Malthus in Rwanda?
Scarcity, Survival and Causes of the Genocide

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Abstract

This paper does two things. First, it develops a game theoretical model over population groups that optimize their survival under resource scarce conditions. The model includes two rather obvious, but in the theoretical literature neglected, strategies - survival by migration and, once a conflict is ignited, survival by taking refuge. Results include determinants of migration and refugee flows, the threshold for violent conflict and its intensity. Second, it derives the necessary and sufficient conditions for a genocide and applies the model in order to analyze the 1994 genocide in Rwanda. It suggests that the extremist regime that seized power on April 6th 1994, while being on a genocide agenda exploited the underlying resource scarce conditions by way of forcefully destroying property rights and massively support appropriative actions, thereby facilitating the killings and persecutions of Tutsis on the scale of a genocide. Finally, key to understanding the scope of the genocide in 1994, is suggested to be that the extremist regime was not only the active support of appropriative actions, but the simultaneous and deliberate destroying of the refugee infrastructure. The difference in the level of refugee infrastucture can possibly explain why earlier violent episodes had lower conflict intensity although sharing some similar characteristics.

Keywords: Genocide, Conflict, Migration, Resource Scarcity, Rwanda, Malthus

JEL-codes: Q29, D74, N47

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1 Introduction

Ever since Thomas R. Malthus published *An Essay on the Principle of Population* in 1798, the link from resource scarcity, via overpopulation, to violent conflict has been a subject of scholarly investigations. In recent years, for example, there has been suggestions that a root cause of the genocide in Rwanda in 1994 was Malthusian concerns of land scarcity (Renner, 1996; André & Platteau, 1998; Diamond, 2005). Furthermore, traditional theory that try to explain the mechanisms between resource scarcity and violent conflict, such as Grossman & Mendoza (2003) and Reuveny and Maxwell (2001), usually lets the optimization problem be over utility or income where the choice set is production or appropriation. This paper, however, takes a step back and instead focuses on the most basic optimization problem - survival. This, in turn, allows us to go beyond the simple appropriation vs production dichotomy and instead incorporate alternative strategies to survival, namely survival by migration and, once a conflict has been ignited, survival by taking refuge. By doing this, the model is able to explain some fundamental characteristics present in conflicts, such as migration and refugee flows as well as their connection to conflict intensity levels.

The main theoretical innovation of this paper is therefore three-folded. First, the focus on the survival of population groups, rather than their utility or income. Second, it explores the determinants of migration, refugee flows and conflict intensity under resource scarce conditions. Third, it explores the necessary and sufficient conditions for the most extreme form of violent conflict - genocide.

Furthermore, the paper then uses the model to conduct a qualitative analysis of conflict periods in Rwanda, which has seen large flows of migrants, refugees, regime changes and violent conflicts, including the genocide in 1994. By using the model it is possible to understand by what mechanism migration opportunities and refugee infrastructure played a key role in the genocide, as well as it gives us some plausible explanations to why earlier conflict episodes that shared some common characteristics as the 1994 genocide did *not* reach the same level of violence.

The paper is divided in the following way. Section 2 reviews the literature on resource scarcity, migration, conflict and refugee flows. Section 3 presents the model. Section 4 goes through the stages of the game and presents its solutions. Section 5 gives a brief historical overview of the genocide. Section 6 analyzes the Rwanda genocide by applying the model. Section 7 concludes.

2 Literature on Scarcity, Migration and Conflict

When Thomas Malthus wrote *An Essay on the Principle of Population* in 1798, he predicted that population would outrun the supply of food and unless moral constraints and vice be put in place, a "check" in the form of, diseases, starvation to death or war would be the unavoidable result. In the following sections, we take a look at some empirical conclusions followed by the current theoretical explanations.

Neo-Malthusians often stress the causal connection between scarcity of environmental renewable resources and conflict, with some confirming empirical findings through a number of case studies (Homer-Dixon 1991, 1994)[1]. Examples of resource scarcity conflicts involve deforestation in Haiti (Homer-Dixon, 1999), land degradation in Rwanda (Renner, 1996) and overpopulation on the Eastern Island (Brander & Taylor, 1998). The connection is however not very strong, and skeptics argue that the link is far weaker than suggested since case-study based conclusion run the problem of dependent variable bias – only conflict cases are studied and not peaceful ones (Diehl & Gleditsch, 2001). Had the connection between resources and conflict been strong, Uvin (1998) give points to the fact that we should also experience conflict in countries such as Bangladesh, Belgium, China, Costa Rica, Egypt, Guinea, Indonesia, Israel, Jamaica, Japan, Jordan, Kenya, Nepal, the Netherlands, South Korea, Switzerland, Tanzania and Vietnam - all which have a higher population density per square km of agrable land, and where many are equally poor as Rwanda.

Furthermore, cross-national studies show that the link between resource scarcity and violent conflict is positive but weak (Hauge & Ellingsen, 1998), or that the link is only weakly positive when population growth is also high (Urdal, 2005). It seems that resource scarcity may lead to conflict as an exception rather than a rule, and it is therefore necessary we need to understand under what additional conditions that violent conflicts do occur.

Therefore, if mere survival is the primary driver when resources are scarce and fighting is not the rule but rather the exception, one alternative and probably more common pathway to survival should be migration. Where there is land degradation, deforestation, desertification (or the relative overpopulation, depending on the perspective) or any other type of resource scarcity, incentives for migration are higher in the search of a survival strategy. These type of migrants are often somewhat controversially referred to as 'environmental refuges', aiming at pin-pointing people who more or less involuntarily migrate

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have been possible. However, the findings, interpretations, and conclusions expressed in this paper are entirely those of the author.

[1] The concept of environmental scarcity, generally defined according to the giant in the field Homer-Dixon, is generally divided into three types: Supply-induced scarcity, demand-induced scarcity, and structural scarcity (Homer-Dixon, 1994). The distinction between renewable and non-renewable natural resources here is important, as the former is the basis for much of the conflict with Malthusian concerns (and the basis for this paper), but the latter has been shown to be a possible prime driver behind civil war in general (Collier & Hoeffler, 2004).

due to the scarcity of necessary environmental resources[2]. An estimation of the current level of environmental refugees in the world point to between 10 million (Jacobson, 1988) and 25 million people (Myers, 1997), mostly capturing migrants in Africa, South Asia and Latin America. In this way, armed conflict should not be unconditional, but related to the possibilities of migration[3]. However, little of the causal relevance is known, and when setting a future research agenda on the connection between renewable natural resources and violent conflict, Barnett states that (2001, p.9)"critical... is the role of emigration and immigration".

Also, there is the rather obvious connection between conflicts and the incidence of 'classic' refugee flows, which has been empirically concluded through a range of statistical studies (Davenport, Moore, and Poe 2003; Moore and Shellman 2004; Schmeidl 1997). Typically, the connection is two-folded. First, conflict causes refugee flows as people flee from the violence. Second, large refugee flows may in turn raise tensions and at times cause violent conflict in the receiving areas (Fearon, 2004; Martin, 2005). As the former connection is rather unquestionable, the jury seems to still be out for the latter.

Moreover, the role of the State is of central importance for the risk and the scope of violent conflict. In essence, a "strong" State - whether being democratic or authoritarian - is generally an effective tool for lowering the internal risk of conflict (Esty et al. 1999; Krause & Suzuki, 2005). Hauge & Ellingsen (1998) have also found in their cross-country study that the type of political regime is a more decisive factor than resource scarcity in predicting the incidence of conflict.

Hence, we are able to conclude on some empirical regularities

- Scarcity of environmental resources may cause conflict, however rather as an exception than as a rule.
- The outbreak of violent conflict is closely connected to the strength and type of the State.
- Migration due to resource scarcity is wide spread and violent conflict causes refugee flows.

