IS INTERNATIONAL COOPERATION AN OPTIMAL SURVIVAL STRATEGY?: A COMPLEX ADAPTIVE MODEL

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ABSTRACT

This paper shows the emergence of strategies as a natural result of the seemingly competitive (selfish) actions of countries all over the world. It is posited that in the long term, the natural instinct of social atoms to dominate and accumulate wealth through competition will eventually prevail. At this stage, Darwin's evolutionary principle of natural selection (survival of the fittest) will begin to take over the process. The study utilized the simulation model of Artificial World Creation made popular for use in the analysis of Complex Adaptive Systems. A Complex Adaptive System is a system consisting of multiple elements, each possessing a characteristic and interacting with other elements in the system. Through these interactions, the elements learn or adapt and change their strategies to maximize benefits for themselves. The particular model used in this study is the Cooperation Model. Results revealed that cooperation is not always the best strategic action that nations in the international community can adopt to maximize benefits for themselves. Cooperation is optimal when the global resources available are low and limited. However, under a high resource availability regime, competition appears to be the better choice of strategic action.

***Keywords**: complex adaptive system, cooperation, competition, evolutionary principles*

1.0 Introduction

As the earth's resources are being depleted, competition for the available resources has become even more intense. Countries seek greater shares of otherwise unexploited territories and, as they do so, international conflicts have been more pronounced in this century than in any other era of human history (Malthus, 1798). Competition is a strategy that aims to monopolize the use of a resource. In contrast, cooperation is another adaptation strategy that focuses on the use of available resources for one's benefit while taking into account the resource requirements of other players in the system. A successful competitive strategy maximizes benefit while a successful cooperative strategy maximizes benefit subject to the resource requirement of the players in the system. A competitive player eliminates the competitors while a cooperative strategist shares the bounty with other players.

With limited and insufficient resources, it is natural to ask which of competition or cooperation is a better strategy to ensure sustainable growth. Holland (2007) averred that "international cooperation is a necessary option for countries all over the world…because a financial bubble in Florida can impact on the economy of Iceland. A small perturbation affects the economies of nations." Morton Deutsch (1949) of the Lewin's Center for the Study of Group Dynamics, proposed that how group members believe their goals are related very much impact their dynamics and success (Social Indicators Research Series, SINS, Vol.6, 2008). Hundreds of studies summarized in a meta-analysis document that cooperative goals promote communication and exchange, and more recently, the open-minded discussion of opposing views, dynamics in turn that result in group productivity, individual learning, psychological health and relationships. Leaders and members can use cooperation knowledge to make them increasingly diverse and disperse teamwork. On the other hand, working in a position of power, powerful nations tend to employ competitive strategies (rather than cooperation) to maximize their shares of the limited resource.

Cooperation is a process by which the components of a system work together to achieve global properties. In other words, individual components that appear to be "selfish" and independent work together to create a highly complex, greater-than-the-sum-of-its-parts system. This phenomenon is generally known as "emergence" and is considered an outcome of self-organization (Mobus, G.E & Kalton, M.C. (2015)). A natural example of this emergent behaviour is when people form families, tribes, cities and nations. Individual action on behalf of a larger system may be coerced (forced), voluntary, or even unintentional, and consequently individuals and groups might at in concern even though they have almost nothing in

common as regards interest or goals. Examples of this can be found in market trade, military wars, families, workplaces, schools and prisons.

This paper shows the emergence of strategies as a natural result of the seemingly competitive (selfish) actions of countries all over the world. While Holland (2007) puts a premium on international cooperation as a strategic move to ensure sustainability, we posit that in the long term, the natural instinct of social atoms to dominate and accumulate wealth through competition will eventually prevail. At this stage, Darwin's evolutionary principle of natural selection (survival of the fittest) will begin to take over the process.

