International Institutions and Peace, An Economic Approach to conflict and integrative activities

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INTERNATIONAL INSTITUTIONS AND PEACE
AN ECONOMIC APPROACH TO CONFLICT AND INTEGRATIVE ACTIVITIES

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# INTERNATIONAL INSTITUTIONS AND PEACE
## AN ECONOMIC APPROACH TO CONFLICT AND INTEGRATIVE ACTIVITIES

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INTRODUCTION

In recent years a large literature on the economics of conflict was developed, sharing the idea to go far beyond the traditional domain of economics, namely ‘exchange’. In the simplest form, two parties agree to exchange something against something else, usually money against goods and services. Exchange is carried out on a voluntary basis by agents which are supposed to interact rationally. It has as a result a mutual advantage for parties. Therefore, in such an ideal form, the exchange is traditionally assumed to be the ‘core’ of economic activity.

However, voluntary exchange does not exhaust the complexity of economic activity. The argument is straightforward. You can buy something, but you can also steal it. You can appropriate, confiscate, grab, plunder instead of producing, contracting or exchanging. Unproductive appropriative activities constitute an ordinary aspect of economic life. History also provides too many examples. Landes (1999) tells brilliantly an emblematic story:

“In 1592 an English naval squadron was waiting off the Azores to intercept and capture Spanish ships coming from the New World […], when along came a Portoguese carrack. This was the Madre de Deus, back from the East Indies, headed for Lisbon. She was bigger than any vessel the English had ever seen[…]. Here was the stuff of dreams – chests bulging
with jewels and pearls, gold and silver coins, amber older than England, bolts of the finest cloth, tapestries fit for a palace[…]. Even before the English squadron commander could take charge of the prize, his rampaging crewmen had stuffed their pockets with everything they could carry. When the prize came into Dartmouth Harbor, it towered over the other ships and the small houses at quayside. Traders, dealers, cutpurses, and thieves came from miles around, from London and beyond, like bees to honey – to visit the ship and seek out drunken sailors in the taverns and dives, the better to buy, steal, pilfer and fence the loot. […] By the time Sir Walter [Raleigh] took things in hand, a cargo estimated at half a million pounds – nearly half of all the monies in the Exchequer – had been reduced to £140,000.[…]”

Needless to say, this story seems a hilarious tale. It is not. Landes also affirms that this event, as the greatest haul in history, moved England and then the whole world on a new course. This example was intended to show clearly how many incentives to appropriation and conflict can emerge and how such incentives can affect behaviour of individuals, groups and organizations at different levels.

Indeed, the idea behind this work is that producing and exchanging goods and services can be considered just an aspect of economics. Conflict, as a rational activity, plays a role as well as exchange. Hirshleifer (1994) uses an evocative expression, to underline its occurrence. He labels it ‘The Dark side of the Force”, making an effective analogy with the Star Wars saga. According to

1 Landes (1999) pp. 150-151
this view, you cannot tell the story of Luke Skywalker and Obe Wan Ben Kenobe forgetting to mention Darth Vader.

However, the dichotomy ‘exchange vs. conflict’, that I define manichean, also does not seem to exhaust the complex range of human economic activities. A third typical behaviour involves concept such as integrative relationship (à la Boulding) and it is mainly concerned with conflict management and resolution. Indeed, this work is intended to deal with an economic approach to conflict and integrative activities.

As the title of work suggests, the analysis developed hereafter is intended to be a contribution to the interdisciplinary field of Peace Science in its sub-field of Peace Economics, whose recognized forefathers are Kenneth Boulding and Walter Isard\(^2\). The work is structured as follows.

Chapter 1 deals with the conceptual grounds of the whole work. In particular, a tentative definition of conflict is presented, linked with the broad class of ‘unproductive activities’. This idea is due to Haavelmo (1954)’s contribution. He presented the occurrence of conflict as an example of ‘unproductive activities’. Indeed, following Bhagwati (1982) a tentative classification of conflict can be introduced, considering differences and characteristics of conflict with respect to contest and rent-seeking activities. Moreover, a tentative original classification of conflicts is presented.

Distinction between productive and unproductive activities, however, exhibits again a *manichean* bias. Buy or steal, plunder or trade; no third alternative seems to emerge. Then, in the second part of chapter 1, I examine a vigorous argument presented by Boulding (1962a). According to his view, the social system can be analysed along the lines of three large, overlapping and interacting subsystems: exchange, threat and integrative activities. All human institutions and relationships involve different combinations of all three. The integrative system, in particular, constitutes the most effective response to threat. In other words, an integrative relationship paves the way for conflict management and resolution. This idea fundamentally contributes to the underlying conceptual framework of this work, that can be quickly summarized in two ideas.

First, I assume conflict as being a permanent feature among economic activities. This idea is consistent with Schelling (1960) and Hirshleifer (1991/2001). Second, I borrow Boulding’s idea of the three systems governing human affairs and assume that agreements and institutions devoted to strengthen exchange interactions between actors can provide incentives for peaceful resolution of conflict.

In second chapter, I examine the economic foundations of conflict following the seminal work of Hirshleifer (1988). This is a general equilibrium model which involves a *Resources Partition Equation*, an *Aggregate Production Equation*, a *Contest Success Function* (CSF) determining the outcome of conflict and an *Income Distribution Equation*. Two risk-neutral actors allocate an initial stock of resource
that between productive and unproductive activities, namely ‘butter’ and ‘guns’. The resources allocated to productive activities determine a total output, say the ‘pie’, that is to be distributed according the resources allocated to conflict, the unproductive activity. In particular, the CSF, being a cornerstone of heterogeneous class of economic models, is further analysed in appendix 2.1. Hirshleifer offers solutions under different protocols: Cournot, Stackelberg and a hierarchical protocol called Threat and Promises (TAP). Moreover, his results are sensitive to the specification of production function. Hence I explore different solutions with respect to the basic model, taking into account different forms of production function.

In a third section, I present a selected survey of recent theoretical contributions by, among others, Michelle Garfinkel, Herschel Grossman, Stergios Skaperdas, Constantinos Syropoulos and Hugh M. Neary. They extended Hirshleifer’s basic model adding new features and insights.

While the second chapter emphasized the choices of agents over the level of ‘guns’ in a bilateral interaction, the third chapter focuses on the emergence of exchange between parties. While conflict activities obviously shrink the amount of resources devoted to productive activities, leading to a shrinking of the Edgeworth Box (as showed in the analysis by Charles Anderton and his associates) it can also be maintained that exchange emerges only in the shadow of conflict. This approach is also in Garfinkel and Skaperdas (2000) which constitutes the basis for my analysis. In fact, such analysis
extends the Garfinkel and Skaperdas’s model in order to consider specific features of international trade and trade policies. Within the framework of my approach actors’ choices are driven through different combinations of a destructiveness parameter and a parameter capturing the expected real impact of a complex range of trade policies. Thus, the model exhibits an original evaluation of different equilibria under trade policies according to different combination of the parameters considered.

The fourth chapter deals with the core analysis of this work aiming at evaluating the possible ‘peaceful’ impact of a trade institution. The classical functional form of CSF is modified in order to capture the emergence of institutional integrative relationship, as a formal representation of Boulding’s idea of ‘grants’. Grants are the cornerstone of integrative relationship and, differently from exchange, are characterised by ‘one-way’ transfer. A grant in this framework is captured through an exogenous determined membership fee, namely a certain amount of resources that parties give up in order to settle under an institution. This settlement, however, emerges on the ‘shadow of conflict’, given the investment in ‘guns’ each party makes.

In chapter five I set down some extensions of the ‘core’ model considering new elements and asymmetries, in order to verify whether they affect the outcomes of the basic model. First, I consider the impact of time, extending the model in a two-period setting. Secondly, I rule out the symmetric division of the contested output assuming that this is to be divided according to an asymmetric rule of division. Last but not least, I consider the impact of different
subjective evaluations of the ‘pie’ on the optimal choices of ‘guns’ as well as the incentives to settle or to be involved in a continuing conflict scenario.

Writing this work I strongly benefited from the contributions of many people. First, I wish to thank my supervisor Simona Beretta who patiently and deeply monitored my work. I also wish to thank the coordinator of the doctoral programme Alberto Quadrio Curzio. Carlo Beretta and Guido Merzoni also enriched this work with useful insights and suggestions.

In addition, I feel warmly in debt with many other people. Walter Isard strongly encouraged me and showed the richness of Peace Science. Paul De Grauwe showed me how to become a professional economist. Jack Hirshelifer kindly commented and revised a paper extracted from this work, shedding light on some important aspects. Lorenzo Ornaghi and Vittorio Emanuele Parsi bet on my abilities some years ago.

The story of this work is also a story of different places and experiences. Attending a Master program at ASERI, the Postgraduate School of Economics and International Relations, I discovered the fruitful aspect of multidisciplinary method and met nice colleagues. At the Catholic University of Leuven I learnt more than the fundamentals of economics. I also benefited from stimulating comments and discussion with people of the Peace Science Society (International) and the Network of European Peace Scientists in Amsterdam. At the Catholic University of Milan, I joined international projects and experiences that led me up to Siberia to give the first lecture of my life.
A special and warm thank is for my girlfriend, Annalisa who is still patiently waiting for me.

However, every human artifact needs a soundtrack. This work would have not been written without rock’n’roll. Keep on rockin’ in a free world.
CHAPTER I
MANICHEAN ECONOMICS?

‘Exchange’ is the traditional domain of economics. In its simplest form, two parties agree to exchange something against something else, usually money against goods and services. Exchange is supposed to be carried out on voluntary basis of agents which interact rationally. The final outcome is a mutual advantage for parties.

Unfortunately, voluntary exchange does not exhaust the complexity of economic activity. You can buy something, but you can also steal it. You can appropriate, confiscate, grab, and plunder instead of producing, contracting or exchanging. Unproductive appropriative activities constitute an ordinary aspect of economic life. By contrast, integrative activities also emerge in ordinary life. This chapter introduces what constitutes the main theme of this work: namely the study of conflict and integrative relationships.

The chapter proceeds as follows: (i) in a first paragraph the linkages and differences between conflict, contests and rent-seeking are presented; (ii) in a second section a tentative taxonomy of conflict activities are explained; (iii) in third section the Boulding’s integrative system is presented; (iv) in the last part some ideas and basic concepts for the continuation of the work will be expounded.
1.1

PRODUCTIVE AND UNPRODUCTIVE ACTIVITIES

CONFLICT, CONTESTS AND RENT SEEKING

The first formal economic analysis of conflict is by Haavelmo (1954). Studying the interaction between regions and the nature of interregional activities, he distinguishes between ‘productive’ and ‘unproductive’ efforts. In his words “We want to be able to express the fact that ‘unproductive’ activities may be directed towards actually hampering the productive efforts of other groups”\(^1\). Through such a distinction he paves the way for the following research. In fact, he binds conflict, war, predation within a specific, although broad, set of activities.

The distinction between ‘productive’ and ‘unproductive’ activities is also one of the widest themes in economics. In more recent years Bhagwati (1982) proposes a general taxonomy for a broader range of economic activities which represent ways of making profit despite being directly unproductive. According to his view, such activities yield pecuniary returns but do not produce goods and services that enter a utility function, either directly or indirectly through increased production or availability to the economy of goods that enter an utility function. He labels them as directly unproductive profit-seeking activities (DUP). Classical examples are tariff-seeking lobbying, tariff evasion, premium(rent) seeking . Their output is clearly zero in terms of the flow of goods and services entering a conventional utility function. Evasion of a tariff, for

\(^1\) Haavelmo (1954, p.91)
example, yields clearly pecuniary returns by means of exploitation of the price differential between legal transactions and illegal transactions.

The world would be distortion-free except for the distortions created by DUP activities either directly or indirectly. Thus, the taxonomy presented by Bhagwati assumes that all DUP activities may involve either a distorted or a distortion-free situation. Note also that DUP activities considered are only those related to governmental policies. Thus, he distinguishes four critical broad classes: (1) initial and final situations are both distorted; (2): initial situation is distorted but the final situation (thanks to the DUP activity) is distortion free; (3) initial situation is distortion free but the final situation is distorted; (4) the initial situation is distortion free and so is the final situation (despite the DUP activity). A second level of classification is related to the legal or illegal nature of activities so that he is able to present eight different classes.

Once explained the general concept of DUP activities as well as their classification Bhagwati’s analysis address directly the issue of welfare consequences of DUP activities. Consider for example activities of tariff-seeking: initial situation is distortion-free but such activity creates, on a legal basis, a distorted final situation. By contrast, theft falls in the domain of illegal activities but it emerges in a distortion-free initial situation which does not become distorted. These cases give a total outcome which is necessarily welfare-immiserizing.

Meanwhile, Bhagwati also indicates some kind of activities which could yield a paradoxical outcome. In fact, activities such as
tariff-destroying lobbying may emerge in a distorted situation (protected trade) and produce a distortion-free situation (free trade). They can be legal or illegal (with bribes to politicians). A paradox can occur: a beneficial outcome is possible. A similar result can also happen with premium-seeking activities (legal); or tariff evasion and smuggling (illegal). All these are characterised by an initially distorted and a finally distorted situation.

In general, the aggregated effect depends upon the diversion of resources into DUP and the welfare impact of the elimination of the distortion in the final situation. Take smuggling. It can be beneficial since it confers production and consumption gains when it cuts an effective tariff.

In category (1) and (3), it is clear that agents contest over a premium or a rent, i.e. a ‘prize’. This links Bhagwati’s contribution with the classical studies on rent-seeking by Krueger (1974) and Tullock (1980). All these studies assume the existence of states and governments. As offshoots, products or by-products of the existence of governments, rents flourish and take a variety of forms. Moreover, the term rent-seeking is commonly designed to describe institutional settings and rewards structure where individual efforts produce social waste instead of social surplus.

In the meantime rent-seeking can also be seen as part of a broader category of unproductive activities. Taking into account the main feature of the existence of a prize, rent-seeking would be a subset of a contest, that embrace many real world situations, among others tournaments, beauty contest, and competition over a R&D innovation. ‘Contest’ is also a broader general category where agents
devote efforts in order to increase their probability of winning a prize. Moreover, contests offer rewards which depend upon an individual’s performance relative to others.

Specification of such categories is also useful in order to capture some specific features of conflict. In fact, in recent years, the linkage between conflict and rent seeking has been enlightened by Jack Hirshleifer in several writings. Using his words:

“Appropriation is a generalization of the more familiar concept of rent-seeking. [...] the rent seeking competition for political privilege is only one of many different ways in which control over resources might be achieved or maintained. Appropriation as a broader category covers not only rent-seeking but also attempts to profit from robbery, confiscatory, redistribution, or coercive encroachment [...]”.

“[...] rent-seeking, in its usual connotation of maneuvering for licenses and monopoly privileges, is to conflict as milkwater is to blood, sweat and tears. The appropriative struggle can also take more energetic forms, for example strikes and lockouts, bank robbery, revolutionary warfare, and international confrontations. In short, the dark side is no mere outlying peninsula but rather an entire intellectual continent on the map of economic activity”.

Hence, conflict, contest and rent-seeking are clearly different. Neither contest nor rent-seeking activities include the use of force or violence in order to win the ‘prize’ or capture the ‘rent’. Then, a characteristic element that distinguishes conflicts from rent-seeking and contests is the use of force and violence. Note also that a conflict

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2 See Dixit (1987a).
3 Hirshleifer (1987) p.2
4 Emphasis in original.
does not necessarily imply actual violence; a credible threat of use of violence suffices. That is, the exploitation of potential force or violence also plays a role.\footnote{This idea is also in Schelling (1960) p.5, \textit{Thus Strategy[...] is not concerned with the efficient application of force but with the exploitation of potential force.} (emphasis in original).}

Another characteristic element of contests is their voluntary nature. As in exchange interactions in most cases agents participate in contests on a voluntary basis. By contrast, since conflict is linked directly with the use of force and violence, it commonly involves the use of coercion affecting the behaviour of opponents.

Hence, improving your performance in contests appears to be an optimal strategy. By contrast, in conflicts, other strategies are likely to occur such as hindering or making ineffective opponents’ strategies. Force and violence play a role also in this case. When one or more competitors adopt hindrance strategies, the result is clearly a conflict. These latter considerations pave the way to understanding the position of the sub-set of conflict activities within the larger set of DUP activities.

Then, trying to reconstruct a classification, it is possible to say that rent-seeking and contests constitute different subsets within the much broader category of conflict interactions (See figure 1.1). However, these can be considered as ideal categories. In fact, there are also instances of hybrid types which can record intersections of the elements considered. Konrad (2000), for example, studies the occurrence of sabotage in rent-seeking. In such a case two types of efforts are considered: efforts that improve the contestants’ performance (standard rent-seeking) and efforts that reduce
particular rivals’ performance (sabotage). The existence of sabotage may increase or decrease standard rent-seeking effort as well as the dissipation of resources. Such a case is clearly more akin to conflict even if there is no exploitation of actual or potential force.

Anyway, conflicts, contests and rent-seeking can be considered directly unproductive activities in the spirit of Bhagwati’s definition. They yield pecuniary returns but do not produce goods and services that enter a utility function directly or indirectly.

Finally, I try a first feasible definition for conflict as: The unproductive use of resources devoted to the appropriation of other resources or goods through the exploitation of actual or potential force or violence towards other competitors in order to hinder their performance and influence their behaviour. Albeit non-fully satisfactory, such a definition contains all the characteristic elements of conflict activities.
1.2
TOWARDS A TAXONOMY

Now, I also try to adapt Bhagwati’s taxonomy to the object of this work (see Table 1.1). Then, I will construct a tentative taxonomy of conflicts by means of the categories indicated in Bhagwati’s work. I deliberately disregard the distinction between legal and illegal activities. I only consider activities within the four broader classes. At the moment I also do not consider their consequences on welfare, since they will emerge in the continuation of the work. I intend to propose some simple examples for all categories considered.

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Table 1.1
EXAMPLES OF CONFLICTS AS DUP ACTIVITIES. ADAPTED FROM BHAGWATI (1982)
The first category (initially distorted/finally distorted) appears to embrace some particular phenomena. An initially distorted situation is often due to the existence of an institution as (a government for example) which allows for monopoly rents over some scarce resources. Consider for instance civil wars and insurrections occurring in LDCs. In many cases an organized group is challenging the ruling elite that has the control over natural resources at its exclusive disposal. Indeed, an opposing group has an incentive to fight against the ruling group because of the expected redistribution of available output occurring after the war\(^7\). However, this phenomenon is not a novelty in history\(^8\).

\(^{7}\) Recent studies confirm this idea. The most famous analyses on the economic causes of civil wars are from Collier and Hoeffler (1998, 2001). The focus is on the dichotomy ‘greed and grievance’. They found that opportunity variables (‘greed’) are more explanatory than ‘grievance’ variables. Measures of grievance are considered: ethnic or religious hatred, political repression, political exclusion, and economic inequality. While common sources of ‘greed’ can be represented by extortion of natural resources, donations from diasporas, and subventions from hostile governments. The main finding is that the greed-motivated rebellions and civil wars are more likely than grievance-motivated ones. It is worth noting point out some variables among others: a higher dependence from primary commodity exports does increase the risk of an internal conflict. Similar results are presented by Azam (1999). See also Garonna and Buchacz (2002).

\(^{8}\) Baumol (1990) studies the entrepreneurs’ allocation between productive activities and unproductive activities such as rent-seeking or organized activities in different historical ages (Ancient Rome, early China, Middle Ages and renaissance). The basic hypothesis is that this allocation is heavily influenced by the relative payoffs society offers to such activities. In fact, there are several unproductive activities among which the entrepreneur’s efforts can be reallocated. Many of them do not follow the productive and innovative script that Schumpeterian tradition attributes to entrepreneurs. Then, changes in the rules – the reward structure in the economy - and other circumstances can modify the composition of the class of entrepreneurs. Albeit the heavy reliance on a unrealistic ideal-type of
The third category is characterised by an initial distortion free situation and a final distorted situation. Take the ‘Tragedy of Commons’. It refers to a particular category of goods with different features. The goods in question could be fish populations in the sea. First these goods are non-excludable as it is the case for pure public goods. Second, these goods are considered rival, as private goods. This means that if one agent gets one unit of a particular good, the other agents have one unit less to consume. The combination of the two features of non-excludability and rivalry makes the good vulnerable to over-exploitation. With poorly defined property rights or lack of political stability, conflicts over the exploitation of the ‘commons’ emerge\(^9\) since agents have incentives to capture the rents from commons and natural resources. The situation is initially distortion-free only because commons or natural resources exist and are subject to human exploitation. Land squatting in nineteenth century America could be also considered an example.

In Category (2) a possible example seems to be the case of international trade dispute under the umbrella of international regime or institution, as in the GATT/WTO system. Since such regimes and institutions are committed to foster free trade, disputes...
commonly are launched against distorted situations which have unfavourable implications for some countries or the whole trading system. In general, litigations and lawsuits within a country are characterised by the existence of a third party that is expected to guarantee enforcement of contracts. That is, the use of the force does not disappear, but it is at a third party’s exclusive disposal.

In international trade disputes among WTO members, the Dispute Settlement Procedure is not capable to effectively guarantee contracts’ enforcement, but it can provide some sort of regulation since countries are expected to comply with obligations emerging in the dispute settlement system. That is, in a rule-based system, at least in formal sense, any existing imbalance of power between members disappear. At the same time the dispute settlement system helps countries to coordinate on more efficient equilibria.

The de-escalation of arms races also can constitute an example. In such a case conflict does not disappear. However, it seems to move nearer to its resolution.

Conflicts in category (4) emerge under an initially distortion-free situation and finish with a final distortion-free situation. An example could be constituted by piracy. In fact, in such a case, efforts of a group (pirates) are offset by an action of policing the seas by another group (private or public). The result is that mutually unproductive efforts lead to a huge dissipation of resources. At the same time, the initially situation is not overturned and remains distortions free. This is also the case of plunder and the protection against it.
1.3

THE BOULDING’S INTEGRATIVE SYSTEM

In the foregoing section arguments I briefly quoted were intended to throw light upon the fact that economic activity counts conflict among its founding pillars. All these points of view, however, show a bias towards a *manichean* argument. Buy or steal, plunder or trade, no third alternative seems to emerge. This does not appear to me as exhausting the interactions occurring between agents in real life. Then, in this section I present a different and vigorous argument expounded by Kenneth Boulding (1962a). Hereafter, I summarise some concepts that will be useful in the proceeding of the work.

To Boulding, the social system can be divided into three large, overlapping and interacting sub-systems: exchange, threat and integrative system. All human institutions and relationships involve different combinations of all three.

**Exchange** relationships constitute the usual domain of economics. In its simplest form two parties agree to exchange something with something else, usually money with goods and services. It is commonly understood as a positive sum game in which parties can be better off after the exchange is concluded. However, it still retains co-operative and competitive elements. It is cooperative since there are gains for both parties. It is competitive when the gains depend upon the terms of trade.

The **threat system**, in its simplest form, is also a relationship between two parties. If you do not do something (or you do) I shall
do something nasty to you. Economic activity is full of examples. However, it is less productive than exchange systems simply because exchange of goods encourages the production of goods, whereas threat discourages the production of goods. It is common sense that an executive can threaten a worker of firing. The government threatens individuals of expropriation if they do not pay taxes, or a state can threaten a tariff retaliation if another state (or a group of states) does not comply with some obligations.

To Boulding there are several feasible reactions threatened agents can set in response: submission, defiance, counter-threat, flight, and integrative response. The subsequent outcome of a threat, in fact, depends upon the reaction of threatened party. For sake of simplicity, let A and B denote the threatener and the threatened respectively. The first reaction could be submission. The threat-submission mechanism is likely to move the parties towards a state in which A is better off and B worse off than in initial condition. The

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10 In general, threat involves the possibility to affect other parties’ behaviour. Schelling (1960) gives a comprehensive definition of threat, see pp. 123-124, “The distinctive character of a threat is that one asserts that he will do, in a contingency, what he would manifestly prefer not to do if the contingency occurred, the contingency being governed by the second party’s behaviour; [...] the threat and the commitment are both motivated by the possibility that a rational player can be constrained by his knowledge that the first player has altered his own incentive structure. [...] While the commitment fixes one’s course of action, the threat fixes a course of reaction, of response to the other player. The commitment is a means of gaining first move in a game in which first move carries an advantage; the threat is a commitment to a strategy for second move. (emphasis in original).

11 Boulding (1963a) distinguishes only four feasible responses to threat. Boulding (1985b, pp. 135-137) also produces a taxonomy of feasible reactions enlarging the number up to five and also changing some of them. I report them all. Anyway, with regard to the discussion and comments I mainly refer to Boulding (1963a).
threat-submission mechanism has been functioning as a powerful social organiser for centuries. Most citizens are used to comply with obligations imposed by rulers.

A second response to threat can be defiance. B does not submit but tells A. ‘Carry out your threat’. Such behaviour imposes a burden on threatener. In fact, A now has to decide whether or not to carry out the announced threat. If A does carry out the threat, this will have a cost as well as B. If A decides not to carry out the threat, a cost of credibility emerges. However, threat-defiance mechanism is a negative-sum game.