Hence, if we want to understand the causal link from resource scarcity to violent conflict it is most likely fruitful to incorporate the empirically established links from resource scarcity to migration, from State characteristics to violent conflict as well as from violent conflict to refugee flows.

In existing models of conflict, the main focus has been on agents optimizing behavior as a choice of either appropriation of resources or production at status quo under insecure property rights (Hirschleifer 1988; Grossman 1991; Grossman & Kim 1995; Hirschleifer 1995). Although fruitful for the understanding of conflict where income or utility optimization is the primary driver of the agents, especially by taking into account the role of the State and the

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[2] A less controversial connotation is 'environmental migrants'.

[3] Standard migration theory normally distinguishes between 'pull', 'push' and 'network' forces, which jointly affect the incentivs for migration.

function of property rights, these models run an imminent risk of missing much of conflict characteristics by not including established links between resource scarcity, migration and refugee flows. Reuveny and Maxwell (2001) as well as Grossman and Mendoza (2003) model conflict under resource scarce conditions, but they do so under the classical assumptions of production opportunity costs and utility maximization with no regards to migration opportunities or refugee infrastructure.

By letting the optimization be about survival, a first step towards a theoretical framework for the struggle for survival by fighting, migrating and taking refuge is taken, and we are able to understand the critical conditions where we are likely to experience an outbreak of a violent conflict when this is a driving force. Also, the theory could help us understand the connections between degree of resource scarcity, level of conflict intensity and the size of refugee flows. We now turn to the model of this paper.

3   The Model

The setup of the model is one country with a large non-formal agricultural subsistence economy inhabiting by separate population groups, each with their respective productive renewable resource endowments and each at their Malthusian population equilibrium. The model is a two-period, predator-prey model similar to Olsson & Congdon (2004). The model focuses on two population groups. In the model, group A initially suffers from an exogenous shock in population leading to resource scarcity and a struggle for survival. Group A can secure their survival by two strategies, either by migrating outside the region, or by trying to appropriate the group B's productive renewable resources, or by a combination. Group B's survival is therefore unsecured by the appropriation efforts of group A and in turn has two strategies for their survival, either by leaving the region as persecuted refugees or by defense actions in protection of their resources, or by a combination. Internal group coordination is assumed to be complete. The State is run by a regime that is enforcing property rights more or less strongly, setting policy exogenously.

This section is divided into three subsections. In the first subsection, we explore the long run Malthusian equilibrium between population levels and productive resources. In the second subsection the survival strategy of group exposed to resource scarcity - group A - is presented, followed by the presentation of the survival strategy of group B.

3.1   Long Run Malthusian Equilibrium

Starting with the total population of the country $N = \sum_{i=1}^{n} N_i$, consisting of a finite number of n separate groups each with group members equal to N_i. The

total renewable productive resources in the country is constant and denoted by $\overline{L}$, where $\overline{L} = \sum_{i=1}^{N} L_i$ in which L_i is the land resources of group i. Furthermore, in this agricultural economy, group i produce for their own consumption only according to a simple constant returns to scale production function

$$Y_i = AN_i^a L_i^{1-a} \tag{1}$$

where A is the agricultural productivity. If we for simplicity assume that there are equal decreasing marginal returns to each productive input of N_i and L_i, then $a = 0.5$.

Furthermore, let's focus on the long run equilibrium between population level and the amount of land resources. For simplicity, in this subsistence economy the production equals consumption and the per capita consumption is $y_i = A\left[\frac{L_i}{N_i}\right]^{0.5}$. Moreover, let the minimum per capita consumption be a constant subsistence level $\overline{y}_{\min}$ by the relationship

$$\overline{y}_{\min} = A\frac{L_i^{0.5}}{N_i^{*0.5}} \tag{2}$$

such that the population of a group i is restricted in the long run by the agricultural productivity and the land resource endowments, giving us the long run Malthusian population equilibrium N_i^*

$$N_i^* = \left[\frac{A}{\overline{y}_{\min}}\right]^2 L_i \tag{3}$$

This tells us that the equilibrium population will be positively and linearly related to the land endowments. Rearranging the terms and solving for the *necessary land* given a certain population at the long run Malthusian population equilibrium N_i^* gives us

$$L_i = \left[\frac{\overline{y}_{\min}}{A}\right]^2 N_i^* \tag{4}$$

Knowing the connection between population and land, we now move on to the survival strategy of population groups, assuming that the economy has two population groups $i = A, B$.

3.2 The Survival Functions

Let's assume that the country is at a Malthusian equilibrium in the period $t-1$ where each group i has the population $N_i^{t-1} = N_i^* \mid L_i^{t-1}$. Furthermore, suppose that group A is exposed to an exogenous shock in population in the beginning of the period t so that $N_A^t > N_A^* \mid L_A^{t-1}$, then group A will suffer from a lack

of the necessary land resources for survival and consequently overpopulation[4]. Furthermore, unless land resources are increased, then period $t+1$ implies that the population reaches the long run Malthusian equilibrium population level $N_A^{t+1} = N_A^* \mid L_A^{t-1}$, so that

$$N_A^{t+1} = (1 - \Phi)\, N_A^t \tag{5}$$

where Φ denotes the degree of resource scarcity and $\Phi \in [0,1]$, defined by the share of the population that cannot survive given the productivity level and available resources. The equation above implies that ΦN_A^t of the group A population will not survive until the second period $t+1$ and as a result, must seek some other survival strategy than production at status quo. This is a key characteristic of the model, that ΦN_A^t by necessity must aim for another survival strategy and that $(1 - \Phi)\, N_A^t$ remain in production and survives. Furthermore, there are two alternative and mutually exclusive survival strategies: 1) Aiming for migration outside the region, or 2) Fighting for survival by appropriation of necessary resources of group B. Therefore, we get

$$\Phi N_A^t = m^t + f^t \tag{6}$$

where $m \geq 0$ is the population of group A facing death that aims for migrating as refugees, and $f \geq 0$ is the population that fight for their survival[5]. First, the opportunities of leaving the region as migrants could be more or less positive in terms of the livelihood possibilities, and is determined by the *migration opportunities* δ_A so that the second period population of the ones that migrate is[6]

$$m^{t+1} = \left(m^t \right)^{\delta_A} \tag{7}$$

where $\delta_A \in (0,1)$ so that there are decreasing survival opportunities to migration flows. Furthermore, the population that choose not to migrate in search of a livelihood will try to appropriate the amount of resources L_f, defined by the amount that is necessary for the survival of f^t given by Equation 4[7]

$$L_f = \left[\frac{\overline{y}_{\min}}{A} \right]^2 f^t \tag{8}$$

Moreover, land resources will be appropriated according to the contest success function

$$p_f = \frac{f^t}{f^t + d^t \theta_{B,A}} L_f \tag{9}$$

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[4] One can analogically assume that there is an exogenous shock in productivity A.

[5] The model implicitly assumes that the agents have savings sufficient for one period of survival.

[6] As in standard migration theory, this variable could be thought capturing the 'pull', 'push' and 'network' factors.

[7] In this way, the model is one of "grievance", rather than "greed", as a underlying determinant of conflict where the fight for survival is primary. Had it been greed that was the causal mechanism, then group A would not be satisfied with this amount of land but rather aim for much more, possibly the entire land endowment of group B.

where p_f is the amount of group B's resources that is successfully appropriated, d is population of group B that are diverted towards defending the land against appropriation, and $\theta_{B,A} \in \mathbb{R}_+$ captures the State's type of property rights regime. More specifically, $\theta_{B,A}$ indicates the property rights protection when property claimed by members of group B is being under appropriation attempts by members of group A.

