in the most recent period. We recall that the death of women - violent and non-violent - was an important factor in our analysis of attrition (tables 4a and 4b). The percentage of households who lost women was much higher in the attrited compared to the panel households. This most likely explains the difference between the multinomial and Heckman corrected results.

The likely explanation for the results above is that although household members who are ill do not contribute to household income generation, they do need to consume from the generated income. As a result, in terms of income per adult equivalent incomes, surviving household members will benefit from higher incomes per adult equivalent once the ill household member

dies. Once we correct for selectivity, the violent death of an adult, most probably healthy and productive, as well as deaths that occurred more than 5 years ago, do not have a positive effect on the escape from poverty.

We find extra evidence for our interpretation that this story is driven by disease when we look at the total income regressions at the level of the household (models 3 and 4 in table 11; in these models the dependent variable is not divided by the number of adult equivalents): none of the labour shocks has a statistically significant effect (-/+) on changes in income, neither in the uncorrected nor in the corrected model. Thus, the deaths from disease of male and female adults seem to have no negative effect on household income and a positive effect on the income of the surviving household members expressed in adult equivalents.

The effect of property destruction and imprisonment

As discussed in section 2, the conflict in Rwanda during the 1990s led to the destruction of assets, such as houses and the imprisonment of a large number of individuals. These events have affected the poverty status of households in our sample. The destruction of a house in the 1990-1996 period – in 90% of the cases because of violence (own calculations from survey) – led to a decreased probability of escaping poverty and a significant decrease (62%) in average incomes (table 11). The destruction of house in the 1997-2002 period – in 90% of the cases due to excessive rain (own calculations from survey) – led to a significant increase in the probability of a households falling below the food poverty line. Both these effects, in the early period because of violence and in the recent period because of excessive rain, are statistically significant for households who were non-poor in 1990 (column 6 in table 11). This result is replicated in the results in table 10 showing a fall into poverty for these households.

The imprisonment of a household member did not have a very significant impact on household poverty dynamics or in changes in income status, except for a decrease in the probability of households escaping from extreme levels of poverty. We remark that Rwandan households bring food to their imprisoned household members, meaning that he (most prisoners are adult males) does nor contribute to household income, but does consume from it.

7. Conclusions

We have presented an analysis of the dynamics of poverty in rural Rwanda spanning a period of violent conflict from 1990 to 2000 and 2002. We aimed to contribute to the understanding of the effect of violent and non-violent shocks on household welfare. We included violent and non-violent demographic shocks, violent and non-violent asset shocks as well more traditional covariate economic shocks such as rainfall. Three stories emerge from our analysis of the panel data on Rwandan households. *First*, previously land-rich, income non-poor households have fared badly over the decade spanning the conflict. We already knew that these households were badly affected by the genocide and the conflict as a whole. The results in this paper suggest further that this has affected the economic well being of the surviving household members. In particular, the destruction of the house and the loss of land have had a negative impact on their welfare, measured by income per adult equivalent. *Second*, previously land-poor, income poor households were able to move out of poverty when an adult member – female or male – who suffered from disease, died. We obtained this result after correcting the income regression for identified selectivity biases. The result is valid for models using income per adult equivalent as a measure of welfare. As it would be expected, total household income does not decrease or increase when an adult dies, but surviving members have more income when measured in terms of adult equivalents. We remind that we obtained this result for a rural economy struck by extreme land scarcity, absence of technological innovation in agriculture and lack of capital. *Third*, female headed households are trapped in poverty. They are more likely to be poor and when poor are less likely to move out of poverty. This shows that female headed households should be a prime beneficiary of development aid.

Acknowledging that our data come from a small panel, we have linked our poverty dynamics analysis to cross-sectional household data sets, both nationally representative; one collected before the genocide, one collected after. We first demonstrated the existence of income convergence across provinces: previously poor provinces have grown much more than previously richer ones. We linked this result to the differential effect of the four conflict shocks at the provincial level. From the analysis, we derive that poverty has increased slightly over time in the whole of the rural areas, with large changes in poverty over provinces. We show evidence for strong similarities between our panel data results and the findings in the cross-sections. Losses of capital (house, land) during the 1990s decreased incomes per adult equivalent in the household panel. This effect offers also a robust explanation for provincial

level income changes in the cross-sections. Losses of labour were found to lead to opposite effect, though this effect is explained in the household panel by non-violent events (illness). The latter may be an indirect effect of the conflict shocks due to lack of health care, but illness does not have to be related to the conflict per sé.

References

Appleton, Simon. 2002. "The Rich Are Just Like Us, Only Richer: Poverty Functions or Consumption Functions?", *Journal of African Economies* 10 (4), 433-469.

Alderman, H., Behrman, J.R., Kohler, H.P, Maluccio, J.A., Watkins, S.C, 2000. Attrition in Longitudinal Household Survey Data: some tests for three developing-country samples, Discussion paper no.96, IFPRI, Washington D.C.

Alderman, H., Hoddinott, J. and Kinsey, B. 2004. "Long Term Consequences of Early Childhood Malnutrition", HiCN Working Paper no. 09, Households in Conflict Network, University of Sussex, UK (www.hicn.org).

André, C and Platteau, J.P.1998. "Land Relations under unbereable stress : Rwanda caught in the Malthusian trap", *Journal of Economic Organisation and Behaviour* 34(1):1-47

Bane, M. J. and Ellwood, D. T. 1986. "Slipping into and Out of Poverty: The Dynamics of Spells", *Journal of Human Resources* 21, 1-23.

Barrett, C. B., Reardon, T., Webb, P. 2001. "Nonfarm Income Diversification and Household Livelihood Strategies in Rural Africa: Concepts, Dynamics, and Policy Implications', *Food Policy* 26: 315-331.

Barro, Robert and Sala-i-Martin, Xavier. 1992. "Convergence", *Journal of Political Economy* 100(2): 223-253

Beegle, K., 2005. "Labor Effects of Adult Mortality in Tanzanian Households", *Economic Development and Cultural Change 53* (3): 655-683

Binswanger, Hans. 1981. "Attitudes Towards Risk: Theoretical Implications of an Experiment in Rural India", *Economic Journal* 91 (364): 867-890

Brück, T. 2004. "Coping Strategies Post-War Rural Mozambique", HiCN Working Paper no. 02, Households in Conflict Network, University of Sussex, UK (www.hicn.org).

Bundervoet, Tom and Verwimp, Philip. 2005. "Civil War and Economic Sanctions: An Analysis of Anthropometric Outcomes in Burundi", HiCN Working Paper no. 11, Households in Conflict Network, University of Sussex, UK (www.hicn.org).

Collier, Paul. 1999. "On the Economic Consequences of Civil War", *Oxford Economic Papers* 51: 168-183.

Collier, Paul and Hoeffler, Anke. 2001. "Greed and Grievance in Civil War", World Bank, Washington DC.

Dasgupta, Partha. 1993. *An Inquiry into Well-Being and Destitution*, Oxford University Press, Oxford.

