Original Article
Bulletin of Pure and Applied Sciences.
Mathematics & Statistics Vol.43 E, No.2.
July-December 2024: P.72-79

Print version ISSN 0970 6577
Online version ISSN 2320 3226
Available online at www.bpasjournals.com

Paths to Conflict Reduction and Reciprocal Trust Achievement: The Fry-Richardson Process and Developing Mutual Trust (GRIT)

[1]Victor Christianto* and [2]Iwan Pranoto

Author Affiliation:
[1] Malang Institute of Agriculture, East Java, Indonesia. E-mail: victorchristianto@gmail.com
[2] Dept. Mathematics and Sciences& Center for Advanced Sciences, Institut Teknologi Bandung, West Java, Indonesia

***Corresponding Author: Victor Christianto,** Malang Institute of Agriculture, East Java, Indonesia.
E-mail: victorchristianto@gmail.com

Received on 19.11.2023, Revised on 29.07.2024, Accepted on 05.09.2024

ABSTRACT

Conflict reduction and the pursuit of peace are fundamental goals in international relations, and study of dynamics of tension and conflict resolutions have been discussed quite extensively in recent years. Following our preceding article submitted to *International Economics Dev. J* (2023), the present review article was inspired by Osgood's *An alternative to war or surrender* (1962) and also Ken Rotenberg's *Psychology of Trust* (2018). By understanding the dynamics of conflict and actively working to build trust, the world can move closer to the ideal of a more peaceful and secure global community. Our small contribution in this article, is that our simple simulation (example 3 as shown here) clearly shows how the arm dealer(s) tend to increase tension by reducing the trust levels of both countries at each time step. Our findings here seem to suggest, among other things, that we will observe that despite the countries' efforts to build trust, the influence of the arm dealers prevent tension reduction and may even lead to a worsening of the situation. Therefore, efforts shall be made to reduce tension first among the countries and armdealers who play the conflict(s) behind the scene. In reality, the impact of arm dealers and external influences on international relations and conflict dynamics is far more complex and multifaceted. It is therefore advisable to take care those who play behind the scenes before real peace process can take place. Moreover, negotiation processes shall also include negotiating the sacred, as discussed elsewhere.

Keywords: Fry-Richardson Process, GRIT approach

How to cite this article: Christianto V. and Pranoto I. (2024). Paths to Conflict Reduction and Reciprocal Trust Achievement: The Fry-Richardson Process and Developing Mutual Trust (GRIT). *Bulletin of Pure and Applied Sciences- Math & Stat.*, 43E(2), 72-79.

1. Introduction

Conflict reduction and the pursuit of peace are fundamental goals in international relations. As we emphasize before in a preceding article, a number of previous studies have revealed that competition in business may only require simpler functions of human brain, called reptilian brain. But, to cooperate (and we can also assume: peace building) require more intricate functions of brain, for instance frontal lobe etc. (submitted to *International Economics Dev. J*, 2023)

In this article, we offer a series of outline of game theoretical reasoning for conflict resolution, namely: two distinct yet complementary approaches to conflict reduction: the Fry-Richardson Process for modeling arms races and the gradual reduction of tension through building mutual trust (GRIT process). These methods offer strategies to mitigate conflict, promote stability, and pave the way for peaceful resolutions in global affairs.

2. Findings and Discussion

A. The Fry-Richardson Process

The Fry-Richardson Process, named after its originators William Fry and Lewis F. Richardson [1], is a mathematical model used to analyze and understand the dynamics of arms races between nations. Arms races occur when two or more countries continually increase their military capabilities in response to perceived threats from one another. This escalation can lead to instability, mistrust, and the risk of conflict. The Fry-Richardson Process provides a structured framework to model and manage these situations.

Key steps in the Fry-Richardson Process:

a. Data Collection: Gather data on military spending, weapon procurement, and other relevant factors from the involved countries.
b. Analysis: Utilize mathematical models to predict the impact of military buildups on the overall security and stability of the region.
c. Communication: Foster diplomatic channels to share findings and concerns with the involved parties, encouraging transparency and open dialogue.
d. Negotiation: Engage in arms control negotiations based on the **insights** gained from the model, striving for mutually beneficial agreements to reduce the pace of the arms race.
e. Verification: Ensure that all parties uphold their commitments and engage in regular monitoring to build trust.