In general, we can identify two different dimensions of the property rights regime. First, there can be a group *bias*, where, for example, $\theta_{A,B} > \theta_{B,A}$ would imply that the State's is biased is favor of group A such that members of group A enjoy stronger protection that does members of group B, while $\theta_{B,A} = \theta_{A,B}$ would capture an unbiased regime. Second, there is another dimension where if $\theta_{i,j} = 1$, for $i,j \in \{(A,B),(B,A)\}$ then the country is defined as being in a Hobbesian state of *anarchy* where the State is not involved in any claims to property, while if $\theta_{i,j} > 1$ the State *protects* the property under subject to the appropriation attempt, and the higher the value takes the stronger is the protection. Consequently, if the value is $\theta_{i,j} < 1$, then there is not only a lack of protection of property by the State, but in fact a regime where the State *actively supports* the appropriative actions.

Combining the two dimensions, a typical democratic State would be characterized by $\theta_{i,j} = \theta_{j,i} >> 1$, while an oppressive authoritarian State with a strong ethnic bias towards group i could be described as $\theta_{i,j} < 1, \theta_{j,i} >> 1$.[8]

Furthermore, equations $3, 8$ and 9 tell us that depending on how successfully the land resources are appropriated, the next period population is determined according to the survival function

$$f^{t+1} = \frac{(f^t)^2}{f^t + d^t\theta} \tag{10}$$

where $\theta = \theta_{B,A}$ for notation simplicity. Also note that this implies that $f^{t+1} \leq f^t$ is always true.

Since group B is also at the long run Malthusian equilibrium in period $t-1$, such that $N_B^{t-1} = N_B^* \mid L_B^{t-1}$, which implies that loosing any of the land resources during time period t implies decreased population when reaching the period $t+1$. More specifically, if the amount of land subject to appropriation attempt, L_f, would be successfully appropriated by group A, then the group B second period population would decrease to

$$N_B^{t+1} = \left[\frac{A}{\overline{y}_{\min}}\right]^2 \left(L_B^t - L_f\right) \tag{11}$$

This tells us that the population under the threat of not surviving until the second period is $\Delta N_B = \left[\frac{A}{\overline{y}_{\min}}\right]^2 L_f$, and from Equation 8 we rewrite this relationship as

$$\Delta N_B = f^t \tag{12}$$

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[8] For simplicity, the model assumes that there is no difference conflict technology of the groups, as well as the "decisiveness" parameter common in conflict theory (see Hirshleifer, 1995) which is assumed to be equal to one.

Thus, it is now clear how the conflict of land resources is a struggle for survival between the two groups, as the population of group B that is under the threat of not surviving the conflict equals the population trying to survive by appropriating resources from group B. Note also that group A members' survival is secured equivalently by forcing the population ΔN_B to leave their land, as well as by the direct use of deadly force.

Furthermore, the population ΔN_B of group B face two alternatives for their survival. They can either 1) Fight for their survival by defending their resources, or 2) flee the region as persecuted refugees. Hence, $\Delta N_B = r^t + d^t$ and together with Equation 15 we get the equation

$$r^t + d^t = f^t \tag{13}$$

where r^t is the population taking refuge, and d^t is the population defending the land resources. The population that choose will survive according to their ability to successfully defend their resources according to Equations 3, 8 and 9 which gives their survival function

$$d^{t+1} = f^t - \frac{\left(f^t\right)^2}{f^t + d^t\theta} \tag{14}$$

Looking at the refugee option, the refugees of group B is assumed to survive according to the function

$$r^{t+1} = \delta_B r^t \tag{15}$$

where $\delta_B \in [0,1]$ denotes *refugee infrastructure* which are the opportunities of refugee livelihood elsewhere. Typically, this parameter will capture both policy as well as policy-independent factors. For example, it could be issues of domestic mobility and international refugee support, where the former be factors such as roadblocks, regional checkpoints, ethnic identity card requirements and geographical barriers, and the latter such aspects as openness of adjacent borders and international supply of refugee infrastructure (legal asylum protection, UNHCR capacity) in neighboring countries.

As a key aspect of the model, the refugee infrastructure δ_B affect the survival possibilities of group B's refugees differently compared to the migrating population of group A and their opportunities δ_A. The model assumes that while the first is independent so that there the survival rate is independent of the size of refugee flows, which is primarily motivated due to the fact that persecuted refugees have a legal right by international asylum laws which are in effect independent of how many the refugees there are. The latter is, however, rather determined by standard employment and agricultural opportunities elsewhere for the migrants, such as labour demand, the availability of productive land and other similar opportunities, motivating the *decreasing* survival opportunities to the size of migrant flows.

Lastly, let's explore the aggregate survival functions of both groups. For simplicity, we normalize group A population to one, and by equations xx, YY,

QQ , the survival of group A is determined according to the survival function

$$N_A^{t+1} = (1 - \Phi) + \left(\Phi - f^t\right)^{\delta_A} + \frac{\left(f^t\right)^2}{f^t + d\theta} \tag{16}$$

Similarily, equations 15, 17 and 18 gives us the survival of group B

$$N_B^{t+1} = (N_B^t - f^t) + (f^t - d^t)\delta_B + f^t - \frac{\left(f^t\right)^2}{f^t + d^t\theta} \tag{17}$$

Knowing the survival functions of both groups, we now move on to the game.

4   The Game

In this game, group A will act first and maximize their population by choosing between fighting or migrating for their survival. Group B will then in turn choose to maximize their population by choosing either to defend or take refuge for their survival. Both groups are risk neutral and the game is solved by backward induction.

4.1   Stage 2: Group B's Move

Group B is under the threat of deadly conflict and will maximize their second period population according to the Equation 19, such that the maximization problem is

$$\max_{d^t} \ N_B^{t+1}$$

$$s.t. \ 0 \leq d^t \leq N_B^t$$

The function N_B^{t+1} is continuous and maximized on a closed, convex and bounded set so we know that a solution to the maximization problem exists. Moreover, the first order condition for maximum with respect to the choice variable d^t is

$$\frac{\partial N_B^{t+1}}{\partial d^t} = \frac{f^2\theta}{(f + d^*\theta)^2} - \delta_B : \begin{Bmatrix} \leq 0, d^* = 0 \\ = 0, d^* > 0 \end{Bmatrix} \tag{18}$$

The upper row describes a corner solution, where the optimal choice is $d^* = 0$. Also, the second order condition gives us a negative sign implying that the population function N_B^{t+1} is a concave function of the defensive action d so that if an interior solution exists it is a maximum. The second row will then apply so that we can solve for group B's nonnegative optimal level of defense

$$d^* = f \left(\sqrt{\frac{1}{\theta\delta_B}} - \frac{1}{\theta} \right) \tag{19}$$

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This function tells us the level of defense that group B will choose as a best response to group A's appropriation efforts. Furthermore, if $d^* > 0$, then $\delta_B < \theta$ is a necessary condition. This tells us that unless this condition is fulfilled, group B will choose not to defend themselves and a violent conflict will not break out. However, if it is fulfilled differentiation gives us $d'(f) \geq 0$, $d'(\theta) \leq 0$ and $d'(\delta_B) \leq 0$.