Dasgupta, Partha and Ray, D. 1986. "Inequality as a Determinant of Malnutrition and Unemployment: Theory", *Economic Journal* 90: 1011-1034

Deaton, Angus. 1997. *The Analysis of Household Surveys: A Microeconomic Approach to Development Policy*. Johns Hopkins University Press.

Dercon, Stefan. 1996. "Risk, Crop Choice and Savings: Evidence from Tanzania", *Economic Development and Cultural Change* 44 (3): 385-514.

Dercon, Stefan. 2002. "Income Risk, Coping Strategies and Safety Nets", *World Bank Research Observer* 17: 141-166

Dercon, Stefan. 2004. "Growth and Shocks: Evidence from Rural Ethiopia", *Journal of Development Economics* 74, 309-329.

Dercon, Stefan. 2005. "Vulnerability: A Micro Perspective", Paper presented at the Annual Bank Conference on Development Economics, Amsterdam, The Netherlands, May 23-24.

Dercon, Stefan and Krishnan, Pramilla. 1996. "Income Portfolios in Rural Ethiopia and Tanzania: Choices and Constraints', *Journal of Development Studies* 32 (6): 850-875.

Des Forges. 1999. Leave None to tell the Story, Human Rigths Watch, New York

De Lame, Danielle. 1996, Une colline entre mille ou le calme avant le tempete, Transformations et Blocages du Rwanda Rural, Musee Royale de l'Afrique Centrale, Tervuren.

de Walque, Dominique. 2006. "The Long-Term Legacy of the Khmer Rouge Period in Cambodia", paper presented at the First Annual Workshop, Households in Conflict Network (www.hicn.org), Berlin January 15-16 and *Population Studies*, forthcoming

Donovan, Cynthia, Bailey ,Linda, Mpyisi, Edson, Weber, Michael. 2003. "Prime-Age Adult Morbidity and Mortality in Rural Rwanda: Effects on Household Income, Agricultural Production, and Food Security Strategies", Research Report, Food Security Research Project, Ministry of Agriculture, Kigali, March

Fafchamps, Marcel, Udry, Christophe and Czukas, K. 1998. "Drought and Savings in West Africa: Are Livestock a Buffer Stock?", *Journal of Development Economics* 55: 273:305.

Fafchamps, Marcel And Lund, S. 2002. "Risk-Sharing Networks in Rural Philippines", *Journal of Development Economics* 71: 261-287.

Fearon, J. D. and Laitin, D. D. 2003. "Ethnicity, Insurgency, and Civil War", *American Political Science Review* 97: 75-90.

Fitzgerald, Gottschalk and Moffitt. 1998. An analysis of sample attrition in panel data, *Journal of Human Resources* 33:251-299

Frankenberg, Elizabeth, Smith, J. and Thomas, Duncan. 2003. "Economic Shocks, Wealth and Welfare", *California Center for Population Research. On-Line Working Paper Series*. Paper ccpr-009-03. http://repositories.cdlib.org/ccpr/olwp/ccpr-009-03

Gertler, P. And Gruber, J. 2002. "Insuring Consumption Against Illness", *American Economic Review* 92 (1): 51-70.

Glewwe, Paul, Gragnolati, M. and Zaman, H. 2002. "Who Gained from Vietnam's Boom in the 1990s?", *Economic Development and Cultural Change* 50 (4), 773-792.

Greene, W. H. 2000. *Econometric Analysis* (4th edition), New Jersey: Prentice-Hall.

Grimard, F. 1997. "Household Consumption Smoothing through Ethnic Ties: Evidence from Cote d'Ivoire", *Journal of Development Economics* 53: 391-422.

Heckman, J. (1979), Sample Selection Bias as a Specification Error, Econometrica 47 (1): 153-161

Heckman, J. (1980),), Sample Selection Bias as a Specification Error with an application to labour supply functions, in *Female Labour Supply*: Theory and Estimation, Ed. James, P.Smith, Princeton University Press, 206-248

Jalan, J. and Ravallion, Martin. 2001. "Behavioral Responses to Risk in Rural China", *Journal of Development Economics* 66 (1): 23-49.

Jenkins, Stephen. 1998. *Modelling Household Income Dynamics*, Institute for Social and Economic Research, University of Essex.

Justino, Patricia. 2006. "On the Links between Violent Conflict and Chronic Poverty: How Much Do We Really Know?", Working Paper, Chronic Poverty Research Centre, University of Manchester.

Justino, Patricia and Litchfield, Julie. 2004. "Poverty Dynamics in Rural Vietnam: Winners and Losers During Reform", *PRUS Working Paper no. 10*, Department of Economics, University of Sussex, UK.

Kanbur, R. and Squire, L. 1999. *The Evolution of Thinking About Poverty: Exploring the Interactions*, World Bank.

Kochar, Anjini, 1995. "Explaining Household Vulnerability to Idiosyncratic Income Shocks." American Economic Review Papers and Proceedings 85: 159-64.

Layte, R. and Whelan, C. T. 2003. "Moving in and Out of Poverty: The Impact of Welfare Regimes on Poverty Dynamics in the EU", *European Societies* 2, 209-233.

Lokshin, M. and Ravallion, Martin. 2000. "Short-Lived Shocks with Long-Lived Impacts? Household Income Dynamics in a Transition Economy", World Bank Working Paper Series 2459, World Bank, Washington D.C.

McCulloch, Neil, Winters, L. Alan and Cirera, Xavier. 2001. *Trade Liberalisation and Poverty: A Handbook*, CEPR, London.

McKay, A. and Loveridge, S., 2005. *Exploring the Paradox of Rwandan Agricultural Household Income and Nutritional Outcomes in 1990 and 2000*, Staff Paper, Department of Agricultural Economics, Michigan State University.

Morduch, J. 1995. "Income Smoothing and Consumption Smoothing", *Journal of Economic Perspectives* 9: 103-114.

Newbury, Catherine. 1988. *The Cohesion of Oppression*. Columbia University Press, New York

Paxson, Christina. 1992. "Using Weather Variability to Estimate the Response of Savings to Transitory Income in Thailand", *American Economic Review* 82 (1): 15-33.

Pitt, Mark and Rosenzweig, Mark. 1986. "Agricultural Prices, Food Consumption and the Health and Productivity of Farmers." In Singh, Squire and Strauss 1986.

Platteau, Jean-Philippe. 1991. "Traditional Systems of Social Security and Hunger Insurance: Some Lessons from the Evidence Pertaining to Third World Countries", in E. Ahmad et al., (eds.) *Social Security in Developing Countries*, Oxford: Clarendon Press.

Prunier, Geard, 1995. The Rwanda Crisis: history of a genocide, Columbia University Press.

Reyntjens, Filip, 1994. *L'Afrique des grands lacs en crise: Rwanda, Burundi: 1988-1994*, Paris, Karthala.

Rosenzweig, Mark and Binswanger, Hans. 1993. "Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments", *Economic Journal* 103.

Rosenzweig, Mark and Wolpin, Kenneth. 1993. "Credit Market Constraints, Consumption Smoothing, and the Accumulation of Durable Production Assets in Low-Income Countries: Investment in Bullocks in India", *Journal of Political Economy* 101 (2): 223-244.

