

Economic Analysis of Conflict

TODD SANDLER

*School of International Relations
University of Southern California*

Living beings everywhere compete for the means of existence. Competition takes the more intense form we call *conflict* when, instead of merely using available resources for productive or consumptive purposes, contenders try to hamper, disable, or destroy rivals. Conflict theory has to deal not only with the standard technology of production, but also with the technology of struggle. . . . *Exchange theory* and *conflict theory* constitute two coequal branches of economic analysis: the former based upon two-sided advantage and contract, the latter upon one-sided advantage and struggle.

—Jack Hirshleifer (1995, 167)

Economists have increasingly turned their attention to the study of conflict and its resolution in the past four decades. There was a time when virtually all of the work in this area was done by political scientists, but this has changed with pathbreaking work by Kenneth Boulding, Jack Hirshleifer, Herschel Grossman, Martin McGuire, Mancur Olson, Thomas Schelling, Ron Smith, Dagobert Brito, Albert O. Hirschman, Michael Intriligator, Walter Isard, Michelle Garfinkel, Stergios Skaperdas, Charles Anderton, Paul Collier, and others. Conflict can occur within states as civil wars, insurrections, or terrorism, or it can occur among states as wars or outside-supported insurrections. Appropriative activities, in which one agent takes from another, can be within or among states. Certainly, the failure to protect and enforce property rights within a nation can have profound consequences on economic activity and growth. If people have to spend some of their resources guarding their possessions and the fruits of their labor, there are fewer resources for productive activities. In addition, there is less incentive to produce as the probability increases that this production can be stolen. Governments arise from a natural state of anarchy, in large part to protect these property rights in return for taxes to support this protection, other services, and those in government. In some autocratic regimes, this appropriation by government may far surpass the financing of protection and may serve to increase the ruler's wealth. To maximize its tax revenues, even autocratic governments face limits to how much they can appropriate (McGuire and Olson 1996; Olson 2000). Surpass these bounds and output declines and, with this decline, taxes decrease. In addition, if too much is appropriated, people resist, and the government has to channel more resources into its military and police to hold incipient rebellions in check (Grossman 1995). Resources allo-



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cated to subdue the populace cannot then be siphoned off by the rulers and/or government officials. Economic analysis underscores the essential trade-offs involved in addressing appropriative behavior.

In recent years, game theory has become the premier theoretical tool in economics and political science. Strategic behavior, the hallmark of game theory, involves how one agent (e.g., person, nation, ruler, firm, government, or institution) behaves when its choice is interdependent with that of others. Interactive choices that cause players' payoffs to be interdependent are viewed as strategic. Strategic behavior also includes a recognition of this interdependence; one player thinks that the opponent(s) will behave in a certain manner and acts on this belief. Similarly, the opponent anticipates the other player's belief-based actions and chooses a strategy based on this belief, and so it goes. Game theory provides an ideal tool in economics to analyze conflict, in which opponents are engaged in intense struggles with one another over property and lives. Most of the articles in this special issue use game theory and its concepts such as that of Nash equilibrium, a position from which no player would unilaterally want to change his or her strategy. Opponents may include government forces and rebels, a ruler and subjects, a government and terrorists, opposing alliances, or countries at conflict over natural resources. The underlying game may be played just once or repeatedly. Moreover, in a repeated game framework, the players may remain the same or else change from one period to the next. When population dynamics are allowed so that players' types and their composition in the population can change over time, an evolutionary game framework applies (Vega-Redondo 1996).

Conflict may assume myriad forms and may influence a vast array of human activities. In politics, conflict may be over a party's nomination or the votes to win an elected office, or it may arise from rent seeking. Rent seeking involves an agent or collective expending resources to obtain a return that results in no net gain to society; that is, rent seeking concerns actions to gain a transfer of resources. A related notion is that of contests or tournaments in which players expend resources to vie with one another for a prize or recognition (Dixit 1987). From a mathematical modeling viewpoint, rent seeking and contests are structurally identical. Conflict may also involve litigation and legal maneuvers over the disposition of wills or property. In labor markets, conflict is associated with strikes, labor lockouts, and employee-employer remunerations and benefits. Conflict also concerns terrorist campaigns designed to achieve political objectives, including resource transfers (Enders and Sandler 1995). In each of these examples of struggles, the outcome is affected by a contest success function, which defines an appropriative outcome based on the "inputs" of fighting effort. Such functions form the foundation of many economic analyses of conflict and figure strongly in this special issue's articles by Jack Hirshleifer, Michelle Garfinkel and Stergios Skaperdas, Dmitriy Gershenson and Herschel Grossman, Charles Anderton, Paul Collier, and Donald Wittman.

