SPONTANEOUS COALITION FORMING: A MODEL FROM SPIN GLASSES

Eastern Europe post cold war instabilities

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1. Introduction

In recent years, physics has poved to be successful in providing several models to describe collective behavior in human societies and social organisations [1]. In particular, new light has been shed on democratic voting biases [2], decision making process [3], the emergence of cooperation [4], social impact [5], and power genesis in groups [6].

However, such a new approach to social behavior is still in its infancy. More work is needed, as well more connections with social data. Its results so far may be the first ingredients to what could become, in the near future, a new field of research by itself. At least, this is our challenge.

It is also worth giving some words of caution, since dealing with social reality can often interfere with the reality itself, via biases in actual social representations. One contribution of this "sociophysics" would indeed be to remove the elements of political or philosophical beliefs from Social Studies, placing it in a modelling framework devoid of any religion-like attitudes.

In this paper we adress the question of coalition forming in the framework of military alliances between countries, using some basic concepts from the physics of spin glass systems [7]. Along this line, an earlier attempt from political sciences [8] used the physical concept of minimum energy. However, this work was misleading [9] since it was based on a confusion between the two physically different spin glass models of Mattis and Edwards-Anderson [10]. The model presented here indeed involves the interplay between these two models.

The paper is organised as follows. Section 2 contains the presentation of our model. Several features of the dynamics of bimodal coalitions are obtained. Within such a framework the single country viewpoint is studied in Section 3, demonstrating the frontiers of turning some local cooperation to conflict or the opposite, still belonging to the same coalition.

The setting up of world-wide alliances is discussed in section 4. The cold war situation is then analysed in section 5. A new explanation is given in Section 6 to Eastern European instabilities following the dissolution of the Warsaw pact, as well as the corresponding instabilities in the West. Some hints are also obtained from the model on how to stabilize these Eastern European instabilities, given the still existing Nato. The model is then applied in Section 7 to the description of the situation in China. The concept of "risky actor" is briefly introduced in Section 8. The last Section contains some concluding remarks.

2. Presentation of the Model

We now address the problem of alignment between a group of N countries [7]. For historical, cultural and economic reasons, there exist bilateral propensities $J_{i,j}$ between any pair of countries i and j towards either cooperation ($J_{i,j} > 0$), conflict ($J_{i,j} < 0$) or ignorance ($J_{i,j} = 0$). Each propensity $J_{i,j}$ depends solely on the pair $(i,\, j)$ itself, and is positive, negative or zero. Propensities $J_{i,j}$ are somehow local, since they don't account for any global organization or net. Their intensities vary for each pair of countries to account for the varying military and economic power of both actors. They are assumed to be symmetric, i.e., $J_{ij} = J_{ji}$.

From the well known saying "the enemy of an enemy is a friend" we postulate the existence of only two competing coalitions, such as the Western and Eastern blocks during the Cold War. They are denoted respectively by A and B.

Each actor then has the choice of being in either one of two coalitions. A variable η_i associated with each actor, where the index i runs from 1 to N, specifies which coalition that actor belongs to. It is $\eta_i = +1$ if actor i belongs to alliance A, while $\eta_i = -1$ in case it is part of alliance B. From symmetry all A-members can turn to coalition B with a simultaneous flip of all B-members to coalition A.

Given a pair of actors (i, j) their respective alignment is readily expressed through the product $\eta_i \eta_j$. The product is $+1$ when i and j belong to the same coalition and -1 otherwise. The "cost" of exchange between a pair of countries is then measured by the quantity $J_{ij}\eta_i\eta_j$.

Factorisation over i and j is not possible here. Indeed we are dealing with pre-given competing bonds or links. This is equivalent to random bond spin glasses as opposed to Mattis random site spin glasses[10].

Given a configuration X of actors, for each nation i we can measure the overall degree of conflict and cooperation with all other $N-1$ countries, using the quantity

$$E_i = \sum_{j=1}^{n} J_{ij}\eta_j \,, \tag{1}$$

where the summation is taken over all other countries including i itself with $J_{ii} \equiv 0$. The product $\eta_i E_i$ then evaluates the local "cost" associated with the choice country i makes. It is positive if i goes along with the tendancy produced by E_i and negative otherwise. For a given configuration X, all country local "cost" sum up to a total "cost",

$$E(X) = \frac{1}{2}\sum_i \eta_i E_i \,, \tag{2}$$

where the 1/2 accounts for counting pairs twice. This "cost" indeed measures the level of satisfaction with each country's choice of alliance. It can be recast as

$$E(X) = \frac{1}{2}\sum_{i,j}^{n} J_{ij}\eta_i\eta_j \,, \tag{3}$$

where the sum runs over the $n(n-1)$ pairs (i,j). Eq. (3) is indeed the Hamiltonian of an Ising random bond magnetic system.