Another feasible response to threat is flight. In such a case the threatened party B has an incentive to move out from the range of threat. This occurs when the cost to move the threat are really high. The general principle ‘the further, the weaker’ does work. This kind of reaction has been also important in history. Consider the settlements in America. They can be considered as a flight response to religious threats people experienced in Europe.

The fifth feasible response to threat is protection or threat reduction. This is intended to diminish the threat of A towards B. Consider the development of defensive weapons and devices, i.e. actor B builds up a city wall, a bomb shelter and so on, namely any protective device does not threaten directly A, but diminishes effectiveness of A’s threat.

Another possible response is counter-threat. Actor B says ‘If you do something nasty to me, I will do something nasty to you’. This is the basic ground of deterrence. It is clearly a negative sum game. With respect to exchange, the scenario appears to be
overturned. Instead of a mutual exchange of goods, a mutual exchange of ‘bads’ occurs. Since the threat-counter-threat mechanism is very much shorter in time horizon of development than exchange systems. “This explains, I think, why in the long pull the free labor market, for instance, has always been able to outdo slavery, and why all classical civilizations have ultimately perished whereas the world of trade has grown slowly but persistently from its very origins.”

Boulding argues that all threat systems experience a basic long-run instability. Deterrence, therefore, is unstable in the long run. When a breakdown in deterrence occurs the subsequent outcome could take the shape of submission or defiance. If A decides to carry out the threat, and B also decides to counter-threat a feasible outcome could be the occurrence of a war.

A more stable response to threat appears to be the integrative action. Using Boulding’s words: “the integrative response is that which establishes community between the threatener and the threatened and produces common values and common interest”. Examples of this kind of response are more difficult to find out. It commonly appears mixed with one of the other responses: Gandhi and non-violent resistance, for instance, seem to be a mixture of defiance and

---

13 The source of Boulding’s argument is the pioneering work on arms race by Richardson (1957/1960). Richardson developed his system using differential equations and demonstrated that an arms race is unstable in the long run even if it can be stable in the short run. It constitutes the classical reference on arms race. See Isard (1988) and Anderton (1989) for further details. Boulding espoused and discussed the Richardson argument in his Conflict and Defense (1962). He also gave a simple explanation in Boulding (1978c).
14 Boulding (1963a) p. 430.
integrative response. In international systems a counter-threat response might appear together with an integrative action.

The integrative system is a ‘looser concept’\(^ {15}\). It involves many other different concepts. Among individuals, an integrative relationship involves a complex spectrum of feelings, such as respect, love, affection and so on. It also involves other concepts emerging between individuals as well as organisations: legitimacy, status, sense of identity, community etc. etc. Legitimacy, in particular, is a powerful concept because if an individual or an organisation loses legitimacy, the integrative relationships are unlikely to continue functioning. In its romantic view, an integrative relationship implies a ‘meeting of minds’\(^ {16}\). There is a convergence and interdependence of utility functions of the parties towards each other. An example of integrative relationship is giving a gift. To Boulding, by abstracting the pure form of giving a gift, there is neither exchange nor barter. I give you something mainly because of love, affection or sympathy.

Even if integrative relationships appear to occur mainly among individuals they also work within other scenarios. In international interactions, for example, foreign aid flowing from a richer country to a poorer one, can be included into integrative systems.

The integrative systems are characterised by what Boulding (1974, p.397) calls the ‘grants economics’. A grant is supposed to be a unilateral transfer from an individual, a group or a social unit to another. When it occurs, the donor agent does not receive anything

\(^ {15}\) Boulding (1985a), p. 85.
\(^ {16}\) Boulding (1962a), p. 425
in return. In a simple two-actor scenario, it involves the grantor or donor on one hand and the recipient (or grantee) on the other hand. Note the deep difference with the exchange system, where an agent A gives agent B something for something else. By contrast, a unilateral transfer occurs only when there is an integrative relationship between actors.

A powerful example of an integrative system could be considered the modern nation-state. On the one hand, states are usually committed to provide grants in different forms to their own citizens; on the other hand, citizens are expected to pay taxes, duties and excises.

Boulding expresses the theory of ‘grants economics’ in a more comprehensive manner in Boulding et al. (1972) and in his book *The Economy of Love and Fear* (1973). The central idea of ‘Grants Economics’ (hereafter GE for brevity), is that exchange does not fully explain contemporary economics, emphasizing the fact that both exchange and grants are necessary to organize the fabric of a modern economic system. In particular, “the grants economy represents the heart of political economy, because it is precisely at the level of one-way transfers that the political system intervenes in the economic system”\(^\text{17}\). Therefore, the existence of GE is a matter of institutions which inform and govern the economic life of individuals, groups and organizations. Different institutionalized scenarios contribute to shape different economic systems. The existence, the measurement and the classification of grant elements in modern economics ought to be

\(^{17}\) Boulding et al. (1972), p.21.
considered as pivotal element in the regular framework of economics.

Obviously, grants can take different shapes. Grants can be either ‘negative’ or ‘positive’. That is, negative grants imply that the utility of grantee diminish instead of increasing. Using Boulding’s words “Negative grants, unfortunately, are still an important element in the world system, especially in international system where the defense industries of the various countries are mainly concerned with producing the capability of making of negative grants to other countries”\(^{18}\). Negative grants are costly for both actors. First the ‘negative’ grantor employs an amount of resources that could be employed in productive activities. Secondly, the recipient actor the grantee, is expected to suffer an injury. This situation recalls the distinction described above between productive and unproductive activities.

‘Implicit grant’ is another interesting concept in Boulding’s theory. In Boulding’s definition, “implicit grants may be defined as redistribution of income or wealth that takes place as a result of structural changes or manipulations in the set of prices and wages, licenses, prohibitions, opportunity or access”\(^{19}\). A first example of implicit grants is monopoly. It is expected to distort the distribution of income in favour of monopolist. Hence, it can be interpreted as an implicit grant towards the monopolist, given that consumers are obliged to pay higher prices of monopolized commodity. Consider also a tariff. Once a tariff is levied, it is intended mostly to favour some home producers negatively affecting both consumers and foreign producers.

\(^{18}\) Boulding (1973) p.22
\(^{19}\) Boulding (1973), p. 49.
The examples given up to this point, however, throw light on a particular aspect of each of the three systems. The threat systems, the exchange systems and the integrative systems, in fact, are not likely to occur in pure form. Each situation, when we analyse it, can contain elements of more than one system. In labour relationships, for instance, the threat relationship is intertwined with exchange and integrative ones. The nation-state also offers plenty of examples of hybrid relationships. Take again taxes and transfers: the government threatens individuals of expropriation if they do not pay taxes; individuals pay taxes, both under threat and also trusting the state administration to provide some public goods (that is, there is a form of exchange). The state provides monetary transfers or direct services to citizens.

Hybrid relationships also emerge in international scenarios. Consider again foreign aid. It is supposed to be a unilateral transfer without counterbalance and to be provided to address issues of poverty and development. It does, but it is also designed to pursue foreign policy objectives of donor countries. In many cases the recipient country is expected to comply with some political obligations in return.

Then, it is possible to roughly classify institutions, regimes, organisations in regard to the proportions of threat, exchange and integrative elements they involve. Boulding creates a ‘Social Triangle’\textsuperscript{20} to illustrate these proportions. At any inner point, say A,

\textsuperscript{20} Boulding presents his Social Triangle both in Boulding (1973, p.107-109) and in Boulding (1985a, p. 85-87).
there is a interconnecting of three systems. The closer is point A to the apex ‘threat’ the more threat there is and so on.

This contributes the underlying conceptual framework of this work. I shall try to capture the impact of an integrative relationship. Boulding devoted particular attention to the extent and occurrence of foreign aid as an extraordinary example of the international grants economy\textsuperscript{21}. However, this does not appear to me as the unique integrative relationship emerging within an international scenario. I maintain that an integrative relationship occurs whenever countries agree to establish an international institution devoted to strengthen exchange interactions between them. Since the occurrence of the integrative system altogether with exchange is supposed to corner

\textsuperscript{21} The argument is mainly expounded in the sixth chapter of Boulding (1973).
threat system, it is also expected to provide a rationale for a ‘peaceful’ settlement.

1.4 BASIC CONCEPTS AND DEFINITIONS FOR THE CONTINUATION OF THIS WORK

In the furtherance of this work I shall apply some ideas presented above. Hereafter, I summarise some recurring basic concepts grounding the whole work.

First, conflict is a permanent feature of economic activities. Then, the extreme cases of conflict and harmony do not occur, namely a total peace or a total war. This idea is consistent with one of the basic concepts expounded by Schelling (1960): “In fact, the richness of the subject arises from the fact that in international affairs there is mutual dependence as well as opposition. Pure conflict, in which the interests of two antagonists are completely opposed is a special case; it would arise in a war of complete extermination, otherwise not even in war”\(^{22}\). And it is also assumed by Hirshleifer (1991/2001): “War and Peace, or more generally conflict and settlement, are usually regarded as mutually exclusive.[…]But it will be convenient here to employ a paradigm in which the choice is not between ‘going to war’ and ‘making peace’. Instead, the parties choose a steady state strategy along a continuum ranging between the extremes of struggle and accommodation”\(^{23}\). Given the existence of conflict parties divide their resources between productive and unproductive activities, namely between ‘butter’ and ‘guns’.

\(^{22}\) Schelling (1960), p.4
Moreover, I borrow Boulding’s idea of the three systems governing human affairs, practically never occurring in pure form. Hence, there are three different ‘states of the world’ according to which system has the dominance on the others.

1) a ‘continuing conflict’ scenario. This definition is borrowed by Hirshleifer (1987b). In such case conflict is the first option of agents. The world is assumed to be anarchic and each agent makes its optimal choice of level of arming.

2) the ‘obstructed trade’ scenario. In this scenario, agents face a trade-off between conflict and settlement. Exchange activities between agents are obstructed through a complex range of trade policies affecting agents’ incentives.

3) in the ‘institutional scenario’, agents give up a certain amount of resources in order to bind themselves into an institution committed to implement a shared set of rules.

In these three ‘states of the world’ incentives for conflict of settlement change. How do they relate with the three systems, threat, exchange and integrative? It had been already noted that these do not occur in pure form. They co-exist and interact. Thus, it should appear clear that, within this framework, in different states of the world there is a dominance of one system on the others. Take the ‘continuing conflict’ state of the world: here, the threat system is supposed to dominate the other two systems, exchange and integrative. That is, the exchange of ‘bads’ is overwhelming the exchange of goods and the grants relationships. In the ‘obstructed trade’ scenario, the exchange system prevails, although it is not perfect due to the existence of unnatural impediments. Some of such
impediments are related to the threat relationships. In the latter, the ‘institutional’ scenario, the exchange system is supposed to be positively affected by the integrative system. Agents have an incentive to give up some resources in order to achieve a higher utility.

In all these scenarios, the threat relationship, namely the exploitation of potential force is captured through the investments in unproductive resources of arming, say ‘guns’. Then, in the next chapters, I shall look at the following elements in order to qualitatively define the results of the models:

1) the optimal level of resources devoted to conflict activities, namely the optimal choice of arming that occurs in all these three scenarios. A scenario can be defined more or less ‘peaceful’ by looking at this element. Let $z^j$ denote the level of ‘guns’ in scenario $j$. More precisely, given a symmetric equal level of arming, if $z^A < z^B$ I shall say that the scenario ‘A’ is more ‘peaceful’ than ‘B’.

2) the level of utility reached in equilibrium by each agent is also taken into account. Regardless of level of arming, the optimal choice of agents is driven by the level of overall utility that each agent can reach in the three different ‘states of the world’.
CHAPTER II
THE ECONOMICS OF CONFLICT

This chapter is devoted to explain the economic approach to conflict. Then, it is mainly devoted to the analysis of the basic model presented in Hirshleifer (1988). In a first part I present the Hirshleifer’s work. Secondly I extend Hirshleifer’s analysis in order to evaluate the impact of different production functions on the optimal choice of ‘guns’ for both parties. In a third section, I present some other recent theoretical contributions.

2.1
MODELING CONFLICT: HIRSHLEIFER’S CONTRIBUTION

Undoubtedly the pioneering work on conflict in recent literature is by Jack Hirshleifer, whose foundations are in Hirshleifer (1987a, 1987b, 1988). More specifically, he introduces the study of conflict by using the Contest Success Function. Hirshleifer’s basic concepts are:

(i) conflict and ‘peace’ are not mutually exclusive situations. Individuals, groups, nations, are not totally at war or totally at peace. According to this view, actors choose a strategy along a continuum ranging between the extremes of struggle and accommodation;

(ii) therefore, they divide their energies between ‘[...]peaceful productive activities on the one hand, and on the other hand warlike or ‘appropriative’ efforts designed to seize resources previously controlled by others[...]’.¹

¹ Hirshleifer (1987), p. 2
(iii) the resources devoted to production determine the available total output whilst the resources devoted to coercion and appropriation determine its distribution through the properties of a CSF\(^2\). That is, production determines total output, whilst the conflict determines its distribution;

(iv) Hirshleifer’s model is intended to build up a general equilibrium model. A general equilibrium approach is supposed to present an explicit provision for the alternative productive or consumptive uses of resources. Moreover, a general equilibrium model is also supposed to make the value of contested ‘prize’ an endogenous variable. This is a main difference between Hirshleifer’s model and the rent-seeking literature, where only partial equilibrium analyses are commonly elaborated.

Then, the basic modelling of conflict features the optimising behaviour of some agents, allocating their resources into productive (devoted to exchange) and directly unproductive activities (devoted to fighting and deterrence).

Consider a two agents world. Agents are not perfectly defined in their details, but, given the main topic of this work, they are implicitly assumed to be countries acting on an international scenario. The world arena is also assumed to be anarchic. There is no supranational institutional framework established in order to bind agents’ behaviour.

\(^2\) Note that in Hirshleifer (1987,1988) the CSF is defined as Combat Power Function.
A pure exchange environment does not exist. Conflict is a permanent feature. Coercive activities as appropriation, predation, and war co-exist with exchange interactions.

In this kind of scenario, agents face a trade-off between productive activities and coercive activities. The two agents are assumed to be rational, risk-neutral and utility maximizers. Moreover there is common knowledge about these assumptions. Agents are self-interested, neither benevolent nor malevolent with regard to other. Agents make simultaneous once-and-for-all choices about their own allocation of resources between ‘butter’ and ‘guns’. Such an assumption rules out issues involving timing.

Hence, each player does maximize its own payoff expecting that the opponent is choosing the similar maximization strategy. This follows the common knowledge assumption. Then, each opponent has an initial stock of resource that is to be allocated between the productive activities and unproductive activities, namely ‘butter’ and ‘guns’. The resources allocated to productive activities determine a total output, say the ‘pie’, that is to be distributed according the resources allocated to the unproductive activities.

Then, the classical economic model of conflict involves four equations\(^3\). (a) a Resources Partition Equation; (b) an Aggregate Production Equation that is characterized by constant returns to scale and constant elasticity of substitution (CES); (c) the Contest Success

\(^3\) This basic specification introduced by Hirshleifer has gone through several re-formulations and revisions by other scholars. Section 2.4 is devoted to survey a selected share of recent literature on conflict. The main contributors to such recent literature have been Michelle Garfinkel, Herschel Grossman, Stergios Skaperdas and Constantinos Syropoulos.
Function determining the outcome of conflict; (d) an income distribution equation. In formal terms, let \( i = 1,2 \) denote respectively contender 1 and contender 2. The **Resources Partition Equation** in general form is defined by:

\[
n_i = (x_i, y_i, z_i), \forall i
\]

where \( n_i \) indicates the exogenous amount of resources given to each player; and \( x_i, y_i, z_i \) denote the productive efforts, the home productive efforts and appropriative efforts respectively. The simplest version of (1) takes an elementary form and omits home production, \( y_i \).

\[
n_i = x_i + z_i, \forall i \quad (1a)
\]

The productive efforts of agents are reflected into the **Aggregate production function** that in its general form can be written:

\[
Y = f(x_i), \forall i
\]

\( Y \) represents the total aggregate social contestable output available for redistribution between the two agents, which is a function of the parties commitments to contestable production. Function (2) can take specific forms. Hirshleifer (1987b) suggests three alternative specifications for the two-players case:
\[ Y = x_1 + x_2 \] (2a)

\[ Y = (a_1 x_1 + a_2 x_2)^g \] (2b)

\[ Y = (a_1 x_1^{1/s} + a_2 x_2^{1/s})^s \] (2c)

In (2b) and (2c) \( a_1, a_2 \) represent the productivity coefficients for the two parties. In (2b) \( g \) is an index of return to scale, and in (2c) \( s \) is an index of productive complementarity. Equation (2b) allows both for increasing \((g > 1)\) and decreasing \((g < 1)\) returns to scale. Equation (2c) allows for negative or positive productive complementarity. Version (2c) is a Constant Elasticity of Substitution (CES), popular for both production and utility functions. The parameter that commonly denotes the degree of substitution between inputs will capture, in this application the degree of integration between parties. Hence, the aggregate production depends upon the efforts devoted to productive activities, the technological level applied to them and also the degree of integration.

The outcome of the conflict is determined through a **Contest Success Function**\(^4\) (hereafter CSF for brevity). It summarizes the relevant aspects of what Hirshleifer defines the *technology of conflict*. It is a mathematical relation that links the outcome of a contest to the efforts of participants. Thus, it indicates how the resources devoted to conflict determine the appropriative success. Let \( p_i \) denote the

\(^4\) Seminal works including the CSF are Tullock (1980), O’Keeffe et al. (1984) and Rosen (1986). See the appendix for a comprehensive overview of CSF forms and properties.
probability of winning the contest, for each player \( i = 1,2 \). Under the assumption of risk-neutrality, they also are considered as proportions of appropriation. Under the condition \( p_1 + p_2 = 1 \), \( p_1 = 1 - p_2 \).\(^5\)

\[
p_i = p(z_1, z_2) \quad \text{for } i = 1,2
\]

(3)

where \( p_1 \) is increasing in the first and decreasing in the second argument. Hirshleifer (1987b, 1989) analyses the different impact of two different function form for CSF: the ratio form and the logistic form. In the first case, the contest outcome depends upon the ratio of the efforts applied, whilst in the second case it depends upon the difference between the resources committed. Different versions of the ratio form for the CSF are:

\[
p_1 = \frac{z_1}{z_1 + z_2}; \quad p_2 = \frac{z_2}{z_1 + z_2}
\]

(3a)

\[
p_1 = \frac{z_1^m}{z_1^m + z_2^m}; \quad p_2 = \frac{z_2^m}{z_1^m + z_2^m}
\]

(3b)

\[
p_1 = \frac{(b_1z_1)^m}{(b_1z_1)^m + (b_2z_2)^m}; \quad p_2 = \frac{(b_2z_2)^m}{(b_1z_1)^m + (b_2z_2)^m}
\]

(3c.1)

where \( b_1 \) and \( b_2 \) are constant coefficients of fighting effectiveness and the parameter \( m \) is a mass effect parameter. Hirshleifer defines it

\(^5\) O’Keefe et al. (1984) presents a version of CSF which does not satisfy such condition. It is the case of unfair contests.
as a decisiveness parameter. That is, the degree to which a superior input ratio $z_1/z_2$ translates into a superior proportionate success ratio $p_1/p_2$.

More precisely, for 2 players:

$$\frac{p_1}{p_2} = \left( \frac{b_1 z_1}{b_2 z_2} \right)^m$$  \hspace{1cm} (3c.2)

When the mass effect parameter $m$ changes, the outcome of the contest also changes. In particular, when $m \leq 1$ diminishing returns to commitments hold. Otherwise, when $m > 1$, there is an initial range of increasing returns up to an inflection point.

A second functional form for CSF is the logistic form. In such a case the success depends upon the difference between the magnitudes of the resources committed.

$$p_1 = \frac{1}{1+\exp[k(b_2 z_2 - b_1 z_1)]} \quad \text{and} \quad p_2 = \frac{1}{1+\exp[k(b_1 z_1 - b_2 z_2)]}$$  \hspace{1cm} (3d)

where $k$ is the mass effect parameter in the logistic equation.

The main difference between the two functional forms of CSF becomes clear when one party, say party 1, puts in zero appropriative effort. Using the ratio form, it necessarily follows that $p_1 = 0$. By contrast, using the logistic form, a party committing zero effort can achieve some degree of appropriative success.

Which of these forms should be used? Quoting Hirshleifer (1989): “In a military context we might expect the ratio form of the Contest
Success Function to be applicable when clashes take place under so close ‘idealized’ conditions such as: an undifferentiated battlefield, full information, and unflagging weapons effectiveness. In contrast, the difference form tends to apply where there are sanctuaries and refugees, where information is imperfect, and where the victorious player is subject to fatigue and distraction. Given such ‘imperfections of the combat market’, the defeated side need not loose absolutely everything”.

The income realized by either party will be the sum of a fraction of total contested output any party is able to retain plus any home income, defined as a function of \( y_i \). Hirshleifer defines it

**Income Distribution Equation**, that can be written in general and alternative forms as:

\[
U_i = \psi(Y, p_i, y_i)
\]

\[
U_i = p_i Y
\]

\[
U_i = \omega_i + p_i Y, \text{ with } \omega_i = \psi(y_i)
\]

It is also possible to assume that the parties have some protected or invulnerable fractional entitlements of overall output available to them. Denote those as \( \alpha_1 \) and \( \alpha_2 \), where \( \alpha_1 + \alpha_2 = 1 \). In such a case another feasible definition of (4) is:

\[
U_i = Y\{\alpha_i + p_i(Y - \alpha_1 - \alpha_2)\}
\]
2.1.1
CONTINUING CONFLICT UNDER THE COURNOT PROTOCOL

For simplicity Hirshleifer first analyses the simplest case. Equations (1a), (2a), (3a), (4a) denote the aggregate production function in its simple linear additive function, the CSF and the utility function respectively in its simplest form. The simplest version of the resources partition equation, omits home production; in such a case the contested output becomes more vital for contenders. Equations (2a) and (3a) also assume that technology is neutral \( a_1 = a_2 = 1 \), that parties have equal coefficients of fighting effectiveness \( b_1 = b_2 = 1 \) and that conflict is not decisive \( m = 1 \).

Through ordinary constrained maximization it is possible find the reaction curves for each player. They show each player’s optimal fighting effort for any given choice of the contender. The Cournot solution occurs at the intersection of the two reaction curves. Players’ maximization problem can be expressed as:

\[
\text{max } U^i = \frac{z_i}{z_i + z_j} (x_i + x_j) \\
\text{s.t. } n_i = x_i + z_j \\
i, j = 1, 2; i \neq j
\]  

(5)

The Lagrangian is given by:

\[
L^i = \frac{z_i}{z_i + z_j} (x_i + x_j) - \mu (x_i + z_j - n_j)
\]  

(6)

First order conditions for player \( i \) are:

\[
\frac{\partial L}{\partial z_i} = \frac{z_j}{(z_i + z_j)^2} (x_i + x_j) - \mu = 0
\]  

(7)
\[
\frac{\partial L}{\partial x_i} = \frac{z_i}{z_i + z_j} - \mu = 0
\]
\[
\frac{\partial L}{\partial \mu} = x_i + z_i - n_i = 0
\]

The optimal choice must satisfy these three first order conditions. Then, by solving the system (7) it is easy to obtain the reaction curve for player \( i \) (RC \( i \)):

\[
\frac{z_i}{z_j} = \frac{x_i + x_j}{z_i + z_j}
\]  
(8)

Reaction curves intersect at \( z_1 = z_2 = 0 \), but this intersection is not a Cournot equilibrium. In fact, if (say) player 1 chooses \( z_1 = 0 \), then the opponent would rationally invest any small positive magnitude in ‘arms’ in order to raise the probability of its fighting success to 100%. Thus, reaction curves are defined only over the open interval that does not include the singular point at the origin. By substituting the constraint into equations and manipulating, we obtain:

\[
z_i = \sqrt{z_j(n_i + n_j)} - z_j
\]  
(9)

The interior Cournot solution is given by:

\[
z_i = z_j = (n_i + n_j) / 4
\]  
(10)
Whatever the amount of resources available for each player, the contenders allocate devote the same effort to ‘guns’. Indeed, exactly half of the available resources are dissipated in mutually wasteful fighting efforts. At the same time, the available output is equally divided between the two contenders. Formally we have:

\[ U_1 = U_2 = \frac{1}{4} (n_1 + n_2); \quad (11) \]

In the symmetric limiting case of equal resource endowments they devote exactly \( z_i = z_j = n/2 \) to fighting efforts. When there are asymmetries, the wealthier party devotes relatively fewer resources to conflict than poorer side.

Representing the model as a game in its normal-form representation, I consider two symmetric players playing a one-shot game. For sake of simplicity consider \( n_1 + n_2 = 1 \). Players 1 and 2 simultaneously choose the level of ‘butter’ and ‘guns’ from their feasible sets. The level of ‘guns’ is the choice variables, with the level of ‘butter’ then being determined from the players’ resource constraint.