Sahn, D.E and Alderman, H.1988. "The effects of human capital on wages, and the determinants of labor supply in a developing country*", Journal of Development Economics* 29 (2): *157-183*

Shemyakina, Olga. 2006. "The Effect of Armed Conflict on Accumulation of Schooling: Results from Tajikistan", HiCN Working Paper no. 12, Households in Conflict Network, University of Sussex, UK (www.hicn.org).

Singh, Inderjit, Squire Lynn, and Strauss, John, 1986. Agricultural Household Models: Extensions and Applications. Baltimore: Johns Hopkins University Press

Stewart, Frances, Fitzgerald, Valpy and Associates. 2001. *War and Underdevelopment: The Economic and Social Consequences of Conflict*. Oxford University Press, Oxford.

Thomas, Duncan, Frankenberg, Elizabeth and Smith, J. P. 2000. "Lost but not Forgotten: Attrition and Follow-Up in the Indonesian Family Life Survey", mimeo, RAND Corporation, CA.

Townsend, Robert. 1994. "Risk and Insurance in Village India", *Econometrica* 62 (3): 539-591.

Vella, Francis. 1998. "Estimating Models with Sample Selection Bias: A Survey", *The Journal of Human Resources* 33(1):88-126

Verpoorten, Marijke. 2005. "Self-Insurance in Rwandan Households: The Use of Livestock as a Buffer Stock in Times of Violent Conflict", mimeo, KU Leuven, Belgium.

Verwimp, Philip. 2003. Testing the double genocide thesis for central and southern Rwanda, *Journal of Conflict Resolution* 47(4): 423-442

Verwimp, Philip. 2005. "An Economic Profile of Peasant Perpetrators of Genocide: Micro-Level Evidence from Rwanda", *Journal of Development Economics* 77: 297-323.

Map 1 : The advance of the RPF in April-July 1994

Map is modelled after Christine Deslaurier for FIDH/Human Rights Watch -1996.
Arrows show the advance of the RPF. The shaded area was occupied by the French Army under
the *Operation Turquoise* from mid-June till September 1994

Table 1a: Percentage change in labour/capital ratios in Rwanda's provinces 1990-2000

Province	Δ (labour/ land)[2]	Rank[4]	Δ (labour/ num.cattle)[2]	Rank[4]	New settlements[3]	Rank[4]	Average rank[5]
Kibungo	8	6	-5	2	90	10	6
Rural Kigali[1]	-4	1	261	8	42	8	6
Ruhengeri	16	8	640	9	45	9	8.67
Byumba[1]	11	7	29	5	20	5	5.67
Gisenyi	18	10	823	10	12	3	7.17
Gitarama	1	4	27	4	35	7	5
Butare	-5	2	200	7	25	6	4.67
Cyangugu	18	10	-47	1	18	4	5
Kibuye	0	3	174	6	12	3	3.83
Gikongoro	5	5	25	3	7	1	3
All Rural	6		113		31		

Souces: Population and surface data (Census 1991 and 2002); number of cattle and (FSRP 2000-2002); number of new settlements (EICV 1999-2001 Community Survey);
Notes:
1. The province of Byumba covers a different area in 1990 compared to 2000 because of administrative reforms. In this table we have taken the 2000 area for comparison, meaning that we dropped the Akagera parc and two former communes from the 1991 surface and population figure. Same issue for Rural Kigali that lost surface to Kigali Capital in the 2000 administrative reform. For reason of comparability we choose the 2000 borders and substracted the relevant areas and population from the 1991 figure.
2. Columns 1, 3 refer to the percentage change in the ratios between 1990 and 2000.
3. Column 5 refers to the percentage of survey cites (cells) in the 1999-2001 EICV Survey that is home to a new settlement (*imidugudu*). Each province had 40 survey sites.
4. Columns 2, 4 and 6 are the ranking of each outcome. In a land-scarce, capital poor, densely populated economy such as Rwanda, high values for the change in labour/capital ratios indicate a worsening evolution.
5. Column 7 is the average rank on the three ratios.

Table 1b: Intensity of different shocks at the province level 1990-2000

Province	Genocide		Civil war		Immigration		(Counter) Insurgency		Sum
	L	K	L	K	L	K	L	K	
Kibungo	1	0	1	-2	-2	1	0	0	-1
Rural Kigal	1	0	1	-2	-2	1	0	0	-1
Ruhengeri	0	0	1	-2	-1	0	1	-2	-3
Byumba	0	0	1	-2	-1	0	0	0	-2
Gisenyi	0	0	0	0	0	0	1	-2	-1
Gitarama	1	0	0	-1	0	0	0	0	0
Butare	2	-1	0	-1	0	0	0	0	0
Cyangugu	2	-1	0	0	0	0	0	0	1
Kibuye	2	-1	0	0	0	0	0	0	1
Gikongoro	2	-1	0	0	0	0	0	0	1

Source: Authors' evaluation based on Desforges (1999),Verwimp (2003), Global IDP Project (2005);
Note: The four shocks (genocide, civil war, immigration and (counter)insurgency) are explained in the text. We make five assumptions to construct a shock index describing the effect of these shocks on the rural economy in each province. Our aim is to see what drives the changes observed in table 1a. (1) Each shock has an impact on both factors of production (labour and capital), but there is a dominant impact on either capital or labour; (2) the impact, be it the dominant or the secondary impact can be negative or positive. In a land-scarce, capital poor, densely populated economy, we assume that a shock has a negative (positive) impact on the economy when it augments (reduces) labour and destroys (increases) capital; (3) We believe (see below) that the shocks of genocide and immigration are dominant on labour and that the shocks for civil war and the (counter)insurgency are dominant on capital; (4) the level of intensity of the shock can be 0 (not intense), 1 (moderately intense) or 2 (very intense); (5) We also assume that the difference between the level of intensity of the shock on the dominant and the secondary factor of production can only be 1 unit (in absolute values), for example (0 and 1) or (-1 and 2). We do the latter in order not to make too much of the distinction between the dominant and the secondary effect as all these shocks affect both factors of production. The sum is the shock index. This remains a subjective exercise, but we believe it reflects lived experiences on the ground and remains very close to the literature. Four observations illustrate this:

1. The first column reflects very close to the percentage of Tutsi at the provincial level before the genocide, where one distinguishes provinces with high, low and medium % of Tutsi. Thus, the impact of the genocide on labour was particularly severe in provinces with a high % of Tutsi.
2. The believe/assumption that capital destruction is not the dominant effect of genocide (but labour is) is derived from the observation that during the genocide, capital was not so much destroyed as it was redistributed. Most frequently from Tutsi to Hutu. Land, cattle and furniture were redistributed on a massive scale during the genocide. Even among Hutu: in several locations of earlier fieldwork the local Interahamwe leader was killed at the moment he wanted to attack rich local Hutu, after having killed (and robbed) the local Tutsi. Also, while the data in table 3a do capture more effects than the effect of genocide, the data on inequality show that inequality has increased in all provinces, but least in those most affected by the genocide (the southern and south-western provinces).
3. Immigration not only adds people, it also adds cattle, as demonstrated by the rising number of cattle in areas with many former refugees. Since not all refugees bring cattle or other capital with them, but all bring labour, we believe the effect on labour is dominant;
4. The assumption that the effect of civil war and (counter)insurgency is dominant on capital is based on observations during the civil war, such as the damage inflicted on the Ntaruka power station by the FPR and the dismantling of the Cyangugu tea factory by the departing FAR.