Lemma 1 *Group B will choose to defend themselves if*

$$\delta_B < \theta \tag{20}$$

Unless this condition is fulfilled, which tells us that defensive effort will be in place depending on the relative opportunities between refugee livelihood and the State's property rights enforcement, the threatened population of group B population will solely take refuge. If it is fulfilled, the defensive action will increase with the difference between δ_B and θ. Also, if the condition is fulfilled there will be declining refugee flows as the defensive efforts increase linearly to group A's land appropriation efforts. More interestingly, since δ_B always take a value equal to or below unity, we will always see defensive action as long as the State is not directly sponsoring group A's appropriative actions, or that anarchy is present. Thus, we may state this as a proposition

Proposition 2 *Only if there is anarchy, or only if the State is actively supporting the appropriative actions of the predator group, will we experience the absence of defensive actions and the sole presence of refugees.*

Proof. Lemma 1 tells us the necessary condition for defensive actions, from where we can conclude that there will be no defensive actions when the condition is not fulfilled, that is when $\theta \leq \delta_B$. Since we have $\delta_B \leq 1$ by definition, this implies that we must also have $\theta \leq 1$. By definition we know that $\theta = 1$ is a state of anarchy with no State enforcement of property rights, and that $\theta < 1$ is defined by the active sponsorship of the appropriative actions of group A. Thus, only when there is anarchy, or if the State is actively supporting the appropriative actions of the predator group A, may group B choose to take refuge only and not to defend themselves. ■

Importantly, the proposition tells us the *necessary* condition for the absence of defensive actions, however, since it is not a *sufficient* condition we can not conclude whether this will be the case or not. However, if we know that $\theta \leq \delta_B$ so that the relationship between the enforcement of property rights and the refugee infrastructure satisfies the condition, than we can conclude by certainty that there will be solely refugee flows and no defensive actions taken by group B.

Moreover, we know that if it exists a nonnegative d^* by differentiation that $d'(\theta) \leq 0$ and $d'(\delta_B) \leq 0$. Therefore, given a θ and δ_B satisfying the conditions in lemma 1, d^* will increase linearly to f by the factor $\left(\sqrt{\frac{1}{\theta \delta_B}} - \frac{1}{\theta} \right)$ and simultaneously decrease the refugee flows by the same factor. We also know from

Equation 16 that d^* is bounded from above by f, so that the maximum level of defense is $d^*_{\max} = f$ which we by looking at (21) get the condition for the absence of refugee flows, and the following lemma

Lemma 3 *Given that Lemma 1 is fulfilled, Group B will choose to solely defend themselves and not take refuge if*

$$\delta_B \leq \frac{1}{\theta + 1/\theta + 2} \tag{21}$$

We can see that this condition is most likely to be fulfilled when we are in a state of anarchy ($\theta = 1$), and that it becomes less likely when the State increases its active support of the appropriative actions of the predatory group ($\theta < 1$), as well as when the State protects the property rights more strongly ($\theta > 1$).

In Stage 1, Knowing the reaction of group B, group A will maximize their population by choosing optimal levels of predatory efforts and migration. We now turn to that stage.

4.2   Stage 1: Group A Move

Given that Group A is exposed to some degree of resource scarcity Φ and knowing the reaction d^* of group B they will maximize their second period population given by the Equation 12, such that the maximization problem is

$$\max \ N_A^{t+1}$$

$$s.t. \ 0 \leq f^t \leq \Phi$$

Since the function N_A^{t+1} is continuous in f and is maximized over a closed, convex and bounded interval, we know that a solution exists.

If there exists an interior solution, using the first order condition for maximum population and solving for the optimal level of predatory efforts by group A gives us

$$f^* = \Phi - \left(\frac{\delta_A \sqrt{\theta}}{\sqrt{\delta_B}} \right)^{\frac{1}{1-\delta_A}}$$

Differentiation gives us $f'(\Phi) > 0$, $f'(\delta_B) > 0$, $f'(\delta_A) < 0$, $f'(\theta) < 0$. Moreover, for a predatory conflict to occur the optimal level of predatory efforts needs to be $f^* > 0$, and from this we can obtain the following proposition

Proposition 4 *A predatory conflict will occur if the degree of resource scarcity is higher than the critical threshold*

$$\Phi > \widetilde{\Phi} = \left(\frac{\delta_A \sqrt{\theta}}{\sqrt{\delta_B}} \right)^{\frac{1}{1-\delta_A}} \tag{22}$$

This critical threshold is more likely to be fulfilled with an increase in Φ and δ_B, and with a decrease in θ and δ_A. This tells us that when resource scarcity is not sufficiently severe, there will not be an outbreak of violent conflict due to that migration will be a sufficiently attractive option for the group struggling for survival. However, as the State is protecting property rights less and as the opportunity of migration is lowered, the incentives for predatory conflict for survival are higher. Also, when the refugee infrastructure is increased, predation become a more attractive option. The logic behind this is that as the refugee infrastructure is improved, group B is more inclined to choose the refugee option in stead of defense, which increases the incentives for predatory conflict as the group A knows that appropriating land will be easier and a relatively more successful survival strategy.

We are therefore able to draw the conclusion that unless there is a combination in which resource scarcity is particularly severe, migration opportunities are slim, the infrastructure for persecuted refugees is good, property rights are weak or nonexistent, we can expect peace. In addition, we are able to conclude that if a predatory conflict actually do break out, there are three possible conflict scenarios:

- Conflict scenario 1: If $\delta_B \geq \theta$ is true then we will see a scenario where there is no defensive actions but solely refugees from group B.

- Conflict scenario 2: If both $\delta_B < \theta$ and $\delta_B \leq \frac{1}{\theta + 1/\theta + 2}$ is true then we will see a scenario where there is only defensive action and no refugees from group B.

- Conflict scenario 3: If both $\delta_B < \theta$ and $\delta_B > \frac{1}{\theta + 1/\theta + 2}$ is true then we will see a scenario where there is both defensive action and refugees from group B, where the defensive action increase with the difference between δ_B and θ.

With these conflict scenarios in mind, before moving on to analyze the genocide in Rwanda, the next section derives the necessary and sufficient conditions for a genocide.

4.3   The Genocide Conditions

To understand the conditions for a genocide, we start with defining genocide as[9]:

$$N_B^{t+1} = 0 \tag{23}$$

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[9] The term "genocide" is far from free of controversy. In the UN's Convention on the Prevention and Punishment of the Crime of Genocide the focus is on "acts committed with intent to destroy, in whole or in part, a national, ethnical, racial or religious group".

That is, when the population of group B due to the conflict is zero there has been a genocide. From Equation 19 we can see that the first term tells us for the genocide definition to be fulfilled, it is necessary to have

$$N_B^t \leq f^* \tag{24}$$

Only if this is true is a genocide possible. This condition tells us that the predatory efforts of group A must be sufficiently high for the survival threat of group B to imply a possible genocide. Thus, since we know the equilibrium predatory efforts f^* we can rewrite this condition as

Lemma 5 *The Necessary Genocide Condition:*

$$N_B^t \leq \Phi - \left(\frac{\delta_A \sqrt{\theta}}{\sqrt{\delta_B}}\right)^{\frac{1}{1-\delta_A}} \tag{25}$$

We can see that this condition is more likely to be fulfilled with an increase in Φ and δ_B, and a decrease in N_B^t, N_A and θ.

Since the The Necessary Genocide Condition is a necessary but not sufficient condition for a genocide, we also need additional conditions to be satisfied. By looking at the conditions for the different conflict scenarios and the second period population equilibrium of group B of Equation 19, we are able to obtain the following result:

Proposition 6 *Given that The Necessary Genocide Condition is satisfied, if $\delta_B \to 0$ and $\theta \to 0$, then there will be a genocide, regardless of the conflict scenario.*

Proof. If we are at the conflict scenario 1 where $\delta_B \geq \theta$, then we know that there will only be refugees and no defensive actions ($d^* = 0$) of group B according to Lemma 1, so for a genocide to be complete (19) tells us that we need $\delta_B \to 0$. However, if $\delta_B \to 0$ then for $\delta_B \geq \theta$ to still be valid we also need $\theta \to 0$.

Now, consider that we are at conflict scenario 2 where both $\delta_B < \theta$ and $\delta_B \leq \frac{1}{\theta+1/\theta+2}$ is true. Then we know that there will only be defensive actions and no refugees ($r^* = 0$) of group B according to Lemma 2, so for a genocide to be complete (19) tells us that we need $\theta \to 0$, when this is true we also need $\delta_B \to 0$ to be true to stay at the conflict scenario 2, and not move to the conflict scenario 1 where $\delta_B \geq \theta$.