<table>
<thead>
<tr>
<th>Player 1</th>
<th>Guns</th>
<th>No Guns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guns</td>
<td>4/4</td>
<td>1,0</td>
</tr>
<tr>
<td>No Guns</td>
<td>0,1</td>
<td>1/2</td>
</tr>
</tbody>
</table>

\[ Table 2.1 \text{ Normal form of Hirshleifer’s basic model} \]
First, with regards to the strategy (no guns, no guns) assume that if neither player holds arms they share the output equally, namely \( p(0,0) = 1/2 \). The strategy (no guns, no guns) is a Pareto-efficient social optimum.

Secondly, consider the case of a winner-take-all mechanism. The ratio form of the CSF implies that if one of the two contestants does not allocate any resource to ‘guns’, the other party does appropriate all the contested output, namely \( p_i(z, 0) = 1, \forall z \in (0, \infty) \). Then, either party would be likely to defect and invest any small positive magnitude in order to raise its fraction of the aggregate output from 50% to 100%, in order to appropriate all the output, say the ‘pie’\(^6\). Thus, if player 1 chooses not to invest in ‘guns’, it will receive a zero payoff, while player 2 will receive the payoff full and vice versa. Thus, for each player, investing in ‘guns’ is the dominant strategy. Since rational parties do not play dominated strategies the outcome reached will be a positive level of ‘guns’ for both players. The dominant strategy (guns, guns) is the Nash-Cournot equilibrium. If ‘peace’ can be defined as the condition in which \( z_1 = z_2 = 0 \), peace can never occur as a Cournot equilibrium under the ratio form of CSF.

---

\(^6\) Hirshleifer (1989, p. 105) also notes that the contested ‘prize’ must be larger than zero. “Then, assuming only that \( V > 0 \) [where \( V \) is the value of the prize], under the Cournot assumption either player would be motivated to defect, since even the smallest finite commitment of resources makes the defector’s relative success jump from 50% to 100%.”,
For an interior solution, the upper-bound constraint on allocation of resources to guns is $z_i \leq n_i, i = 1,2$. Hence, the interior solution (10) is a solution if and only if:

\[
\frac{1}{3} < \frac{n_i}{n_j} < 3 \tag{12}
\]

That is to say, an interior solution is reached when the resource disparity is not too large. A corner solution would require that either side’s productive or appropriative efforts to equal its resources endowment. It is possible to identify a critical ratio beyond which the poorer side, say player 2, will be forced to a corner solution (devoting all resources to fighting $n_2 = z_2$) and it is given by:

\[
\rho^* = \frac{n_1}{n_2} = 3 \tag{13a}
\]

Considering the case where the a mass effect parameter $m$ assumes a value other than unity in (3b) Hirshleifer\(^7\) points out the critical ratio is:

\[
\rho^* = \frac{n_1}{n_2} = \frac{2 + m}{m} \tag{13b}
\]

Thus, two circumstances can lead to a corner solution: (i) a significant resource disparity between players; (ii) the magnitude of mass effect parameter, i.e. the degree of decisiveness of conflict. The

larger is $m$, the greater is the marginal impact of appropriation relative to productive activity.

Up to this point, the main results under the Cournot protocol are: (a) a total peaceful scenario is not reachable; (b) the poorer side devote in relative terms more resources to ‘guns’ than the richer opponent; (c) if resource disparity is greater than a critical ratio, the poorer side enters the range of a corner solution and devote all the resources to ‘guns’.

The last result introduces what Hirshleifer (1991) defines *The Paradox of Power*. In a contest, he says, the initially disadvantaged group has an incentive to fight harder. By fighting, the less endowed side improves its relative position with respect to the better-endowed rival. Through appropriative activities, the poorer side has an opportunity to “tax” the opponent productive effort. “*In wars, smaller or poorer nations have often fought much larger ones to a standstill, the recent Vietnam conflict being but one instance. As a more general historical phenomenon, from earliest times poor nomadic tribes have successfully preyed upon more affluent cities and empires.*”

Continue supposing agent 2 is the poorer side. Differentiating (4a) for player 2 with respect to $z_2$ and $x_2$ yields:

$$\frac{\partial U_2}{\partial x_2} = \frac{z_2}{z_1 + z_2}$$ \hspace{1cm} (14a)

$$\frac{\partial U_2}{\partial z_2} = \frac{z_1(x_1 + x_2)}{(z_1 + z_2)^2}$$ \hspace{1cm} (14b)

---

Equation (14a) denotes the marginal payoff of productive activities, whilst equation (14b) denotes the marginal payoff of fighting activities. When the resource endowment \( n_2 \) is small, then \( x_2, z_2 \) and must be small. As \( n_2 \) goes to zero, the marginal payoff of fighting effort remains positive whilst the marginal payoff of productive activities becomes negative. Substituting (1a) into (14a) and (14b), It is possible to write:

\[
\lim_{n_2 \to 0} \frac{n_2 - x_2}{n_1 - x_1 + n_2 - x_2} = 0 \tag{15a}
\]

\[
\lim_{n_2 \to 0} \frac{(n_1 - x_1)(x_1 + x_2)}{(n_1 - x_1 + n_2 - x_2)^2} = \frac{(n_1 - x_1)(x_1 + x_2)}{(n_1 - x_1 - x_2)^2} > 0 \tag{15b}
\]

As \( z_2 \) goes to zero the marginal payoff of fighting again remains positive, that is:

\[
\lim_{z_2 \to 0} \frac{z_2}{z_1 + z_2} = 0 \tag{16a}
\]

\[
\lim_{z_2 \to 0} \frac{z_1(x_1 + x_2)}{(z_1 + z_2)^2} = z_1(x_1 + x_2) > 0 \tag{16b}
\]

Any positive level of \( z_2 \), however small, gives a positive marginal payoff. Thus, a preponderant resource ratio (i.e. \( n_1 / n_2 > 1 \)) is not reflected in a correspondingly large achieved payoff ratio.
Hirshleifer, in particular, distinguishes between a strong form and a weak form of the POP. The strong form applies when contenders have an initial endowment of resources moderately unequal. In such a case, equilibrium can be found in the interior range. The rational strategy implies that the poorer side specialises in fighting rather than in producing, and vice versa.

\[
\frac{U_1}{U_2} = 1 \iff \frac{n_1}{n_2} \leq \rho^* \quad \text{Strong Form of Paradox of Power} \quad (17)
\]

When the resource ratio is larger than the critical ratio, \( \rho^* \), the poorer side devotes all of its resources to fighting. As resource disparity increases, the strong form of the paradox no longer holds. When the resource asymmetry becomes sufficiently large, the opponents enter a corner-solution range where only a weak form of the paradox of power applies. It is defined ‘weak’ because, although no longer equalized, attained incomes could be less unequal than the initial resource endowment, namely

\[
\frac{n_i}{n_2} > \frac{U_1}{U_2} > 1 \iff \frac{n_1}{n_2} > \rho^* \quad \text{Weak Form of Paradox of Power} \quad (18)
\]

A change in conflict technology that raises the mass effect parameter has a contrasting effect on the POP. In fact, as the mass effect parameter becomes larger and larger, the critical ratio, captured by (13b) becomes smaller and smaller. Consider that a richer party can better afford large investments in fighting efforts needed to take advantage in the conflict. Then, the balance of relative
advantage is the result of two countervailing factors. On the one hand, poorer contenders have a comparative advantage in fighting; on the other hand given a high decisiveness of conflict the richer party is better placed to take advantage of it. It is also clear that if $m < 1$ the critical ratio is larger and then the poorer side has an advantage; the strong form of POP applies.

2.1.2 THE CONTINUING CONFLICT UNDER THE STACKELBERG PROTOCOL

Hirshleifer also presents the model under the Stackelberg protocol. The classical Stackelberg argument relates to a bilateral interaction where one party (called the ‘leader’) moves first and the other (called the ‘follower’) moves second. Then, a Stackelberg solution to this asymmetrical interaction is based upon the idea that the follower responds rationally to the choice selected by the first mover or leader. The choice variable is the optimal level of ‘guns’ for both agents. Being the second party’s choice predictable, the leader is able to optimize along the follower’s reaction curve. Assuming an initial resources disparity, within this framework, the Stackelberg leader is also assumed by Hirshleifer to be the wealthier party, while the follower is poorer side. Hence, the timing is so described:

1. The Stackelberg leader, assumed to be the wealthier party, chooses its optimal level of ‘guns’;
(2) The follower observes the choice of the leader and then chooses an optimal level of ‘guns’;

(3) The payoff to party \( i \) is measured according to the utility function.

Let equations \((1a), (2a), (3a) \) and \((4a)\) describe the system, player 1 being the leader. Recall equation \((8)\) which was the reaction curve in the Cournot protocol above. Substituting \( Y = x_1 + x_2 \) and \( p_1 = z_1 / (z_1 + z_2) \) in \((8)^9\) the utility for the player 1 is given by:

\[
U_1 = p_1 Y = z_2
\]  \hspace{1cm} (19)

The Stackelberg leader can maximize \( z_2 \) in the RC2 equation. Since \( U_1 = z_2 \) it is also true that:

\[
\frac{\partial U_1}{\partial z_1} = \frac{\partial z_2}{\partial z_1}
\]  \hspace{1cm} (20)

Deriving \((8)\) with respect to \( z_1 \) yields:

\[
\frac{\partial U_1}{\partial z_1} = \frac{1}{2} \left( \frac{n_1 + n_2}{z_1} \right) - 1
\]  \hspace{1cm} (21)

---

\(^9\) Expression \((8)\) becomes for player 2:

\[
\frac{z_2}{z_1} = \frac{Y}{z_1 + z_2} \Rightarrow z_2 = Y \frac{z_1}{z_1 + z_2} \Rightarrow z_2 = p_1 Y
\]
Setting (21) equal to zero the optimal choice of guns for the leader is:

\[ z_1 = \frac{n_1 + n_2}{4} \]  

(22)

The follower reacts, as predicted, along the RC2. Substituting (22) into RC2 yields:

\[ z_1 = z_2 = \frac{n_1 + n_2}{4} \]  

(23)

Indeed, in an interior solution, the leader and the follower devote the same amount of resources to ‘guns’ and then receive the same payoff. This result is exactly the same as the interior Cournot equilibrium. In fact, given the symmetry of the game and considering both parties’ utility along the other side’s reaction curve, it is possible to write:

\[ U_i = z_2 \text{ along RC2, } U_2 = z_1 \text{ along RC1} \]  

(24)

This means that with the ratio model of CSF there is not any specific advantage in being a Stackelberg leader.

2.1.3

\[ \frac{1}{2} \sqrt{\frac{n_1 + n_2}{z_1}} - 1 = 0 \Rightarrow \sqrt{\frac{n_1 + n_2}{z_1}} = 2 \Rightarrow \frac{n_1 + n_2}{z_1} = 4 \Rightarrow z_1 = \frac{n_1 + n_2}{4} \]
The Threat and Promise (hereafter TAP for brevity) protocol is based upon the existence of a stronger concept of leadership than in Stackelberg protocol. In fact, the Stackelberg leader has the first move, but this does not suffice to say that it also retains a real leadership role. Hirshleifer (1977) in particular stresses the importance in having ‘the last word’. Then, the TAP protocol, in some sense, is the reverse of the Stackelberg mechanism. The TAP leader has at its disposal an effective powerful leadership role. The timing of interaction is:

1. The TAP leader, say controller, pre-specifies a set of threat and promises, that is an optimal reaction function. This can be also called a pre-play move;\(^\text{11}\)
2. The other player, say the subordinate or the target, is allowed to make the first choice of its level of guns;
3. the Controller plays its optimal re-active commitment. That is its ‘last word’.

Then, it is clear that TAP protocol is intended to send a threat or a promise toward the opponent to force it into doing something that otherwise it would not be expected to do. Let controller and subordinate be denoted by subscripts 1 and 2 respectively. Ideally,

---

\(^{11}\) The latter definition is in Hirshleifer (1993) which provides a discussion over the concept of commitment.
the controller would prefer to induce the subordinate to choose a zero level of guns \((z_2 = 0)\), but this is not possible.

Then, assume that the controller chooses a minimum level of guns for the controller, \(z_2 = \bar{z}\). If the subordinate chooses such level of guns the controller issues a promise. If the subordinate chooses \(z_2 > \bar{z}\), the controller has to carry out the threat. In particular, assume threat takes the form of ‘massive retaliation’, namely the controller devotes all its resources to guns. Otherwise, if \(z_2 \leq \bar{z}\) the controller is expected to carry out the promise. The promise takes the form of a payoff for subordinate that “needs only be infinitesimally greater than the maximum the latter could achieve by defiant behaviour”\(^{12}\).

In formal terms:

\[
\begin{cases}
  z_1 = n_1 & \text{if } z_2 > \bar{z} \\
  z_1 = z_1^* & \text{if } z_2 \leq \bar{z}
\end{cases}
\]  

The level of guns, when the promise is \(z_1^*\) can be determined as follows, \(U_2\) can be written as a function of \(z_2\) given \(z_1^*\):

\[
U_2(\bar{z} \mid z_1^*) = U_2(RC2 \mid n_1) 
\]

that is, the subordinate will be allowed to reach a level of utility equal (or rather infinitesimally greater than) that it can achieve by making its best response to the controller’s ‘massive retaliation’ \((z_1 = n_1)\). Under the ratio form of CSF only nonzero amount of guns

---

are achievable. Suppose a minimum threshold level of guns exist, i.e. the minimum nonzero amount possible, say $\bar{z} = 1$. Then the CSF becomes:

$$p_1 = \frac{z_1}{z_1 + 1}; p_2 = \frac{1}{1 + z_1} \quad (27)$$

It is clear from (27) that $\forall z_1 > 1$

$$\begin{cases} p_1 > p_2 \\ U_1 > U_2 \end{cases} \quad (28)$$

Then, the richer and more powerful actor is better off with TAP than in Cournot and Stackelberg protocols, where the attained utilities of parties equalize. In fact, the controller receives a larger fraction of the contestable output. In particular, there is a tremendous advantage in being the controller, even if the controller is the poorer side. Moreover, the parties are closer to the social Pareto optimum, since a lower level of resources is wasted into unproductive ‘guns’.

2.2 SUSTAINABILITY OF ANARCHY

Hirshleifer (1995) addresses the question of whether an anarchic system can break out. Anarchy is defined as spontaneous order in which participants can seize and defend resource without regulation from above. When anarchy becomes ‘amorphy’ or ‘hierarchy’? When is ‘anarchy sustainable? He develops and discusses a model to face
such questions. The formal analysis is akin with the ones presented above having the CSF as cornerstone. The main difference with respect to the basic model is that here agents contest over resources and no longer over the output.

Moreover, Hirshleifer deals with ‘intensities’ (defined as the ratio of fighting efforts over the resource endowment). Resource control is achieved through fighting. Then, the fraction of total resources achieved enters a utility function. The results of the model are:

1) A sustainable anarchic system must be dynamically stable and viable. The condition for dynamic stability is a sufficiently low decisiveness of the struggle. As usual, this is captured by a decisiveness parameter which in the CSF is the degree to which a superior efforts ratio translates into a superior proportionate success ratio. When such a parameter is large, it leads to a movement towards a corner solution. On the other hand, viability requires a sufficiently high payoff (income adequacy). In particular, it must be larger than a minimum share of output required; let \( \tilde{u} \) denote the minimum utility required. The necessary conditions for sustainability of a two-party anarchic system are:

\[
(i) \ m < 1; \quad \text{condition for dynamic stability;} \quad (29)
\]

\[
(ii) \ U_i \geq \tilde{u}, i = 1,2; \quad \text{condition for viability} \quad (30)
\]

2) When the conditions for dynamic stability and viability both hold, in symmetrical conflicts the larger the value of
decisiveness parameter the higher the level of ‘guns’ implied. At the same time, the lower is the cost coefficient (quantifying the resource burden per fighting unit supported) the greater the equilibrium value of fighting efforts.

3) When the conditions for dynamic stability and viability both hold payoffs (i) rise if the aggregate resource availability raises (ii) rise if a productivity parameter rises; (iii) fall when the decisiveness parameter rises; (iv) fall as the production cost coefficient increases.

4) When the conditions for sustainability hold, as the number of contenders grows exogenously, the equilibrium fighting efforts increase. Also in this case, the income attained for each player falls. Individual utilities fall because of (i) the smaller pro-rata resource share and (ii) the greater equilibrium level of guns. Result (ii) also implies that resource availability increases in proportion to the numbers of contenders, while individual utilities still fall because of the greater level of guns.

5) If population increases or decreases according to a Malthusian framework, the viability limit \( \bar{u} \) becomes a kind of zero profit condition which will establish the viable number of contestants.

6) The Stackelberg solution, as compared with the symmetric Cournot solution, involves reduced fighting on both sides, but the follower gains relative to the leader. As a first mover, the Stackelberg leader chooses a fighting intensity to which the opponent optimally responds. If player 1 as leader were to choose a smaller intensity of fighting than Cournot, player 2 would also react with a smaller
intensity. When the conflict is not decisive the reaction curves have positive slopes throughout. In the neighbourhood of equilibrium the best reply to an increase/decrease in the opponent’s fighting efforts is less than one for one. Hence, even if the leader gains in absolute terms, it loses in relative terms. Hirshleifer considers the example of arms reduction process: if there is a nation which takes the initiative in disarmament (the leader), the model predicts that the opponent (the follower) partially disarm, leaving the first disarmer at a relative disadvantage.

2.3

**DIFFERENT PRODUCTION FUNCTIONS AND LEVEL OF GUNS**

In this section, I present some extensions of Hirshleifer’s basic model. In particular, I try to evaluate the impact of different functional forms for the aggregate production. Equilibrium choices of ‘guns’ are expected to be affected by them. However, given the analytical complexity only reaction curves for both agents will be derived. Then, a first section analyses a Cobb-Douglas specification for the production function. A second part is devoted to evaluate the contrasting impact of interdependence, decisiveness and destructiveness.

2.3.1 A COBB-DOUGLAS PRODUCTION FUNCTION

The specification of the aggregate production function intuitively can be supposed to affect the results of the model. It can be showed,
however, that applying a Cobb-Douglas specification the main findings of the model are not subject to any overthrow. Let equations (1a), (3a) and (4a) denote the resource constraint, the CSF and the utility function respectively. The production function specification is:

\[ Y = x_1^\alpha x_2^\beta \]  

(31)

where \( Y \) is the aggregate output. I assume constant returns to scale (CRS). In modelling conflict it is possible to say that \( x_1, x_2 \) denote the contribution of each party to the total output that will be the object of the contest and \( \alpha,\beta \) provide information on the size and productive capacity of the party. Then, if \( \alpha > \beta \) I assume that, given a higher contribution to the aggregate output, agent 1 will also be considered both larger and more productive than the opponent.

The maximization problem is:

\[
\text{max } L' = \frac{z_i}{z_i + z_j}(x_1^\alpha x_j^\beta) - \mu(x_i + z_i - n_j) 
\]

(32)

Reaction curves for agent 1 and agent 2 are respectively:

\[ z_1 = \frac{z_2 \cdot x_1}{\alpha \cdot z_1 + z_2} \]  

(33a)

\[ z_2 = \frac{z_1 \cdot x_2}{\beta \cdot z_1 + z_2} \]  

(33b)
It appears that the optimal choice of ‘guns’ of each agent is negatively related to its share in total aggregate production confirming the Hirshleifer Paradox of Power in a broader sense: the larger and the more productive an agent is, the relatively less involved it will be in fighting. The main result, applying a Cobb-Douglas specification, is that solutions are not symmetric. Whilst in the elementary specification the reaction curves (8) intersect on the 45 degrees line, in the Cobb-Douglas case they do not, except in the case where the following conditions simultaneously hold: $\alpha = \beta, n_1 = n_2$.

Substituting the resource constraint into (33a) and (33b) therefore they become:

$$z_1 = \frac{z_2 n_1 - z_1}{\alpha z_1 + z_2} \quad (34a)$$

$$z_2 = \frac{z_1 n_2 - z_2}{\beta z_1 + z_2} \quad (34b)$$

Equations (34a) and (34b) suggest that initial resources endowment and the share in the aggregate production function may have a contrasting impact.

Does a greater resource endowment offset the negative effect on ‘guns’ of production-share? Call **Resource Effect** the impact of initial resources endowment on the level of ‘guns’ and **Participation Effect** the impact of the share in the Cobb-Douglass aggregate production function. Assuming for analytical simplicity that
\( n_1 + n_2 = 1 \), I run some simulations by giving arbitrary different values to \( n_1, n_2, \alpha, \beta \). The graphs below depict different situations:

(i) parties are equally endowed, \( n_1 = n_2 \) but the contribution of party 1 to production is greater than party 2, \( \alpha > \beta \). (Fig. 2.1);
(ii) party 1 has a larger initial endowment than party 2, \( n_1 > n_2 \), party 1 also contributes to aggregate production more than party 2, \( \alpha > \beta \). (Fig. 2.2);
(iii) party 1 has a larger initial endowment than party 2, \( n_1 > n_2 \), party 2 contributes to aggregate production more than party 1, \( \alpha < \beta \). (Fig. 2.3).
Fig. 2.2
Reaction Curves $n_1 > n_2; \alpha > \beta$

Fig. 2.3
Reaction Curves $n_1 > n_2; \alpha < \beta$
In fig. 2.1, it is clear that party 1, characterised by a lower contribution to the aggregate function, arms less than the opponent. That is, if \( n_1 = n_2 \) with \( \alpha > \beta \), then \( z_1 < z_2 \).

In fig. 2.2, party 1 is assumed to be initially wealthier than the opponent, and at the same time it also contributes more to the aggregate function than party 2. In such a case, the resource effect offsets the participation effect: party 1 arms more than party 2, namely \( z_1 > z_2 \).

In fig. 2.3, party 1 is again initially better endowed than party 2, but it is a ‘lazy’ contributor to the aggregate production since the less-endowed party does contribute more, \( \beta > \alpha \). Again the resource effect offsets the participation effect and party 1 arms more than party 2. These latter outcomes contrast with the Hirshleifer’s Paradox of Power. In fact, in both case (ii) and case (iii) the better endowed party will invest more in guns than the opponent.

2.3.2 THE IMPACT OF INTERDEPENDENCE, DECISEVENESS AND DESTRUCTIVENESS

In this section the production and the contest functions are assumed to take different forms, in order to study the complex impact of productivity complementarity, expected destructiveness and decisiveness of conflict. Recall that the latter is captured through the mass effect parameter, \( m \), while the productive complementarity through \( s \) in the production function. The resource constraint is given by (1a). Let the production function take the CES form (2c) assuming for analytical simplicity that the productivity coefficients
for the two parties $a_1, a_2$, are both equal to unity. The aggregate production function reduces to:

$$Y = (x_1^{1/s} + x_2^{1/s})^s$$  \hspace{0.5cm} (35)

If $s = 1$, equation (35) assumes the simple linear additive form and the elasticity of substitution between the two inputs is infinite; when the parameter $s$ rises the productive complementarity rises. Using Hirshleifer’s terminology, the higher is $s$, the higher is the ‘degree of integration’ between the two agents.

Let the CSF be (3b) and the utility function (4a), modified it by means of a new parameter $\beta \in (0,1)$ that captures the expected real ‘destructiveness’ of conflict (where $\beta = 0$ means totally destructive). That is, the expected utility is based only a upon fraction $\beta$ of the contested output, $Y(x_1, x_2)$. The utility function for both players can be written:

$$U_i = p_i \beta Y$$  \hspace{0.5cm} (36)

From the Lagrangian:

$$\text{max } L = \frac{\beta z_i^m}{z_i^m + z_j^m} (x_1^{1/s} + x_2^{1/s})^s - \mu(x_i + z_i - n_i)$$  \hspace{0.5cm} (37)

The first order conditions can be derived:
Solving the system (38) it is possible to find the reaction curve for the two players (39).  

\[
\begin{align*}
\frac{\partial L}{\partial z_i} &= \frac{\beta mz_i^{m-1}(z_i^m + z_j^m) - \beta z_i^m m z_i^{m-1}(x_i^{1/s} + x_j^{1/s})^s}{(z_i^m + z_j^m)^2} \mu = 0 \\
\frac{\partial L}{\partial x_i} &= (x_i^{1/s} + x_j^{1/s})^{1-s} x_i^{s} \frac{\beta z_i^m}{z_i^m + z_j^m} - \mu = 0 \\
\frac{\partial L}{\partial \mu} &= x_i + z_i - n_i = 0
\end{align*}
\]

(38)

Note that the parameter denoting the destructiveness of conflict cancels out, defining each player fighting efforts in terms of the opponent fighting efforts. They also relate this choice to the decisiveness and complementarity parameters. Note that if \( m = s = 1 \), then reaction curves reduce to (8).

These equations show that \( m \) and \( s \) exercise contrasting effects on the optimal choice of guns: the higher is \( m \) the higher the amount of resources devoted to fighting. That is, the decisiveness of conflict increases the fighting efforts of opponents. On the contrary, the higher is \( s \), the lower the amount of resources devoted to fighting.

To verify this, assume for simplicity \( m = 1 \); for any \( s > 1 \) the following relation holds:

\[
(n_1 - z_i)^{s-1} [(n_1 - z_i)^{1/s} + (n_2 - z_2)^{1/s}] > (n_1 - z_1 + n_2 - z_2)
\]

(40)
Hence, the productive complementarity between parties involve less efforts in conflicting.