During the 21st century, conflict will involve Earth's natural assets, including its species, water, rivers, oceans, atmosphere, ozone shield, and minerals. As populations grow and the Earth's carrying capacity is increasingly exceeded, more effort will be put into the appropriation of needed resources, resulting in conflict and defense growing in importance. Disputes over territories and resources already represent the leading

cause of civil war and interstate conflicts. Given the prevalence of conflict and its influence on resource allocation and income distribution, it is surprising that it has taken this long for economists to show an interest in its study.

The purpose of this special issue is to apply economic methods to the study of conflict and related issues. The contributors to this issue are some of the leading economists who have written about conflict over the past three decades. A variety of issues are examined with diverse methodologies.

COVERAGE OF THE SPECIAL ISSUE

McGuire's (2000 [this issue]) article on managing supply uncertainties in an era of globalization applies concepts from the study of insurance and risk to develop a unified analysis for providing for war or other adversity through either stockpiling of goods or protecting domestic industries via subsidization. This article shows the applicability of the notion of the "perfect insurance reversal paradox," in which the purchase of insurance is such that the "bad" state is more preferred after the transfer than was the "good" state of the world prior to the transfer. In particular, the article indicates the circumstances when stockpiling is preferable to protecting domestic producers. McGuire's article is important because it has much to say about options that nations can rely on to manage risk at a time when the globalization of markets heightens nations' vulnerabilities to shocks beyond their control. Political instabilities in developing countries that supply strategic resources represent yet another factor that necessitates insurance against contingencies. A logical extension of his contribution would be to expand the framework to consider other means for addressing uncertainties such as the formation of special agreements to guarantee supply.

In the biodiversity article, Arce (2000 [this issue]) studies an intergenerational public good whose benefits are nonexcludable and nonrival within and among countries *and* generations. The overall level of a public good is typically represented as being composed of the sum of agents' contributions or efforts. With such a "summation" contribution aggregator, the underlying game is frequently that of the prisoner's dilemma, which may not bode well for a positive outcome. Arce stresses other contribution aggregators, including weakest link, weaker link, best shot, and better shot, which have counterparts in terms of scenarios involving biodiversity protection. Most important, the underlying game associated with each of these contribution aggregators is not the prisoner's dilemma, thus holding out greater promise of collective action. The author applies evolutionary game theory—in terms of the evolutionary stable strategy—to investigate whether individual agents can achieve greater cooperative outcomes. Given its focus on population dynamics, evolutionary game theory is an ideal tool for studying an intergenerational public good such as biodiversity. Arce emphasizes the heterogeneity of the equilibria of the underlying games, in which identical agents must act asymmetrically owing to the underlying games. The problem of *scale* concerns the size of the population contemplating the regime and is an essential consideration. This article should appeal to a wide audience and concerns a truly fascinating issue with a fresh approach.

The next five papers directly address the theory of conflict, in which agents allocate resources to augment their probability of winning a contested prize. In Hirshleifer's (2000 [this issue]) contribution, each of two contenders allocate his or her resources between a productive activity and fighting in which the two sides' relative contributions toward fighting determine the extent of "appropriative success" or the likelihood of winning. Hirshleifer focuses on the technology of conflict (or contest success function) that relates fighting efforts of the participants to their probability of success. The properties of two canonical technologies of conflict—the *ratio* form and the *difference* form—are analyzed in detailed. An interesting part of the study relates the two canonical forms to appropriative applications, including some interesting historical examples. Hirshleifer also makes a useful distinction between short-run and long-run analyses of the contest success function. In the second half of the article, the contest success function is related to Lanchester's model of battles, the distinction between offense and defense, and other novel considerations. This article is positioned before the four companion articles because these others rely on one of the alternative forms of the technology of conflict presented by Hirshleifer.

In *Arms and Influence*, Thomas Schelling (1966) argued that nations would never go to war with complete information if the costs of fighting are great. If the tripwire to war is known for certain, he argued that nations would always settle. War is thus understood to stem from misunderstanding, misperceptions, incomplete information, or irrationality. In their provocative article, Garfinkel and Skaperdas (2000 [this issue]) demonstrate that conflict can ensue even without misperceptions or incomplete information when the antagonists take a long-run view. War can then be a rational equilibrium to a conflict model if the short-run losses associated with fighting are more than outweighed by a longer run gain from weakening an opponent. With a denigrated adversary, the victor can gain in the longer run from allocating fewer resources to arming and thus more to production. These authors first show that in a single-period conflict model with complete information, settlement is preferred to fighting. In their two-period model, the subgame perfect equilibrium may be consistent with warfare as a rational first-period response. Their model relies on a contest success function in ratio form and represents a simple yet elegant analysis.