2.1. THE CHOSEN DYNAMICS

At this stage we postulate that the actual configuration is the one which minimizes the cost in each country's choice. In order to favor two cooperating countries ($G_{i,j} > 0$) in the same alliance, we put a minus sign in front of Eq. (3), to get

$$H = -\frac{1}{2}\sum_{i,j}^{n} J_{ij}\eta_i\eta_j \,. \tag{4}$$

There exist by symmetry $2^n/2$ distinct sets of alliances, since each country has 2 choices for coalition.

Starting from any initial configuration, the dynamics of the system is implemented by single actor coalition flips. An actor turns to the competing coalition only if the flip decreases his local cost. The system has reached its stable state when no more flips occur. Given $\{J_{ij}\}$, the $\{\eta_i\}$ are thus obtained by minimizing Eq. (4).

Since here the stable configuration of the system minimizes the "energy", we are from a physical viewpoint, at the temperature "$T = 0$". Otherwise, when "$T \neq 0$" it is the free-energy which has to be minimized.

In practice, for a finite system the theory can tell which coalitions are possible and how many of them exist. But when several coalitions have the same energy, it is not possible to predict which one will be realized.

2.2. FRUSTRATION EFFECT

The physical concept of frustration [10] is embodied in the model. For instance, in the case of three conflicting nations as Israel, Syria and Iraq, any possible alliance configuration always leaves someone unsatisfied.

To define this feture more precisely: let us attach the labels 1, 2, 3 to the three countries. When we have equal and negative exchange interactions $J_{12} = J_{13} = J_{23} = -J$ with $J > 0$, the associated minimum of the energy (Eq. 4) is equal to $-J$. However, this value of the minimum is realized for several possible and equivalent coalitions. Namely, for countries (1, 2, 3) we can have the alignments (A, B, A), (B, A, A), (A, A, B), (B, A, B), (A, B, B), and (B, B, A). The first three are identical to the last three by symmetry since what matters is which countries are in the same coalition. The peculiar property of this system is that it never attains stability in just one configuration, since it costs no energy to switch from one to another. This is the archetypical case of frustration, which means that several ground states with exactly the same energy exist.

Otherwise, for non-equal interactions, the system has one stable minimum and no frustration occurs according to the physiscal usage of the word, defined above. The fact that some interactions are not satisfied does not automatically imply frustration in the above sense of multiple equivalent sets of alliances.

3. A One Country Viewpoint

We now make this point more quantitative within the present formalism. Consider a given site i. Interactions with all other sites can be represented by a field,

$$h_i = \sum_{j=1}^{n} J_{ij}\eta_j \tag{5}$$

resulting in an energy contribution

$$E_i = -\eta_i h_i \tag{6}$$

to the Hamiltonian $H = \frac{1}{2}\sum_{i=1}^{n} E_i$. Eq. (10) is minimized when η_i and h_i have the same sign. For a given h_i there always exists a well-defined coalition, except for $h_i = 0$. In this case site i is "neutral", since both coalitions are identical with respect to its local "energy" which remains zero. A neutral site will flip with probability $\frac{1}{2}$.

3.1. SHIFTING COALITION

The couplings J_{ij} are given. Let us then assume that there exists only one minimum. Once the system reaches its stable equilibrium, it gets trapped and the energy is minized. At the minimum the field h_i can be calculated for each site i since J_{ij} are known, as well as the η_i's.

First consider all sites which have the value -1. The existence of a unique non-degenerate minimum makes the associated fields also negative. We then take one of these sites, e.g. k, and shift its value from -1 to +1 by simultaneously changing the sign of all its interactions J_{kl}, where l runs from 1 to n ($J_{kk} = 0$). This transformation gives,

$$\eta_k = +1 \qquad \text{and} \qquad h_k > 0 \tag{7}$$

instead of

$$\eta_k = -1 \qquad \text{and} \qquad h_k < 0\,, \tag{8}$$

which means that actor k has shifted from one coalition to the other one.

It is worth emphasizing that such a systematic shift of the propensities of actor k has no effect on the other actors. Taking, for instance, actor l, its unique interaction with actor k is through J_{kl} which did change sign in the transformation. However, as actor k has also turned to the other coalition, the associated contribution $J_{kl}\eta_k$ to the field h_l of actor l is unchanged.