Table 1c: Rank correlation (Spearman's rho) between income, growth rate, Δ L/K ratios and shocks

Measure	Income 1990	Growth rate 1990-2000 (in table 2)	Δ L/K 1990-2000 (average rank, table 1a)	Shocks (sum, Table 1b)
Income 1990	1	-0.842***	0.683**	-.0804***
Growth rate 1990-2000 (in table 2)		1	-0.567*	0.679**
Δ L/K 1990-2000 (average rank, table 1a)			1	-0.856***
Shocks (sum, table 1b)				1

*** significant at the 1% level; **5% level; *10 % level

Note: Ranking the provinces on the basis of four indicators yields high and statistically significant correlations, supporting the usefulness of the exercises undertaken in tables 1a and 1b.

Table 2: Changes in income in Rwanda's provinces 1990-2000

Province	Income 1990 in RwF per ae	Rank 1990	Income 2000 in RwF per ae	Rank 2000	Real income 2000 $(Y_{2000}/3,26)$	growth rate of real income $\log(Y_{r,\,2000}/Y_{1990})$*	Rank
Kibungo	22494	1	56822	1	17430	-0.26	10
Rural Kigal	15151	2	38930	8	11942	-0.24	9
Ruhengeri	14160	3	54260	3	16648	0.16	7
Byumba	12949	4	52536	4	16115	0.22	6
Gisenyi	12937	5	56603	2	17363	0.29	4
Gitarama	11954	6	50875	5	15606	0.27	5
Butare	9624	7	35743	10	10964	0.13	8
Cyangugu	9217	8	41803	6	12823	0.33	3
Kibuye	8857	9	41691	7	12788	0.37	2
Gikongoro	7804	10	38931	8	11942	0.43	1
All Rural	12600		48000		14724	0.16	

Source: Agricultural Household Survey (DSA, 1990), EICV (1999-2001)

* The Consumption Price index in on 2000 is 326 compared to 100 in 1990.

Figure 1 : Initial income and the growth rate of income per province, 1990-2000

When regressing the equation (as in Barro and Sala-i-Martin, 1992)

$$Ln\left[\frac{Y_{r,2000}}{Y_{1990}}\right] = b_0 + b_1 Y_{1990} + \varepsilon \text{ , we obtain}$$

Linear Regression of the growth rate on initial income

Dependent variable	coefficient	t-value	Significance
Income 1990	-0.64E-05	-4.346	0.002***
constant	0.751	5.344	0.001***

N=10
Rsq = 0.702

*** significant at the 1% level

This linear relationship, showing convergence, is depicted in the following figure

Growth Rate 1990-2000
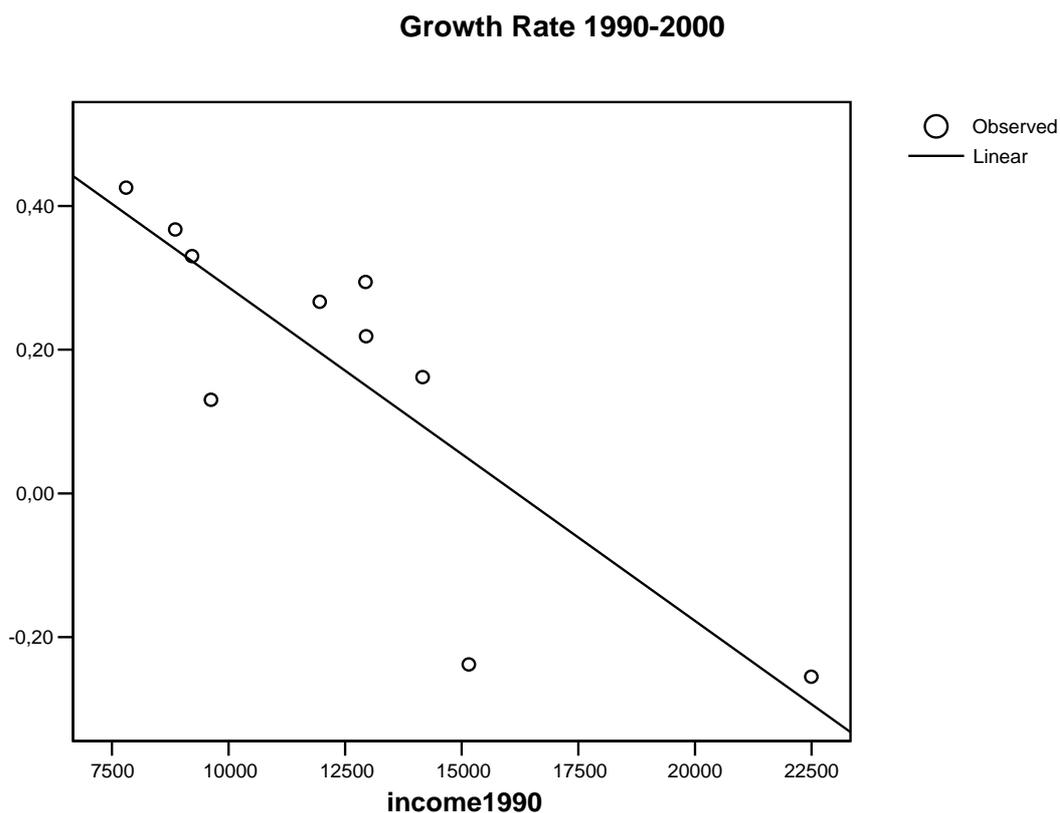
Figure 2 : Chain of causation

$$Y_{1990} \longrightarrow \text{conflict shocks} \longrightarrow \Delta\, L/K \longrightarrow Y_{2000}$$

growth rate
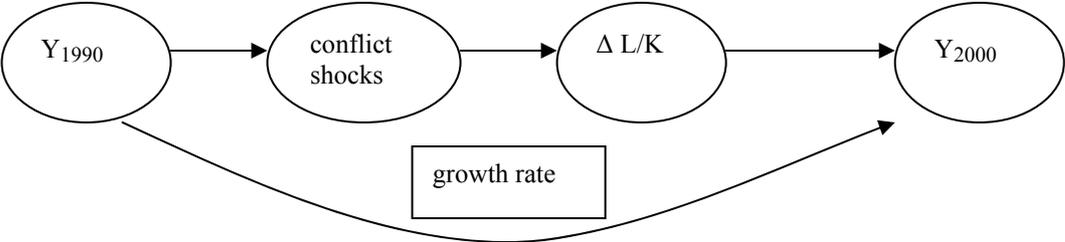
Table 3a : Household poverty and inequality in rural Rwanda 1990-2000