Finally, consider that we are at the conflict scenario 3 where $\delta_B < \theta$ and and $\delta_B > \frac{1}{\theta+1/\theta+2}$, then we know by Lemma 1 that there will be some defensive actions ($d^* > 0$) as well as some refugees ($r^* > 0$), and for a genocide to be complete (19) tells us that we need both $\theta \to 0$ and $\delta_B \to 0$ to be true.

Thus, as long as The Necessary Genocide Condition is satisfied, regardless of the conflict scenario we will experience a genocide if both $\delta_B \to 0$ and $\theta \to 0$ is true. ∎

The interpretation of The Necessary Genocide Condition and the additional conditions is that the former is a basic and necessary condition in such that a

genocide is only possible by the strong and direct involvement by the State given by Proposition 6, but a regime needs the necessary opportunity of exploiting the grim survival struggles among the ordinary population. Put differently, if a regime has a genocide agenda, they will aim for $\delta_B \to 0$ and $\theta \to 0$ but they need The Necessary Genocide Condition to be satisfied in order to engage a sufficiently large amount of ordinary people in the killings, since if it is not satisfied the population is not sufficiently willing to fight for their survival.

5   Analysis of the Genocide

In this section the model is used to analyze some key aspects of the 1994 genocide in Rwanda. Before conducting the analysis, one should be aware of the complexity of the historical social, economic and political mechanisms leading up to the genocide. Therefore, one should also be aware of explanatory limits of any theoretical model, as other possibly significant factors are left out for reasons of simplicity. Among these is the question of how ethnical divisions are constructed over time, how the political agenda is formed and perhaps most importantly, how factors of collective action work. More specifically, in the case of Rwanda, this model does not explore how and why the identities of Hutus and Tutsis have been central in these conflicts, rather than religious, nationalistic, or any other group belonging. Also, regarding collective action forces, the model does not explicitly explore implications of *not* taking part in the persecutions and killings of Tutsis and moderate Hutus, such as running the risk of being a "traitor" and "enemy" with consequences sometimes leading to death, which is widely known to have been a highly present factor.

However, if resource scarcity and the struggle for survival was a main underlying factor in the genocide, then the model should be able to predict and explain certain key aspects of the genocide.

Furthermore, the basic assumptions of the model are in line with the realities of Rwanda, as it is almost entirely an agricultural economy with only 6% urbanization rate, and ethnical divisions of Hutu, Tutsi and Twa population groups, thereby making the model suitable for analysis.

Moreover, the analysis aims at answering two central questions.

- First, why did we *not* experience a genocide during the earlier conflict episodes of 1959-64 and 1973?

- Second, what were the conditions causing the genocide to start in April 1994?

The main motivation behind the first question is closely connected to the second, as any model that aims at explaining genocide should also be sufficiently able to explain peace as well as violent conflict that does not take the extreme form of a genocide. Since central factors were present also in the earlier clashes

as those in 1994, such as ethnically biased regime changes and State-sponsored organized persecutions of ethnic Tutsis, it is not obvious why the scenarios were so fundamentally different in the scale of the violence. The advantage of the model is that we are able to make us of the necessary and sufficient conditions for a genocide in order to try to explain the different scenarios. Before conducting the analysis, we take a brief look on the historical events leading to the genocide[10].

5.1 A Brief History of the 1994 Rwanda Genocide

This section is aimed at giving a brief background of the genocide, in order to understand the analysis more profoundly.

Albeit the genocide was a conflict of ethnic character, the division and animosity between the Hutu majority and the Tutsi minority had not always been the same in scope and nature, but had rather evolved during decades of racial mythologizing, colonial divide-and-rule, and the use of ethnic propaganda for political purposes.

More specifically, Rwanda's population is usually described as consisting of two major groups – approximately 84 percent Hutu and 15 percent Tutsi, and in addition around one percent Twa[11]. Conventional wisdom has it that the pygmy people Twa was the first to arrive between 2000 BC and 1000 AD, while the agricultural Hutu immigrated around 1000-1500 AD, followed by the pastoral Tutsi arrival between 1500-1800 AD. At the beginning of the colonizer Germany's arrival in 1899, Rwanda was a highly organized kingdom with a centralized rule exclusive to ethnic Tutsis. Due to conscious royal policy during the 19th century Rwanda had evolved to a feudal-like society of labour duties, *ubuhake*, where agricultural Hutus had to supply labour for access to land but where Tutsis where exempt ..

Belgium received control after the First World War (previously a German colony), on a mandate by the UN, existing ethnic cleavages were reinforced by a range of policies induced by the Belgians. They spread the racist ideology that the Tutsi constituted a superior race with a Nilo-Hamitic origin, thereby justifying the allocation of power positions to Tutsis. Ethnic identity cards were also introduced and a person with ten cows or more would be a Tutsi (Prunier, 1995).

Between 1959 and 1961 there was a complete reversal of power supported by the Belgians called the "Hutu Revolution", where the monarchy was abolished, a series of killings of Tutsis leading to approximately 10,000 deaths and 120,000 fleeing to neighboring countries, and independence in 1962 (Waller, 1993). Some Tutsi refugees tried to reclaim power by unsuccessfully doing raids into Rwanda in 1963, and this was followed by another wave of officially instigated persecution of Tutsis where practically all Tutsis in political positions in Rwanda were killed and some 236,000 fled the country as refugees.

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[10] Readers familiar with the basic facts of the genocide may skip this section.

[11] The figure was roughly the same in 2006 as in the years before the genocide in 1994.

A period of relative stability then followed, but in 1972 large-scale killings of approximately 200,000 Hutus took place in neighboring Tutsi-ruled Burundi, leading to reprisal killings of Tutsis in Rwandan schools and another wave of Tutsi emigration. In the middle of this period of violence and instability, the young and brutal military leader Juvénal Habyarimana managed to seize power in a coup d'état in July 1973. Violence against Tutsis came to a halt, and promises of uniting the nation had the Tutsis welcoming Habyarimana as a saviour. However, the uniting took a form of a one-party state, ethnically segregated with a system of quotas for education an all public positions, built on the 90 percent majority of Hutus, leading to one of the most rigidly controlled countries in the world at the time.

In October 1990, a rebel army invaded Rwanda from Uganda. The rebels, of the Rwandan Patriotic Front (RPF), was representing the refugees that had fled during the "Hutu Revolution" and demanded amongst several things an end to the ethnic divide and presented itself internationally as a democratic multi-ethnic movement trying to overthrow a corrupt regime. The rebel army of about four thousand well-trained troops consisted mostly of second-generation Rwandan refugees that had gained experience from having been in Uganda's National Resistance Army (NRA) that seized power in Uganda in 1986. It was after it had been decided that Rwandan refugees were to be excluded from owning land in Uganda, that the decision to invade their country of origin and to regain the right of citizenship was taken.

In April 1992 a transitional multi-party government was formed and after periods of negotiations and unrest with the RPF, a peace agreement was finally signed in Arusha on August 4th, 1993. With sparse resources and a weak mandate, UNAMIR was to facilitate the installation of the transitional government, but after periods of violence and unrest, postponed installations, President Habyarimana's jet was shot down on April 6th 1994, and hours later the killings started.

The killings were in no way spontaneous. Due to a highly organized command structure and that Hutu extremists who had been talking and planning for the "final solution" for years seized political power in a coup d'etat, the killings started within hours where the regime were active in all parts of the government branches, from Presidential Guards, the regular army FAR, national *gendarmes*, via the civil administration down to the mobilization and supply of resources to the *Interahamwe* and *Impuzamugambi* militias, as well as ordinary peasants who were the main agents conducting the killings (Prunier, 1995).

