E C O N O M I C S B U L L E T I N

Why Global Integration May Lead to Terrorism: An Evolutionary Theory of Mimetic Rivalry

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Abstract

We study the emergence of the recent form of terrorism using evolutionary game theory. The model is an economic interpretation of René Girard's theory of mimetic rivalry. This theory presents terrorism as the result of competition between countries, when the desire to imitate the leading country is frustrated by the impossibility of doing so. We define a multi−country setup where interaction takes place in an international trade game, which is a coordination game. Countries follow a simple behavioral rule trying to reduce the gap between the maximal payoff obtained and their own payoff. In a coordination game, this may lead to mimetic rivalry behavior, that is the deliberate choice of a strategy degrading the situation of the leading country. Paradoxically, we find that the desire of convergence may lead to a more partitioned world economy.

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1 Introduction

René Girard (1996)'s theory of *mimetic rivalry* presents *terrorism* as the result of competition between countries, when the desire to imitate the leading country is frustrated by the impossibility of doing so. Integration and economic competition are usually viewed as the way to generate positive gains for all participants of international trade. In this paper, we show that even if global integration is a Pareto-dominant state, it can lead to *negative* behaviors with the aim of degrading the situation of the leading country.

We use an evolutionary game model[1] describing the long-run behavior of n asymmetric countries. Cross-country differential may come from the country size, the technology used or the endowment of knowledge but are not formally described in our model.[2] Asymmetries are captured by the gain a country makes in international trade, which is summarized in a simple coordination game. In this game, each country has to choose between two strategies: integrating the world economy or not, that is staying in autarky. Integrating the world economy may lead to the Pareto-dominant outcome, even if the gain from this coordination differs between countries.

Each country follows a simple learning rule of *satisficing*, trying to reduce the gap between the leading country's payoff and its own payoff. In the international trade game, we show that this learning rule may lead to the choice of a strategy which is intended to degrade the situation of the leading country. This *negative* behavior is close to the mimetic rivalry concept in that it is generated by the failure to obtain the same thing as the leading country. The mimetic rivalry behavior is generated in our model by the presence of cross-country differential and the fact that integrating the world economy may not constitute a risk-dominant strategy for lagging countries. In the long run, as the payoff of the leading country rises, one observes the formation of two blocs which reflects the persistent gap between the leading country (and its satellites) and the others, for instance more and less developed countries, even non-islamic and islamic countries.[3] Thus, and perhaps paradoxically, the desire to obtain the same thing as the other (in our model, the same payoff), that is the desire of convergence, may lead to a more partitioned world economy.

Our results may be related to Goodfriend and McDermott (1998)'s theoretical predictions resulting from cross-country disparities. They define the notion of *familiarities* in order to account for asymmetries between countries, and to explain the rising of the productivity gap between less and more developed countries. The lack of familiarity with the leading economy is due to such barriers as distance, language, and culture, or deliberate impediments to commercial intercourse. In their model, an enormous productivity gap is hard to close because it inhibits the kind of commercial interaction that promotes familiarization and reduces asymmetries.

The rest of the paper is organized as follows: Section 2 presents the evolutionary model of Mimetic Rivalry. Section 3 states the long-run equilibria of the model. Section 4 concludes the paper and gives some comments.

[1] For book-length introductions to evolutionary game theory, see Vega-Redondo (1996) and Weibull (1995).

[2] This paper is not interested in the origin of the cross-country differential but rather by the consequences. For more details on the literature of international trade, see Grossman and Helpman (1991).

[3] As noted by René Girard, under the label of Islam, we find a will to rally and mobilize an entire third world of those frustrated victims in their relations of mimetic rivalry with the West.