	Real mean income 1990	Real mean income 2002	% Δ 90-02	Headcount index 1990	Headcount index 2002	% Δ 90-02	Headcount index 1990 (food poverty)	Headcount index 2002 (food poverty)	% Δ 90-02	Gini 1990	Gini 2002	Δ 90-02
All Rural	12600	14724	16.9	69.7	72.0	3.3	52.4	55.0	5.0	0.41	0.51	24.4
Province												
Butare	9624	10964	13.9	80.5	80.1	-0.5	65.2	65.8	0.9	0.36	0.47	30.6
Buymba	12949	16115	24.4	64.3	70.1	9.0	49.7	53.3	7.2	0.39	0.55	41.0
Cyangugu	9217	12823	39.1	88.2	75.3	-14.6	77.1	61.2	-20.6	0.41	0.51	24.4
Gikongoro	7804	11942	53.0	85.5	77.5	-9.4	73.9	61.5	-16.8	0.43	0.45	4.7
Gisenyi	12937	17363	34.2	67.9	71.8	5.7	50.0	52.0	4.0	0.39	0.54	38.5
Gitarama	11954	15606	30.6	66.2	64.9	-2.0	47.0	48.7	3.6	0.34	0.49	44.1
Kibungo	22494	17430	-22.5	35.4	59.3	67.5	15.1	40.0	164.9	0.35	0.44	25.7
Kibuye	8857	12788	44.4	93.4	74.6	-20.1	74.8	59.1	-21.0	0.40	0.45	12.5
RuralKigali	15151	11942	-21.2	55.8	77.5	38.9	34.4	62.1	80.5	0.38	0.53	39.5
Ruhengeri	14160	16648	17.6	69.8	74.0	6.0	50.6	53.1	4.9	0.44	0.55	25.0
Umutara	-		-	-	62.7	-	-	45.0	-		0.53	-
Gender												
Male	12746	16390	28.6	69.0	69.1	0.1	50.9	51.9	2.0	0.40	0.53	32.5
Female	10934	11260	3.0	73.2	77.8	6.3	58.7	61.0	3.9	0.41	0.45	9.8
Age of the head												
20-30	14853	18482	24.4	61.4	65.3	6.4	39.0	45.9	17.7	0.39	0.54	38.5
30-40	12022	16450	36.8	72.5	68.9	-5.0	54.6	52.7	-3.5	0.39	0.55	41.0
40-50	10902	12041	10.4	73.4	77.4	5.4	57.5	61.5	7.0	0.41	0.47	14.6
50-60	11908	13814	16.0	69.2	75.2	8.7	54.6	57.3	4.9	0.40	0.52	30.0
+60	12634	13699	8.4	68.0	70.5	3.7	50.9	54.1	6.3	0.41	0.47	14.6
Size in adult eq												
0-3	16252	17445	7.3	56.1	62.1	10.7	37.8	42.8	13.2	0.43	0.49	14.0
3-6	12273	13838	12.8	71.2	74.7	4.9	54.6	57.6	5.5	0.41	0.51	24.4
+6	10760	13302	23.6	75.8	78.0	2.9	58.2	64.0	10.0	0.39	0.54	38.5
Education												
None	10516	11532	9.7	75.0	78.0	4.0	59.2	61.8	4.4	0.38	0.53	39.5
Primary	13320	16116	21.0	66.3	70.1	5.7	46.6	52.1	11.8	0.39	0.53	35.9
>Primary	41640	26397	-36.6	17.1	42.3	147.4	8.0	27.7	246.3	0.44	0.47	6.8
Occupat.												
Farming	11654	13170	13.0	71.5	74.1	3.6	53.3	56.3	5.6	0.38	0.48	26.3
Agr labour	8108	11264	38.9	90.1	76.8	-14.8	80.8	62.2	-23.0	0.41	0.46	12.2

N-agr Lab	22818	28718	25.9	34.1	36.5	7.0	23.9	21.6	-9.6	0.42	0.46	9.5
Business	14551	82052	463.9	55.3	23.9	-56.8	39.9	14.6	-63.4	0.29	0.67	131.0
Adm, prof	47558	34799	-26.8	0.0	15.8	-	0.0	9.0	-	0.37	0.37	0.0

Source: Agricultural Household Survey (DSA, 1990), EICV (1999-2001)

Notes: The Poverty Line is defined at 49.575 RwF per adult equivalent per year in 2000 and 13.300 RwF per adult equivalent in 1990. The Extreme or Food Poverty Line is defined as 35.000 RwF per ae in 2000 and 9.400 Rwf in 1990. For calculation of these Poverty Lines we refer to the text. The samples are population weighted: N (1990) is 1248, N (2000) is 5218.

Table 3b Mean real household income and underestimation of income per income quintile in RwF per year*

	Mean	Median	Poorest 20%	Second quintile	Third quintile	Fourth quintile	Richest 20%
Real Income							
Real income 1990	58.429	40.291	14.326	27.679	40.776	63.580	145.962
Real income 2000	62.563	36.624	7.985	22.414	37.039	59.732	185.687
% difference 2000-1990	+7	-9	-44	-19	-9	-6	+27
Underestimation of 2000 income							
Average underestimation in % of income	1.6		3.2	1.3	1.0	1.1	1.2
% with no underestimation	95.6		91.5	96.8	96.6	96.9	95.9
% with less then 3% underestimation	3.2		5.2	1.8	2.9	2.6	3.8
% with more the 3% underestimation	1.2		3.2	1.3	0.5	0.6	0.4

Source: Agricultural Household Survey (DSA, 1990), EICV (1999-2001)

Notes: *Only households living in the rural areas are included as household level data for urban Rwanda in 1990 are not available

Table 4a: Testing for selection attrition, comparing means for households in the 1990 sample

	178 hh with two observations	65 dropped hh or hh with new head	T-statistic on diff. in means
Characteristics of the household			
Residing in Gitarama	66.3	52.3	3.97**
Residing in Gikongoro	33.7	47.7	3.97**
Household size	5.53	4.42	-3.33***
Adult equivalents	5.01	3.9	-3.53***
Age of head	51	46	1.97*
% head female	16.3	27.0	3.44*
% of hh with Tutsi head	7.9	11.3	0.676
% of hh with educated head	44.4	40.6	0.271
Size of cultivated land	0.99	0.69	-3.21***
Size of cultivated land per ae	0.223	0.195	-1.21
Household income for A season	22946	16634	-2.55**
Income per ae, A season	5105	4721	-0.65
Number of cattle	0.75	0.40	-2.32**
Altitude	1724	1775	1.48
Distance to market	4.16	4.28	0.62
% poor	72.5	73.8	0.045
% extreme poor	57.9	69.2	2.58
Shocks			
% hh with male adult violent death 94-96	13.5	12.3	0.058
% hh female adult violent death 94-96	1.1	9.2	9.8***
% hh male died 1990-96	19.7	26.2	1.19
% hh female adult died 1990-96	7.9	30.8	20.75***
Rain levels	738	777	2.002*

Source: Rwanda panel household survey 1990-2002.