The genocide ended in late July when the RPF drew the *genocidaires* out of the country by force, after approximately 800,000 Tutsis had been slaughtered, and where only about 130,000 had managed to survive by hiding and taking refuge. As the RPF had gained ground, approximately 2 million Hutus fled to neighboring countries, to DR Congo in particular, as peace was restored in the following months. In the following years, nearly all Hutu refugees returned under the promise of the new regime that there would be no reprisal killings.

As the country now tries to move in a direction of peace, justice and reconciliation, approximately 11,000 special *Gacaca* courts with newly elected and

trained civil judges have been set up to handle the matter of those accused of participation. About 130,000 have been in jail awaiting trials, while in total the government of Rwanda approximates that the number of people involved in the genocide is roughly 800,000 (Wolters, 2005). Those accused of involvement are divided into four separate categories, ranging from the planners and organizers of the genocide (Category 1) to those guilty of homicide or similar participation (Category 2), or other serious violent acts without the intent to kill (Category 3) as well as those who committed crimes against property (Category 4).

Of the 11,000 Gacaca courts that are to try the accused in category 2-4, about 9,200 courts will only deal with the Category 4 cases. Thus, it is rather obvious that property issues and appropriation during the genocide was a highly present factor. There are also micro-studies that confirm that the issue of land property was a significant factor in both who were killed (André & Platteau, 1998) and of those who were the perpetrators (Verwimp, 2005). Verwimp concludes from his econometric study on the characteristics of the perpetrators that (2005, p.316):

> "It is not the lack of land to cultivate per se that is important in the profile of the perpetrators in our sample, it is the status of that land. The rented land variable is highly significant and it has a strong marginal effect. This suggests that people who are active in the land market, be it out of land scarcity (for quasi-landless people) or out of opportunity, had a higher probability of becoming perpetrators."

Keeping this is mind, we now use the model in order to explain some key mechanisms of the genocide.

5.2   Applying the model

Starting with the first question, we want to understand the timing of the genocide and why it happened in 1994 rather than during the earlier conflict episodes in 1959-64 and 1973. Through the model, we are able to understand why this might be so[12]. First, it is quite straightforward to see that due to the fact that there were major shocks in the policy variable θ, first by the time of the independence and the Hutu Revolution during the period of 1959-64 as the previous Tutsi political domination switched in favor of Hutu privileges throughout society, and then when there was a reaction to the 200,000 Hutu who were killed in Burundi in 1973, where Kayibanda decided to "purify" the country and persecute Tutsis in Rwanda. Both these periods were associated with large scale Tutsi refugee flows. Although this shock in the variable θ was sufficient to cause

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[12] The analysis builds an analogy of group A being the Hutu population and group B being the Tutsi population of Rwanda, in the sense that these are ordinary peasants. As we know, ethnic identities are far from unproblematic to define, and we also know that Thus, refugees in exile, including the RPF, are not a part of the analysis.

a predatory conflict outbreak given by the critical threshold of Proposition 4, it was not, however, associated with the other central factors necessary for a genocide.

More specifically, the reason we saw a genocide in 1994, but not in the earlier clashes was that the conditions for a genocide given by the model were not satisfied. First, it is not entirely obvious but it could be argued that the The Necessary Genocide Condition was not fulfilled, due to that the degree of resource scarcity Φ was not particularly high, especially compared to the migration opportunities δ_A which were relatively fair.

This is supported by the fact that before independence in 1962, migration was quite large and instigated by the Belgian colonial authorities, as there was managed resettlement from the most densely populated parts of the country to unsettled regions of Zaire. Approximately 264,000 were resettled under this scheme from 1920 to 1959. After independence, there was more organized migration within the country as a part of the official agricultural policy. There was both extension as well as intensification, thereby indicating the presence of additional resources. This was conducted from areas of land shortage, especially Gisenyi, Ruhengeri, Butare, and Gikongoro to areas unused or less intensively used for pasturing such as the areas of Mutara and Bugesera, as well as the area around the Volcanoes National Park.

In addition, these formal resettlements were even smaller in scope compared to the informal independent migrations in search of land or employment (Waller, 1993). Although the facts support the view that The Necessary Genocide Condition was not satisfied, it is somewhat ambiguous as we will see that both the variables θ and δ_B speak in favor of the condition being satisfied, where the lower was very low but that the latter was rather quite high.

However, regardless of the status of The Necessary Genocide Condition, we know from Proposition 6 that there are additional necessary conditions for a genocide, so that even if The Necessary Genocide Condition was indeed satisfied, *both* the policy variable θ and the refugee infrastructure δ_B must approach zero.

First, looking at the policy variable θ, it was definitely below one and possible quite close to zero. During the Hutu Revolution and the Kayibanda regime years there was indeed a very strong ethnic bias in favor of Hutus, and there was direct organized killings of Tutsis in these years, supported by a racist ideology. For example, in 1959 thousands of Tutsis were killed, particularly in the northwest, as the government and the Belgian authorities replaced Tutsi chiefs and sub-chiefs with Hutus, and when the UN General Assembly sent a special commission to Rwanda for investigation, the report said that racism bordered on "Nazism against the Tutsi minorities" and that the government together with the Belgian authorities were responsible.

Furthermore, soon after the independence, when about 1,500 Tutsi refugees that had left for Burundi unsuccessfully attempted to oust the Kayibanda regime in 1963, the regime began a planned campaign to kill Tutsis, ranging from political opponents to ordinary peasants. Each prefecture was also provided with a minister whose task was to supervise the killings, as the typical killings were conducted by local population accompanied by propagandists (Melvern,

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2004)[13]. In these killings, the death toll reached approximately 10,000 - 14,000. Therefore, the policy variable θ was possibly quite close to zero, indicating that a genocide was possibly not restricted by this factor. So, why was there no genocide before 1994?

The key to why we did not experience a genocide in the earlier clashes lies in the refugee infrastructure. More specifically, it is quite obvious that the condition $\delta_B \to 0$ was not satisfied. Indeed, there were some organized attempts at lowering δ_B such as roadblocks aimed at trying to prevent Tutsi from successfully fleeing the country, but these were not especially intensive and the borders to neighboring countries were relatively easy to cross. Thus, fleeing the country was relatively easy and δ_B was far from zero.

Furthermore, are we able in any way to find additional empirical support for this analytical proposition? In fact, we are. If θ was close to zero, and δ_B was far from zero, we can confidently say that $\delta_B > \theta$. Also, we know from Lemma 1 that this gives us a conflict scenario where the model predict that there will be no defensive actions of the Tutsi and only large scale refugee flows. Well, this is precisely what happened. Basically, there was not more than sporadic fighting by Tutsis refugees entering from neighboring countries, especially compared to the scope of the refugee flows. Looking at the numbers, approximately 336,000 Tutsi fled as refugees to neighboring countries (the majority to Burundi) during the period 1959-1964, and as the estimated population at the beginning of this period was 450,000 (Prunier, 1995)[14]. This means that about 75 percent of the total Tutsi population fled, thereby implying that there was indeed an imminent risk for a genocide in such that a very high share of the Tutsi population were persecuted and that The Necessary Genocide condition was probably satisfied, However, due to the relatively high refugee infrastructure variable δ_B, a genocide was prevented. Thus, the model fit the facts correctly.