2 An evolutionary model of Mimetic Rivalry

The model we present is inspired by the recent developments of evolutionary game theory. In this literature, players are boundedly rational agents using past experience and simple behavioral rules. We use methods introduced by Kandori, Mailath and Rob (1993) and Young (1993) to examine the long-run behavior of players.[4]

We consider a population of n asymmetric countries denoted by $C = \{1, ..., i, ..., n\}$, with $n \geq 2$. Asymmetries may come from the country size, the technology used or the endowment of knowledge but they are not formally described in our model. Asymmetries are captured by the gain a country makes in the international trade, which is summarized by a 2×2 coordination game. In this game, each country i has to choose between two strategies: integrating the world economy (Strategy E) or not, that is staying in autarky (Strategy A). Time is measured discretely and indexed by $t = 1, 2, 3....$ In each period, countries are repeatedly matched to play the coordination game and adjust their behavior over time. Let the international trade between countries i and j be summarized by the following coordination game:

	E	A
E	a_i, a_j	$0, \lambda_j$
A	$\lambda_i, 0$	λ_i, λ_j

where $0 < \lambda_i < a_i$ for all $i \in C$. In this game, (E,E) and (A,A) are two strict Nash equilibria, with the added feature that (E,E) Pareto-dominates (A,A). Thus, it is assumed that « integrating the world economy » can lead to the Pareto-dominant outcome even if the gain for this cooperation can differ between countries (the gain from autarky can also be different). This assumption is made without loss of generality.[5]

We define the evolutionary dynamics describing the strategic behavior adopted by countries in the long run. In an evolutionary model, results are driven by two different mechanisms: selection and mutation.

2.1 The selection mechanism

Let z_t be the number of countries adopting strategy E at time t. The average payoff of country i is given by

$$u_i(E,z) = \frac{(z-1)}{n-1} a_i, \tag{1}$$

$$u_i(A,z) = \frac{z}{n-1} \lambda_i + \frac{(n-z-1)}{n-1} \lambda_i, \tag{2}$$

Note that the payoff to playing A is independent of the distribution population, so that $u_i(A,z) = u_i(A) = \lambda_i$. Thus, if a country chooses strategy A, his payoff is λ_i no

[4] We refer the reader to these articles for a more detailed discussion of the model assumptions.

[5] For instance, assuming that integrating the world economy cannot lead some countries to the Pareto-outcome reinforces the result of the model.

matter what the others'choices are. If it chooses strategy E, then its payoff depends on z_t, the number of countries participating in the world economy.

In an evolutionary model, the way players choose their strategies, revise their previous choices and thus get experience, is described by a *selection mechanism*. This mechanism considers that players are myopic and adaptive, implying that they do not form expectations about the future course of play and simply take into account the decisions made in the past. The selection mechanism adopted here reflects René Girard's theory of mimetic rivalry. To this end, we use a variation of the *satisficing dynamics* proposed by Smallwood and Conlisk (1979).

Let $u_t = (u_{1t}, ..., u_{it}, ..., u_{nt})$ be the payoff profile of countries at period t. In the same way, define the strategy profile at t as $s_t = (s_{1t}, ..., s_{it}, ..., s_{nt})$. We denote by μ the maximal payoff realized. This maximal payoff can be attained by one or several countries at a given period. Countries are assumed to observe μ, which represents some level of satisfaction. Next, they compare it to the average payoff which they earn from their current strategy s. When $\mu - u_i > 0$, countries choose a strategy in order to reduce the gap between μ and their own payoff. Formally, country i selects at t a strategy satisfying the behavioral rule

$$s_{it} \in argmin_s \ \ \mu - u_i(s, z_t). \tag{3}$$

The state space (the range of z_t) of the dynamic process (3) is identified with the set $Z = \{0, 1, ..., n\}$.

The idea of mimetic rivalry is close to the behavioral rule defined in (3). Recall that mimetic rivalry is the frustration generated by the desire to imitate the other in order to obtain the same thing. In our model, « reducing the gap » can lead to two types of behavior: either a country can choose a strategy that increases its payoff (compared to the maximal payoff), or it can choose a strategy with the aim of degrading the situation of the country with the maximal payoff. When the benefits of trade are relatively low (i.e., $a_i - \lambda_i$ low), the latter behavior can appear to be the best for a country. This *negative* behavior is similar to mimetic rivalry in that it is generated by the failure to obtain the same thing as the best country. In section 3, we demonstrate that the mimetic rivalry behavior is due to the presence of asymmetries between countries, leading to the autarky strategy which induces a reduction of the advantages of the leading countries.