Summarizing the results, it is possible to write the following results:

(i) The degree of destructiveness does not affect the optimal choice of ‘guns’. The result of the simplest model is confirmed. The parties do not relate their choices of arms to the destructiveness of the conflict.

(ii) Productive complementarity between parties implies a lesser amount of resources devoted to ‘guns’. That is, as economies become more intertwined, the contenders are less devoted to fighting, wasting resources in unproductive activities. This seems to confirm the liberal idea according to which economic interdependence leads to more harmonious relations between states.

(iii) As conflict becomes more decisive, the contenders have an incentive to choose higher levels of ‘guns’. This is again in line with Hirshleifer’s analysis. The parameter $m$ can be intuitively linked to some aspects as military capabilities, geography and political regime of states. First, military capabilities of opponents determine the degree of decisiveness. Imagine an opponent armed with cannons and the other armed with machetes. In such a case, it is simple to think that the parameter $m$ would be large. On the contrary, a lower $m$ refers to the case when such decisiveness does not exist.
Hirshleifer quotes World War I scenario “the entrenchment plus the machine gun made for very low decisiveness”\textsuperscript{13}. Moreover, he also points out that political regimes affect the decisiveness factor. Indeed, democratic regimes are supposed to moderate the impact of pro-conflict factions, whilst in other political systems, dictatorships for instance, the pro-conflict factions, if in charge, can induce a higher decisiveness of conflict.

Geographic features also matter. In his Conflict and Defense, Boulding (1962b), introduces the concept a loss-of-strength-gradient (LSG) of nation, i.e. the degree to which its military and political power diminishes moving away from its home base. The LSG continually decreases as the distance increases. The costs of transport obviously affect the impact of distance in determining the outcome of conflict. Moving on a twin path, it is possible to say that the larger the distance the lower is $m$. Needless to say, the sole distance does not exhaust the impact of geographic factors. The existence of natural barriers for example (mountains, sea etc.) should also be considered. A lower $m$ corresponds to the defence having the upper hand (Hirshleifer, 1995).\textsuperscript{14}

\textbf{2.3.3 TECHNOLOGICAL ASYMMETRY}

Up to this point, only the symmetric case for technological productivity has been considered. That is, the parties were assumed to be perfectly symmetric in technology applied to productive


\textsuperscript{14} In a contest on a market share, it can be related to some other factors as geography, for example, that, \textit{ceteris paribus}, do affect the outcome.
activities. Now, it is possible to relax this assumption moving towards a more realistic scenario. Let the resource constraint be given by (1a), the production function by (2c), the CSF by (3b) and the utility function by (4a). The same optimisation process yields the reaction curves both for agent 1 and agent 2 are:

\[ z_i = z_j \left( \frac{\sum_{s=1}^{x_i} x_i^{s-1}}{a_i} \left( \frac{m(a_i x_i^{1/s} + a_j x_j^{1/s})}{z_i^m + z_j^m} \right) \right) \quad (41) \]

Consider \( s = 1, m = 1 \) for analytical simplicity using (2c), then re-write (41) as:

\[ z_i = z_j \left( \frac{1}{a_i} \left( \frac{Y}{z_i + z_j} \right) \right) \quad (42) \]

This expression shows that the optimal choice of \( z_i \) is negatively related to its technological productivity (\( \frac{\partial z_i}{\partial a_i} < 0, i = 1,2 \)). The more productive the agent, the lower its incentive to arm. This result appears to be surprising, but it is not. In fact, being the more productive agent better off in producing instead of fighting, it will have a higher incentive to devote resources to butter. In a broader sense, this result also confirms the Hirshleifer Paradox of Power. On the other hand, the higher the contestable aggregate output, the higher will be the level of guns for each party (\( \frac{\partial z_i}{\partial Y} > 0, i = 1,2 \)).
2.4

THEORIES ABOUT CONFLICT

This section is devoted to survey selected recent literature on conflict. A large part of it can be considered as an offshoot of Hirshleifer’s seminal work.

This survey of conflict models is partly organised in chronological order and partly based on analytical complexity in order to reconstruct the path of this common-grounded particular approach in modelling conflict. For clarity’s sake I will need at time to repeat some concepts and definitions that constitute the common ground of this literature\(^{15}\).

The main recent contributors are Michelle Garfinkel, Herschel Grossman, Stergios Skaperdas, Constantinos Syropoulos and Hugh M. Neary. They extended Hirshleifer’s basic model adding new features and insights. The common base of their papers surveyed here is the ‘focus’ on the optimal choice of guns, feasible equilibria, and the different parameters which can induce new results, as compared to the basic model.

Skaperdas (1992) applies the common trade-off between productive and coercive activities in absence of property rights in order to examine the possible emergence of cooperation between two parties. In particular, the author states that conflict is not the

\(^{15}\) Most of this survey is supposed to be non-technical. Formulas and expressions are reported only if considered useful for a better understanding or when they constitute some interesting insights of that model. In particular, for distinction with respect of the main formulas and equations of this work, some few expression will be labelled through the initials of author(s), if necessary the year and then indexed.
necessary outcome of one-time interaction, given a room for cooperation depending upon the dominance of an actor over the other. The total available output is determined by agents’ choice of productive activities. The investment in arms (which does proxy the efforts devoted to coercive activities) determines each agent’s probability of winning a war. The winner receives the total product as prize or could divide the total product when a war does not occur in proportion to their respective probability of winning that represents a ‘clear index of the agent’s power’\textsuperscript{16}.

Each agent is endowed with one unit of inalienable resource that can be transformed into two inputs. Normalizing the resources constraint makes easier to concentrate on symmetric results of the model. The production technology is assumed to exhibit constant returns of scale. Each agent marginal product is positive and decreasing and their ratio is finite and nonzero. The probability of winning is described in its general form, under the assumption that the sum of probabilities equals unity. The assumptions on the conflict technology are sufficient for a pure strategy Nash equilibrium other than the worst case scenario when both parties devote all the resource endowment to ‘guns’. The assumptions are:

i) the power of a player is increasing in its strategy and decreasing in the opponent’s strategy. Moreover the power is assumed to be concave in a player’s strategy when its strategy is greater than opponent’s, and convex otherwise. Although the author does not define any functional form for the conflict technology, the

latter assumptions better fits with the logit form of CSF. Under these assumptions the author show that three different Nash equilibria are feasible:

1) the.full cooperation equilibrium, when there is no investment in arms on both sides. Note that this equilibrium is feasible only if a logit form of CSF is applied. In fact, in this case when $z_i = 0$, player 1 still retains a share of success. Otherwise no full cooperation (namely complete peaceful) equilibrium is feasible. In particular, a full cooperation equilibrium is more likely the more close to unity is the ratio of marginal products evaluated at the point of full cooperation, and the less ‘effective’ is the conflict technology. That is, given for example a large differential in armaments, only a small increase in winning probability emerges. Moreover it is necessary that the opportunity costs of investing in arms of both agents must be not so dissimilar.

2) a second feasible Nash equilibrium is the partially cooperative equilibrium. In such a case only one player devotes resources to the unproductive activity of conflict. That agent also receives her or his best payoff. To reach this, it is necessary that (i) the conflict technology is sufficiently ineffective even is not as much in full cooperation equilibrium; (ii) the marginal products are sufficiently diverse, with the more powerful having a lower marginal product.

3) a third feasible Nash equilibrium is the conflict equilibrium. It occurs when the effectiveness of conflict technology is sufficiently high. That is, when investment in arms easily increases power of the agents. Moreover, it is also necessary that the ratio of marginal

17 See Appendix 2.1 on CSF.
products is sufficiently close to unity as well as in full cooperation equilibrium.

To summarise, the results show that the prevailing equilibrium depends upon the relationship between the effectiveness of the conflict technology and the ratio of marginal products. In particular the author points out that, considering imbalances of power “cooperation itself can be consistent with domination of one party over another”\(^{18}\). In fact, since the more powerful agent invests more in arms, it must have a lower opportunity cost for that investment. Therefore, the marginal cost of arms is inversely related to each agent contribution to the total output.

Garfinkel (1994) is intended to explore the interactions between domestic politics and international conflict. The main finding seems to recall the ideal of Kantian peace, also showing that electoral uncertainty in democratic states can reduce the severity of international conflict. In particular, it induces less arming.

The author models the internal policy outcome by using a two-period model, which takes into account the optimization problem faced by voters (or consumers) and the political parties of one nation. In a first section, foreign nations military expenditures are assumed to be given. In a second part, the model is extended to illustrate the linkage between international conflict and political competition. A limiting assumption is that nations are considered perfectly identical. Each nation chooses its military policy in an effort to secure a proportion of a given world resource. The defence

technology is specified through a classical CSF. Comparing dictatorships and democracies it is shown that political competition reduces the severity of conflict between nations. This easing is supposed to be the lowering of the amount of resources allocated to military spending in both nations.

This result is driven through the fact that the party in office in the first period can choose the allocation of resources secured by current military spending among peaceful investment activities (goods and services provided by the government to the voters on a non-discriminatory basis) in the next period only if re-elected. The probability of not being reappointed produces a negative bias in military spending, while under autocracies the probability to stay in office exactly equals unity so as to rule out any uncertainty. In the latter case there is no negative bias on military spending.

However, the results of the model suggest that international cooperation, as an international disarmament, is more likely to be sustained in a cooperative equilibrium without threat and punishments19. Thus, Garfinkel’s model goes far beyond the implicit assumption of Hirshleifer considering the state as a unitary actor. In fact, in the basic model the trade-off between ‘guns’ and ‘butter’ is completely exhausted on the international scenario, since the agents only rationally simultaneously react to the opponent’s rational

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19 In Garfinkel (1990) the author develops a positive economic theory of military spending. Then the analysis shows that if there are repeated interaction between nations, a game of threat and punishments usually does not support a disarmament outcome and that fluctuations in military spending can be an endogenous result of fluctuations in aggregate economic activity. Moreover military spending depends upon whether governments are acting cooperatively or opportunistically.
optimal choice. This mechanism then is relaxed by Garfinkel even if with strict limiting assumptions (i.e. countries perfectly identical in resources, preferences etc..etc..). Note that in Garfinkel the ‘pie’ of conflict also changes. It is no longer the output produced through the joint production function, but a fraction of a contested resource which is to be secured in the next period.

Noh (1997) also goes beyond the assumption of agents as unitary actors. The author proposes a general equilibrium model where agents, competing for common pool of output, are two groups with characteristic intra-group rules of sharing. Then, the allocations of resources between productive and appropriative activities take shape following both the inter-group and intra-group interaction. In particular, the two-group competition occurs in two-stages. In the first stage, sharing rules of each group is determined followed by second stage allocation of resources between productive and appropriative activities. The author first considers Cournot-Nash intra-group sharing rules in which sharing rules of each group are determined simultaneously. These sharing rules are chosen such that one group’s appropriative activities are exactly matched by those of the other group.

This produces an infinite number of Cournot-Nash endogenous sharing rules. At one extreme, both groups adopt fully egalitarian rules. At the other extreme, the larger sized group adopts a partially egalitarian rule, whereas the smaller sized group does not use the egalitarian rule at all and all the group income is distributed
according to each member contribution to the group’s appropriative activities.

Whenever the sharing rules are chosen sequentially, under a Stackelberg protocol, independent of which group plays the leader, a unique pair of sharing rules is selected in which both groups adopt the fully egalitarian rules, producing an individual and social optimum outcome given the inter-group competition. The author underlines that such a result suggests that inter-group competition with the use of egalitarian principle in the distribution of group income among group members, “which is not available to the Hobbesian state of nature, is one of the cheaper social devices in restraining individuals from engaging in costly appropriative activities.”20

However, the interesting result is mainly driven by a formal modelling that does not imply any technology of conflict. That is, the conflict is not decisive, since the CSF used has no mass effect parameter. Note also in such an equalitarian construction, that since group incomes are the same and that the group income is equally shared among the group members in each group, the final income of an individual in the larger sized group is less than that of an individual in the smaller sized group.

Such result appears to be misleading. It also could seem a contest where individuals have to compete for two prizes, a top-prize and a bottom-prize21. Under complete information, this can lead to insufficient effort for same participants that would prefer coast instead of compete. Nevertheless, the formal construction of the

21 On this point see O’Keffe et al. (1986).
interaction between intra-group and inter-group conflicts provides interesting insights.

Grossman (1991) develops a positive theory of insurrections and its deterrence or suppression as economic activities that compete with production for scarce resources. The story features a ruler and a large number of peasants families. The ruler enforces the collection of land rents and or taxes on productive labour. In addition, the ruler is an employer of soldiers in order to reduce the probability of a successful insurrection. The ruler is also an income-maximizers. In particular he is assumed to maximize his own income and that of his own clientele. Peasant families allocate labour time alternatively to production, soldiering or partaking in an insurrection. A successful insurrection is supposed to be a winner-take-all contest, namely insurgents gain all of the revenue of the ruler and his clientele. However, time and resources devoted to insurrection are considered socially wasteful.

Grossman claims his contrast with Hirshleifer (1988) and Garfinkel (1990) because the later works analyse the effect of technology on the allocation of resources between productive and appropriative activities, without analysing the behaviour of subjects. That is, in Hirshleifer and Garfinkel models competing parties are as rulers and no mention of subject is provided. The model is built on three fundamentals functions: (i) the income of ruler’s clientele; (ii) the income of peasants’ families; (iii) a technology of insurrection and its suppression. The latter, in particular, is a modified form of CSF:
\[ \beta = \frac{I^{1-\theta}}{S^{\sigma} + I^{1-\theta}} \]  

where \( I \) and \( S \) denote the fraction of peasant time allocated to insurrection and the fraction of time allocated to soldiering respectively. Of course, \( \beta \) is increasing in \( I \) and decreasing in \( S \), and is bounded between zero and unity. The parameters \( \sigma \) and \( \theta \) capture the technology of insurrection are both assumed to be bounded between zero and unity. The resulting equilibrium allocation of resources and probabilistic distribution of income depend on these parameters.

The results of the model show that a high tax rate imposed by the ruler to the peasant families can have two negative effects. First, it depress the tax base, secondly it increase the probability of a successful insurrection. In fact, at a higher tax rate the fraction of time that peasants devote to insurrections become higher and higher. Even if peasants do not devote any time to insurrection, with a positive technology of insurrection, the threat of insurrection induces the ruler to demand for soldiering and to set a low enough positive tax rate in order to deter insurrection completely. Then, the technology of insurrection is the element driving the optimal choice both for ruler and peasants.

Although Grossman intended to contrast Hirshleifer, the model ends up with a very similar outcome. In fact, Hirshleifer (1988) stressed the importance of technology of conflict through the mass effect parameter, renamed ‘decisiveness’ parameter. In a similar fashion Grossman argues that technology of insurrection is
the most important force driving towards an equilibrium of allocation between labour, soldiering and insurrections. However, through the CSF (gr.1) he distinguishes between the technology applied to defensive and appropriative efforts.

This final is extended in Grossman and Kim (1995), which underlines the distinction between offensive weapons and instruments that can provide defence against predation. Many of the ‘appropriative’ activities are purely defensive and they are supposed to be a deterrent to predation. They explicitly consider the allocation of resources among productive and appropriative activities and the equilibrium security of claims of property. Moreover, the analysis does not address the possibility that a third a party, such a government, enforces claims of property. There are two risk-neutral agents (individuals, tribes or nation states) not integrated. They have initial resources endowments, that are claims to the property, subject to appropriation. Each agent chooses the allocation of resources following the sequence: 1) choice of defence, 2) allocation of resources between production and appropriation. Let $h_i, z_i, x_i$ denote respectively the amount of defensive resources, the amount of offensive weapons and the share devoted to independent productive activities of consumables. Hence at the first step, each agent chooses $h_i$ such that $0 \leq h_i \leq n_i$. At the second step each agent chooses $x_i$ and $z_i$ such that $x_i \geq 0, z_i \geq 0$. The resource partition equation is:

$$x_i + z_i = n_i - h_i \quad \text{(gk.1.1)}$$

Note that this equation differs from (1a) only for the amount of defensive resources subtracted from the initial endowment. It is assumed for simplicity that the entire endowment of agent $i$ is
subject to appropriation by opponent, hereafter denoted by $j$ ($j \neq i$), whereas the consumables are not. A particular formulation of CSF describes how the agent $i$ retains a fraction $p_i$ of its endowment.

$$p_i = \frac{1}{1 + y_i}, \quad y_i = \theta \frac{z_j}{h_i}, \quad 0 \leq p_i \leq 1 \quad (gk.1.2)$$

In this equation $y_i$ captures the offensive strength of agent $j$ relative to the defensive strength of agent $i$, and $\theta$ is a positive parameter that indicates the effectiveness of offensive weapons against defensive structure\textsuperscript{22}. It is affected by technical advancements, both positively and negatively. This formulation differs from CSF presented because $y_i$ is assumed to be a homogenous function of degree zero in $z_j$ and $h_i$ and of degree one in the ratio $z_j / h_i$. In fact, the formulation in (3b) assumes that $y_i$ is homogenous of degree $m>0$ in the ratio $z_j / h_i$.

Predation is assumed to be destructive. This implies that in any appropriative interaction the predator gains less than the prey loses. The net result of appropriative activities for agent $i$ is a nonnegative wealth. The objective of each agent is to maximise the sum of its consumables (that are assumed not to be subject to appropriation) and the final wealth. Hence at the second stage agent $i$ takes the level of defensive efforts as given and maximise its utility

\textsuperscript{22} Dixit (2004) develops a simple model applying the basic framework of Hirshleifer (1995) enriched by the effectiveness parameter of offensive weapons proposed by Grossman and Kim (1995). In the resulting symmetric equilibrium, the resources spent both on defence and offence by both agents equal. As the technology favours defence over offence the productive use of resources increase.
subject to the resource constraint and the non-negativity constraint for ‘guns’.

For sake of brevity, I do not report the analytical results of maximisation process. To summarise, the findings show that the equilibrium security of the claims to property is independent of the size of endowments, but depends only upon the degree of effectiveness of offensive weapons and the destruction parameter. Under some circumstances the equilibrium is not aggressive and claims to property are considered fully secure. By contrast, there are equilibria less than fully secure where the claims to property are negatively related to the effectiveness of offensive weapons against defensive structure, and is positively related to the destructiveness.

In non aggressive equilibria the total cost of appropriative activities is lower than in any equilibrium with less than fully secure claims to property. For non-aggressive equilibria the welfare of agent $i$ is negatively related to effectiveness of offensive weapons and positively related to destruction parameter, and negatively related to the total cost of appropriative activities. If agent $i$ is relatively rich, its welfare is higher the smaller the effectiveness of offensive weapons and the larger the destruction parameter. (i.e. when the claims to property are more secure). If agent is relatively poor the welfare is higher the larger is effectiveness of offensive weapons and the smaller is the destruction parameter, i.e. if claims to property are less secure. This means that if offensive weapons are highly effective and predation is not too destructive, a relatively poor agent can be better off in an equilibrium with less secure claims to property.
Another prominent contribution is in Neary (1997) that, following Hirshleifer and Skaperdas, develops a model of a society where only armed self-enforcement of property rights is possible. The main parameters considered are the level of system total wealth and the initial asymmetrical distribution of this resource stock between the actors. The bilateral interaction is two-stage shaped. In the first stage each player has an initial stock of resource that is committed to an allocation between ‘guns’ and ‘butter’. The allocation of resources to productive activities result in a consumable output, say the ‘pie’.

In stage two, parties divide the ‘pie’ according to the investment in ‘guns’ chosen in the first stage. Then, given a positive initial total wealth, asymmetrically distributed according to a parameter, \( \sigma \in (1/2,1] \). The initial endowments are given by \( n_1 = \sigma N \) for player 1 supposed to be the richer, and \( n_2 = (1-\sigma)N \). In the first stage, the players must decide the level of ‘guns’. In the second stage, the divide the ‘pie’ according to a CSF as in (3a). The production function is assumed to be symmetric, concave and increasing in both arguments. Neary assume Nash behaviour by each player. Then, both parties maximize simultaneously their own payoffs subject to the constraint of productive resources.

There are four types of equilibrium: (i) communal equilibrium; (ii) suzerainty equilibrium; (iii) hobbesian equilibrium; (iv) banditry equilibria. These are depicted in figure 2.4
1) The *communal equilibria*. In such a case parties do not devote any resource to ‘guns’, $z_1 = z_2 = 0$. Zero-guns allocations are chosen non-cooperatively simply because the marginal benefit of investment in butter outweighs its marginal cost. Thus, given by assumption that $p(0,0) = 1/2$ each party has an equal share of ‘pie’. The communal are those defined ‘full cooperation’ by Skaperdas (1992).

2) The *suzerainty equilibria*. The richer party puts resources into both guns and butter. The poorer side only invest in ‘butter’. In such a case a hierarchical relationship between parties exists. Neary
cites as examples: the hierarchical relationship between an imperial centre and the periphery as tributary centres or colonies. This is also a reminiscent of authoritarian, despotic or feudal situations in which one group dominates another. As a special case when the production function is linear there are no Suzerainty equilibria.

3) The Hobbesian equilibria. In this case, both players devote an amount of resources to guns, according to \(0 < z_i < n_i, i = 1,2\). The Hobbesian equilibria are interior, since the solution vectors lie in the interior strategy space. The European Great Powers are an example of Hobbesian equilibria, as well as Third Reich.

4) The Banditry equilibria is characterised by the poorer side devoting all resources to guns. This outcome reflects the fact that, as the less-endowed party, it runs into a severe resource constraint as \(\sigma\) increases. This also involves a level of initial total wealth sufficiently high. Banditry equilibria do not occur at all. Neary shows that neither the Cobb-Douglass nor the CES forms of the production function allows banditry equilibria to exist. However, the banditry equilibrium concept is akin to that of Paradox of Power expounded by Hirshleifer.

Through this analysis, Neary also contradicts the intuition which suggests that increasing absolute scarcity increases the likelihood of conflict. In fact, as showed in communal equilibria, at very low levels of total wealth equilibria occur at zero-investment in arms. This outcome emerges simply because absolute poverty makes the return on arms expenditure unattractively low to both players; so neither player arms and each shares equally the output irrespective of the initial resource distribution.
Skaperdas and Syropoulos (1996) explore the possibility for cooperation in a long-term relationship. They show that in an inter-temporal model of conflict the possibility of opposite effect arises, i.e. the conflict intensifies. The basics of the model are: (1) a Cobb-Douglas specification of the functional form of production function exhibiting decreasing returns of scale. However, the authors suggest that the results of the model are expected to remain unaffected if other type of functions exhibiting constant returns to scale are adopted; 2) a logit form of the CSF; 3) an equal initial endowment of resources; 4) a common specification for the income distribution equation. Given the perfect equality of agents the equilibrium depends upon the mass effect parameter of CSF. This implies that with symmetric players a sufficiently low level of decisiveness of conflict lead to a full cooperation \((z_i = 0, i = 1, 2)\) Nash equilibrium. When the conflict is decisive both parties invest a positive amount of resources to ‘guns’.

To evaluate the impact that a long-term horizon can have on cooperation the authors focus on values of mass effect parameter and resource endowment which satisfies the condition for a full cooperation Nash equilibrium in the one-shot game. The second period game differs from the first only because of the resources endowment that is a function of past payoff weighted by a positive growth parameter. Each agent’s total two-period payoff is the sum of utilities in the two periods. In particular, the second-period payoff is discounted through a discount parameter which lies in a half-open interval \((0,1]\).
To solve the model, Skaperdas and Syropoulos employ the concept of the sub-game perfect equilibrium. First they solve for the symmetric equilibrium in the second period, and then they find the optimal first period investments in arms. There is still room for a full cooperation equilibrium in the two-period game. Both parties will refrain from investing in arms since the second period investment in arms is not influenced by changes in the first period arms investment. On the contrary, when the product of resource endowment, the growth and the mass effect parameter, there are three possible scenarios depending on other feasible combinations of discount factor and growth factor:

(i) parties undertake positive investment in the second period but not in the first. This is because future is not valued enough (the discount parameter lies between zero and a critical values which is a function of growth parameter);

(ii) if future payoffs are highly evaluated both parties undertake positive investments in arms only on the first period;

(iii) parties invest in arms in both periods. Taking into account any exogenous growth factor there exist a discount factor so that conflict activities occur in both periods.

The authors, then, state that a longer shadow of the future may discourage cooperation and intensify conflict. However, the main result of the model is based upon the assumption a party’s payoff
today affects tomorrow’s resources, and indirectly also tomorrow’s payoff.

Grossman (1998) explores a series of general equilibrium models in which agents choose to be either producers or predators by allocating their own resources either to production or to guarding their production against predators. Agents’ choices depend upon the level of consumption they would get. In the first model, given perfect equal productive opportunities among agents, it is showed that the technology of predation (depicted through a modified form of CSF), determines both the equilibrium ratio of predators to producers and the equilibrium amount of resources allocated to guarding against predators.