In sum, the reason there was not a genocide in the earlier clashes were *possibly* that the resource scarcity was not sufficiently high and the migration opportunities were sufficiently bad such that The Necessary Genocide Condition was satisfied. Therefore, even though the regimes were actively persecuting Tutsis, the opportunity to exploit ordinary people was perhaps not present. However, regardless of whether this was the case or not, it is quite obvious that the additional necessary condition $\delta_B \to 0$ was not satisfied, as the opportunities of fleeing the country were quite positive. This is sufficient for a genocide to be prohibited. It is also as the regime realized this key factor between persecution and genocide, as in 1964 at a time when a majority of the Tutsi population had fled the country, president Kayibanda warned that if they ever sought to come back and obtain power, they could expect that "the whole Tutsi race will be

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[13]Théoneste Bagosora, at the time a young army officer but later the central organizer of the genocide in 1994, would in his cell at the Internation Criminal Tribunal in Arusha thirty years later proudly claim on his curriculum vitae: "1963 Campaigns in the Bugesera against Inyenzi". By using the kinyarwanda word for "cockroach" when describing Tutsis, the message is quite clear (Melvern, 2004).

[14]Different figures circulate which are often highly politicized. These figures come from the estimations conducted by Gérard Prunier.

wiped out" (Melvern, 2004, p9).

5.2.1   Why in April 1994?

Moving on, having explored the absence of genocide, why we *did* experience a genocide starting from April 1994? Looking at the variables, the short answer is that all the conditions given by the model for a genocide were satisfied in the evening of April 6th 1994.

More elaborately and by beginning with The Necessary Genocide Condition, which questionably was not satisfied in the earlier clashes due to that the degree of resource scarcity Φ was not particularly high, especially when the migration opportunities δ_A which were relatively fair, had by 1994 significantly changed. First, there is much evidence pointing to the fact that there was a rather large resource scarcity Φ shock in the years preceding the genocide. By looking at the Figure 1, which describes the production per capita and the population growth over the period 1960-1995, we can see that from the mid-eighties and on the production per capita decreased steadily and sharply up to the genocide, accompanied by a strong population growth. Although population grew strongly throughout the period, resource scarcity Φ had been kept down before the mid-eighties by migration, agricultural extension and intensification. When approaching mid-eighties, however, agricultural extension and intensification was stopped, and this was no longer a viable option.

Instead, due to overcultivation of the land the productivity dropped as the soil fertility decreased rapidly. For example, grain harvests which in 1985 reached approximately 50 kg per capita in 1985, had decreased to 39 kg in 1990 while it dropped down further to 24 kg in 1993 and 17 kg per capita in 1994[15]. Clearly, resources were getting dangerously scarce, and when a drought hit the country in 1989, roughly 300,000 people depended on food aid for their survival. In other words, it is quite clear that by the time of the outbreak of the genocide in 1994, Φ was positive and quite high.

Furthermore, any understanding of the genocide is incomplete without the background of the civil war between Rwanda government forces and RPF since October 1990, and the Arusha Peace Agreement that followed in August 1993[16]. This agreement involved the repatriation of refugees from the earlier clashes, which at the time meant roughly 600,000-700,000 refugees[17]. Thus, if the agents are forward-looking, the resource scarcity looked even grimmer and Φ even lower, as it was unclear what land the repatriating refugees would live off.

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[15] Own computation using agricultural data from Renner (1995) and population data from Bosworth & Collins (2003).

[16] This is perhaps most important in any understanding why the Hutu extremists were on a genocide agenda, and many critics of the peace agreement claim that it was too favourable for the RPF, and thereby pushed the extremists into a corner.

[17] Based on the estimates of Prunier (1995), where the refugees include the living descendents of the ones who originally fled.

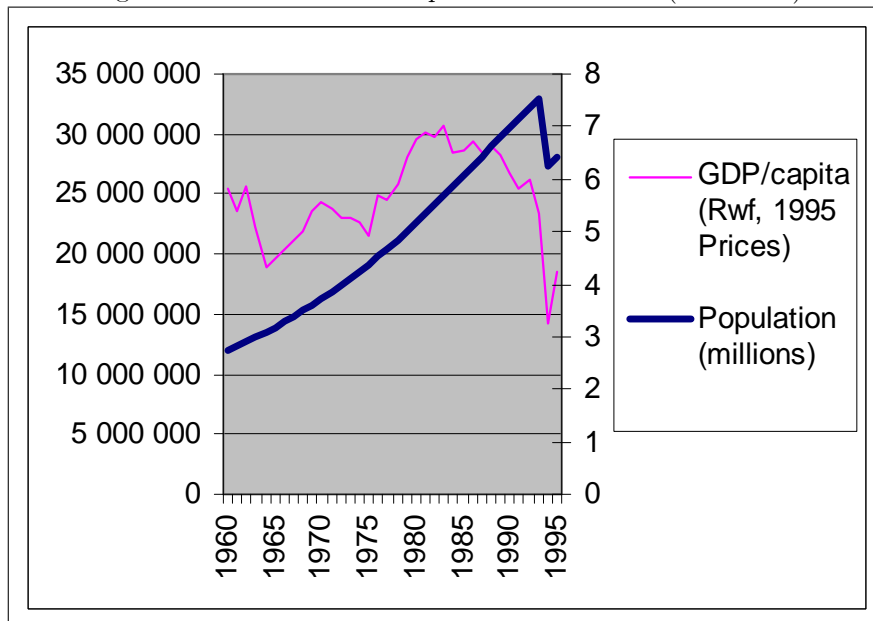Figure 1: Production and Population in Rwanda (1960-1995)

Figure 2: Source: Bigsten & Yanagizawa (2005)

Looking at the other variables in The Necessary Genocide Condition, by the time of the genocide δ_A was quite low, thereby supporting the proposal that the condition was satisfied. As we know, agricultural extension and intensification within the country had reached its limits given the level of technology so that internal migration was not possible, but the opportunities for migrating to neighboring countries had also decreased in the preceding years to 1994. Rwandan migrants and refugees were increasingly unwelcome by the host communities in the other countries and often used as scapegoats for economic decline and political turmoil.

In Uganda, for example, there was outright attacks on the settled refugees from the earlier clashes. In other neighboring countries such as Zaire and Tanzania there was not the same level of violence, however, opportunities of migration had definitely got grimmer when in 1989 the governments of Tanzania and Rwanda agreed on actively prohibiting migration by forcing emigrants to Tanzania migrating after 1986 back to Rwanda. In neighboring Burundi, there was a rampant civil war from 1993 between Hutu and Tutsi forces and with a Tutsi dominated army the opportunities δ_A of migrating to Burundi, especially for Hutus, were miniscule.

Due to these two factors, that Φ was quite high and δ_A sufficiently low, the underlying conditions for a genocide were in place, in such a way that a mali-

cious regime now had the opportunity to exploit these survival hardships of the population by using malicious policy measures. Unfortunately, this malicious regime seized power April 6th 1994. We therefore take a look on how this caused the genocide.

As we know, another genocide condition is $\theta \to 0$. In fact, given that there was an underlying resource scarcity in Rwanda at the time, and that the migration opportunities were very small, this was the trigger factor of the outbreak of the genocide as there was a major shift down in θ on April 6th as President Habyarimana was shot down in his airplane. This shift was in a practice a coup d'etat in which Hutu extremists seized political power, and who had been talking and planning for the "final solution" for years[18]. More specifically, the regime change caused a large shock in the property rights policy that implied that the government forces was massively supporting appropriative actions, thereby paving the way for the killings and persecutions of Tutsis. The regime was active in all parts of the government branches and due to a long tradition of hierarchical organization culture, effectiveness was high $\theta \to 0$ was substantiated by Presidential Guards, the regular army FAR, national gendarmes, via the civil administration down to the mobilization and supply of resources to the *Interahamwe* and *Impuzamugambi* militias.