The shift process is then repeated for each member of actor k's former coalition. Once all shifts are completed, there exists only one unique coalition. Everyone is cooperating with all the others. The value of the energy minimum is unchanged in the process.

The above transformation demonstrates that the J_{ij} determine the stable configuration. In particular, it shows that given any site configuration, there always exists a set of J_{ij} which will give that particular configuration as the unique minimum of the associated energy. At this stage, what matters are the propensity values.

The above gauge transformation shows what matters is the sign of the field $\{h_i\}$ and not a given J_{ij} value. A given set of field signs, positive and negative, may be realized through an extremely large spectrum of $\{J_{ij}\}$.

This very fact opens a way for exploring some possible deviations from a national policy. For instance, given the state of cooperation and conflicts of a group of actors, it is possible to find limits in which local pair propensities can be modified without inducing coalition shifting. Some country can turn from cooperation to conflict or the opposite, without changing alliance, as long as the sign of the associated field is unchanged. This means that a given country could becomes hostile to some former allies, still staying in the same overall coalition. One illustration is given by German recognition of Croatia against the will of other European partners like France and

England, without risking its belonging to the European Union. The Falklands war between England and Argentina is another example, since both countries have strong American partnerships.

4. Setting up Coalitions

From the above analysis, countries were found to belong to some alliance without a priori macro-analysis at the regional or world level. Each country is adjusting to its best interests with respect to countries with which it interacts. However, the setting up of global coalitions aimed at spreading and organizing economic and military exchanges produces an additional ingredient in each country's choice.

Still staying in the two-coalition scheme, each country has an a priori natural choice. To account for this fact, we introduced for each actor i, a variable ϵ_i. It is $\epsilon_i = +1$ if actor i would like to be in A, $\epsilon_i = -1$ if in B, and $\epsilon_i = 0$ for no a priori preferences. Such a priori tendencies are induced by cultural and political history.

Moreover, we measure exchanges produced by these coalitions through a set of additional pairwise propensities $\{C_{i,j}\}$. They are always positive since sharing resources, information, weapons is basically profitable. Nevertheless, for a pair (i, j), the propensity for cooperation, conflict or ignorance is $A_{i,j} \equiv \epsilon_i \epsilon_j C_{i,j}$, which can be positive, negative or zero. Now we do have a Mattis random site spin glasses [10].

Including both local and macro exchanges results in an overall pair propensity

$$O_{i,j} \equiv J_{i,j} + \epsilon_i \epsilon_j C_{i,j} \tag{9}$$

between two countries i and j with $J_{i,j} > 0$ always.

An additional variable $\beta_i = \pm 1$ is introduced to account for the benefit from economic and military pressure attached to a given alignment. It is still $\beta_i = +1$ in favor of A, $\beta_i = -1$ for B and $\beta_i = 0$ for no preference. The amplitude of this economical and military interest is measured by a local positive field b_i, which also accounts for the country's size and its importance. At this stage, the sets $\{\epsilon_i\}$ and $\{\beta_i\}$ are independent.

Actual actor choices for cooperation or conflict result from the given set of above quantites. The associated total cost is,

$$H = -\frac{1}{2} \sum_{i>j}^{n} \{J_{i,j} + \epsilon_i \epsilon_j C_{ij}\} \eta_i \eta_j - \sum_{i}^{n} \beta_i b_i \eta_i \,. \tag{10}$$

5. Cold War SCenario

By Cold War scenario we mean that the two existing world level coalitions generate much stonger couplings than purely bilateral ones, i.e., $|J_{i,j}| < C_{i,j}$, since to belong to a world level coalition produces more advantages than purely local unfriendly relationships. In others words, local propensities were overridden by the two block trend. The overall system was very stable. We can thus take $J_{i,j} = 0$. Moreover, each actor must belong to a coalition, i.e., $\epsilon_i \neq 0$ and $\beta_i \neq 0$. In that situation local propensities to cooperate or to conflict between two interacting countries result from their respective individual macro-level coalition memberships. The cold war energy is

$$H_{CW} = -\frac{1}{2}\sum_{i>j}^{n} \epsilon_i \epsilon_j J_{ij} \eta_i \eta_j - \sum_{i}^{n} \beta_i b_i \eta_i \,. \tag{11}$$