2.0 Conceptual Framework

The study rest on the idea that both competition and cooperation strategy benefits the players in the system. This study is conceptualized through Complex Adaptive System, which imposes the characteristics of each element and their interaction to each other.   The conceptual paradigm of the study is illustrated in Figure 1.
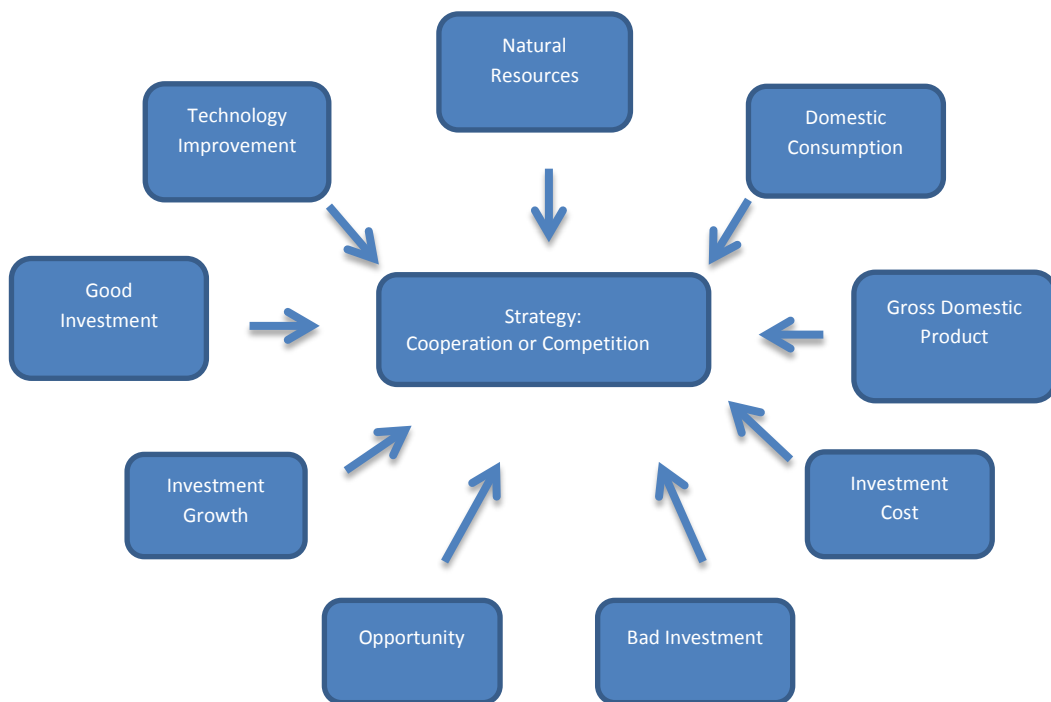

Figure1. Conceptual Paradigm of the Study.

3.0 Research Design and Methods

The study utilized the simulation model of Artificial World Creation made popular for use in the analysis of Complex Adaptive Systems. A Complex Adaptive System is a system consisting of multiple elements, each possessing a characteristic and interacting with other elements in the system. Through these interactions, the elements learn or adapt and change their strategies to maximize benefits for themselves. The particular model used in this study is the Cooperation Model.

This model (and Altruism and Divide the Cake) are part of the EACH unit ("Evolution of Altruistic and Cooperative Habits: Learning About Complexity in Evolution"). See http://ccl.northwestern.edu/rp/each/index.shtml for more information on the EACH unit. The EACH unit is embedded within the BEAGLE (Biological Experiments in Adaptation, Genetics, Learning and Evolution) evolution curriculum. See http://ccl.northwestern.edu/rp/beagle/index.shtml.

This is an evolutionary biology model. In it, agents (cows) compete for natural resources (grass). Cows that are more successful in getting grass reproduce more often, and will thus be more evolutionarily successful. This model includes two kinds of cows, greedy and cooperative. It shows how these two different strategies do when competing against each other within a population that evolves over time.