Table 4b:Probit models testing for selective attrition, using FGM method*

	Model 1	Model 2	Model 3
Constant	-2.15** (2.31)	2.24** (2.05)	0.30 (0.72)
Characteristics of the household			
Log Household income	0.243* (2.38)		
Household size	0.089** (2.20)		0.15 ***(3.04)
Log Income per adult equivalent		-0.165 (1.31)	
Size of cultivated land		0.003 ** (2.26)	0.003 * (1.74)
Number of cattle		0.37 (0.37)	-0.027 (0.27)
Head Tutsi		-0.33 (1.11)	0.30 (0.76)
Age of head		-0.014** (2.40)	-0.012** (2.00)
head female		-0.25 (1.08)	-0.037 (0.15)
Province of residence		0.38 * (1.81)	0.29 (1.41)
Shocks			
Female adult violent death 94-96			-1.19** (1.97)
Female adult death 90-96			-0.90 *** (3.07)
Pseudo R-squared	0.06	0.08	0.19
Goodness of fit (Chi2)	249.18	243.89	274.53 **

Source: Rwanda panel household survey 1990-2002.
Notes: * All models are clustered around survey cites to obtain robust standard errors; z statistics in absolute values are in parenthesis; Fitzgerald, Gottschalk and Moffitt (1998)

Table 5: Poverty and inequality within population subgroup in Rwanda (n = 178)

	Income 1990	Income 2002	% Δ 90-02	Poverty 1990	Poverty 2002	% Δ 90-02	Extreme poverty 1990	Extreme poverty 2002	% Δ 90-02	Gini 1990	Gini 2002	% Δ 90-02
Entire Sample				73.1	75.3	3.0	57.9	66.9	15.5	0.397	0.549	38.3
Gikongoro	3223	8709	170.2	91.7	66.7	-27.3	83.3	56.7	-31.9	0.459	0.587	27.9
Gitarama	6010	5435	-9.6	62.4	80.3	28.7	44.9	72.0	60.4	0.332	0.505	52.1
Sex of head												
Male	5308	7431	40.0	70.5	74.5	5.7	55.7	66.4	19.2	0.387	0.566	46.3
Female	3866	4987	29.0	86.2	79.3	-8.0	69.0	69.0	0.0	0.427	0.488	14.3
Ethnicity												
Hutu	5156	6475	25.6	73.1	77.5	6.0	56.2	68.7	22.2	0.396	0.558	40.9
Tutsi	4929	7059	43.2	66.7	60.0	-10.0	66.7	53.3	-20.1	0.336	0.478	42.3
Age of head												
20-30	6760	7007	3.7	47.4	89.5	88.8	42.1	73.7	75.1	0.377	0.439	16.4
30-40	5532	7830	41.5	71.9	82.5	14.7	54.4	75.4	38.6	0.334	0.616	84.4
40-50	3616	4428	22.5	83.3	83.3	0.0	73.3	70.0	-4.5	0.483	0.413	-14.5
50-60	4569	6399	40.1	79.4	70.6	-11.1	58.8	64.7	10.0	0.350	0.484	38.3
60+	5142	8023	56.0	73.7	55.3	-25.0	57.9	50.0	-13.6	0.420	0.618	47.1
No of Adult Eq.												
0-3	7320	9916	35.5	48.5	69.7	43.7	30.3	57.6	90.1	0.316	0.500	58.2
3-6	5024	5666	12.8	73.1	75.3	3.0	60.2	67.8	12.6	0.399	0.520	30.3
+6	3734	5501	47.3	88.5	78.9	-10.8	71.2	71.2	0.0	0.374	0.561	50.0
Education of head												
No schooling	4095	5290	29.2	80.8	75.8	-6.2	66.7	65.7	-1.5	0.406	0.512	26.1
Primary	5952	6946	16.7	65.2	76.4	17.1	47.2	69.4	47.0	0.348	0.541	55.4
>Primary	9859	15754	59.8	42.9	57.1	33.1	42.9	57.1	33.1	0.322	0.590	83.2
Head occupation												
Farming	5570	3438	-38.3	72.7	75.8	4.3	56.5	67.1	18.8	0.514	0.465	-9.5
Non-farming	5020	5170	3.0	76.5	70.6	-7.7	70.6	64.7	-8.4	0.380	0.390	2.6
Land size (in hect.)												
0-0.33	3845	6028	56.8	88.2	94.1	6.7	76.5	88.2	15.3	0.407	0.524	28.7
0.33-0.66	4513	5584	23.7	73.5	75.5	2.7	61.2	59.2	-3.3	0.390	0.535	37.2
0.66-1	5646	4345	-23.0	67.5	62.5	-7.4	42.5	57.5	35.3	0.355	0.410	15.5
+1	5914	9298	57.2	67.3	72.3	7.4	54.6	67.3	23.3	0.389	0.582	49.6

Source: Rwanda panel household survey 1990-2002.

Figure 3: Cumulative distribution functions, Rwanda 1990, 2002
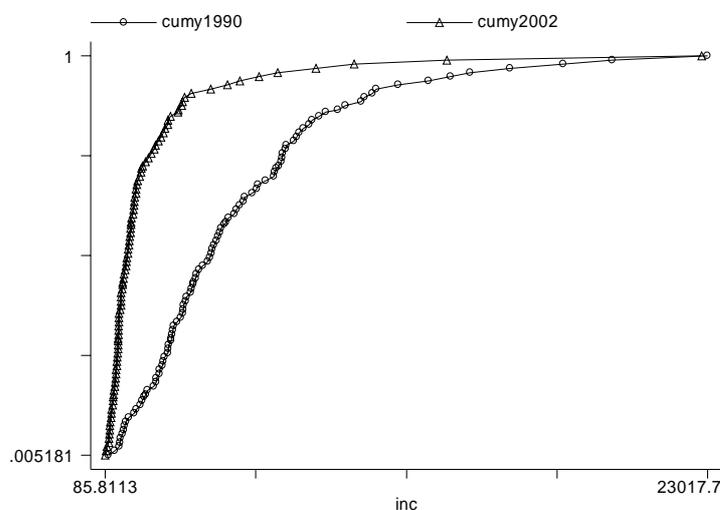
Source: Rwanda panel household survey 1990-2002.
Note: Incomes are expressed in 1990 real prices. The cut-off line in the graph of
24000 RwF is roughly three times the size of poverty lines used in the paper

Table 6: Share (%) of between-group inequality in total inequality in Rwanda

	1990		2002	
	G(0)	**G(1)**	**G(0)**	**G(1)**
Group:				
Province	13.25	13.85	4.84	4.55
Ethnic	3.64	2.69	0.19	0.17
Adult equivalent	8.94	10.38	5.77	5.73
Age of head	5.30	5.77	5.03	4.38
Gender of head	1.99	2.31	3.35	2.87
Education of head	9.27	11.92	6.15	6.58
Occupation of head	0.33	0.38	0.74	0.67
Land size	4.64	5.00	6.33	5.90

Source: Rwanda panel household survey 1990-2002.
Notes: G(0) and G(1) represent, respectively, mean logarithmic deviation (also known as the Theil's second measure) and the Theil inequality index.