In the second model, an irreversible collective choice of the amount of resources invested in deterrence against a possible predation decreases the social cost of predation. In the third model, the basic analytical framework is extended. Agents are now well-endowed or poorly endowed. Since production is more productive, well-endowed agents have lower incentives to be involved in predation. Individual choice of guarding assumed and given only a small fraction of poorly-endowed agents within the system, it is expounded how all the poorly-endowed agents as well as some of the well-endowed would choose to be predators.

As the fraction of poorly endowed people increases, all of them still would choose to be predators whilst all the well-endowed agents would choose to be producers. The equilibrium ratio of predators to producers increase as well as the equilibrium amount of
resources allocated to guarding against predators. In the last model the fraction of well-endowed people makes an irreversible collective choice of the amount of resources to allocate against predators. The amount of this allocation is enough to deter well-endowed people from becoming predators. Finally, the poorly-endowed people choose to be predators.

A related argument is then expounded by Grossman and Mendoza (2001). This model develops a general equilibrium approach in which rival rulers are engaged in economic competition for the allegiance of subjects and in military competition for the control of land. The rival rulers control a fraction of arable land. The production functions on the lands are assumed to be Cobb-Douglas with decreasing return of scale and land and labour force as inputs. The income for both rulers is simply determined as the difference between the total gain and the cost of labour force. If an amicable split of land is assumed, the rulers equally divide the land, and then number of farmers hired and the production. Indeed they equal their own income to the value of the marginal products of their lands, whereas the income of subject farmers equals their own marginal products.

The military competition is introduced through a CSF that does determine the amount of land which can be gained by both rulers. In the perfect symmetric case, however, the results do not change apart from the net income of rulers. The rulers simply divide equally the land, the production and the income of farmers subjects are exactly the same, but because of the resources dissipated in military
competition the incomes of rulers are lower than in the foregoing situation. Introducing the existence of soldiers as to proxy the military strength, the outcome of model changes. The soldiers have to be provided with a net income as well as the farmers. Given the symmetry of the model the authors show: a) the production on the lands of each ruler decrease since the people hired in the army cannot longer farm the land. Then, the subjects receive higher incomes than in economic competition only. In addition, the social cost of military competition is given by the foregone production of soldiers and the incomes of the rulers are decreased by more than this social cost.

Moreover, allowing the military competition be destructive the results change and appear to be more realistic. As the destruction parameter increases, the value of the marginal product of farmers decreases as well as the incomes of the subjects of the rival rulers. As long as military competition is not too destructive the subjects of rival rulers have higher incomes with both military and economic competition than with economic competition alone.

Stauvermann (2002), intends to explore under what circumstances a total peace can occur. He notes that no model exists where a peaceful anarchy without arming constitutes an equilibrium. In fact, he argues that peaceful outcomes based upon deterrence are to be distinguished from peace without any investment in weapons. In other words, he does recall the ‘full cooperation’ scenario where no investment in any coercive unproductive is made. Differently form the most existing literature it is assumed that the agents act
sequentially like in a Stackelberg game. Hence, one agent moves first as a Stackelberg leader choosing its optimal armament. The opponent observes the optimal choice of the leader and also chooses its optimal armament. The main result of the paper is that a war only occurs if both adversaries are sufficiently different concerning their production possibilities, effectiveness of their arms and their resources. Whenever rivals are relatively homogenous peace can take place.

Hirshleifer-style models are commonly static analyses. Reuveny and Maxwell (2001) produce a dynamic Hirshleifer-style model with two agents, dependent on a single renewable resource. Moreover, the authors underline that their work is also based on the ecological competition literature. In this latter body of literature, in fact, the recurring feature is represented by the competition between two interacting species that feed off the same renewable resource.

The dynamic models are commonly composed as a system of differential equations for the stocks of the species and a resources stock. A rise in the size of either species reduces the resource stock, whereas a rise in the size of one species reduces the size of the other. Then, the authors study the dynamic interaction between conflict, population, and resources in a lesser developed society. The model has five steady states. Four steady states exhibit no conflict because either one or both groups are extinct. They also present a possible condition for the breakdown of anarchy which is more complicated than in Hirshleifer (1995). The breakdown depends upon parameters of the resource and population, not only on the decisiveness
parameter. Then, the authors focus on a fifth steady state that features conflict. The comparative statics reveal that changes enhancing the resource stock or the population raise conflict. Whenever, the conflict efficiency of one group relative to the other raises it reduces its conflict effort. A rise in the model’s decisiveness parameter generates an ambiguous effect on conflict, which also differs from Hirshleifer static model. The effect of raising harvesting efficiency on conflict is positive when the resource stock is high. Turning to the dynamics, the results fit with the stories of historical societies that exhibited a relatively brief flowering, followed by decay, all the while exhibiting conflict over the resource base.
APPENDIX 2.1

THE CONTEST SUCCESS FUNCTION (CSF)

A contest is a game in which the players compete for a prize choosing their efforts in order to increase their probability of winning. The Contest Success Function (CSF) is a mathematical relation that links the outcome of a contest and the efforts of the players. It can be applied to several scenarios. In rent-seeking efforts, it represents the amount of money spent by each player; in military context efforts could be measured by arms, while in tournament the efforts of each participant. The CSF is, very often, a pillar of more complex models. In this appendix I underline some basic characteristics on its structure. For sake of simplicity, notation and subscripts are standardized.

The first seminal contribution is by Tullock (1980). He applied a contest success function to a rent-seeking scenario. In his basic model the CSF is:

\[ p_1 = \frac{x_1}{x_1 + x_2} \quad (\text{CSF.1}) \]

The probability of success for player 1 depends upon the investment he or she made to win the game and the total amount of resources invested. He also pointed out that there is no reason why the function should be a simple linear relationship of contributions; hence, he also designed an exponential form with more than two rivals to play:
Following Tullock, imagine a lottery with two partaking agents. Each party is allowed to buy as many tickets as she or he wishes at one dollar each. The lottery tickets are put in a drum. One ticket will be pulled out and whoever has that ticket wins the prize. The probability of winning is described by the CSF. Moreover, it is also to be considered that the amount spent to buy the tickets is not added to the prize; hence what is spent in buying the tickets is also a waste of resources. Hence, the loser has truly sunk cost: once spent, the money cannot be got back. This is the fundamental idea behind the obnoxiousness of rent-seeking: wasted resources.

Dixit (1987) develops a general framework for contests using the general properties of logit functions. The basic idea relies upon the consideration that players can have the opportunity to make a strategic pre-commitment to the level of effort. The question he addresses is when a player will choose a level of effort that is higher or lower than the Nash equilibrium. With two asymmetric players Dixit finds out that the favourite player will be induced to over-exertion of her or his efforts. The players’ expected payoffs are:

\[ u_1 = Kp(x_1, x_2) - x_1, u_2 = K\left[1 - p(x_1, x_2)\right] - x_2 \] (CSF.3)

The CSF function describes the probability of winning. Dixit notes that it belongs to the general class of logit functions.
\[ p(x_1, x_2) = \frac{f_1(x_1)}{f_1(x_1) + f_2(x_2)} \]  

(CSF.4)

where \( x_{1,2} \) denote the level of effort, and \( f_1, f_2 \) are increasing functions. Twice differentiating:

\[ p_{12} = \frac{f_1' f_2' (f_1 - f_2)}{(f_1 + f_2)^3} \]  

(CSF.4.1)

where subscripts denote partial derivatives and the arguments are omitted. The second derivative shows that \( p_{12} > 0 \) if and only if \( f_1 > f_2 \). Hence, given the asymmetry, one rival will have the incentive to overexert her or his effort. Dixit considers commitments as first-mover advantages. Take a contract or a public licence. Since the participants are not equally efficient and politicians also take in account this, according to this argument, the more efficient, if given first access to the politician, will bribe more than she or he would in the case of simultaneous access. Dixit also points out that if we consider commitments as conditional instead of unconditional, the outcome could be really different. Agent 1 could drive agent 2 out by committing herself or himself to an impressively large \( x_1 \).

Hirshleifer (1989) focuses on a different form for the CSF. He points out that in the traditional Tullock’s framework (assuming a two-player contest) each party’s success is a function of the ratios of the respective efforts or inputs. More precisely, for 2 players:

\[ \frac{p_1}{p_2} = \left( \frac{x_1}{x_2} \right)^m \text{ given } p_1 + p_2 = 1 \]  

(CSF.5)
He argues that even if it is often plausible that the contest power is a function of the ratio of the efforts committed, it also seems acceptable that CSF depends upon the difference between the efforts committed. This idea relies upon a simple consideration. Assume that player 2 is not providing any effort \((x_2 = 0)\). In such a case the probability of Player 1 to win the contest is exactly equivalent to unity. In an asymmetric contest the smaller rival has no chance at all. Considering differences instead of ratios between efforts and applying a logistic curve, the CSF becomes:

\[
p_1 = \frac{1}{1 + e^{k(x_2-x_1)}},
\]

where \(k\) denotes the common mass effect parameter of a logistic function. It is simple to verify that in this case even when \(x_1 = 0\) player 1 still retains a share of success, thanks to \(p_1 = \frac{1}{1 + e^{kx_2}} > 0\); and there is a similar result holds for player 2. Generalising for \(n\) player:

\[
p_i = \frac{e^{kr_i}}{\sum_j e^{kr_j}},
\]

Skaperdas (1996) provides an axiomatization of the additive CSF, both the one in which the winning probabilities depend upon the ratio of players’ efforts, and the one in which the winning
probabilities depend upon the difference of efforts between contestants.

First consider the general \( n \)-players case. Let \( x = (x_1, x_2, \ldots, x_n) \) denote a vector of efforts of the \( n \) players. The probability of winning for each player is indicated by \( p \), the CSF satisfies the following properties:

A1) The CSF satisfies the conditions of a probability distribution function; and when the effort of a player is positive the player’s probability of success is also positive. That is, \( \sum_{i \in n} p_i = 1 \) and \( p_i \geq 0 \) for all \( i \in N \), if \( x_i > 0 \) then \( p_i > 0 \);

A2) a player’s probability of success is increasing in the player’s own effort but decreasing in every other player’s effort. That is, for all \( i \in N \) \( p_i \) is increasing in \( x_i \) and decreasing in \( x_j \) for all \( j \neq i \).

A3) each player’s probability of success should not depend on her or his identity or on the identities of their opponents, but just on the efforts of the players.

These three properties guarantee that each player probability is governed by the same function as every other player’s probability, in a general formulation of CSF which is applicable to contexts with \( n \) players.

Further properties relate to the number of agents involved into the context. Does the CSF also govern the interaction between coalitions of players or between players belonging to a subset of the original set of players?
A4) A basic consistency property implies that the contest among smaller numbers of agents is similar to those among a larger number of them.

\[ p^i_n(x) = p^i(x) / \left[ \sum_{j \in M} p^j(x) \right] \forall i \in M \text{ and } \forall M \subseteq N \text{ with at least two elements} \]

A5) The probability of success is independent of the efforts of the players not involved in a contest. The applicability of CSF in a contest with less than \( n \) players it also matters in contests where there is a formation of coalitions between different agents.

A5.1) For every subset such that \( M(\subseteq N) \) the CSF has the following additive representation:

\[ p_i = f(x_i) / \left( \sum_{j \in N} f(x_j) \right) \text{ for all } i \in N \]

and

\[ p_{jm} = f(x_i) / \left( \sum_{j \in M} f(x_j) \right) \text{ for all } i \in M(\subseteq N) \]

where \( f(\cdot) \) is a positive increasing function in its argument. Therefore, as a first theorem, Skaperdas proves that if a CSF does satisfy the property A5.1, hence it does satisfy the A1-A5 properties.

Furthermore, Skaperdas focuses on the different functional form of the CSF: the power and logit form. Prior contribution by Hirshleifer (1989) pointed out these two possible functional forms. They differ upon the interaction between the efforts of contenders. In the most common functional form the ratio between each agent’s efforts is considered, whereas in the ‘logit’ form the difference between efforts is applied.

To axiomatize the first functional form consider an equiproportionate \( (\lambda > 0) \) change in agents’ efforts leave unchanged
the probability of winning the contest. Hence the ratio of the winning probabilities depends upon the ratio of efforts.

A6) \( p_i(\lambda x) = p_i(x) \) for all \( \lambda > 0 \) and for all \( i \in N \)

A6.1) \( f(x_i) = \alpha x_i^r \) for \( \alpha > 0 \) and \( r > 0 \)

A second theorem proved by Skaperdas tells us that this functional form is the only one that does satisfy the A1-A6 properties. In other words, the power form of CSF do satisfy all the properties that relate to the probability of winning for different agents, plus those ones regarding the interaction between players included and not included in the subset of a contest. The other functional form the ‘logit’ form has also been credited with satisfying the A1-A5 properties. But it also does satisfy a new relevant property.

A7) \( p_i(x) = p_i(x + c) \forall c \in R^n \), such that \( x_i + c \geq 0, \forall i \in N \), assuming also that \( f(.) \) is defined for \( x_i = 0 \). \( c \) is a vector whose components are all equal to \( c \). the only functional form that does satisfy this property is the ‘logit’ form: A7.1) \( f(x_i) = e^{kx_i} \) for some \( k > 0 \). Nevertheless, the use of this is much criticized, in particular when \( c \) is very large. Consider, for instance, the probabilities of winning for both agents with \( x_1 = 4, x_2 = 5 \) should be equal with \( c = 100000, x_1 + c = 100004, x_2 + c = 100005 \). In this case, obviously, we have \( x_2 - x_1 = (x_2 + c) - (x_1 + c) \). The importance of this functional form relies upon the consideration suggested by Hirshleifer (1989). Taking into account the extreme case in which player 2 does not put any effort she or he can still retain a positive probability of winning.
CHAPTER III

Integrating Exchange and Conflict

In the foregoing chapter the basic economic foundations of conflict have been expounded. In particular, the seminal work by Hirshleifer and his followers have been examined. The cornerstone of such school of modeling was the CSF in its different forms. The emphasis was on the choices of agents over the level of ‘guns’ in a bilateral interaction.

In this chapter the main focus is the emergence of exchange between parties. Consider now the fact that the mainstream economic activity of production and exchange emerge ‘in the shadow of conflict’. Economic activity is distorted because of the dark side of the force, as in the brilliant statement by Hirshleifer.

More precisely, what is the impact of conflict on exchange? The main contribution on this side is by Charles Anderton and his associates. They formalized the emergence of exchange in the shadow of conflict by enriching the Hirshleifer’s basic model using the CSF, with an explicit consideration of prices and terms of trade, showing that terms of trade also depend upon the level of predation and conflict. Anderton and Anderton (1997) present integrated model of conflict, production and exchange through a shrinkage of the classical Edgeworth Box. The level of production serves as the ‘pie’ to be distributed under conflict, but also as to re-define the size of
Edgeworth Box. More refined models are in Anderton et al. (1999), Anderton (2000/2003)\(^1\).

However, the negative impact of conflict on trade does not exhaust the complex causal relationship between exchange and conflict. This casual relationship, in fact, has been extensively debated. Then, it also should be asked: what is the impact of exchange interactions on conflict? Does exchange create incentives for conflict resolution or for conflict escalation?

Skaperdas and Syropoulos (2001) deal with the question whether international trade can be considered as an instrument to ease tensions between countries, given changes in incentives for arming. Two ‘small’ countries dispute a resource that can be used in production of tradables denoted commonly as butter. Claims on the resource are developed through arming (guns). The focus of the paper is on the price of the contested resource. If the international price is lower than a country’s autarkic price, the opportunity cost of arming rises, and, a freer trade softens the intensity of competition, reduces

\(^1\) Another interesting Hirshleifer-style study is by Anderson and Marcouiller (1997). They consider an anarchic world with agents that are rational utility maximizers and allocate labour between predation and the production of two goods. Under some assumptions, three types of equilibria may emerge: (i) autarky, with no predation and no defence; (ii) insecure exchange equilibria (with predation and defence); (iii) secure exchange equilibria (when defence completely deters predation). The interaction of predation and production and the general equilibrium interaction between two trading economies determine the terms of trade and gains from trade. In fact, since changes in technologies of defence and predation have terms of trade effects, some producers are hurt by enhanced security. This is idea of ‘immiserizing security’. Since some larger and poorer countries can lose from improvements in the security of international exchange, immiserizing security suggests a potential for international conflict due to the opposing interests with respect to security.
arming and raises welfare. The opposite can occur when the international price is higher than its autarkic price.

This chapter is also intended to contribute to this enduring debate among scholars. Then, the chapter is organized as follows: (i) in a first part, a model by Garfinkel and Skaperdas (2000) is deeply studied, since it will be the base for the next analyses produced in this work; (iii) in a second part the foregoing model is extended in order to consider specific features of international trade and trade policies.

3.1

WHEN A SETTLEMENT IS PREFERABLE

Up to this point, I did not consider any other feasible scenario other than pure conflict. In this section an alternative scenario will be studied. Agents may either fight or settle. Their choice will be driven also by rational and optimisation behaviour. The model I develop hereafter is by Garfinkel and Skaperdas (2000) in its one one-period version able to illustrate the short-run incentives to settle. Note that conflict here is identified only with actual fighting and war. There are two risk-neutral parties indexed by $i = 1, 2$. Each one is endowed with an initial resources, $n_i$, which can be converted into ‘guns’, or ‘butter’ according to the constraint exactly equal to:

$$n_i = x_i + z_i, \forall i$$  \hspace{1cm} (1a)
The total contestable output, say the ‘pie’ is exactly:

\[ Y = x_1 + x_2 \]  

(2a)

It can be disposed in one of two ways: through conflict with an uncertain outcome or through a peaceful and predefined division in the shadow of conflict. ‘Guns’ play a role in both cases. In case of a conflict ‘guns’ determine the probability of winning for each party; while in case of settlement they influence each party’s negotiating position and therefore the share of the ‘pie’ they receive. Then, each party has an incentive to allocate some of the initial resource to ‘guns’.

Recall that the world is assumed to be anarchic. There is no institutional framework established in order to bind agents’ behaviour. Then, in the same period the protocol of moves of the two sides can be decomposed in two stages: (i) firstly each opponent allocates its endowed resources to the production of guns and butter as described in (1a); (ii) secondly, given this resources allocation each side chooses whether to conflict or to settle. The model is solved by backward induction.

To capture this, they assume that each party’s share of total contestable output is a weighted combination of two possible rules: (i) the CSF and (ii) a symmetric split-of-surplus\(^2\) rule of division, and

\(^2\)An equal split of a pie under some circumstances is a common feature of bargaining theory. Hence the split-of-surplus is the solution of a bargaining protocol. Lopomo and Ok (2001) provide a positive theory for such a fair (50-50) division of gains from trade.
the relative weights are determined by a destruction parameter \( \beta \in (0,1) \). As \( \beta \) increases the conflict becomes less and less destructive. The contested output is exactly the same as in (2a) and the outcome of the conflict is determined by the CSF:

\[
p_1 = \frac{z_1}{z_1 + z_2}; p_2 = \frac{z_2}{z_1 + z_2}
\]

(3a)

The income distribution equation is given by:

\[
U_i = p_i \beta Y
\]

(36)

Garfinkel and Skaperdas show that within a one-period static setting negotiating and settle is always preferable to conflict. However, they assume that the contestable output, namely the ‘pie’ is affected negatively only by the destructive impact of a war.

First, consider the destructiveness of a conflict. In fact, a conflict is also costly because of the amount of resources destroyed. The level of ‘guns’ chosen in equilibrium is exactly:

\[
z_i = z_j = (n_i + n_j) / 4
\]

(10)

that is the destructiveness parameter does not affect the optimal choice of guns in case of war. That is, in an activity of appropriation the predator does not gain all the available output since the conflict (a war in the gravest example) is destructive. Solving the

\[^3\] Some recent studies throw light on this point. Romer (2001, ch. 4) underlines that since 1947, in nine post-war periods the US output
maximisation problem, in case of a war, the equilibrium choices of destructive weapons are given (10) and the expected payoffs are:

\[ U_1 = U_2 = \frac{1}{4} \beta (n_1 + n_2) \]  \hspace{1cm} (44)

Therefore the two opponents make the same choice of fighting efforts and receive the same utility, although the initial endowment of resources differ. Payoffs denoted by (44) are unambiguously lower than those in equation (10). That is, the more destructive is the conflict, the lower is the each agent’s utility.

Consider now the probability of settlement taking into account the rule for dividing the output produced through the aggregate production function. Each party’s share of total output is:

\[ U_i = [\beta p_i + (1 - \beta) q_i] (x_i + x_j) ; \]  \hspace{1cm} (45)

Under the assumption of the split-the-surplus, \( q_i = 1/2, i = 1, 2 \), equation clearly (45) becomes:

\[ U_i = [\beta p_i + \frac{(1 - \beta)}{2}] (x_i + x_j) ; \]  \hspace{1cm} (46)

decreased. The patterns of the output declines, however, vary greatly. Consider the Gulf War post-war recession. In this case a decline of 1.5 percent took place gradually over three quarters. After the Vietnam war was declared ended in 1973, a decline of 3.4% took place in five quarters. Barro and Lee (1994), and Sala-i-Martin (1997) also found evidence of a negative impact of war occurrence on growth in a cross-section of countries.
This scenario refers to a settlement between the contenders. Hence, relative weights between the two rules of division are determined by the destruction parameter. When $\beta$ it is small, the contest success function of armed conflict plays a smaller role in the determination of the distribution of output under settlement. That is, each side’s choice of fighting efforts has a small impact on the settlement outcome.

Anticipating settlement in the second stage each party $i=1,2$ chooses the level of ‘guns’. The first order conditions are:

$$\frac{\partial U_i}{\partial z_i} = \frac{\beta z_j}{(z_i + z_j)^2} \left(n_i + n_j - z_i - z_j\right) - \left(\frac{\beta z_i}{z_i + z_j} + \frac{1 - \beta}{2}\right) = 0$$

(47)

The Nash equilibrium under settlement is denoted by:

$$z_i^* = \frac{\beta (n_i + n_j)}{2(1 + \beta)}$$

(48)

$$U_i^* = \frac{1}{2(1 + \beta)} (n_i + n_j)$$

(49)

In this case, an interior solution requires that the initial resource endowments should not differ very much, namely$^4$:

---

$^4$ Compare inequality (50) with inequality (13a) in the foregoing chapter. It should be noted that once the destruction parameter is considered the range of interior solutions is smaller than in Hirschleifer’s basic model of conflict because of $\beta \in (0,1)$. However, if inequality (51) is not satisfied then the less-endowed enter the range of corner solutions and devote all its resources to ‘guns’.
Comparing the payoffs of pure conflict and settlement it is possible to determine when settlement is preferable to conflict: given that $\beta < 1$, the payoffs under settlement are higher than those under war. More precisely $U'_1 = U'_2 > U_1 = U_2$. At the same time, when $\beta < 1$ the settlement induces less arming, i.e. $z'_1 = z'_2 < z_1 = z_2$. Note that if $\beta = 1$ (i.e. the conflict is not destructive) the payoffs are identical in both scenarios. Hence, within this static setting, it would appear that settlement is better than arming and conflicting for both parties. Therefore, given a higher payoff, settlement is likely to be preferred by both rational parties. Formally speaking, it is possible to write that a settlement is always preferable if and only if:

$$\frac{1}{2(1 + \beta)} (n_1 + n_2) > \frac{1}{4} \beta(n_1 + n_2);$$

namely, if and only if:

$$\frac{1}{\beta(1 + \beta)} > \frac{1}{2}.$$  

If $\beta = 1$ (i.e. a conflict is not destructive), the inequality is violated since the payoffs are identical in both scenarios and agents have no particular incentives to choose settlement instead of conflict and vice versa. For sake of simplicity call (53) a settlement condition. Whenever
it holds (for $\beta < 1$), the settlement is expected to be preferable with respect to conflict.

The model can also be written in game form. There are two stages, in the second stage the level of resources to ‘guns’ are given. That is players 1 and 2 observe the outcome of the first stage and then simultaneously choose actions. The first stage is exactly that captured by table 2.1 in the foregoing chapter.

<table>
<thead>
<tr>
<th>Player 1</th>
<th>Conflict</th>
<th>Settle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflict</td>
<td>$\frac{\beta}{4} \frac{\beta}{4}$</td>
<td>1,0</td>
</tr>
<tr>
<td>Settle</td>
<td>0,1</td>
<td>$\frac{1}{2(1 + \beta)} \frac{1}{2(1 + \beta)}$</td>
</tr>
</tbody>
</table>

Table 3.1
Garfinkel-Skaperdas (2000) in a game form

Since $\beta \in (0,1)$, the strategy (settle, settle) provides a higher payoff for both players. The strategy (conflict, conflict) implies an uncertain outcome since the outcome is driven through the probabilistic rule of CSF. Then, since both parties are assumed to be risk-neutral, they prefer to settle instead of conflict. Hence, parties anticipate settlement in the second stage and this behaviour induces less arming in the first stage. Thus, this outcome involves the concept of
backward induction. Anticipation of settlement in the second stage induces less arming in the first stage.