We begin by associating each cow with N international policy leaders who are equally likely to be cooperative or competitive. As the system evolves, we observe the number of policy leaders that become proponents of either "cooperation" or "competition" strategies. The assumption of having an equal probability of being cooperative or competitive is hinged on equiprobable considerations. The other assumptions include the following:

Original Parameter	Parameter as Used in the Study	Values Used	Remarks
Stride Length	Technology Improvement	0.10	Time Duration for Technology Improvement
Grass Energy	Natural Resources	50,100	Low = 50 High = 100
Metabolism	Domestic Consumption	6, 10	Low = 6 High = 10
Reproduction Threshold	Gross Domestic Product	200	Constant
Reproduction Cost	Investment Cost	50	Constant
Low Growth Chance	Bad Investment	30	Constant
High Growth Chance	Good Investment	99	Constant
Maximum Growth Height	Investment Growth	10	Constant
Low-High Threshold	Opportunity	10	Constant

4.0 Results and Discussion

We arbitrarily assumed that 100 ticks of the program equals one year of exposure of the initial number of international leaders to their constituencies. Twenty (20) international leaders (representing twenty competing countries) vie for resources for their own use. Of these, ten (10) are branded as "cooperative" while ten (10) are "competitive". Table 1 shows the number of followers convinced by these types of international leaders to take a stance similar to theirs in pursuit of needed resources.

Table 1: Leaders Convinced by the Initial International Leaders after One Year.

20 Leaders							
Competitive				**Cooperative**			
	Low Resources	**High Resources**	**Row Total**		**Low Resources**	**High Resources**	**Row Total**
	779	7556	8335		1559	58805	60364
	748	6971	7719		1250	5065	6315
	791	8054	8845		1662	6640	8302
	847	8423	9270		1605	6005	7610
	1050	9108	10158		1761	5487	7248
	904	9482	10386		1959	4962	6921
	943	9172	10115		1876	7724	9600
	968	11053	12021		1787	5474	7261
	726	8373	9099		1475	8784	10259
	933	8742	9675		1774	4990	6764
Column total	8689	86934	95623	**Column total**	14934	108946	123880

In order to determine which of "cooperation" or "competition" is leading as an international strategy for resource acquisition, we considered the ratio of "competitive" to "cooperative" leaders over the simulation runs. Table 2 shows the ratios under conditions of Low Resource Availability".

Table 2. Low Resource Ratio of Competitive to Cooperative Leaders.

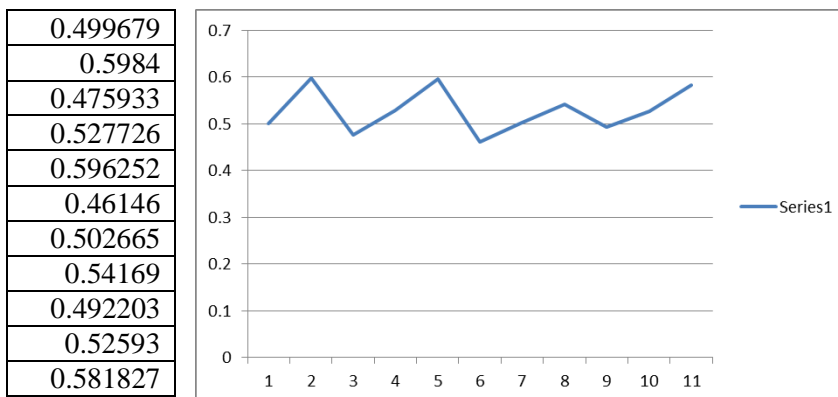| |
|---|
| 0.499679 |
| 0.5984 |
| 0.475933 |
| 0.527726 |
| 0.596252 |
| 0.46146 |
| 0.502665 |
| 0.54169 |
| 0.492203 |
| 0.52593 |
| 0.581827 |

Figure 2: Ratio of Competitive to Cooperative Leaders

Tabular values indicate that there is a definite tendency to become more cooperative among the leaders convinced by the initial number of international leaders within their countries. From an initial probability of 50% or 1:1 ratio, the probability of being more cooperative has increased to 58% after one year under a "low resource availability" regime. Thus, when resources are limited and low, international leaders will have a tendency towards cooperation rather than competition after one year. This appears to be consistent with Holland's (2007) conjecture that cooperation is the key to survival and sustainable growth.