Evolutionary game theory does not consider that all players simultaneously adjust their strategy following (3) at each period t. Rather, there is some *inertia* in evolutionary models, that is to say players infrequently adjust their strategies. The inertia assumption is not a necessary assumption in our model but it gives some plausibility to the assumption of myopic behavior: as players know that only a small segment of agents changes its action, strategies that proved to be effective today are likely to remain effective in the near future. Formally, each player independently with some fixed probability $\theta \in (0, 1]$ receives the opportunity to update its strategy in each period.

2.2 The selection mechanism with mutations

Besides the selection mechanism, the presence of *mutations* is the other assumption influencing results in evolutionary models. With a small probability, each player « mutes » and plays a non-optimal strategy in the sense of selection mechanism (3). This

mechanism is then perturbed[6]. We may propose two economic justifications to sustain the idea of mutation phenomenon in our setup. Firstly, mutation can be viewed as « deliberate experimentation » of a new strategy. Players are uncertain as to the structure of the economy and then experiment strategies in order to obtain some information as to how they work in some contexts. This approach is based on trial-and-error learning. Secondly, we may argue that mutation corresponds to the exits of players that are replaced with new players knowing less or nothing about the game and so choose a strategy at random.[7]

Formally, each player independently changes its strategy with a small probability ε. A player mutation occurs after the completion of the learning adjustment. The combination of selection mechanism (3) and the mutation phenomenon generates a Markov chain over state space Z. The recent literature on evolutionary game theory shows that the existence of a small probability $\varepsilon > 0$ ensures that the process has a unique stationary distribution[8] summarizing the long-run behavior of the system, regardless of initial conditions. The latter characteristic of the model is particularly interesting when the selection mechanism presents several absorbing states, since it allows a selection to be made between them. Our goal is to find the *long-run equilibrium* of the game assuming that $\varepsilon \to 0$. The long-run equilibrium is simply the one requiring the fewest mutations.[9]

3 The long-run equilibria of the international trade game

Harsanyi and Selten (1988)'s concept of *risk-dominance* plays a crucial role in our model. This criterium proposes an equilibrium selection theory based on the comparisons of riskiness of the equilibria. The risk-dominant equilibrium is the one with the largest Nash product, that is, the one for which the product of the deviation losses is largest.

In the stage game defined in the previous section, the Pareto-dominant equilibrium (E,E) risk-dominates (A,A) if $(a_i - \lambda_i)(a_j - \lambda_j) > \lambda_i\lambda_j$. Assume that countries are perfectly symmetric, that is $a_i = a_j$ and $\lambda_j = \lambda_i$ for all $i, j \in C$. Then, (E,E) risk-dominates (A,A) if $\lambda_i < a_i/2$, meaning that the payoff from the autarky strategy must be less than half of the payoff from trade. Defining a world of symmetric countries as a place where $\lambda_i < a_i/2$, $a_i = a_j$ and $\lambda_j = \lambda_i$ for all $i, j \in C$, we can state the following result.

Proposition 1 *In a world of symmetric countries as defined above, the long-run equilibrium of the international trade game is the one in which all countries are engaged in the world economy.*

This result comes from Kandori, Mailath and Rob (1993)'s model which states that the long-run equilibrium in coordination games is the one associated with the largest

[6] Samuelson (1997) considers the mutation phenomenon as a residual capturing of whatever has been excluded when modeling selection.

[7] See Canning (1989).

[8] See Kandori, Mailath and Rob (1993) or Young (1993).