3.2

THE IMPACT OF TRADE POLICIES

In the foregoing section, I discussed the settlement condition for two risk-neutral rational opponents. Thus, such an agent is expected to prefer settlement if and only if the settlement condition is fulfilled, e.g. if and only if its own utility under settlement is higher than in case of a war. Under settlement, agents prefer to exchange instead of fighting. The discriminating element in this setting is the destructiveness of a war: the more destructive is a war, the lower will be the incentive to wage it. Assuming the split-the-surplus rule of division into the payoff equation, settlement in the shadow of conflict is preferable to the escalation of a conflict.

Since the main focus of this work is on international interactions, consider the outcome of the foregoing paragraph as referred to two states. The division of the ‘pie’ can be interpreted as a negotiated trade settlement over an aggregate output. Of course it would be simple to say that a perfect free trade environment, albeit in the shadow of war, is strictly preferable to a war. It is possible now add a new element into the analysis. Hereafter I borrow and extend the model of Garfinkel-Skaperdas (2000) in order to capture the
First, I assume that conflict does not involve actual violence, but only a potential use of force and violence. Potential exploitation of force is captured through the level of arming chosen by both parties. Following Hirshleifer, I assume that each side makes an optimal once-and-for-all choice of ‘butter’ and ‘guns’. In such a case, parties are involved in a ongoing conflict. Considering conflict as a permanent feature leads the idea that states compete and exchange in shadow of conflict.\footnote{5}

Moreover, I re-define the destructiveness parameter affecting the optimal choice and the behaviour of agents. Note that the degree of destructiveness can be interpreted as the perception agents retain about the expected real impact of conflict. In other words, they are expected to make a choice taking into account the perceived impact of a conflict as an \textit{ex-ante} evaluation of the outcome of a struggle. Thus, it is the expected real impact of conflict. The common assumption of $\beta \in (0,1)$ implies that the struggle is always considered destructive, since only a fraction of the available output can be retained by each contestant.

Consider the occurrence of a war. In such a case, parties perceive that they will retain only $\beta(x_1 + x_2)$. Reality offers plenty of examples to support such idea.\footnote{6} That is, at the end of a conflict,

\footnote{5} Such concept helps to pave the way for interpreting the trade policy as an important part of foreign policy. A first excellent analysis is in Hirschmann (1945/1980). In recent years this argument has been strongly affirmed by R. N. Cooper in Cooper (1972/1973/1987).

\footnote{6} See footnote n. 3.
parties are aware that the payoff available is worth only a fraction of the contested output.

Recall that the underlying argument of this work considers conflict as a permanent feature of the interaction between the two opponents. Therefore, when conflict is permanent, the expected real impact links with the welfare losses due to devoting resources to military expenditures. Moreover, trade patterns are negatively affected by the diplomatic climate and uncertainty (since the two party are considered as trading competitors).

Within this setting, I assume for sake of simplicity that parties have the same expectation about the real impact of conflict and that there is common knowledge about this. This assumption can be relaxed. Taking into account that $\beta$ proxies an evaluation of parties it would be possible to say that they can also assume that $\beta > 1$. In other words, parties can look at conflict as stimulating the existing output. Parties can consider the conflict as a ‘stimulus’ for its own economy. The argument is trivially known as ‘Keynesian Militarism’.

---

7 A huge literature on the negative affects of military investments exists. See Arrow (2000) for a general framework.
8 The impact of diplomatic climate and uncertainty on trade has been empirically studied. Linnemann (1966) Gasiorowski and Polachek (1982), Van Bergeijk (1994, ch.7) show how diplomatic conflict constitutes a serious barrier to trade. Anderson and Marcouiller (2002) also show that uncertainty dramatically reduce international trade. Moreover, in reality, as the level of ‘guns’ increase in the system, it also does simulate the volume of international transaction of arms. An interesting account is given by Bergstrand (1992). This points out the linkage between arms trade and international trade. It is showed that in the long-run a reduction in arms trade is likely to enhance non-arms international trade. Then, given the results Bergstrand maintains (even if counterfactual demonstrations constitute a slippery ground) that the existence of arms trade does negatively affect the patterns of international trade.
This is a much debated question, but the idea behind is simple. A huge government spending is supposed to increase the global demand and therefore increases growth⁹.

Consider the case when a total war does not break out. According to this view, even if a war does not break out large investments in military sector can also be expected to have a positive impact on aggregate output¹⁰.

Then, hereafter, let define the parameter $\beta$ as the expected real impact of conflict and assume that $\beta \in (0, \infty)$. When $\beta \in (0,1)$ the expected real impact of the conflict is destructive. On the other hand when $\beta \in (1, \infty)$ the conflict is not-destructive. At $\beta = 1$ the conflict can be considered neutral. The limiting assumption is still that agents, within this simultaneous setting, share the same expectations on the real impact of conflict.

The second extension presented deals with the existence of trade policies. In fact, in reality trade is often obstructed by several unnatural measures imposed by rulers and commonly known as trade policies: tariffs, quotas, blockades, standard regulations etc..etc.. These measures negatively affect the patterns of trade

---

⁹ The classical example is the US economy before the World War II. In 1941 the American economy had still not recovered from the Great Depression. The war spending provided the necessary ‘stimulus’: GNP grew by 12 percent from 1941 to 1942, 18 percent the following year and by 1945 half of United Stated GDP was war production but at the same time the civilian production was higher than 1941.

¹⁰ Empirical support to this view is given by Benoit (1973) who found a significant positive correlation between the share of production devoted to defence and military expenditures and the growth rate of non-military output. Weede (1986) also finds out that there may be beneficial effects of a large military investment for LDCs.
between the two parties. Following the traditional international trade theory, in most cases, it is possible to say that tariffs and other instruments of trade policy affect negatively the welfare effects of trade through the combined effect of consumer surplus, producer surplus and government revenue. More precisely, a tariff raises the producer surplus and government revenue, and dampens the consumer surplus. Hence the net cost of a tariff is:

\[
\text{Net cost of a tariff} = \text{Consumer Loss - Producer Gain - government Revenue.}
\]

In general, protectionism benefits producers and hurts consumers. In fact, protectionist policies are commonly designed and implemented to favour interest groups and to redistribute income to politically influential sectors.

However, in some cases, the impact of trade policies on the whole economic welfare can be ambiguous. For instance, the argument of the optimum tariff, suggests that at small tariff rates a large country’s welfare is higher than with free trade\(^\text{11}\). An optimal tax on exports also can have a similar impact. Strategic trade policies as beggar-thy-neighbour policies can increase the national welfare at expense of that of other countries. Moreover, when markets are not perfectly competitive some instruments can generate welfare gains\(^\text{12}\).

\(^{11}\) Note that the argument of optimal tariff proves that a large country can benefit from tariffs. Whenever this happens it is only at expense of other countries. The phenomenon is more evident when larger countries levy a tariff on small countries. In fact, small countries, as price-takers, cannot affect world prices and then the terms of trade. Hence, small countries’ welfare declines more than the increase of welfare in large country. In such a case it seems to be the case that \(\theta > 1\) for both countries is not allowed.

\(^{12}\) A tax on exports of a monopolist could be an example. Imperfectly competitive markets constitute the ‘core’ of the account given by Helpman.
Then, it is possible to find some features able to proxy this kind of impact\textsuperscript{13}. Therefore, let modify the value of the contested output using a weight that is assumed to proxy the complex range of trade policies. (Note that in this extremely simplified scenario, I do not consider the effects of prices, exchange rates, and hence of terms of trade).

Let $\theta$ denote the expected real impact of trade policies and add it to each agent’s utility function under settlement. Thus, it is possible to write:

$$U_i^{ss} = \left[ \beta p_i + \frac{(1-\beta)}{2} \right] \theta (x_i + x_j);$$ \hspace{1cm} (54)

I assume $\theta \in (0, \infty)$. Note that if $\theta = 1$, trade policies are neutral. That is, it means that trade policies are supposed not to affect the contested income, or that there is no kind of impediment. If $\theta < 1$ trade policies negatively affect the available output. By contrast, if $\theta > 1$ trade policies are expected to benefit welfare.

As before, comparing the payoffs of pure conflict and settlement (now under protection) it is possible to determine when

\textsuperscript{13} Note also that in determining the impact of trade policies it could be useful also to refer to some ideas developed in literature regarding non-economic effects of trade policies. First, Hirschmann (1945/1980) presents the argument of the two-fold effect of international trade: (i) the \textit{supply effect} that is the ordinary and well known benefiting effect of larger markets; (ii) the \textit{power (influence) effect} according to which trade can become a direct source of power.
settlement is preferable to conflict. Through ordinary maximization process\(^{14}\) the optimal simultaneous choices of arming are derived, as well as the payoffs.

\[
z^* = z_1 = z_2 = \frac{\beta \theta (n_1 + n_2)}{2(\beta \theta + 1)}
\]

\[
U_i^s = U_1^s = U_2^s = \frac{\theta (n_1 + n_2)}{2(\beta \theta + 1)}
\]

It is possible now to rewrite the appropriate settlement condition. Recalling equation (45) denoting the payoffs under continuing conflict, it is possible to write that a settlement is always preferable if and only if:

\[
\frac{\theta (n_1 + n_2)}{2(\beta \theta + 1)} > \frac{\beta (n_1 + n_2)}{4}
\]

Call (57) settlement condition under trade policies, linking the expected impact of conflict with the existence of trade policies. Rearranging and manipulating inequality (57), the settlement condition becomes:

\[
\theta > \frac{\beta}{2 - \beta^2}
\]

Moreover, it is also possible to look at the ‘peacefulness’ of the latter scenario. As specified above, a state of the world is considered more

\(^{14}\) The F.O.C are:

\[
\frac{\partial U_i^s}{\partial z_i} = \frac{\beta z_i}{(z_i + z_j)} \left( \theta (n_i + n_j - z_i - z_j) \right) - \frac{\beta z_i}{z_i + z_j} \left( \frac{1 - \beta}{2} \right) = 0, i \neq j
\]
‘peaceful’ than another if the equilibrium level of arming is lower. In this case, it implies that: $z_{1}^{*} < z_{2}^{*}$ where the stars subscripted denote the symmetric equilibrium level. That is, recalling (55) and (44) ‘peacefulness’ implies that:

$$\frac{\beta \theta (n_1 + n_2)}{2(\beta \theta + 1)} < \frac{n_1 + n_2}{4};$$

(59)

Rearranging, simplifying and manipulating (59) becomes a simple ‘peacefulness condition’:

$$\theta < \frac{1}{\beta};$$

(60)

Using (58) and (60) as strict equalities it is possible to plot the indifference loci curves. Scaling the expected real impact of the conflict ($\beta$) against the impact of trade protection ($\theta$), different areas can be identified.
The dashed curve plots the indifference locus given by:

$$\theta = \frac{\beta}{2 - \beta^2}, \quad (61)$$

that is, at any point of this curve agents are able to reach the same level of utility both if they choose to conflict and if they choose to settle and exchange. At any point on the right of this curve conflict provides a higher utility than settlement. The solid curve plots the indifference locus given by:

$$\theta = \frac{1}{\beta}, \quad (62)$$
At any point below this curve, the level of arming under protection is lower than in the continuing conflict scenario. Hence, figure 3.4 shows how the settlement/conflict trade-off is modified when the impact of protection and of conflict changes. Note that these conditions hold regardless of any disparity in initial resources endowments. In fact, manipulating (57) and (59), the sum of endowments \((n_1 + n_2)\) cancels out. Therefore, only the impact of trade policies and of conflict respectively matters.

The four areas drawn have different equilibria configurations:

Area (I) is characterized by the following relations:

\[
\begin{align*}
U^{at} &> U^{CC} \\
z^{at} &> z^{CC}
\end{align*}
\]  

That is, the equilibrium utility level is higher in case of settlement, whilst the level of arming is higher under protection than in continuing conflict. Call this \textit{armed settlement}. The agents have incentives to settle and trade but they also choose a higher level of arming than in continuing conflict. This can occur when the conflict is less and less destructive or when it is perceived as not-destructive.

At the same time trade policies also are expected to foster welfare gains. This also could be the case of an interaction between a larger and powerful country and a smaller and less powerful country. This appears to refuse the liberal idea of ‘peacefulness’ of the trading state. It may fit with the concept according to which merchant states arm in order to a) protect their trade linkages in absence of property
rights and contract enforcement mechanisms; b) to expand their own control over resources.

This condition I defined armed settlement, could be seen in the experience of the British navigation act. It was intended to assure that foreign trade would be carried on in such a way as to yield the maximum advantage to Great Britain. Thus, the existence and the protection of a monopoly induced higher spending for ‘guns’. Adam Smith was aware that military expense was required to the maintaining of this monopoly. Take also Opium War between Great Britain and China, which lasted from 1840 to 1842. The Treaty of Nanjing (August, 1842) and supplement treaties (July and October 1843) radically increased the openings for trade in China and expanded the scope of British activities. The preferential treaties opened five ports: Canton, Fuzhou, Xiamen, Linbou and Shanghai. Hong Kong was surrendered to the British, giving the British a base for further military, political and economical penetrations of China. Furthermore, the Chinese import duties were lowered from 65% to 5%. Finally, the treaties also allowed British merchants free trade in China and every treaty port to have one British military ship.

Such kind of scenario perfectly fits with the underlying idea of this work. Recall what Boulding expounded about the three systems governing the human affairs. They are not likely to occur in pure form. Thus, the armed settlement scenario can be interpreted as a

\[15\] Adam Smith, (Book IV, Chapter VII, part second) “Whatever expence Great Britain has hitherto laid out in maintaining this dependency, has really been laid out in order to support this monopoly[...] The expence of the ordinary peace establishment of the colonies amounted[...], to the pay of twenty regiments of foot; to the expence of artillery, store, and extraordinary provisions with which is necessary to supply them; and to the expence of a very considerable naval force which constantly kept up[...]”
scenario where it is clearer that the threat relationship is intertwined with exchange.

Area (II), that I shall call *peaceful settlement*, is characterised by:

\[
\begin{align*}
U_{ot}^* &> U_{cc}^* \\
z_{ot}^* &< z_{cc}^*
\end{align*}
\]  

(63b)

That is, the level of utility due to trade, although under protection, of each agent is higher than in the continuing conflict scenario. In a parallel way, the settlement occurs with a lower level of arming. This scenario better fits with the idea of the ‘peaceful spillover’ of trade between states. Albeit non-cooperative, the agents recognize the incentives to trade instead of engaging in a continuing conflict.

This is also due to the opportunity cost of a conflict. When the conflict is perceived to be destructive, agents make their simultaneous choice taking into account the deadweight loss of a conflict. This appears to be extremely powerful if it is considered that states are also willing to suffer a high burden of trade protection instead to be engaged in a struggle. This can also link with the traditional liberal idea according to which free trade is associated with a more peaceful situation because of the certainty of welfare gains to be achieved by societies. This seems the case of historical experience of German *Zollverein*\(^\text{16}\).

The area (III), denoted by the expression *weak conflict*, is characterised by:

\[
\begin{align*}
U_{cc}^* &> U_{ot}^* \\
z_{cc}^* &> z_{ot}^*
\end{align*}
\]  

(64c)

\(^\text{16}\) On development of *Zollverein* see Bazillion (1990).
That is, agents have an incentive to follow the path of a continuing conflict due to the higher utility they can reach, but at the same time the level of arming they choose simultaneously is lower than that they would have chosen under trade policies. This is due to the different impact (somewhat changing) of destructiveness and trade protection. More precisely, on the left of the intersection point of the two curves the expected real impact of conflict appears to be more powerful. States are willing to suffer the burden of a depriving trade protection because a struggle appears to be extremely destructive.

This could be close to the historical experience of the Cold War. The political climate, in fact, strongly affected the potential trade patterns between Western and Eastern hemispheres, through creating formal and informal high trade impediments. At the same time the escalation of a nuclear war appeared to be so destructive as to prevent the occurrence of a total war. As the conflict becomes less and less destructive, agents choose to be engaged in a permanent conflict at a lower level of arming then in continuing conflict scenario. When the conflict appears to be not-destructive parties are still willing to experience a weak conflict if the impact of trade policies is expected to deprive available income. Anyway, there is no ‘peaceful’ settlement.

This seems to be the case of international economic sanctions (boycotts and embargoes)\(^1\). They are commonly imposed in order to

inflict an economic damage to one opponent country. The phenomenon of international negative sanctions is a clearer example of conflict as a permanent feature. Both sender and target country are negatively affected because of the trade disruption that emerges.

Area (IV), does fit perfectly with the continuing conflict state of the world and it is characterised by:

\[
\begin{align*}
U^{cc} &> U^{ot} \\
z^{cc} &> z^{ot}
\end{align*}
\]

(63d)

That is, a continuing conflict provides a higher utility and the agents allocate a higher amount of resources to arming. Such a case seems to be also considered as the prelude to the outbreak of a war. Quoting Cooper (1972b), for example: Where the total gains from trade are high, preservation of trade becomes a matter of high foreign policy, as it is sometimes called, or even of national security. Thus, a high value placed on trade may lead countries to war over it, as it led Japan in 1941 to attack the Philippines and the United States fleet at Pearl Harbor to remove threats to its oil trade with the east indies18.

Thus, the model shows how trade different combination of the parameters lead to different equilibria. Note that an important finding is linked to the initial resource endowments, where


18 Cooper (1972b) p. 179.
asymmetry does not seem to affect the choices of parties. The most important element is re-distributive mechanism.

Moreover, the findings of the model contribute to a neverending debated among scholars (mainly among political scientists): the relationship between trade and conflict. In fact, the linkage between international trade and conflict is complex but indisputable. The nature of this relationship, however, is highly debated. Traditionally there are two basic theoretical positions. The liberal idea argues that international trade is the root of political co-operation and amity. A second position argues that international trade can contribute to political conflict and hostility.

The basic idea surrounding the argument of peaceful effect of trade relies upon the idea that restricted trade affects the well being of trading nations. In sum the basic assumption is that societies can gain and pursue a higher level of welfare from trading. Hence when a rational actor (the State) has to choose to be involved in conflict and wars, it takes into account the opportunity cost of reducing welfare. Hence free trade is associated with a more peaceful situation because of the certainty of welfare gains to be achieved by societies.  

19 Among economists, Polachek (1980) firstly provides a simple formal microeconomic model. The model is based on a country social welfare function assumed to be derived from the preference sets of the entire population. Following a standard trade model, when a country is engaged in a conflict, a restriction in trade foster a deterioration of terms of trade given the impact of conflict on prices. Then, since conflict is assumed to affect the price of trade, rational behaviour of a country will be choosing an optimal level of hostility that maximizes the welfare function given the balance of payments constraint. The equilibrium is reached when results of the model that the net cost associated with extra hostility equals the welfare benefit of more hostility. Polachek has refined his basic model also.
The opposite argument, advanced by neo-marxists and neo-realist scholars, is based upon the idea that countries are to be in competition for scarce production inputs and markets. As competition intensifies, state power is used to guarantee national access to resources and markets. When the level of state intervention increases, one is more likely to observe a rise in protectionism, trade wars, economic penetration, colonial expansion, intervention in local conflicts, and an overall decrease in international cooperation.

providing empirical support of his argument in Polachek (1992, 1994, 1997) and in Polachek et al. (1999). There are also many empirical studies which analyse impact of interdependence on the onset of a Militarized Intestate Dispute (MID). Most of these studies are by John Oneal, Bruce Russett and their associates (Oneal et al. 1996, Oneal and Russett 1997, 1999, Oneal 2003). Other studies are Bennet and Stam (2000) and Gartzke and Li (2001).
THE PEACEFUL EFFECT OF INSTITUTIONS

What are the potential ‘peaceful’ benefits from establishing rules for the conduct of trade policy? Moreover, what are the gains in terms of peace of a trade arrangement? Although the relationship between trade and conflict has been controversial among scholars, relatively little attention has been paid to the impact of institutional framework underpinning the expansion of economic interactions. Few studies deal with the question of whether an institutional scenario fosters an easing of tensions between members. The objective of this chapter, therefore, is to evaluate the ‘peaceful’ impact of a trade institution.

Mansfield and Pevehouse (2000) and Mansfield (2003) argue that parties in a same preferential trade agreement are less prone to interstate conflict than other states. The idea behind appears to be simple. The expected gains of expanded trade are higher under a preferential arrangement than in anarchy, whilst conflict and hostilities are supposed to threaten these economic benefits. Even if little trade is conducted among members of a preferential trade agreement (PTA), these groupings can inhibit conflict if participants expect to derive economic benefits in the future. This involves the concept of opportunity cost of a conflict. As a last feature is that these arrangements provide also a forum for bargaining and conflict resolution on economic dispute. An empirical analysis in Mansfield
and Pevehouse (2000) supports the argument. In particular the results show that commerce for PTA members inhibits hostilities.

The most important criticism that can be made on Mansfield’s argument is that he minimizes the importance of specific choice among several types of preferential trade agreement. Using his words: “Despite these differences, however, all such arrangements grant each participant preferential access to every other member’s market”\(^1\). In reality, a different institutional framework affects and modifies incentives, gains and costs for participating countries.

Schiff and Winters (1997) model a world in which regional trade agreements are expected to reduce security tensions between neighbors. Security among neighbors is assumed to increase as imports from that neighbor increase. The results of the model show that 1) The formation of a customs union (CU) - accompanied by appropriate domestic taxes -provides an optimum economic arrangement under symmetry, and the same holds for a free trade agreement (FTA) under asymmetry; 2) If the level of security depends on current as well as past trade flows and is in steady state in the absence of trade barriers, the optimum external tariffs decline over time; and 3) Enlargement of bloc size (in terms of the number of symmetric countries) implies higher welfare, with an ambiguous impact on the optimum Common External Tariff (CET) although it is likely to be higher; and some form of domino effect exists.

Externalities associated with security matters imply that a Regional Agreement (RIA) may maximize welfare, Schiff and Winters (1997) suggests that the RIA is a transitory arrangement in

\(^{1}\) See Mansfield (2003) p. 223
the sense that optimum trade preferences are highest at the time the RIA is formed (when security is low) and tend to decline over time. In other words, the RIA’s external trade policy becomes increasingly open over time.

The distinction between several forms of integration is also addressed by Padoan (1997). He distinguishes different degree of integration. The deeper the level of integration the higher are the gains in terms of security. Given the benefits of reciprocal exchange are higher than those of reciprocal aggression. Moreover, a deeper integration also raises the capability of resistance against a common external threat, both economic and non economic. Also in this case the ‘peacefulness’ of a trade arrangement is interpreted as a positive externality of economic integration.

All these studies, however, abstract from the relevance of defense expenditures as a way to generate security. If we do not consider the existence of resources allocated to defense and aggression, this implies that in a broader view all the literature on economic integration can be broadly meant as a literature on security and formation of peaceful environment.

But, as I noted before this is just a part of the story. In fact, the outcome of the foregoing chapter showed that two opponents may have incentive to settle, but under a wide set of conditions they maintain incentives to arm (recall the armed settlement scenario). This result does suggest that the expected gains of exchange do not suffice to prevent arming and perhaps escalation of a conflict. Harmony does not take place suddenly because of higher gains. It is reasonable
to think that there is an amount of resources agents are willing to devote for pursuing this kind of goal.

To the best of my knowledge, a first attempt in this direction is by Genicot and Skaperdas (2002). They develop a model where adversaries divide their resources between guns, butter and investments in conflict management. Their modeling takes account of two characteristics of institutions of conflict management: a) time needed to build up institutions; b) the uncertainty about the impact of these investments. A first finding of Genicot and Skaperdas is that how rich the adversaries are has a large effect on the probability of peace. The poorer are the adversaries, in the sense of the real resources they possess, the lower is their investment in conflict management and the lower is the probability of peace. In addition, poorer adversaries will devote proportionately greater percentage of their resources to guns and less to butter than richer adversaries would, thus compounding the effects of initial resource poverty.

Taking also into account the number of adversaries Genicot and Skaperdas show that a greater number of adversaries increases the probability of peace, when adversaries start with their own resources - like when a new country enters an existing conflict. When, however, a greater number of adversaries is the result of the fragmentation of existing adversaries, (after civil wars for example) the effect of a greater number of adversaries is to reduce investments in conflict management and the probability of peace.

The impact of investments in conflict management are determined through a function that takes value between 0 and 1. This is an offshoot of the Cobb-Douglas production function. It is
assumed to be either constant returns of scale or decreasing returns of scale. A parameter $\alpha$ is a measure of returns to scale (or, of the degree of homogeneity) of the investment function. When $\alpha = 1$ a simultaneous doubling of all parties’ investments in conflict management would also double the probability of peace. When $\alpha < 1$ a doubling of all investments would less than double the probability of peace. The model is developed in two periods and no future assumed beyond. In the first period, since investments in conflict management are assumed to have an effect only in the second period, conflict is unavoidable. Thus, a party $i$’s share of the net output in the first period is determined by a CSF. In the second period, because there is no future beyond that, there is no reason to invest in conflict management. The first period’s investments in conflict management, however, have an effect on how the available surplus is divided. In particular, the more the two sides have invested in conflict management the higher is the probability that they will cooperate and will not need to resort to guns to divide the total surplus. In the event of peace they hold on to the butter they have produced, whereas under war all the butter that is available is divided in accordance with the relative amount of guns each adversary possesses.