The next three articles specifically apply to intrastate conflict. Building on work by Anderton, Anderton, and Carter (1999), Anderton (2000 [this issue]) presents a model that integrates production, exchange, and conflict. Traditional economic models are concerned with just production and exchange and cannot provide insights about insecure economies plagued by appropriative behavior and weak property rights. In contrast, conflict models consider production and conflict but ignore exchange. By constructing an integrated model with all three components, Anderton examines the influence of alternative technologies of conflict (ratio and difference), weapons productivity, resource endowments, input productivities, conflict decisiveness, and other parameters on the insecure economy. This task is accomplished with a set of simulations, which show that comparative advantage may allow trade to inhibit conflict. Other interesting conclusions follow.

The 20th century has witnessed a continuous stream of civil conflicts in Europe, Asia, Africa, and North and South America. Despite the end to the cold war, civil con-

flicts rage throughout the globe. Some past conflicts—the Russian revolution, the Chinese civil war, and the overthrow of the white regime in South Africa—ended after victory by one side, whereas other conflicts—the war in Angola and the Israeli-Palestinian conflict—seem never ending even after one side gained a victory or dominance. Gershenson and Grossman (2000 [this issue]) construct a model to identify factors that determine whether civil conflict ends with victory or becomes an ongoing struggle. The outcome hinges on the values that rival groups attach to political dominance. The technology of conflict also plays a pivotal role, a result not uncommon for conflict models. In particular, large or small *ratios* of values attached to political dominance by adversaries are *not* conducive to civil conflict ending. A number of important historical cases are illuminating by their analysis.

Collier (2000 [this issue]) distinguishes between greed-based and grievance-based rebellions. After raising problems with past models of such rebellions, he focuses on greed-based uprisings and puts forward a conflict model with a contest success function in ratio form in which rebel efforts are compared with government efforts to thwart a rebellion. If rebels are motivated by looting natural resource wealth, then the underlying model shares a similar structure to that of the economic analysis of organized crime. Despite this similarity, the greed-based rebellion model yields findings at odds with those addressing criminal activity. For example, rebellion is anticipated to be organized on a much larger scale than criminal activity owing to geographical differences of the sought-after loot. That is, rebels are after concentrated (and well-protected) natural resources, whereas criminals are after dispersed (and less protected) household wealth. Other empirical regularities, associated with rebellions, are consistent with Collier's model.

Ihori (2000 [this issue]) applies game theory to analyze allied and adversarial relationships. For two allies and one adversary, Bruce (1990) has shown that increased allied cooperation may lower the cooperators' welfare if their higher level of defense spending causes an arms increase by the adversary. Such increased defense spending of one's enemy may mean that the extra defense efforts achieved through cooperation has merely used up resources without providing more security, thus the welfare loss. Ihori extends Bruce's analysis to a case of multiple allies and multiple adversaries in opposing alliances. He shows that the negative welfare implications of the "Bruce effect" of greater adversarial spending may be more than offset by greater allocation efficiency stemming from allied cooperation. The latter strengthens when there are more allied countries cooperating. Ihori also examines the case in which one bloc is a leader and the other is a follower. His article represents a useful extension to the theory of alliances.

Wittman (2000 [this issue]) combines elements of efficiency and coercion to explain the unification, dissolution, and wealth of nations. In a formal model, he relates the size and wealth of nations to production technology, political transaction costs, coercion costs, and enforcement technology. The success of nations is shown to hinge on the enforcement of property rights and the provision of public goods (including social infrastructure). It also depends on the establishment of a system of rules that minimizes political costs by limiting influence costs and promoting preference diversity. The latter is conducive to immigration. To prosper, nations must be secure from

invasion from abroad, and this requires sufficient military capabilities. The resulting explanation of the size of nations is related to economies of scale and the costs associated with interstate versus intrastate transactions. Some supranational institutions, such as the World Court, economize on interstate transaction costs and so reduce the efficient size of nations. Wittman's formal model combines features of spatial voting theory, economic production functions, and predation models. His analysis is ambitious, creative, and insightful.

In an important series of recent papers, Smith, Levine, and their associates have created a general framework for analyzing arms trade and its underlying dynamic allocational decisions. For example, arms trade can reduce unit production costs, an important consideration in the post-cold war era of shrinking defense budgets, but at the expense of creating an externality for the world community that may be at greater risks from these weapon sales. Moreover, decisions to license weapon production abroad may lead to weapon proliferation as these licensees acquire the knowledge and skills to produce conventional and unconventional weapons. Levine and Smith (2000 [this issue]) first present a general framework for analyzing arms trade for which optimization decisions on the part of buyers and sellers determine arms prices and quantities. This is followed by an analysis of the collective action problems associated with establishing arms export controls. Finally, they formulate a novel model of arms proliferation based on dynamic investment under uncertainty.

CONCLUDING REMARKS

The articles herein represent a diverse set of analyses on topics of profound current interest. The authors have been instructed to define economic concepts to make their analysis understandable to the general and diverse readership of the *Journal of Conflict Resolution*. All papers have been refereed by two anonymous reviewers. No one was assured of a publication, and all articles went through numerous drafts. The end result is a fascinating set of quality contributions of social importance.

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