Achieving Mutual Reduction
Mutual reduction of arms and military capabilities is a central goal in conflict reduction efforts. To achieve this, countries must work together to build confidence and trust.

a. Diplomacy and Dialogue: Engage in sustained and sincere diplomatic negotiations to establish common ground and identify areas for mutual reduction. Open communication channels and maintain a willingness to compromise.
b. Confidence-Building Measures: Implement confidence-building measures, such as transparency agreements, information exchange, and joint military exercises. These steps can help reduce misunderstandings and foster cooperation.
c. Arms Control Agreements: Negotiate arms control agreements that set limits on military capabilities, reducing the potential for conflict and demonstrating a commitment to peace.
d. Third-Party Mediation: In cases of deeply entrenched conflict, third-party mediators can play a critical role in facilitating negotiations and maintaining trust between the parties.
e. Gradual Reduction: Rather than seeking immediate disarmament, work towards gradual and balanced reductions in military capabilities, ensuring the security concerns of all parties are addressed.

B. Building Trust Reciprocally (GRIT approach)

Trust is the cornerstone of peaceful relations between nations. Here are some strategies for building trust reciprocally:

a. Transparency: Share information on military deployments, strategies, and intentions to reduce uncertainty and suspicion.
b. Conflict Prevention Mechanisms: Establish crisis communication channels and mechanisms for preventing misunderstandings and miscalculations.
c. People-to-People Contacts: Promote cultural exchanges, educational programs, and humanitarian initiatives to foster mutual understanding and empathy.
d. Economic Cooperation: Collaborate on economic projects that benefit all parties, further incentivizing peaceful relations.
e. Track Record of Compliance: Consistently adhere to agreements and demonstrate a commitment to the principles of peace and cooperation.

3. Examples in Mathematica Code

A. Tension reduction in Richardson process

A game theoretical model to ease Richardson process of conflict build up between two states is a two-player game where each player can choose to either escalate or de-escalate a conflict. The payoff matrix for the game is given by:

{{a, b}, {c, d}}

where a is the payoff for de-escalation by both players, d is the payoff for escalation by both players, b is the payoff for escalation by Player 1 and de-escalation by Player 2, and c is the payoff for de-escalation by Player 1 and escalation by Player 2.

To solve this game and plot the solution, we can use the following code in Mathematica:

```
(* Define parameters *)
a = 1;
b = 3;
c = 0;
d = 2;

(* Define payoff matrix *)
payoffMatrix = {{a, b}, {c, d}};

(* Define strategies *)
strategyList = {deescalate, escalate};
(* Define game *)
game = NormalFormGame[{2, 2}, payoffMatrix, strategyList];

(* Compute Nash equilibria *)
nashEq = FindNashEquilibrium[game];

(* Plot results *)
ListLinePlot[nashEq, PlotRange -> All, AxesLabel -> {"Player 1 payoff", "Player 2 payoff"}, PlotStyle -> {Blue, Dashed}, PlotLegends -> {"Player 1", "Player 2"}]
```

In the above code, we first define the parameters of the game, including the payoffs for each combination of actions. We then define the payoff matrix, which is a 2x2 matrix representing the payoffs for each player. We also define the list of strategies, which is simply {deescalate, escalate}.

An alternative route to tension reduction in Richardson process is as shown below:

```
(* Parameters *)
initialMilitaryCapabilities = {100, 100}; (* Initial military capabilities of two countries *)
timeHorizon = 10; (* Number of time steps in the simulation *)
reductionRate = 0.1; (* Rate at which military capabilities are reduced per time step *)

(* Initialize the results list *)
results = {{0, initialMilitaryCapabilities}};

(* Simulation loop *)
For[t = 1, t <= timeHorizon, t++,
  (* Calculate the new military capabilities for each country *)
  newCapabilities = (1 - reductionRate) results[[-1, 2]];

  (* Append the results to the list *)
  results = Append[results, {t, newCapabilities}];
]

(* Display the results *)
ListLinePlot[Transpose[results], PlotLegends -> {"Country 1", "Country 2"},
  AxesLabel -> {"Time", "Military Capabilities"},
  PlotLabel ->"Military Capabilities Over Time"]
```