The authors show that there are different feasible equilibria. First a pure conflict equilibrium occurs when none of the adversaries invests in conflict management. When the function of investment in conflict management presents decreasing returns of scale the probability of peace is strictly lower than unity. They call this equilibrium partial cooperation. This equilibrium is Pareto-superior to
the pure-conflict. When the probability of peace equals unity no guns are acquired in the second period and the equilibrium is denoted as pure cooperation. The payoffs are higher than under pure conflict and are Pareto dominant. These equilibria occur when decreasing returns to scale are assumed in conflict management. On the contrary, under constant returns to scale there is no possibility of obtaining partial cooperation as an equilibrium.

As the number of contenders increases the results change taking into account whether additional adversaries have their own resources $R$ or they divide up a constant amount of total resource, $n$. The first situation can be considered one of replication of the adversaries and is perhaps more fitting to cases of international conflict. The latter situation with a fixed amount of total resources is one of fragmentation and would be more appropriate for cases of internal conflict.

The main criticism that could be made relates to the identification of conflict management institutions. The authors do not distinguish clearly between several types of international institutions. Therefore, investing in the League of Nations, in United Nations, or in WTO appear to be somewhat equivalent.

### 4.2 Some Assumptions to Model a Trade Institution

Before deepening the ‘core’ argument of this work, I summarise again some basic concepts and ideas that contribute to give the model the presented shape. First, the following discussion
assumes the world is made of two competing countries only. These countries are assumed to behave like rational risk-neutral agents. They are utility maximizers, and moreover neither benevolent or malevolent. Agents are also assumed to be unitary actors. That is, considering the case of nations-states, they are not subjected to pressure from a variety of internal interest groups. In this two-countries world the technology is neutral, that is, both countries retain the same level of technology. In addition geography does not matter. Then, the conflict is not decisive.

As in the previous chapter, the one-period protocol of moves of the two sides can be decomposed in two stages: (i) firstly each opponent allocates its endowed resources to the production of ‘guns’ and ‘butter’ according to the Hirshleifer’s once-and-for-all assumption. That is, namely each side makes an optimal once-and-for-all choice of ‘butter’ and ‘guns’; (ii) secondly, given this resources allocation each side chooses whether to conflict or to settle. The difference with the previous model is that agents can choose whether to be involved into a continuing conflict or to settle under the umbrella of an institution. To do that, agents reduce resources devoted to conflict by a certain amount. The resources constraint is to be modified. Up to this point, in fact, only two kind of activities have been considered: appropriative and productive. They were considered rival. Resources of agents now are

---

2 Under these circumstances this mechanism would proxy the process of creating/joining an institution. This is clearly an extensive reduction. Institutions, regimes and agreements of several species take shape after years of negotiation. See Young (1998, ch.1) for an explanation for feasible stages of international regime formation.
expected to be devoted also to a third activity. That is, a certain amount of them is diverted to join a trade institution.

The agents of the model can either fight or settle, as before. The main difference is in the existence of institutions which affect the incentives of agents. Therefore, the agents can bind themselves in a set of rules and procedures that affect the outcome of the contest on a pool of available income. This relates to Boulding’s idea of ‘grant economics’ in integrative systems.

As in the foregoing chapter, I assume that the split-of-surplus rule of division holds. Since trade is also affected by geography and technology, by modelling the market as a contest, the outcome would also depend upon technological asymmetry between contestants. In particular, the more productive agent is likely to gain more from trade. This fact also would affect the choice on the allocation of resources.

Let’s also introduce some limiting hypothesis on the ‘benchmark’ design for a trade institution. First, this trade institution is capable to establish and enforce a free trade area between members; no barriers to trade are allowed. This is a very strict assumption, which does not fit much with reality. However, since the objective of the model is to design a ‘benchmark’, it will be kept in developing the argument.

Moreover, the institution is supposed to implement a set of rules and procedures governing trade interactions. Hence, given the existence of rules, trade is supposed to be ‘fair’. Any agent has the same rights and the same duties. In other words, there is no bias in favour of a more powerful or an unfair ‘contestant’. Usually an
enduring enforcement is associated with the existence of a dispute settlement system (DSS)\(^3\). Hence, this rules out any ‘imbalance of power’ between countries, since a dispute settlement procedure is designed to be rule-driven and not power-driven and it is assumed not to be biased in favour of any party in a dispute. This is supposed to pave the way for a stable rule-oriented system. Agents observe the existence of DSP and assume that it is able to enforce the set of rules to keep the trade contest ‘fair’. Since the system is designed to preserve free and fair trade, each player trusts the capacity of the institution to ensure an enduring compliance with the institutionalized set of rules. Moreover, the DSS is assumed to be costless; therefore, there are no unaffordable disputes because of high costs. The countries join the institution by giving up a certain amount of resources, say the membership fee. This amount of resources is assumed to be equal between contestants. Paying this membership fee signals countries’ intention to comply with obligations emerging under an institutional regime. For analytical simplicity, it is assumed to be exogenous.

Parties obviously expect to benefit from this disbursement. Such a benefit is expected to come indirectly through enhancing the advantage of trade within the framework of the institutional set of rules.

To summarise, in the benchmark case, a trade institution is assumed to: a) establish free trade between participants; b) make the

\(^3\) Perhaps, the most effective example of a successful dispute resolution mechanism is the European Court of Justice. It doubtlessly had been a cornerstone of European integration.
trade ‘fair’, that, in absence of asymmetries by assumption, does imply the *split-of-surplus* rule of division of the pie between contestants holds; c) preserve a ‘fair’ free trade trough a rule-driven DSS. Whatever distorting behaviour making the trade unfair occurs is it corrected and trade remains ‘fair’; d) it also requires an exactly identical *membership fee* from all members. This assumption rules out any other possible asymmetry.

### 4.3 The model

Hereafter I extend the model of the third chapter in order to investigate the possible impact of enhancing the advantages of trade. The resources partition equation is now:

\[ n_i = x_i + z_i + h_i \]  \hspace{1cm} (64)

where \( h \) denotes the exogenous share of resources devoted to institutions building, membership and negotiating. As in the foregoing section, each party’s share of total output is a weighted combination of two rules of division. Their relative weights are determined by the parameter denoting the expected real impact of the conflict.

\[ U_i = [\beta p_i + (1 - \beta)\delta](x_i + x_j); \]  \hspace{1cm} (65)

where
The membership fee is required to join the institution. Although in reality the membership contributions to institutions are usually proportionate to the wealth and the size of countries, I assume that it is a fixed amount. Note that in case of perfect symmetry between countries this perfectly fits. Thus, more formally:

\[ h_i = h_2 = h \]  

then (66) becomes:

\[ p_i = \frac{z_i - h}{z_i + z_j - h_j}; \]

\[ \delta = 1/2 \]  

Studying the behaviour of the CSF, \( h \) can be considered a constant vector that affects the ordinary outcome of the contests\(^4\). In the CSF the membership fee decreases the amount of resources devoted to arming. In this case it negatively affects the poorer participant. That is, given the resources constraint of each contestant the poorer side is relatively more impoverished.

Then, also in this case, the second rule is indicated as the split-the-surplus rule of division. The utility function for each country becomes:

\[ U_i = \beta \frac{z_i - h}{z_i + z_j - 2h} + (1 - \beta)/2(n_i + n_j - z_i - z_j - 2h) \]  

\[ \text{(69)} \]

\(^4\) As pointed out by Skaperdas (1996) this is not true for ‘logit’ form of CSF. See property (A7) in appendix 2.1.
For an interior solution the first order conditions for the maximization problem are:

$$
\frac{\partial U_i}{\partial z_j} = \left[ \frac{\beta(z_i - h)}{(z_i + z_j - 2h)^2} \right] (n_i + n_j - z_i - z_j - 2h) - \left[ \frac{\beta(z_i - h)}{(z_i + z_j - 2h)^2} \frac{1 - \beta}{2} \right] = 0
$$

(70)

Solving (70) the problem of maximization yields a symmetric interior Nash equilibrium with $z^* = z_1^{ins} = z_2^{ins}$. It is simple to demonstrate that the Nash equilibrium level of arming is:

$$
z^* = z_1^{ins} = z_2^{ins} = \frac{\beta(n_i + n_2) - 2h(\beta - 1)}{2(\beta + 1)}
$$

(71)

In this symmetric Nash equilibrium the payoffs of both agents are:

$$
U_i^{ins} = U_1^{ins} = U_2^{ins} = \frac{\beta(n_i + n_2) - 2h}{2(\beta + 1)} - \frac{2h}{\beta + 1}
$$

(72)

Remembering also the symmetric equilibrium payoff under ‘continuing conflict’ it is possible to show that a settlement under a trade institutions is always preferable for both agents when:

$$
U_i^{ins} > U_i^{cc}, \quad \frac{\beta(n_i + n_2)}{2(\beta + 1)} - \frac{2h}{\beta + 1} > \frac{1}{4} \beta(n_i + n_2)
$$

(73)
Manipulating and rewriting, the settlement condition becomes:

\[
h < \frac{(\beta + 2)(1 - \beta)(n_1 + n_2)}{8}
\]  

(74)

Call this settlement condition under institution. This inequality depends upon the value of \( \beta \). If \( \beta \in (0,1) \) this inequality always holds. That is, when parties perceive the conflict as destructive they will prefer to settle under the umbrella of a trade institution.

By contrast, if \( \beta \in [0,1] \) this inequality does not hold. In particular, if \( \beta \in (1, \infty) \) the first term is positive whereas the second term is negative. Then, it is false. In other words, when the expected real impact of conflict is not-destructive parties do not settle. That is, the expected benefit from being involved in conflict is higher than joining an institution.

What about the level of ‘guns’? According the common definition adopted in this work, a scenario is considered more peaceful if and only if the level of guns is lower than in another scenario. Therefore, the peacefulness condition under institution is:

\[
\frac{\beta(n_1 + n_2) - 2h(\beta - 1)}{2(\beta + 1)} < \frac{n_1 + n_2}{4}
\]  

(75)

Manipulating and re-arranging:

\[
\frac{h(\beta - 1)}{\beta + 1} > \frac{(n_1 + n_2)(\beta - 1)}{4(\beta + 1)}
\]  

(76)
Inequality (76) also depends upon the value of $\beta$. The allocation of resources to conflict in equation (71) is unambiguously lower than ‘continuing conflict’ scenario for any $\beta \in (0, 1)$ and any $h \in \left[0, \frac{n_1 + n_2}{4}\right]$. (77)

Note that the upper bound for $h$ equals exactly the level of ‘guns’ which parties would choose in continuing conflict scenario. This suggests the idea that the amount of resources devoted to guns and membership fee can be interpreted as substitutes.

When the conflict appears to be destructive and the membership fee is lower than the amount of resources allocated to ‘guns’ under conflict, joining a trade institution is unambiguously more peaceful than continuing conflict. By contrast, when $\beta \in [1, \infty)$ joining an institution is more peaceful if and only if

$$h > \frac{n_1 + n_2}{4}.$$ (78)

That is, when conflict does not appear to be destructive the membership fee ought to be higher than the optimal level of ‘guns’ in continuing conflict. This is obviously a paradoxical result.

To summarise, the model shows that both parties are better off if they settle under an institution. The choice of parties is driven by the level of payoffs which are higher than in continuing conflict. In other words, parties are aware of the room of improvement in both of their payoffs. Then they decide to decrease their allocations to guns and increase their allocations to productive activities. In such a way, they move towards a more efficient equilibrium.
This outcome emerges in *the shadow of conflict* since investment in guns are kept. Moreover, the outcome is symmetric. That is, initial asymmetries in resource endowments are ruled out. This outcome suggests that cooperation with some set of institutions is possible without a necessary domination of a party over the other\(^5\).

\(^5\) This idea is in Skaperdas (1992), Neary (1997), Garfinkel and Skaperdas (2001).
In the foregoing chapter a basic model showed the potential benefits of a trade institution in creating a peaceful environment. Two risk-neutral agents, supposed to be two states in an international arena, convert their resource endowment in ‘butter’ and ‘guns’ and conflict over a common output, say ‘pie’. They will settle instead of fighting under some conditions.

The contested output can be appropriated investing resources in ‘guns’ or can be split under the set of rules of a trade institution. In particular, through diverting a small amount of resources (‘membership fee’) to join a trade institution both parties are better off than in a continuing conflict scenario. Such ‘one-way’ transfer of resources links with the concept of ‘grant’ as a cornerstone of an integrative system à la Boulding.

This institutional scenario, however, takes shape on the ‘shadow of conflict’ given the investment in ‘guns’ each party makes. The findings of the model are: (1) With the existence of a trade institution the level of resources devoted to ‘guns’ is lower than in pure continuing conflict scenario. (2) Comparing the payoffs under continuing conflict and under institution it is possible to show that: 2.a) The existence of a trade institution makes countries able to receive a higher utility than in the continuing conflict scenario. Therefore, in a two-country world the rational choice of both agents will be joining a trade institution capable to establish free trade area.
This outcome holds both with equally endowed and differently endowed countries.

Now I extend the analysis considering new elements and asymmetries in order to verify whether they affect the outcomes of the basic model. First, I consider the impact of time. The model will be extended in a two-period setting. Secondly, I relax the \textit{split-of-surplus}, i.e. the fair division of the contested output. To be more realistic, I assume that the contested output, say the ‘pie’, is to be divided according to an asymmetric rule of division. Last but not least, I consider the impact of different evaluations of the ‘pie’ on the optimal choices of ‘guns’ as well as the incentives to settle or to fight.

\section*{5.1 A two-periods mechanism}

Up to this point a one-period model has been considered. In this section the model will be extended in order to take into account the impact of the future upon the choices of agents. Consider, for sake of simplicity two periods and no future beyond them. Within this simple dynamic setting, the two rational parties take into account second period payoffs when making their own first period choices. Therefore, the model can be solved by backward induction, starting from the final period outcome.

Let $n_i$ denote the initial endowment of resources of agent $i=1,2$ at time $t=1,2$. In the first period the resources partition equation is as in (64). Suppose second period resources depend upon
the realised payoff in the first period. In the simplest case the resources available to each agent equal exactly the payoffs realized in the first period. No discount factor is considered. This means that later utility is evaluated as much as the earlier utility. More formally:

\[ n_{i,2} = U_{i,0} \]  

(79)

The maximization problem in the second period is the same as in the first period. Thus, by substituting (64) into (69), and (72) it is possible to write the second period payoffs in the different scenarios.

In the first period each party look at the sum of the \textit{ex-ante} payoffs it receives over the two periods. The objective function is therefore so described:

\[ V_i' = U_i' + U_i^{ins}, j = cc, ins; i = 1, 2 \]  

(80)

Trough the comparison between the two-period payoffs it is possible to determine the choices of both agents. For instance, if \( V_i^{ins} > V_i^{cc} \) for both \( i = 1, 2 \), it would be possible to say that both agents would be willing to settle under the umbrella of an institution instead of being involved in a continuing conflict situation. In other words this condition could be considered as a \textit{settlement condition} within a dynamic setting.

Now, recall the expressions (44) and (72). They represent the payoffs for both agents under continuing conflict and under institutions respectively. The \textit{membership fee} due to join an institution is assumed to be unchanged in the second period for both parties.
Moreover for analytical simplicity consider only the case of \( \beta \in (0,1) \). For sake of simplicity, notations for the first period are unchanged: then \( n_{ii} = n_i, U_{ii} = U_i, z_{ii} = z_i \). Therefore, using equation (44) it is possible to write:

\[
V^{cc}_1 = V^{cc}_2 = \frac{\beta(n_1 + n_2)}{4} + \frac{\beta(U^{cc}_{11} + U^{cc}_{12})}{4} \tag{81}
\]

\[
V^{ins}_1 = V^{ins}_2 = \frac{n_1 + n_2}{2(\beta + 1)} - \frac{2h}{\beta + 1} + \frac{U^{ins}_{11} + U^{ins}_{12}}{2(\beta + 1)} - \frac{2h}{2(\beta + 1)} \tag{82}
\]

Where (81) and (82) denote the two-periods payoff function for the continuing conflict and the institutional scenario respectively. Rewriting (81) and (82) yields

\[
V^{cc}_1 = V^{cc}_2 = \frac{\beta(n_1 + n_2)}{4} + \frac{\beta(n_1 + n_2)}{4} = \frac{\beta(n_1 + n_2)(\beta + 2)}{8} \tag{83}
\]

\[
V^{ins}_1 = V^{ins}_2 = \frac{n_1 + n_2}{2(\beta + 1)} - \frac{2h}{\beta + 1} + \frac{n_1 + n_2}{2(\beta + 1)} - \frac{2h}{2(\beta + 1)} - \frac{2h}{(\beta + 1)} = \frac{(n_1 + n_2)(\beta + 2) - 4h(2\beta + 3)}{2(\beta + 1)^2} \tag{84}
\]

Also in this case parties will settle in the first period and join an institution if and only if \( V^{ins}_i > V^{cc}_i, i = 1,2 \). That is, if and only if:

\footnote{See Appendix 5.1 for the complete algebra.}
\[
\frac{(n_1 + n_2)(\beta + 2) - 4h(2\beta + 3)}{2(\beta + 1)^2} > \frac{\beta(n_1 + n_2)(\beta + 2)}{8}
\]

(85)

Such settlement condition holds if and only if:

\[
h^{**} < \frac{(n_1 + n_2)(\beta + 2)[4 - \beta(\beta + 1)^2]}{16(2\beta + 3)}
\]

(86)

Where \( h^{**} \) denotes the critical value of the membership fee over the two periods.

Such critical value for the membership fee can be interpreted as proxy of the willingness to settle for both parties. The higher is the critical value of \( h \), the higher is the willingness to settle. In order to highlight a special feature of the two-periods model, recall the critical value \( h^{*} \), captured by (74) for the membership fee in the basic model. Through a simple comparison it is possible to verify that:

\[
h^{**} < h^{*}
\]

(87)

That is, the **critical value of the membership fee in the two-period model is strictly lower than in the one-period model.** Thus, albeit simple, the analysis in this section does shed light on a particular aspect. The point of interest in such case is that parties will be willing to settle and join an institution if and only if the amount of resources devoted to it is relatively low. In particular, as the time horizon becomes larger and larger, making an institution becomes more and
more ‘suspect’. Then, rational parties taking into account ex-ante payoffs would settle and join an institution at a relatively low levels of ‘membership fee’. In other words, it also would be possible to say that the willingness to settle decreases as the future becomes too far. This result contrasts with the famous idea due to Axelrod (1984) according to which contenders in a long-term relationship are more willing to co-operation. At the same time it is line with Skaperdas-Syropulos (1996), which show that in the presence of time dependence can intensify conflict.

5.2

UNFAIRNESS OF SETTLEMENT

In the foregoing chapter a cornerstone of the model presented was the split-of-the-surplus rule of division. In fact, following Garfinkel and Skaperdas (2000) it was assumed that parties apply a particular rule for dividing output under settlement. It is a weighted combination of two possible rules (i) the CSF; (ii) a symmetric 50-50 split of the output. Now I relax this assumption. More precisely, the 50-50 split of the output is relaxed. Albeit rationally justified, a symmetric split is not likely to occur very often in reality. Therefore, it is possible to say that expression (69) is a special case of:

\[
U_i = \beta \frac{z_i - h}{z_i + z_j - 2h} + (1 - \beta) \delta_j [(n_i + n_j - z_i - z_j - 2h)] \quad (88)
\]
Where $\delta_i \in [0,1], i = 1, 2$ denotes the share of output received by each agent under a negotiated settlement. Moreover, I assume that $\delta_1 + \delta_2 = 1$ and that $\delta_1 > \delta_2$. Then, more precisely $\delta_1 \in (1/2, 1]$ and $\delta_2 \in [0, 1/2)$. That is, agent 1 retains a larger fraction of contested output than agent 2.

Many situations in reality confirm the existence of ‘unfair’ agreements. Several of the negotiated regional trade agreements (Canada-U.S., NAFTA, E.C.-Hungary/Poland/Czech and Slovak Republics) contain significantly fewer concessions by the large countries to smaller countries than vice versa\(^2\).

For analytical simplicity in this section I also relax two limiting assumptions. First, I do not consider the degree of destructiveness of conflict. Second, countries are equally endowed\(^3\). Then, given also $n = n_1 = n_2$, utility functions for both parties become:

\(^2\) Perroni-Whalley (1994) try to resolve this seeming paradox by interpreting such agreements as insurance arrangements for smaller countries, which partially protect them against the consequences of a global trade war. What they offer to the large countries in return is largely non-trade benefits (such as restraints on domestic policies in the smaller countries, firmer intellectual property protection, firmer guarantees of royalty arrangements affecting resources on state-owned lands). In fact, when evaluated relative to a post-retaliation tariff equilibrium the value of these agreements to small countries is large because they help preserve existing access to larger foreign markets.

\(^3\) Usually the idea of unfairness is related to a disparity between countries. That is, it is commonly assumed that the wealthier party is also the more powerful party. The disparity of resources will be examined later. However, recall in the second chapter the general form of resource constraint in equation (1). In a more general form in fact, a part of resource endowment also contains a home productive efforts that are not appropriable. Whether a country is richer or poorer also depends on that. However, throughout the work I only considered that amount of resources that is to be converted in ‘guns’ or ‘butter’ to produce and appropriate a share of the aggregate output, namely the ‘pie’.
This extension of the model is to be solved in the same way of the basic model. Then, the first order conditions for the maximization problem are:

\[
\frac{\partial U}{\partial z_1} = \frac{(z_2 - h)}{(z_1 + z_2 - 2h)^2} (2(n - h) - z_1 - z_2) - \frac{z_1 - h}{z_1 + z_2 - 2h} - \delta_1 = 0 \quad (90a)
\]

\[
\frac{\partial U}{\partial z_2} = \frac{(z_1 - h)}{(z_1 + z_2 - 2h)^2} (2(n - h) - z_1 - z_2) - \frac{z_2 - h}{z_1 + z_2 - 2h} - \delta_2 = 0 \quad (90b)
\]

Solving the system of equations (90a) and (90b) it is possible to find the equilibrium level of ‘guns’ for both players. Moreover I use \(\delta_1 + \delta_2 = 1\) since it is useful to express the level of ‘guns’ of each agent as a function of its own share of the ‘pie’, that is \(z_i = f(h, \delta_i, n), i = 1, 2\).

\[
z_1 = \frac{2\delta_1 (2h - n) + h + 4n}{9} \quad (91a)
\]

\[
z_2 = \frac{2\delta_2 (2h - n) + h + 4n}{9} \quad (91b)
\]
Since $\delta_1 \neq \delta_2$ the equilibrium level of ‘guns’ for both agents differ, that is $z_1 \neq z_2$. In particular, given $\delta_1 > \delta_2$ by assumption, it can be proved that $z_2 > z_1$.

Therefore, the higher is the fraction of the available income one party retains the lower is the equilibrium level of ‘guns’ of that party. This means that that agent which knows it will retain a higher share of the ‘pie’ under an institutional settlement has less incentives to arm than the opponent. By contrast, the party that will receive a lower share of the ‘pie’ has incentives to arm more. This outcome appears to re-produce in some sense the argument of the Paradox of Power expounded by Hirshleifer.

Using (91a) and (91b) in the utility functions of both agents the equilibrium payoffs of both agents are respectively:

$$U_i = \frac{8(n - 2h)(\delta_i + 1)}{9}, i = 1, 2$$

For $\delta_1 > \delta_2$ it is clear that $U_1 > U_2$. Thus, the agent with a higher share of the ‘pie’, also gets a higher payoff than the opponent.

Given such asymmetric outcome, is an institution still preferable? To verify this, recall the settlement condition: $U_i^{ins} > U_i^{ce}, i = 1, 2$. Since $U_1 \neq U_2$, two settlement conditions exist:

$$\frac{8(n - 2h)(\delta_i + 1)}{9} > \frac{n}{2}, i = 1, 2$$

4 The second term of inequality (93) denotes the payoff in continuing conflict under the assumption of equal initial endowment for both agents.
Rearranging and manipulating (94) in terms of \( h \) the settlement condition for both parties become:

\[
h^* < \frac{n(16\delta_i^* + 7)}{32(\delta_i^* + 1)}, i = 1, 2
\]  

(94)

In this case the contenders have different critical values for the membership fee. In particular, given \( \delta_1 > \delta_2 \) by assumption, it yields \( h_1^* > h_2^* \). That is, that party which retains the larger fraction of the available output is able and willing to sustain a higher membership fee to join the trade agreement. Thus, the willingness to settle of agent 1 is higher.