Table 7: Probability of being poor and very poor in Rwanda (logit model, estimates are odds ratios)

	Probability of being poor			Probability of being very poor		
	in 1990, n=238	in 1990, panel, n=178	in 2002, panel, n=178	in 1990, n=238	in 1990, panel, n=178	in 2002, panel, n=178
Household characteristics						
Household size 1990	1.67 ***	1.70***	1.09	1.67 ***	1.67**	1.06
Size of cultivated land	0.99 ***	0.99***	1.00	0.99 ***	1.00**	1.00
Characteristics of the head						
Sex (1=female)	2.03 *	2.41*	3.23**	1.81	1.76	2.65**
Age	1.10	1.08*	0.90	0.99	0.97	0.91
Squared age	0.99	1.00**	1.00	1.00	1.00	1.00
Education (yes/no)	0.58	0.53	0.40	0.49 **	0.46**	0.63
Farmer (yes/no)	0.42	0.59	0.43	0.67	0.93	0.48
Ethnicity (1=tutsi)	0.50 *	0.58	0.20	1.17	1.44	0.20*
Commune variables						
Altitude	1.00 *	1.00	1.00**	1.00 ***	1.00**	1.00***
Distance to market	0.65 **	0.68*	1.06	0.54 ***	0.56***	1.17
Shocks						
Rainfall	1.00 *	1.01**	1.00	1.00 ***	1.01***	1.00
Loss of land 90-96			1.24			1.77
Loss of land 97-02			2.83			3.43**
Death adult male 90-96			0.39**			0.73
Death adult male 97-02			0.37*			0.26***
Death adult female 90-96			3.93			2.60
Death adult female 97-02			0.69			0.68
House destroyed 90-96			4.57			3.32
House destroyed 97-02			1.28			2.67*
Adult in prison			0.62			1.22
Pseudo R-squared	0.280	0.296	0.203	0.30	0.302	0.211
Goodness of fit	Chi2=253.31 *	Chi2 = 221.8***	Chi2 = 197.8**	Chi2= 226.92	Chi2 = 179.2*	Chi2 = 179.31**

Source: Agricultural Household Survey (DSA, 1990), EICV (1999-2001) and Rwanda panel household survey 1990-2002. Notes: * statistically significant at 10%, ** statistically significant at 5%, *** statistically significant at 1%.

Table 8: Poverty dynamics for panel (household characteristics) (n = 178)

	% sample in 1990	% sample in 2002	P → P		P → NP		NP → P		NP → NP	
			Poverty	Food poverty	Poverty	Food poverty	Poverty	Food poverty	Poverty	Food poverty
Entire Sample			55.1	40.5	18.0	17.4	20.2	26.4	6.7	15.7
Province										
Gikongoro	33.7	33.7	58.3	48.3	33.3	35.0	8.3	8.3	0.0	8.3
Gitarama	66.3	66.3	53.0	36.4	9.4	8.5	27.4	35.6	10.3	19.5
Age of head										
20-30	10.7	4.50	36.8	26.3	10.5	15.8	52.6	47.4	0.0	10.5
30-40	32.0	12.4	61.4	43.9	10.5	10.5	21.1	31.6	7.0	14.0
40-50	16.9	29.8	70.0	56.7	13.3	16.7	13.3	13.3	3.3	13.3
50-60	19.1	23.0	58.8	41.2	20.6	17.7	11.8	23.6	8.8	17.7
60+	21.4	30.3	39.5	29.0	34.2	29.0	15.8	21.1	10.5	21.1
Sex of head										
Male	83.7	63.5	52.4	38.9	18.1	16.8	22.2	27.5	7.4	16.8
Female	16.3	36.5	69.0	48.3	17.2	20.7	10.3	20.7	3.5	10.3
No of Adult Eq.										
0-3	18.5	21.9	33.3	18.2	15.2	12.1	36.4	39.4	15.2	30.3
3-6	52.3	42.7	54.8	40.9	18.3	19.4	20.4	26.9	6.5	12.9
+6	29.2	35.4	69.2	53.9	19.2	17.3	9.6	17.3	1.9	11.5
Education of head										
No schooling	55.6	45.5	61.6	46.5	19.2	20.2	14.1	19.2	5.1	14.1
primary	40.45	50.56	48.6	33.3	16.6	13.9	27.7	36.1	6.9	16.6
>Primary	3.9	3.9	28.6	28.6	14.3	14.3	28.6	28.6	28.6	28.6
Head occupation										
Farming	90.4	94.4	54.0	39.1	18.6	17.4	21.7	28.0	5.6	15.5
Non-farming	9.6	5.6	64.7	52.9	11.8	17.7	5.9	11.8	17.7	17.7
Land size (in hect.)										
0-0.33	19.1	29.9	85.3	67.7	2.9	8.8	8.8	20.6	2.9	2.9
0.33-0.66	27.5	27.7	55.1	36.7	18.4	24.5	20.4	22.5	6.1	16.3
0.66-1	22.5	14.7	40.0	25.0	27.5	17.5	22.5	32.5	10.0	25.0
+1	30.9	27.7	47.3	38.2	20.0	16.4	25.5	29.1	7.3	16.4

Source: Rwanda panel household survey 1990-2002.

Notes: P = poor; NP = non-poor.

Table 9: Poverty dynamics for panel (conflict shocks) (n = 178)

	% sample in 1990	% sample in 2002	P → P		P → NP		NP → P		NP → NP	
			Poverty	Food poverty	Poverty	Food poverty	Poverty	Food poverty	Poverty	Food poverty
Ethnicity of the head										
Hutu	90.0	90.0	57.5	41.3	15.6	15.0	20.0	27.5	6.9	16.3
Tutsi	8.4	8.4	33.3	33.3	33.3	33.3	26.7	20.0	6.7	13.3
Adult men died 90-96										
No	80.9	80.9	57.6	42.4	16.0	16.0	19.4	25.0	6.9	16.7
Yes	19.1	19.1	44.1	32.4	26.5	23.5	23.5	32.4	5.9	11.8
Ad. female died 90-96										
No	92.1	92.1	52.4	38.4	18.9	17.7	22.0	27.4	6.7	16.5
Yes	7.9	7.9	85.7	64.3	7.1	14.3	0.0	14.3	7.1	7.1
Adult men died 97-02										
No	92.7	92.7	56.4	42.4	17.0	15.8	20.6	26.7	6.1	15.2
Yes	7.3	7.3	38.5	15.4	30.8	38.5	15.4	23.1	15.4	23.1
Ad. female died 97-02										
No	91.0	91.0	55.6	40.7	16.7	16.7	20.4	26.5	7.4	16.1
Yes	9.0	9.0	50.0	37.5	31.3	25.0	18.8	25.0	0.0	12.5
House destroyed 90-96										
No	90.4	90.4	55.3	39.8	18.6	18.0	19.9	26.7	6.2	15.5
Yes	9.6	9.6	52.9	47.1	11.8	11.8	23.5	23.5	11.8	17.7
House destroyed 97-02										
No	91.0	91.0	55.6	40.7	18.5	17.9	19.1	24.7	6.8	16.7
Yes	9.0	9.0	50.0	37.5	12.5	12.5	31.3	43.8	6.3	6.3
Lossed land 90-96										
No	86.0	86.0	54.3	39.9	17.7	19.0	20.9	25.5	7.2	15.7
Yes	14.0	14.0	60.0	44.0	20.0	8.0	16.0	32.0	4.0	16.0
Lossed land 97-02										
No	79.2	79.2	53.2	38.3	19.9	20.6	19.2	24.1	7.8	17.0
Yes	21.8	21.8	62.2	48.7	10.8	5.4	24.2	35.1	2.7	10.8
In prison										
No	92.1	92.1	54.3	39.6	18.3	18.9	20.7	26.2	6.7	15.2
Yes	7.9	7.9	64.3	50.0	14.3	0.0	14.3	28.6	7.1	21.4

Source: Rwanda panel household survey 1990-2002.
Notes: P = poor; NP = non-poor.