Table 3 shows the same ratio under a high resource availability regime after one year.

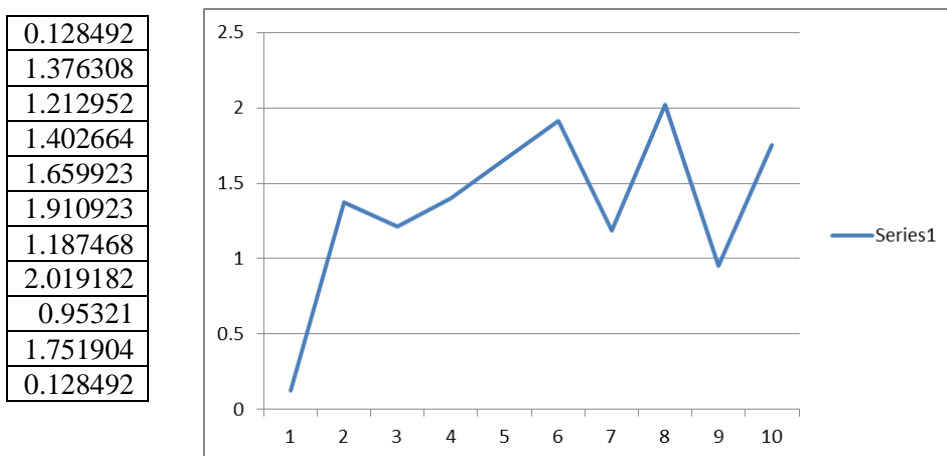| |
|---|
| 0.128492 |
| 1.376308 |
| 1.212952 |
| 1.402664 |
| 1.659923 |
| 1.910923 |
| 1.187468 |
| 2.019182 |
| 0.95321 |
| 1.751904 |
| 0.128492 |

Figure 3: Competitive to Cooperative Ratio under High Resource

Tabular values show, albeit surprisingly, that under a high resource availability regime, the instinct to accumulate more for resource for themselves has become clearly pronounced. The ratio of competitive to cooperative leaders registered a huge 1.75 or a ratio of 7:4 (for each 7 competitive leaders are 4 cooperative leaders). That is, from the original 1:1 ratio of competitive to cooperative international leaders, the ratio indicated lopsidedness in favor of those convinced to be competitive after one year. Indeed, the Darwinian evolutionary instinct to accumulate resources for one's self for survival is clearly demonstrated by these results.

It is natural to ask if this tendency going to be permanent or transient in nature. We calculated the same quantities for 300 ticks or 3 years. The results are shown in Table 4.

Table 4. Leaders Convinced by the Initial International Leaders after Three Years.

20 Leaders							
Competitive				**Cooperative**			
	Low Resources	**High Resources**	**Row Total**		**Low Resources**	**High Resources**	**Row Total**
	680	2553	3233		1291	88	1379
	604	2881	3485		1113	1	1114
	587	2696	3283		1343	1	1344
	765	2595	3360		876	1	877
	594	2889	3483		1103	1	1104
	705	3090	3795		1218	661	1879
	671	2715	3386		1192	1	1193
	653	2897	3550		1330	1	1331
	557	2819	3376		1234	1	1235
	700	2856	3556		1000	126	1126
Column total	6516	27991	34507	**Column total**	11700	882	12582

As before, we analyze the figures obtained by looking into the ratios of competitive to cooperative leaders under low and high resource availability regimes after three years. Table 5 shows the ratios under a low resource regime.