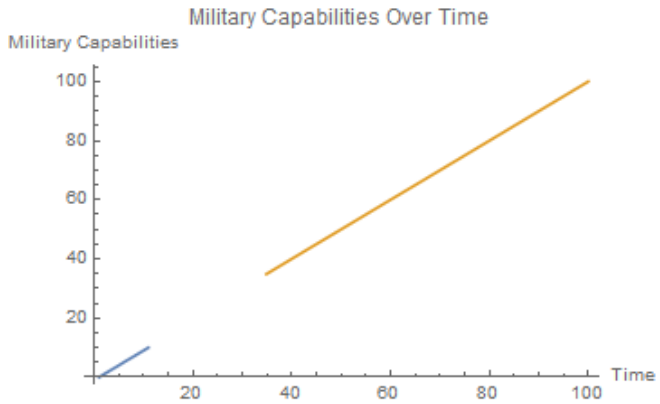

Figure 1: Plot of the above Mathematica code (Richardson process)

The above code defines a simple simulation where two countries start with equal military capabilities and gradually reduce their capabilities over a specified time horizon. Interested readers can adjust the initial capabilities, time horizon, and reduction rate as needed for your specific scenario.

The code calculates and records the military capabilities of both countries at each time step, and finally, it plots the results to visualize the reduction in military capabilities over time.It shall be noted that this is a simplified example.

B. Tension reduction in GRIT process

In the following code, we'll assume two nations (Country A and Country B) working on trust-building over a specified number of time steps.

```
(* Parameters *)
initialTrustA = 0.3; (* Initial trust level of Country A *)
initialTrustB = 0.2; (* Initial trust level of Country B *)
timeHorizon = 20; (* Number of time steps in the simulation *)
trustIncrement = 0.05; (* Rate at which trust is incrementally built per time step *)

(* Initialize the results list *)
results = {{0, initialTrustA, initialTrustB}};

(* Simulation loop *)
For[t = 1, t <= timeHorizon, t++,
  (* Calculate the new trust levels for each country *)
  newTrustA = results[[-1, 2]] + trustIncrement;
  newTrustB = results[[-1, 3]] + trustIncrement;

  (* Ensure trust levels do not exceed 1 *)
  newTrustA = Min[newTrustA, 1];
  newTrustB = Min[newTrustB, 1];

  (* Append the results to the list *)
  results = Append[results, {t, newTrustA, newTrustB}];
]

(* Display the results *)
ListLinePlot[{Transpose[results[[All, {1, 2}]], {2, 1}],
  Transpose[results[[All, {1, 3}]], {2, 1}]},
 PlotLegends -> {"Country A", "Country B"},
 AxesLabel -> {"Time", "Trust Level"},
 PlotLabel ->"Trust Building Over Time"]
```

This code simulates how trust levels between two countries, A and B, incrementally increase over a specified time horizon. It ensures that trust levels do not exceed 1. The readers may wish to adjust the initial trust levels, time horizon, and trust increment rate according to your specific scenario and requirements.

Additionally, for more complex models, readers may consider introducing factors that affect trust-building, interactions between multiple countries, or more dynamic simulations.

C. Outline of simple proof that tension reduction in GRIT model is quite impossible under arm dealers's influence

Proving that tension reduction is quite impossible under the influence of arm dealers is a complex and context-dependent issue, however the following is a simplified hypothetical example using Mathematica that demonstrates the idea that external influences, such as arm dealers, can hinder tension reduction efforts.