Table 10: Movement in and out of poverty and extreme poverty 2002-1990, (multinomial logit model, estimates are rrr) (n =178)

	Movement out of poverty/extreme poverty (model 1)		Movement out of poverty/extreme poverty (model 2)		Movement into poverty/extreme poverty (model 1)		Movement into poverty/extreme poverty (model 2)	
	P to NP	VP to NVP	P to NP	VP to NVP	NP to P	NVP to VP	NP to P	NVP to VP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Household characteristics								
Household size 1990	0.94	1.11	0.94	1.06	1.02	0.85	1.09	0.84
Size of cultivated land	1.00	1.00	1.00	1.00	1.01***	1.01*	1.01**	1.00*
Characteristics of the head								
Sex (female=1)	0.23*	0.40	0.19**	0.35	1.47	2.65	1.99	2..03
Age	1.04	0.88	1.00	0.91	0.93	0.86	0.82	0.84
Age squared	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Education (educated=1)	2.21	1.90	3.48	2.57*	0.11***	0.90	0.28*	1.04
Occupation (non-farmer=1)	0.75	2.59	0.65	2.46	0.001***	0.19	0.004***	0.23
Ethnicity (1=tutsi)	17.86***	23.21**	14.23**	19.42**	1.33	0.46	2.15	0.48
Commune variables								
Altitude	1.00***	1.01***	1.00**	1.00***	1.00	1.00**	1.00	0.99*
Distance to market	1.01	1.11	0.91	0.96	0.81	1.64*	0.78	1.63*
Shocks								
Rainfall	1.00	1.00	1.00	1.00	1.15***	1.00	1.15***	1.00
Loss land 90-96	0.57	0.28***	0.95	0.37**	1.52	1.45	2.38	1.43
Loss land 97-02	0.40	0.11**	0.43	0.15**	171.5***	4.54**	55.85**	4.07*
Viol death adult male 94-96			2.72*	5.37*			3.19	3.05
Non-viol death male 90-96			22.70***	10.91**			1.20e+10	3.81
Non-viol death male 97-02			8.57***	39.33***			0.70	0.66
Total death male 90-96	8.41***	10.84***			14.84	2.36		
Total death male 97-02	3.41	10.46**			0.02**	0.31**		
Viol death adult fem 94-96			8.59e-16***	6.27e-19***			0.08**	0.77
Non-viol death fem 90-96			2.80e-15***	3.80			0.018***	6.65e+09***
Non-viol death fem 97-02			4.07*	5.73*			4.17+e08	2.33
Total death female 90-96	0.07***	0.47			2.76e-21	1.82		
Total death female 97-02	4.37*	6.34*			9.12e+09	2.13		
House destroyed 90-6	0.09**	0.025**	0.11**	0.054**	1.65	1.52	0.68	1.35
House destroyed 97-2	0.48	0.58	0.43	0.72	3.32	6.60**	1.36	6.20**
Adult in prison	3.17	5.87e-15***	2.72	2.31e-18***	3.21	1.07	1.57	1.09
Pseudo R2	0.381	0.346	0.366	0.356	0.381	0.346	0.366	0.356
Hausman statatistic	336.2***	34.2***	16.1***	2.4***	336.2***	34.2***	16.1***	2.4***

Source: Rwanda panel household survey 1990-2002. Notes: *, **, *** statistically significant at 10%, 5% and 1%. P/NP = poor/non-poor; VP/VNP = very poor (food poverty line).

Table 11: Change of log income per adult equivalent and change of log income 2002-1990, linear regression and Heckman sample selectivity model

	Change in log income per adult equivalent		Change in log income		Change in log income per ae for the poor only	Change in log income per ae for the non-poor only
	not corrected (1)	Corrected (+) (2)	Not corrected (3)	Corrected (+) (4)	(5)	(6)
Household characteristics						
Household size 1990	0.14***	0.16***	0.046*	0.12*	0.12***	0.087
Size of cultivated land	-0.002	-0.001	-0.0016	-0.0002	0.000	-0.004***
Characteristics of the head						
Sex (female=1)	-0.02	-0.03	-0.16	-0.19	-0.098	0.29
Age	0.004	0.001	-0.006	-0.015	-0.02	0.045
Age squared	0.00	0.00	0.00	0.00	0.00	-0.00
Education (educated=1)	-0.106	-0.11	-0.002	-0.023	-0.247	-0.19
Occupation (non-farmer=1)	0.079	0.066	0.12	0.16	-0.48	1.36***
Ethnicity (1=tutsi)	0.35	0.39	0.36	0.48	0.57	0.058
Commune variables						
Altitude	0.002***	0.002***	0.002***	0.002***	0.02**	0.001*
Distance to market	-0.229**	-0.23***	-0.218***	-0.222***	-0.26**	-0.084
Shocks						
Rainfall	0.001	0.007	0.009	0.0007	0.001	-0.008***
Loss of land 90-96	-0.01	0.01	-0.12	-0.09	-0.062	-0.18
Loss of land 97-02	-0.36*	-0.36*	-0.47**	-0.46**	-0.08	-0.81**
Violent death adult male 1994-96	0.14	0.16	0.014	0.05	0.24	0.22
Non-violent male death 90-96	0.10	0.10	-0.13	-0.14	0.30	-0.49
Non-violent male death 97-02	0.50**	0.52*	0.30	0.36	0.70*	0.18
Violent death adult female 94-96	-0.46	-0.99	-0.27	-1.88	-0.65	-
Non-violent female death 90-96	0.23	0.03	0.36	-0.23	0.11	-
Non-violent female death 97-02	0.48	0.49*	0.37	0.42	0.57	0.37
House destroyed 90-96	-0.57	-0.59**	-0.50	-0.57	-0.44	-1.24***
House destroyed 97-02	-0.28	-0.29	-0.33	-0.36	-0.02	-0.57**
Adult in prison	-0.31	-0.32	-0.09	-0.11	-0.24	-0.28
Constant	-4.57***	-4.68***	-3.46***	-3.78***	-3.71*	-1.91
Mills Lambda		0.48		1.46		
Wald Chi2		142.89 ***		66.68 ***		
R-squared	0.46		0.39		0.46	0.60

Source: Rwanda panel household survey 1990-2002. Notes: * statistically significant at 10%, ** statistically significant at 5%, *** statistically significant at 1%. (+) These regressions are Heckman selection models where the estimates for the selection variables are not shown. The selection equation is exactly the same as the last probit model in table 4b, where the estimation results can be consulted.