5.1. COHERENT TENDENCIES

We consider first the coherent tendency case, in which cultural and economical trends go along the same coalition, i.e., $\beta_i = \epsilon_i$. Then from Eq. (15), the minimum of H_{CW} is unique with all country propensities satisfied. Each country chooses its coalition according to its natural disposition, i.e., $\eta_i = \epsilon_i$. This result is readily proven via the variable change $\tau \equiv \epsilon_i \eta_i$, which makes the energy

$$H_{CW1} = -\frac{1}{2}\sum_{i>j}^{n} J_{ij} \tau_i \tau_j - \sum_{i}^{n} b_i \tau_i \,, \tag{12}$$

where $C_{i,j} > 0$ are positive constants. Eq. (16) is a ferromagnetic Ising Hamiltonian in positive symmetry breaking fields b_i. Indeed, it has one unique minimum with all $\tau_i = +1$.

The remarkable fact is that the existence of two a priori world level coalitions is identical to the case of a unique coalition with every actor in it. This sheds light on the stability of the Cold War situation, where each actor satisfies its proper relationship. Differences and conflicts appear to be part of an overall cooperation within this scenario. Both dynamics are exactly the same, since what matters is the existence of a well-defined stable configuration. However, there exists a difference, which is not relevant at this stage of the model, since we assumed $J_{i,j} = 0$. However, in reality $J_{i,j} \neq 0$ making the existence of two coalitions produce a lower “energy” than a unique coalition, since in that case more $J_{i,j}$ can be satisfied.

It is worth noticing that field terms $b_i \epsilon_i \eta_i$ account for the difference in energy cost in breaking a pair proper relationships for large and a small countries, respectively. Consider, for instance, two countries i and j with $b_i = 2b_j = 2b_0$. The associated pair energy is

$$H_{ij} \equiv -J_{ij}\epsilon_i\eta_i\epsilon_j\eta_j - 2b_0\epsilon_i\eta_i - b_0\epsilon_j\eta_j\,. \tag{13}$$

Conditions $\eta_i = \epsilon_i$ and $\eta_j = \epsilon_j$ give the minimum energy,

$$H_{ij}^m = -J_{ij} - 2b_0 - b_0\,. \tag{14}$$

From Eq. (18) it is easily seen that in case j breaks proper alignment shifting to $\eta_j = -\epsilon_j$, the cost in energy is $2J_{ij} + 2b_0$.

Similarly, when i shifts to $\eta_i = -\epsilon_i$, the cost is higher, with $2J_{ij} + 4b_0$. Therefore, the cost in energy is lower for breaking proper alignment by a small country ($b_j = b_0$) than by a large country ($b_j = 2b_0$). In the real world, it is clearly not the same for instance for the US to be against Argentina as for Argentina to be against the US.

5.2. INCOHERENT TENDENCIES

We now consider the incoherent tendency case, in which cultural and economic trends may favour opposite coalitions, i.e., $\beta_i \neq \epsilon_i$. Using the above change of variable $\tau \equiv \epsilon_i\eta_i$, the Hamiltonian becomes

$$H_{CW2} = -\frac{1}{2}\sum_{i>j}^{n} J_{ij}\tau_i\tau_j - \sum_{i}^{n}\delta_i b_i\tau_i\,, \tag{15}$$

where $\delta_i \equiv \beta_i\epsilon_i$ is given and equal to ± 1. H_{CW2} is formally identical to the ferromagnetic Ising Hamiltonian in random fields $\pm b_i$. However, here the fields are not random.

The local field term $\delta_i b_i \tau_i$ modifies the country field h_i in Eq. (9) to $h_i + \delta_i b_i$, which can now happen to be zero. This is a qualitative change, since now there exists the possibility to have "neutrality", i.e., a zero local effective field coupled to the individual choice. Switzerland's attitude during World War II may have resulted from such a situation. Moreover, countries which have opposite cultural and economical trends may now follow their economical interest against their cultural interest or vice versa. Two qualitatively different situations may occur.

- Unbalanced economical power: in this case we have $\sum_i^n \delta_i b_i \neq 0$.
  The symmetry is now broken in favor of one of the coalitions. But still, there exists only one minimum.
- Balanced economical power: in this case we have $\sum_i^n \delta_i b_i = 0$.
  Symmetry is preserved and H_{CW2} is identical to the ferromagnetic Ising Hamiltonian in random fields which has one unique minimum.