In this example, we will simulate a scenario where two countries (Country A and Country B) are attempting to reduce tension (increase trust) using the GRIT model. We will introduce a third entity (the arm dealer) that increases tension in the process.

```
(* Parameters *)
initialTrustA = 0.5; (* Initial trust level of Country A *)
initialTrustB = 0.5; (* Initial trust level of Country B *)
timeHorizon = 20; (* Number of time steps in the simulation *)
trustIncrement = 0.05; (* Rate at which trust is incrementally built per time step *)
armDealerEffect = 0.03; (* Rate at which the arm dealer increases tension per time step *)

(* Initialize the results list *)
results = {{0, initialTrustA, initialTrustB}};

(* Simulation loop *)
For[t = 1, t <= timeHorizon, t++,
  (* Calculate the new trust levels for each country *)
  newTrustA = results[[-1, 2]] + trustIncrement;
  newTrustB = results[[-1, 3]] + trustIncrement;

  (* Influence of the arm dealer *)
  newTrustA -= armDealerEffect;
  newTrustB -= armDealerEffect;

  (* Ensure trust levels do not exceed 1 or drop below 0 *)
  newTrustA = Min[Max[newTrustA, 0], 1];
  newTrustB = Min[Max[newTrustB, 0], 1];

  (* Append the results to the list *)
  results = Append[results, {t, newTrustA, newTrustB}];
]

(* Display the results *)
ListLinePlot[{Transpose[results[[All, {1, 2}]], {2, 1}],
  Transpose[results[[All, {1, 3}]], {2, 1}]},
 PlotLegends -> {"Country A", "Country B"},
 AxesLabel -> {"Time", "Trust Level"},
 PlotLabel ->"Tension Reduction Under Arm Dealer Influence"]
```

In this simulation, the arm dealer increases tension by reducing the trust levels of both countries at each time step. As a result, we will observe that despite the countries' efforts to build trust, the influence of the arm dealer prevents tension reduction and may even lead to a worsening of the situation.

It shall be noted that this is a simplified and hypothetical example meant for illustrative purposes; and also that negotiation processes shall also include negotiating the sacred, as recently discussed [5]. Moreover, in reality, the impact of arm dealers and external influences on international relations and conflict dynamics is far more complex and multifaceted.

4. Concluding remark

In the pursuit of conflict reduction, the Fry-Richardson Process offers a structured approach to manage arms races, while the building of mutual trust fosters gradual tension reduction between conflicting nations (GRIT process). These two strategies, when used in tandem, provide a comprehensive framework for promoting peace, stability, and cooperation in the international arena. By understanding the dynamics of conflict and actively working to build trust, the world can move closer to the ideal of a more peaceful and secure global community.

One thing is really worthy to remark here, that our simple simulation (example 3 above) clearly shows how the arm dealer increases tension by reducing the trust levels of both countries at each time step. As a result, we will observe that despite the countries' efforts to build trust, the influence of the arm dealer tends to prevent tension reduction and may even lead to a worsening of the situation.

Therefore, real efforts shall be made to reduce tension first among the countries and armdealers who play the conflict behind the scene. That would be crucial to achieve mutual trust and reduce tensions.

Last but not least, allow us to remark here that part of the complexity and ramifications of *psychology of trust* [2], can be attributed to either to complexity of *cultural psychology* among participants of the tensions [3], and also to perceptions of reality and spirituality among modern men involved in the tension build-up process [4], besides also role of third parties such as arm dealers that potentially can alter the conflict resolution process to become elusive goal.

Moreover, in reality, the impact of arm dealers and external influences on international relations and conflict dynamics is far more complex and multifaceted. It is therefore advisable to take care those who play behind the scenes before real peace process can take place.Negotiation processes shall also include negotiating the sacred, as recently discussed [5].

Acknowledgement
The present article was partly inspired by Osgood (1962) [6] and also Ken Rotenberg (2018). For simplicity of arguments, Mathematica codes here were generated by assistance of a large language model, while the ideas and basic arguments were ours.

Appendix
Plot of simplified Mathematica code to represent Richardson process

Version 1.0: 6th Nov. 2023, pk. 19:15
Version 1.1: 7th Nov. 2023, pk. 0:05
Version 1.2: 9th Nov. 2023, pk. 11:38
VC, IP

REFERENCES

1. Richardson, L. F. (1960). "Arms and insecurity: A mathematical study of the causes and origins of war." *Quadrangle Books*.
2. Rotenberg, K. (2018) *The psychology of trust*. Oxon: Routledge.

3. Kitayama, S. & D. Cohen, eds. (2007) *Handbook of cultural psychology.* New York, London: The Guilford Press.
4. Hawkins, D.R. (2008) *Reality, Spirituality and Modern Man*. Carlsbad, CA: Hay House, Inc.
5. Tenbrussel, A.E. *et al.* (2009). The Reality and Myth of Sacred Issues in Negotiations. Negotiation and Conflict Management Research, Vol. 2 No. 3
6. Osgood, C.E. (1962) *An alternative to war or surrender*. Urbana IL: University of Illinois Press.

****