Table 5. Low Resource Ratio of Competitive to Cooperative Leaders.

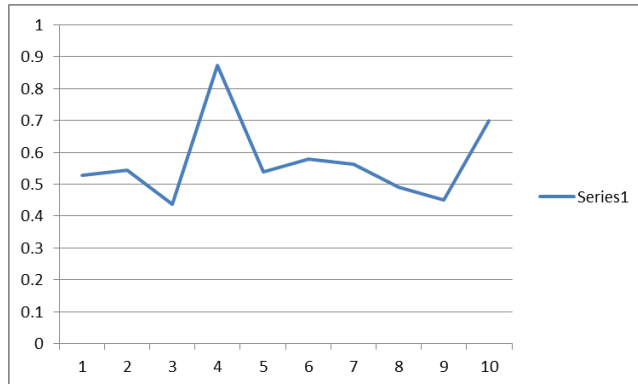|	
0.526723	
0.542677	
0.437081	
0.873288	
0.538531	
0.578818	
0.562919	
0.490977	
0.451378	
0.7	
0.526723	

Figure 4: Low Resource Ratio of Competitive to Cooperative
Leaders.

Since the ratios are all less than unity (1.0), we deduce that under a low resource ratio, the cooperative leaders tended to outnumber the competitive leaders after three (3) years. Thus, the initial year's propensity to be cooperative has been maintained after three years under a low resource regime. However, it is noticeable that the number of cooperative leaders in the first year has reduced by about 20% viz. some twenty percent of those convinced in the first year to be cooperative shifted their sentiments to being more competitive.

Table 6. High Resource Ratio of Competitive to Cooperative Leaders.

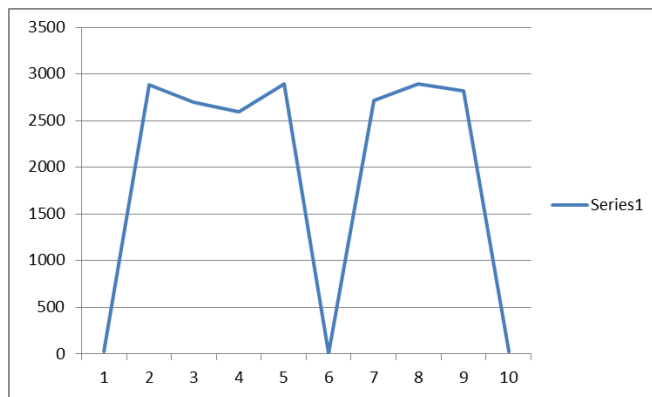|	
29.01136	
2881	
2696	
2595	
2889	
4.674735	
2715	
2897	
2819	
22.66667	

Figure 5. High Resource Ratio of Competitive to Cooperative
Leaders.

Under a high resource regime, competitiveness becomes almost the unanimous strategic choice of the leaders. All the ratios computed significantly exceeded the 1:1 ratio. The leaders believed that since there are more than enough

resources for everyone, there is a need to strategize to obtain as much of these available resources for their own use.

In summary, we have shown that under a low resource availability regime, international leaders tend to coalesce and cooperate for more judicious allocation of the limited resources to the individual nations. The other option of being more competitive entails more costly conflict situations for these countries. Hence, forced by circumstance, the nations involved choose to be satisfied with whatever they can get from cooperative actions rather than risk getting into very costly conflicts with neighboring nations. On the other hand, when resources are plentiful, the risk of getting into conflicts with other nations is minimized since there are enough resources for everyone. Consequently, the best course of action would be to become more competitive and independent. Padua (2017) observed the same phenomenon when analyzing the marine ecosystem productivity in various parts of the Philippines.

5.0 Conclusion

Cooperation is not always the best strategic action that nations in the international community can adopt to maximize benefits for themselves. Cooperation is optimal when the global resources available are low and limited. However, under a high resource availability regime, competition appears to be the better choice of strategic action.

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