[9] For more details on this result, see Kandori, Mailath and Rob (1993) or Samuelson (1997) or Vega-Redondo (1996).

basin of attraction, that is the risk-dominant one. When countries are symmetric, the mechanism selection (3) is *payoff monotonic* dynamics[10] in which any strategy enjoying the highest payoff should never decrease. The result of Proposition 1 holds for low asymmetries, but differs when the gap between countries, represented by $a_i - \lambda_i$, becomes large enough.

In order to see how the mimetic rivalry behavior emerged in our evolutionary model, it is necessary to define a world of asymmetric countries. To this end, consider the non-empty subsets C_E and C_A with $C_E \cup C_A \equiv C$. C_E represents the subset of countries for which strategy E is the risk-dominant strategy (that is the strategy associated with the highest deviation losses). In the same way, C_A is the subset of countries for which A is the risk-dominant strategy. Then, assuming that there is no country for which $a_i = 2\lambda_i$, we can establish the following proposition.

Proposition 2 *In a world of asymmetric countries as define above, country $j \in C_A$ for which $a_j - \lambda_j < \mu/(n-1)$ chooses strategy A from the equilibrium in which all countries are engaged in the world economy.*

Proof. Consider state $z_t = n$ and assume that country $j \in C_A$ receives the opportunity to update its choice at period $\tau > t$. With strategy E, country j's payoff is $a_j < 2\lambda_j$ and it has to compare it to μ. On the other hand, using strategy A country j obtains λ_j and compares it to $[(n-2)/(n-1)]\mu$. Thus, country j chooses strategy A if $a_j - \lambda_j < \mu/(n-1)$. ■

The intuition behind Proposition 2 is the following. In state $z_t = n$, the leading countries' payoff is μ. During the subsequent periods, the other countries compare their own payoff to μ and possibly change their strategies when they receive the opportunity of doing so. For countries $j \notin C_E$, choosing strategy A may reduce the gap $\mu - u_j$ because (i) the gain from trade is close to the gain from autarky ($a_j - \lambda_j$ low) and (ii) strategy A degrades the payoff of the leading bloc.

The mimetic rivalry condition, defined in Proposition 2, specifies how the gap between strategies A and E has to be large for the appearance of the negative behavior in C_A. Thus, country j's membership of C_A is not a sufficient condition for playing strategy A, and the set of countries adopting the mimetic rivalry behavior may be empty even in an asymmetric world. It can be seen that for n very large compared to the leading countries' payoff the mimetic rivalry condition may be hard to fulfill. However, this can be outweighed when μ is large enough.

As cross-country differential increases, the number of countries $j \in C_A$ choosing the negative behavior becomes larger. At one extreme, this may generate the formation of two blocs reflecting the persistent gap between less and more developed countries. Thus, and paradoxically, the desire to obtain the same thing (here, the same payoff), that is the desire of convergence, may lead to a more partitioned world economy and the deliberate choice of degrading the situation of the leading bloc.[11]

4 Conclusion

This paper offers a positive explanation of the recent form of terrorism. It presents an economic interpretation of René Girard's theory of mimetic rivalry by using

[10] See Weibull (1995).

[11] This may be related to the literature on trade and war. See, for example, Bearce and Fisher (2002).

evolutionary game theory. The model shows that integration and greater cross-country interaction between symmetric countries lead in the long-run to the highest payoff strategy, that is to say, integration in the world economy as a Pareto-dominant state. However, when one observes the presence of large cross-country differential, global integration may lead to negative behaviors as the deliberate choice of degrading the situation of the leading country or leading bloc. Large disparities may be related to the notion of familiarity of Goodfriend and Mc Dermott (1998), in which an unfamiliar country is characterized by barriers towards cultural or commercial interaction. This kind of unfamiliar country is expected to develop negative behaviors towards the leading country because of the existing gap. This result may be related to the idea that cross-country interaction is a powerful means of reducing disparities between countries. Some empirical studies, as Keller (2001), show that technological diffusion does not depend directly on trade flows. It can be argued that trade alone is unable to generate a greater familiarity between countries, and may even lead to violence and terrorism, as developed by the notion of mimetic rivalry.

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