What about the peacefulness of such asymmetric settlement? The peacefulness conditions are given by \( z_i^{\text{int}} < z_i^{\text{cc}}, i = 1, 2 \). Therefore using (91a) and (91b) they are:

\[
\frac{2\delta_i (2h - n) + h + 4n}{9} < \frac{n}{2}, i = 1, 2
\]  

(95)

Inequalities for both parties hold whatever the level of \( h, \delta_1, \delta_2 \). Thus, albeit asymmetric such agreement appears to each party as more ‘peaceful’ than the continuing conflict scenario. Thus, the remarkable point is that, although asymmetric, a trade institution committed to free trade is strictly preferable for both parties. The findings of the basic model are not overturned.
5.2.1 DIFFERENTLY ENDOWED PARTIES

In the foregoing section the analysis assumed the limiting hypothesis of equally endowed countries and without considering any destruction parameter. This contributed to shed light on the impact of an unfair division of the available pool of income between contenders. Now, it is possible to relax the assumption of equal endowment. Then consider \( n_1 \neq n_2 \) with \( n_i \in [0, \infty), n_2] [0, \infty) \). As commonly assumed in the previous sections the initial endowment of both parties is converted in ‘butter’, ‘guns’ and the ‘membership fee’ to join a trade institution. Therefore, the utility functions of both agents become:

\[
U_{1}^{ins} = \left[ \frac{\beta(z_1 - h)}{z_1 + z_2 - 2h} + (1 - \beta)\delta_1 \right] (n_1 + n_2 - z_1 - z_2 - 2h) \quad (96a)
\]

\[
U_{2}^{ins} = \left[ \frac{\beta(z_2 - h)}{z_1 + z_2 - 2h} + (1 - \beta)\delta_2 \right] (n_1 + n_2 - z_1 - z_2 - 2h) \quad (96b)
\]

The first order conditions for the problem of maximization are:

\[
\frac{\partial U_{1}}{\partial z_1} = \left[ \frac{\beta(z_2 - h)}{(z_1 + z_2 - 2h)^2} \right] (n_1 + n_2 - z_1 - z_2 - 2h) - \left[ \frac{\beta(z_1 - h)}{(z_1 + z_2 - 2h)} + (1 - \beta)\delta_1 \right] = 0
\]

(97a)

\[
\frac{\partial U_{2}}{\partial z_2} = \left[ \frac{\beta(z_1 - h)}{(z_1 + z_2 - 2h)^2} \right] (n_1 + n_2 - z_1 - z_2 - 2h) - \left[ \frac{\beta(z_2 - h)}{(z_1 + z_2 - 2h)} + (1 - \beta)\delta_2 \right] = 0
\]

(97b)
Solving simultaneously the system of (97a) and (97b) and using \( \delta_1 + \delta_2 = 1 \) yields the asymmetric equilibrium choices for ‘guns’ of the two parties:

\[
z_i = \frac{\beta(n_i + n_j)(\beta\delta_i - \delta_i + \delta_j + 1) - \delta_i [4 \beta \delta_i (\beta - 1) - (\beta - 1)^2]}{(\beta + 1)^2}
\]

Equilibrium level of ‘guns’ are expressed in terms of any party own share of the ‘pie’, the destruction parameter, the ‘membership fee’ and the sum of both parties initial endowment:

\[
z_i = f(\beta, \delta_i, n_i, n_j, h), i = 1, 2, j \neq i
\]

Given \( \delta_i \neq \delta_j \) the equilibrium level of ‘guns’ for both agents differ, that is \( z_i \neq z_j \). In particular given \( \delta_i > \delta_j \) and \( \beta \in (0, 1) \) by assumption it is possible to verify that \( z_i < z_j \) if and only if \( h < \frac{n_i + n_j}{4} \).

Thus, the party which has to receive the larger part of the output would arm less than the opponent. This confirms the outcome of the previous section. Using (98) payoffs for both parties are derived:

\[
U_i = \frac{(4h - n_i - n_j)\left(\beta(\delta_i - 1) - \delta_i\right)}{(\beta + 1)^2}, i = 1, 2
\]

Since \( \delta_i > \delta_j \) it is simple to verify that \( U_i > U_j \), that is the agent which has to receive the larger part of the income will get a higher payoff than the contender.
Recall the level of payoffs of the symmetric equilibrium in the continuing conflict scenario denoted by (44). Since within this last framework the equilibrium is no longer symmetric two settlement conditions are to be derived. Then, agent 1 will prefer to settle under an institution if and only if $U_{1}^{\text{inst}} > U_{1}^{cc}$. In a similar way agent 2 will settle if and only if $U_{2}^{\text{inst}} > U_{2}^{cc}$. Therefore, the settlement conditions for both parties are:

$$\frac{4(n_{1} - n_{2})(\beta(\delta_{i} - 1) - \delta_{i})}{(\beta + 1)^{2}} > \frac{\beta(n_{1} + n_{2})}{4}, i = 1, 2 \quad (101)$$

Manipulating and re-writing inequality (101) it is possible to find the critical value\(^5\) for the membership fee. Given $\delta_{1} \neq \delta_{2}$ critical values clearly differ. Then, for both parties the critical values of $h$ are:

$$h_{1}^{*} < \frac{\beta(n_{1} + n_{2})(\beta + 1)^{2}}{16(\beta(\delta_{1} - 1) - \delta_{1})} + \frac{n_{1} + n_{2}}{4} \quad (102a)$$

$$h_{2}^{*} < \frac{\beta(n_{1} + n_{2})(\beta + 1)^{2}}{16(\beta(\delta_{2} - 1) - \delta_{2})} + \frac{n_{1} + n_{2}}{4} \quad (102b)$$

Both critical values depend upon the fraction of the ‘pie’ each party can retain. In particular, they differ and $h_{1}^{*} > h_{2}^{*}$. Also this result is consistent with the outcome of the foregoing section. The party with a higher fraction is likely to sustain the burden of a higher membership fee to join a trade institution.

\(^5\) See Appendix 5.2
Recall that the equilibrium level of ‘guns’ of the party with a lower ‘share’ of the contested income is higher than the opponent. Is this environment more peaceful than continuing conflict? That is, is the level of guns for both contenders lower than in continuing conflict scenario? Comparing (98) with (43) it is possible to say that:

\[ z_{i}^{nc} > z_{i}^{ins} > z_{i}^{ins}, i = 1,2, \forall \delta_{i} \]

Then, whatever the ‘share’ of the ‘pie’ each party can retain and the initial endowment the institutional scenario can be considered ‘more peaceful’ than the continuing conflict for both parties.

This section confirmed the ‘core’ outcomes of the basic model: with the existence of a trade institution two risk-neutral agents can compete for a higher utility than in a continuing conflict scenario. That is, within this framework they are predicted to settle under an institution whatever the fraction of the contested output each party can retain. More precisely, this kind of asymmetry did foster interesting results:

(i) both parties arm less than in ‘continuing conflict’ scenario and retain a higher payoff than in continuing conflict scenario. Such ‘unfair’ division of the expected gains from exchange under an agreement also make parties better off, but the party which is supposed to retain a lower part is predicted to arm more than the opponent;

(ii) both parties are willing to transfer ‘one-way’ a certain amount of resources to join a trade institution. Consider the critical value of the membership fee as a proxy for the
‘willingness to settle’ of each agent. The point of interest is that that party which retains a higher fraction of the contested output and arm more also has a lower willingness to settle than the opponent.

(iii) The level of initial endowments does not matter. Only the predicted fractions of the ‘pie’ do. Then, the driving force for agents is represented by the re-distributive mechanism.

5.3 Different Evaluations of the Pie

Up to this point the analysis proceeded under the assumption that agents know perfectly the value of the contested output which is the ‘prize’ of the contest, namely the ‘pie’. Moreover, agents share the same evaluations of it. That is, in other words it would be possible to say that the expected value of income is equal for both parties. Information is homogenous in this framework. Now, relax this assumption. Consider agents with asymmetric evaluations of the contested income. This condition is likely to occur very often in reality. Moreover, it can be related to other types of asymmetry.

For instance, consider a common pool of resources. As the level of productivity of agents differ the expected income also can differ for both agents. It can also be related to heterogeneous information. A contestant can retain information not available to the other contestants.
Then this section will consider this aspect. It links to the standard literature on asymmetric rent-seeking. The point of interest is to verify if the existence of an institution can modify the incentives of actors in such scenario. Therefore, I modify the utility functions under continuing conflict and under institution (5) and (69) in order to take into account such asymmetry. As above the mechanism of comparative statics will allow to evaluate the incentives to fight or to settle under an institution.

5.3.1 The Continuing Conflict Scenario

Consider the continuing conflict scenario. Let \( V_i \in [0, \infty), i = 1, 2 \) be each agent evaluation of contested income (that is, the expected value of the common pool of income: \( V_1 = (x_1 + x_2); V_2 = (x_1 + x_2) \)). Expression (5) becomes:

\[
U_{1}^{ce} = \frac{\beta z_1}{z_1 + z_2} V_1 - z_1 \\
U_{2}^{ce} = \frac{\beta z_2}{z_1 + z_2} V_2 - z_2
\]

(103a) (103b)

I assume $V_1 > V_2 > 0$. That is, player 1 has a higher evaluation than player 2. The contest in such case is modelled as being costly. The first order conditions in the maximization mechanism are given by:

\[
\frac{\partial U_{1}^{cc}}{\partial z_1} = \frac{\beta z_1 V_1}{(z_1 + z_2)^2} - 1 = 0
\]

\[
\frac{\partial U_{2}^{cc}}{\partial z_2} = \frac{\beta z_2 V_2}{(z_1 + z_2)^2} - 1 = 0
\]

Then, solving the system of equations (104a) and (104b) the equilibrium level of ‘guns’ for both agents are:

\[
z_1 = V_1 \frac{V_2}{(V_1 + V_2)^2} \beta
\]

\[
z_2 = V_2 \frac{V_1}{(V_1 + V_2)^2} \beta
\]

Since $V_1 > V_2 > 0$ it is clear that $z_1 > z_2$. That is, the agent with a higher evaluation of the ‘pie’ will allocate more resources in ‘guns’. The payoffs for both agents are given by:

\[
U_{1}^{cc} = \frac{V_1^3 \beta}{(V_1 + V_2)^2}
\]

\[
U_{2}^{cc} = \frac{V_2^3 \beta}{(V_1 + V_2)^2}
\]

The agent with an higher evaluation of the ‘pie’ will have a higher payoff than the other ($U_{1}^{cc} > U_{2}^{cc}$).
5.3.2 UNDER AN INSTITUTION

Hereafter, I extend and modify the model expounded in third chapter in order to evaluate the impact of different evaluations of ‘pie’. Recall expression (69). It now becomes:

\[
U_{i}^{\text{inst}} = \left[ \frac{\beta(z_{i} - h)}{z_{i} + z_{2} - 2h} + \frac{(1 - \beta)}{2} \right] V_{i} - z_{i} - h
\]

\[
U_{2}^{\text{inst}} = \left[ \frac{\beta(z_{2} - h)}{z_{1} + z_{2} - 2h} + \frac{(1 - \beta)}{2} \right] V_{2} - z_{2} - h
\]  

(107a)

The first order condition for the maximization problem in this case are:

\[
\frac{\partial U_{1}^{\text{inst}}}{\partial z_{1}} = \beta(z_{2} - h) V_{1} = 0
\]  

\[
\frac{\partial U_{1}^{\text{inst}}}{\partial z_{2}} = \beta(z_{1} - h) V_{2} = 0
\]  

(108a)

Solving the system of equations (108a) and (108b) it is possible to find the equilibrium level of ‘guns’ for both players.

\[
z_{1} = V_{1} \frac{V_{2}}{(V_{1} + V_{2})^{2}} \beta + h
\]

\[
z_{2} = V_{2} \frac{V_{1}}{(V_{1} + V_{2})^{2}} \beta + h
\]  

(109a)

(109b)
As above, it is simple to verify that \( z_1 > z_2 \). Moreover, since \( h > 0 \) by assumption the equilibrium level of guns after agents joined an institution is higher than in continuing conflict scenario. This result appears to be contrasting with the outcome of the foregoing chapter. According with the underlying definitions of this work, it would be possible to say that joining an institution appears to be less ‘peaceful’ than the continuing conflict.

The payoff are given by:

\[
U_{ins}^i = \frac{V_i^2 \beta (3V_i + 2V_2)}{(V_i + V_2)^2} + \frac{V_i(\beta + 1)}{2} - 2(V_i \beta + h) \quad (110a)
\]

\[
U_2^{ins} = \frac{V_2^2 \beta}{(V_1 + V_2)^2} - \frac{V_2(\beta - 1) + 4h}{2} \quad (110b)
\]

Then, it is possible now to write the settlement conditions. As usual, it is possible to say that each agent would prefer to settle if and only if the \textit{settlement condition} holds: that is if and only if \( U_{ins}^i > U_{cc}^i, i = 1,2 \). Such condition holds if and only if the level of \textit{membership fee} is below a critical value \( h^* \). Therefore using (106a,b) and (110a,b) as inequalities, re-arranging and manipulating the level of critical value is given by:

\[
h_i^* < V_i \frac{(1-\beta)}{4}, i = 1,2 \quad (111)
\]
Thus, the critical value of each agent depends upon the valuations of the ‘pie’ it retains. Consider also that $V_i$ represents the expected value of the contested income. Since $V_1 > V_2$ it is simple to say that $h_1 > h_2$. Therefore, agents with different evaluations of contestable output retain different willingness to settle. A paradox appears to occur: the agent with a higher willingness to settle is the agent with a higher level of ‘guns’. This situation recalls what I called ‘armed settlement’ in the third chapter. A settlement appears to occur with a higher level of ‘guns’. But is also higher than in ‘continuing conflict scenario and a settlement. That is, that party which has a higher evaluation of the ‘pie’ will also have a higher willingness to settle because of the higher payoff. At the same time this party will arm more than the opponent. To interpret this, consider the level of ‘guns’ as a proxy of the willingness to loose. The higher is the level of ‘guns’ the lower is the willingness to loose. Then, since one party has a higher evaluation of the ‘pie’, it will also have a low willingness to loose. Thus, such kind of asymmetry gives very interesting findings. An agreement in such a case is no longer more ‘peaceful’ than a continuing conflict scenario. Also in this case it could be said that parties look at the institution and interpret it as ‘suspect’.
APPENDIX 5.1

Payoffs for both players over the two periods in a continuing conflict scenario.

\[ V_{1}^{cc} = V_{2}^{cc} = \frac{\beta(n_{1} + n_{2})}{4} + \frac{\beta(U_{11}^{cc} + U_{12}^{cc})}{4} = \]
\[ = \frac{\beta(n_{1} + n_{2})}{4} + \frac{\beta(n_{1} + n_{2})}{4} = \]
\[ = \frac{\beta(n_{1} + n_{2})}{4} + \frac{2\beta(n_{1} + n_{2})}{4} = \]
\[ = \frac{\beta(n_{1} + n_{2})}{4} + \left[ \frac{2\beta(n_{1} + n_{2})}{4} \times 1 \right] = \]
\[ = \frac{\beta(n_{1} + n_{2})}{4} + \frac{\beta^{2}(n_{1} + n_{2})}{2} = \]
\[ = \frac{2\beta(n_{1} + n_{2}) + \beta^{2}(n_{1} + n_{2})}{8} = \]
\[ = \frac{\beta(n_{1} + n_{2})(\beta + 2)}{8} \]

Payoffs for both players over the two periods under an institution

\[ V_{1}^{ins} = V_{2}^{ins} = \frac{n_{1} + n_{2}}{2(\beta + 1)} - \frac{2h}{\beta + 1} + \frac{U_{11}^{ins} + U_{21}^{ins}}{2(\beta + 1)} - \frac{2h}{(\beta + 1)} \]
\[
\frac{n_1 + n_2}{2(\beta + 1)} - 2h \left( \frac{n_1 + n_2}{2(\beta + 1)} - \frac{n_1 + n_2}{2(\beta + 1)} \right) = \frac{n_1 + n_2}{2(\beta + 1)} - 2h \left( \frac{n_1 + n_2}{2(\beta + 1)} - \frac{4h}{2(\beta + 1)} \right) = \frac{n_1 + n_2}{2(\beta + 1)} - 2h \left( \frac{n_1 + n_2}{2(\beta + 1)} - \frac{4h}{2(\beta + 1)} \right) = \frac{n_1 + n_2}{2(\beta + 1)} - 2h \left( \frac{n_1 + n_2}{2(\beta + 1)} - \frac{4h}{(\beta + 1)} \right) = \frac{n_1 + n_2}{2(\beta + 1)} - 2h \left( \frac{n_1 + n_2 - 4h}{2(\beta + 1)} - \frac{4h}{(\beta + 1)} \right) = \frac{n_1 + n_2}{2(\beta + 1)} - 2h \left( \frac{n_1 + n_2 - 4h}{2(\beta + 1)} - \frac{4h}{2(\beta + 1)} \right) = \frac{n_1 + n_2}{2(\beta + 1)} - 2h \left( \frac{(n_1 + n_2 - 4h)}{2(\beta + 1)} - \frac{4h}{(\beta + 1)} \right) = \frac{n_1 + n_2}{2(\beta + 1)} - 2h \left( \frac{(n_1 + n_2 - 4h)}{2(\beta + 1)} - \frac{4h}{(\beta + 1)} \right) = \frac{n_1 + n_2}{2(\beta + 1)} - 2h \left( \frac{(n_1 + n_2 - 4h - 8h(\beta + 1))}{2(\beta + 1)^2} \right) = \frac{(n_1 + n_2)(\beta + 2) - 4h[1 + 2(\beta + 1)]}{2(\beta + 1)^2} = \frac{(n_1 + n_2)(\beta + 2) - 4h(2\beta + 3)}{2(\beta + 1)^2}
\]
APPENDIX 5.2

The settlement condition under an institution with an asymmetric division of the ‘pie’ is given by:

\[
\frac{(4h - n_{1} - n_{2})(\beta(\delta_{1} - 1) - \delta_{1})}{(\beta + 1)^{2}} > \frac{\beta(n_{1} + n_{2})}{4}
\]  \hspace{1cm} (101a.1)

Given \( \delta_{1} \in [0.5,1] \) and \( \beta \in (0,1) \) the term \( \beta(\delta_{1} - 1) - \delta_{1} \) is negative. Then, I divide by the same negative number on the both sides and change the orientation of the inequality sign. Therefore inequality (101a.1) becomes:

\[
\frac{(4h - n_{1} - n_{2})}{(\beta + 1)^{2}} < \frac{\beta(n_{1} + n_{2})}{4(\beta(\delta_{1} - 1) - \delta_{1})}
\]  \hspace{1cm} (101a.2)

This last expression can be manipulated and rewritten as:

\[
4h - (n_{1} + n_{2}) < \frac{\beta(n_{1} + n_{2})(\beta + 1)^{2}}{4(\beta(\delta_{1} - 1) - \delta_{1})}
\]  \hspace{1cm} (101a.3)

\[
4h < \frac{\beta(n_{1} + n_{2})(\beta + 1)^{2}}{4(\beta(\delta_{1} - 1) - \delta_{1})} + (n_{1} + n_{2})
\]  \hspace{1cm} (101a.4)

\[
h < \frac{\beta(n_{1} + n_{2})(\beta + 1)^{2}}{16(\beta(\delta_{1} - 1) - \delta_{1})} + \frac{n_{1} + n_{2}}{4}
\]  \hspace{1cm} (101a.5)
CONCLUSIONS

This work elaborates an economic approach to conflict theory and tries to develop a theory of integrative action which takes the existence of conflict into account from the start. In particular, in the first chapter, it embraces a novel definition of ‘conflict’, linked with the broad class of unproductive activities and with contests and rent-seeking activities.

The main original results I would claim for this work are twofold. First, I show how a peaceful settlement can occur in the shadow of conflict under an institutional set of rules. Although the relationship between trade and conflict has been controversial among scholars, relatively little attention has been paid to the impact of institutional framework underpinning the expansion of economic interactions. Only a few studies of international economic relations deal with the question of whether an institutional setting fosters an easing of tensions between members. Most of them, however, do not consider the existence of resources allocated to ‘guns’; this would imply that in a broader view all the literature on economic integration can be broadly meant as a literature on security and formation of peaceful environment since ‘peace’ is simply considered a positive externality of economic integration. Differently from existing literature, in this work ‘peacefulness’ does not appear to be a mechanical benign externality of trade interactions; the reductions of resources allocated to ‘guns’ takes shape under an institutional setting. Being so, the existence of an institutional scenario requires
that actors would be willing to devote resources for preventing and solving conflicts.

This is in the spirit of integrative relationships, as described by Kenneth Boulding. Indeed, the modelling proposed in the fourth chapter is a novel tentative formalization of Kenneth Boulding’s idea of integrative relationship. To Boulding, the social system can be divided into three large, overlapping and interacting sub-systems: exchange, threat and integrative system. All human institutions and relationships involve different combinations of all three. In particular, an integrative relationship seems to be the most stable response to the existence of a threat. The cornerstone of integrative relationships are ‘one-way’ transfers (or ‘grants’ in Boulding’s definition). Through a crucial extension of CSF, formal key of Hirshleifer-style models of conflict, the emergence of institutions is modelled.

The results of the model provide interesting findings and insights on the role of institutions. On the one hand, the optimal choice of ‘guns’ in an ‘institutional scenario’ is lower than in ‘continuing conflict’ scenario; that is, this state of the world is more ‘peaceful’. On the other hand, the opponents are both better off under an institution. Even if a certain amount of resources is still diverted to guns, final payoffs are higher than in the ‘continuing conflict’ scenario. Therefore, both opponents are willing to ‘one-way’ transfer a certain amount of resources to provide for a settlement of conflict under a trade institution. In formal terms, this result has been obtained through the modification of the CSF in its ratio form. At the same time the choice of the ratio form for the CSF rules out any
possible equilibrium which could be defined as ‘total peace’, namely when there is no investment in guns for both parties.

A second point of interest in the analysis relates to the idea of dominance. Skaperdas (1992) and Neary (1997) models allow for equilibria characterised by only one armed side, respectively labelled as ‘partial cooperation’ and ‘suzerainty’ equilibria by the two authors. Thus, the dominance argument also connects with the idea, largely diffused among political scientists, of ‘hegemonic stability’, according to which concentration of power in one dominant state facilitates the development of strong international regimes.

My model, since both agents devote resources to ‘guns’, underlines how integration can work in preventing conflict even if there is no dominance of an actor on the other.

In the fifth chapter, some modifications to the basic model are taken into account. A first extension of the basic model shows that even if the settlement is predicted to be ‘unfair’, both parties arm less than in the ‘continuing conflict’ scenario and also gain a higher payoff. Such an ‘unfair’ division of the expected gains from exchange under an agreement also makes parties better off with respect to continuing conflict; in the meanwhile, the party which is supposed to gain a lower amount is predicted to arm more than the opponent.

The above results hold irrespectively of the level of initial endowments. Only the predicted fractions of the ‘pie’ accruing to the
parties matter. Then, the driving force for agents’ decisions is represented by the re-distributive mechanism.

Taking into account a two-periods setting, a second extension of the basic model is intended to study the impact of a larger horizon of time on the parties’ willingness to settle. The findings of the extended model suggest that as the time horizon expands, rational parties which interact in redistributing a ‘pie’ between themselves are less willing to co-operate under an institution. This outcome clashes with the famous idea of Axelrod (1984), according to which binding actors in a long-term, multilevel game, promotes the emergence of co-operation; it should be reminded that in my extended model no formal analysis of interaction inducing growth is provided so that the size of the ‘pie’ shrinks over time.

Another contrasting result also emerges when evaluations of the ‘pie’ differ between contestants. In this section modelled as asymmetric rent-seeking contest, agents with different evaluations of contestable output retain different willingness to settle. Finally, the agent with a higher willingness to settle will also be the agent with the equilibrium higher level of ‘guns’. In such a case, an agreement is no longer more ‘peaceful’ than a continuing conflict scenario.

Even if the ‘core’ goal of this work is devoted to studying the emergence of institutions, interesting insights emerge analysing the impact of trade policies on conflict in an anarchic world. The findings of the third chapter contribute to an enduring debate among scholars: the existence of a causal relationship between trade and conflict. Traditionally there are two basic theoretical positions. The
The liberal idea argues that international trade is the root of political cooperation and amity. The second idea argues that international trade can contribute to political conflict and hostility. The model does not allow to espouse neither the first nor the second. It provides the classical economists’ answer, namely ‘it depends’.

In fact, I analyse and extend a model presented by Garfinkel and Skaperdas (2000). In the ‘obstructed trade’ state of the world the extended model allows for different equilibria areas, which I label as (i) armed settlement; (ii) peaceful settlement; (iii) weak conflict; (iv) continuing conflict. Different equilibria link with different combination of the destructiveness parameter and the parameter measuring the impact of trade policies on real output appropriation. It is proved, for example, that when parties assign a high value on contestable output they have incentives to arm more.

A paradoxical outcome can also occur: parties can prefer to settle, but at a higher level of ‘guns’. This equilibrium, which I define ‘armed settlement’ appears to fit with the trading expansion of some European powers in last centuries. Under different parameters values, parties prefer to settle and exchange in a more ‘peaceful’ environment. It is also possible that parties engage in an enduring conflict, but at a low level of ‘guns’. This seems to be the case of boycotts and embargoes. In such a case both sender and target country are negatively affected, because of trade disruption.

Finally, this work is of course little more than an exciting start, but much remains to be done. However, even if relaxing some of
these assumptions could lead to different results, the main findings appear to be quite robust.

There is a large agenda for future research, mainly concerning how to relax some simplifying assumptions I employed throughout the work: (i) only two party interaction; (ii) full information; (iii) a not-decisive technology of conflict; (iv) no distinction between offensive and defensive technologies; (v) agents as unitary actors; (vi) risk-neutrality of both actors; (vii) no definition of market structure and prices.
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