Having this said, the main bulk of the perpetrators engaged in the killings were still ordinary peasants corresponding to the variable f^* (Prunier, 1995). As our model predicts, as $\theta \to 0$ we will see the predatory efforts f^* rise and this mechanism, how the underlying conditions of resource scarcity given by The Necessary Genocide Conditions were exploited by the regime by pushing their property rights policy towards $\theta \to 0$ and thereby instigating both lootings and killings by raising f^*, is well captured by the Human Rights Watch (1999)[19]:

"Authorities offered tangible incentives to participants. They delivered food, drink, and other intoxicants, parts of military uniforms and small payments in cash to hungry, jobless young men. They encouraged cultivators to pillage farm animals, crops, and such building materials as doors, windows and roofs. Even more important in this landhungry society, *they promised cultivators the fields left vacant by Tutsi victims* (italics by the author). To entrepreneurs and members of the local elite, they granted houses, vehicles, control of a small business, or such rare goods as television sets or computers. Many poor young men responded readily to the promise of rewards. Of the nearly 60 percent of Rwandans under the age of twenty, tens of thousands had little hope of obtaining the land needed to establish their own households or the jobs necessary to provide for a family."

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[18] According to Melvern (2004), the first serious plans for genocide started in a series of secret meetings at the end of October 1990, just after the RPF had invaded the country.

[19] Citation taken from the web-version of the report (available 02 September 2005):

http://www.hrw.org/reports/1999/rwanda/Geno1-3-02.htm#P39_15287

The question of appropriation of resources was omnipresent and as we know, of the 11,000 Gacaca courts that are to try the accused, consisting of about 800,000 individuals, about 9,200 courts will only deal with the Category 4 cases that deal with crimes against property. Thus, it is rather obvious that by exploiting the underlying resource scarcity, the presence of property appropriation was so overwhelming as a consequence of the regime that supported it by forcefully pushed property rights policy against the Tutsi minority via a range of means.

Expanding the analysis somewhat, an additional factor that helped $\theta \to 0$, was that the UNAMIR peace keeping forces were there on a weak mandate with insufficient resources. Had UNAMIR had a stronger mandate with additional sources, protection of Tutsis (as well as Hutus) would have increased and the *de facto* value of θ would have been raised well above zero, making the necessary genocide condition $\theta \to 0$ impossible. In this way, the conditions for genocide would most probably not have been satisfied. According to the UN Commander in Chief, Lieutenant General Romeo Dallaire, this could have been accomplished. According to Dallaire, the genocide would have been prevented if the mission budget had increased by \$100 million and with roughly 5,000 well-equipped troops (Dallaire, 2003). Instead, as political leaders of the world became increasingly aware of what was taking place, the UN mission left Rwanda after a few weeks with only a few observers staying.

Having showed how $\theta \to 0$ was a necessary condition for the 1994 genocide, we know by Proposition 6 that this is not sufficient and that for a genocide, we must also experience $\delta_B \to 0$. This is the key.

We know that in the earlier clashes this condition was not satisfied, and that genocide was thereby avoided. In 1994, this was not the case. Instead, it seems as if the main organizer of the genocide, Theoneste Bagosora, had drawn his conclusion of the earlier years when 75 percent of the Tutsi population successfully fled the country, as lowering δ_B towards zero became a central theme of the genocide. Therefore, rather than just engage governmental forces in attacks, it became a priority to make sure that anybody trying to flee the country, would not successfully be able to do so.

The *Interahamwe* and *Impuzamugambi* militias had been trained and equipped by the government, with the official connotation that it was "civil defense", but supplied with portable transmitter-receivers one of the major tasks of these militias was to obey different orders aimed at lowering δ_B, by setting up hundreds of roadblocks all over the country. Together with the obligatory ethnic identity card, which was an effective tool for identifying Tutsis especially among crowds, domestic mobility for Tutsis were incredibly low. Moreover, the radio station Radio-Télévision Libre des Mille Collines (RTLM) was extensively used as by army officers for broadcasting "search notices" with the names, addresses and descriptions of people who had somehow successfully escaped the widespread network of roadblocks (Melvern, 2004).

Furthermore, civil servants in the central government, the *préfets, bourgmestres* and local councillors were engaged in the administrative tasks of transmitting orders from Kigali to the local *Gendarmerie* and *Interahamwe.* In other words,

the civil administration made sure that the ones needed to be killed were identified and marked, while the network of roadblocks and radio communication made sure no one could escape successfully. The regime lowered δ_B in several ways, among them by pursuing a policy where a Hutu that helped a Tutsi fleeing would be punished, so that domestic mobility would be very low, and one survivor witnessed that he "needed six days to traverse a distance that he could normally walk in two hours" (Human Rights Watch, 1999)[20]. In other words, the refugee infrastructure was practically nonexistent and $\delta_B \to 0$.

Furthermore, although the prospect of fleeing was minimal, persecuted Tutsis were left with no other option. We know from Lemma 1 that for any major resistance to take place so that d^* be high, we need the condition $\delta_B < \theta$ to be satisfied and the difference between the variables to be high, but since both $\delta_B \to 0$ and $\theta \to 0$ the conditions for any major defensive resistance by the Tutsi population were not satisfied. Only in some places were there known defensive actions by Tutsi, such as the hills of Bisesero, the swamps of Bugesera, and at the church of Cyahinda (Human Rights Watch, 1999). Fighting was simply not an option for ordinary Tutsis, as the prospects of surviving by fighting were miniscule and practically nonexistent, and therefore not a very attractive alternative in their survival strategy.

Instead of fighting, people tried desperately to hide and flee wherever there was a small chance of surviving. Prunier writes (1995, p.253):

> "Inside town houses (...) Others tried to hide in banana groves, in abandoned car wrecks, in pit latrines, in swamps, in cupboards, almost anywhere that might not be noticed."

In many cases, people thought that by regrouping together by collectively hiding inside churches, football stadiums and hospitals, δ_B would not be zero and that there would be some safety. Unfortunately, most of these hopes were in vain as these places were targeted as forcefully as any other.

In all, of the total population of 930,000 Tutsi living in Rwanda on 6 April 1994, only 130,000 Tutsi refugees managed to survive. Of these, only 30,000 were refugees that successfully managed to flee the country into refugee camps in Burundi, 105,000 survived in refugee camps inside Rwanda and 25,000 managed to stay alive by hiding at scattered places (Prunier, 1995). When RPF gained control of the country in late July 1994, the genocide was practically complete and approximately 800,000 Rwandans had lost their lives.

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[20] Quote from the web-version (available 02 September 2005):
http://www.hrw.org/reports/1999/rwanda/Geno4-7-02.htm#P665_176649

6   Conclusion

This paper has done two things.

First, it has developed a game-theoretical model on how population groups may choose survival strategies under resource scarce conditions, where central possible choices are migration, fighting or taking refuge. Results include that unless there is a combination in which resource scarcity is particularly severe, migration opportunities are relatively slim, infrastructure for persecuted refugees is good, property rights are weak or nonexistent, we can expect peace. In addition, the model has presented necessary and sufficient conditions for a genocide under resource scarcity.

Second, it has used the theoretical framework and necessary conditions for a genocide to analyze the 1994 genocide in Rwanda by aiming at answering two fundamental questions:

- First, why did we *not* experience a genocide in the earlier conflict episodes of 1959-64 and 1973?

- Second, what were the conditions causing the genocide in 1994?

The first question is most straightforwardly answered by the differences in refugee infrastructure, which was much better in the earlier conflict episodes than in 1994. Another possible additional explanation is that it was due to a combination of rather fair migration opportunities and not particularly severe resource scarcity. Either how, is it obvious that the necessary conditions for a genocide developed by the model were not satisfied in the earlier conflict episodes. On what caused the 1994 genocide, the paper finds that the Hutu extremist regime that seized power on April 6th 1994 exploited the underlying resource scarce conditions, by way of forcefully pushing property rights policy and massively supporting appropriative actions, thereby causing the killings and persecutions of Tutsis on the scale of a genocide.

However, the final key to understanding why the genocide was "successful" in 1994, is suggested to be that the extremist regime policy was not only actively instigating the killings by destroying property rights protection, but the simultaneous and deliberate destroying of the refugee infrastructure.

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