6. Unique World Leader

Now we consider the current world situation, namely the disappearance of the Eastern Block. However, it is worth emphazing the fact that the Western Block is still active as before in this model. With our notations, denoting by A the Western alignment, we still have $\epsilon_i = +1$ for countries which had $\epsilon_i = +1$. On the contrary, countries which had $\epsilon_i = -1$ have now turned to either $\epsilon_i = +1$ or to $\epsilon_i = 0$.

Therefore, the above $J_{i,j} = 0$ assumption based on inequality $|J_{i,j}| < |\epsilon_i \epsilon_j| C_{i,j}$ no longer holds for every pair of countries. In particular, the propensity $p_{i,j}$ becomes equal to $J_{i,j}$ in the two respective cases, where $\epsilon_i = 0$, $\epsilon_j = 0$ and $\epsilon_i = \epsilon_j = 0$.

A new distribution of actors results from the collapse of one block. On the one hand, coalition A countries still determine their actual choices according to $C_{i,j}$. On the other hand, former coalition B countries are now found to determine their choices according to competing links $J_{i,j}$, which did not automatically agree with the former $C_{i,j}$. This subset of countries has turned from a Mattis random site spin glass without frustration into a random bond spin glass with frustration. In other words, the former B coalition subset has jumped from one stable minimum to a highly degenerate unstable landscape with many local minima. This property could be related to the fragmentation process, where ethnic minorities and states shift alliances back and forth rapidly, whilst they were part of a stable structure just a few years ago.

Whilst the coalition B world organization has disappeared, the A coalition world organization did not change, and is still active. This makes $|J_{i,j}| < C_{i,j}$ still valid for A countries with $\epsilon_i \epsilon_j = +1$. Associated countries thus maintain a stable relationship and avoid a fragmentation process. This result supports a posteriori arguments against the dissolution of Nato once Warsaw Pact has been disolved.

The above situation could also shed some light on the European debate. It would suggest that European stability is a result in particular of the existence of European structures with economical reality. These structures produce associated propensities $C_{i,j}$, much stronger than local competing propensities $J_{i,j}$, which are still present. In other words, European stability would indeed result from $C_{i,j} > |J_{i,j}|$ and not from either all $J_{i,j} > 0$ or all $J_{i,j} = 0$. An eventual setback to the European construction ($\epsilon_i \epsilon_j C_{i,j} = 0$) would then automatically yield a fragmentation process with activation of ancestral bilateral oppositions.

In this model, once a unique economical as well as military world level organisation exists, each country's interest becomes a part of it. We thus have $\beta_i = +1$ for each actor. There may be some exception like Cuba staying almost alone in former B alignment, but this case will not be considered here. The associated Hamiltonian for the $\epsilon_i = 0$ subset actor is,

$$H_{UL} = -\frac{1}{2}\sum_{i>j}^{n} G_{ij}\eta_i\eta_j - \sum_{i}^{n} b_i\eta_i\,, \qquad (16)$$

which is formally equivalent to a random bond Hamiltonian in a field. At this stage $\eta_i = +1$ means being part of coalition A, which is an international structure. Meanwhile $\eta_i = -1$ is to be in a non-existing B-coalition which really means to be outside of A.

For a small field with respect to the interaction the system may still exhibit physical-like frustration depending on the various $J_{i,j}$. In this case the system has many minima with the same energy. Perpetual instabilities thus occur in a desperate search for an impossible stability. Actors will flip continuously from one local alliance to the other. The dynamics we are referring to is an individual flip each time it decreases the energy. We also allow a flip with probabilty $\frac{1}{2}$ when the local energy is unchanged.

It is worth pointing out that only strong local fields may lift fragmentation by putting every actor in the A-coalition. This can be achieved through economic help, for instance, in the Ukraine. Another way is military A enforcement, like for instance in former Yugoslavia.

Our results point out, that the current debate over integrating former Eastern countries into Nato is indeed relevant for opposing the current fragmentation processes. Moreover, it indicates that an integration would suppress present instabilities by lifting frustration.

7. The Case of China

China is a huge country composed of several very large states. These states are themselves much larger than most countries in the world. It is therefore interesting to analyse China's stability within our model, since it represents a case of simultaneous Cold War scenario and Unique World Leader scenario.

There exist n states which are all part of a unique coalition, the Chinese Central State. Then all $\epsilon_i = +1$ but $\beta_i = \pm 1$, since some states maintain economic and military interest in the "union" ($\beta_i = +1$), while capitalistically advanced rich states contribute more than their share to the "union", ($\beta_i = -1$). The associated Hamiltonian is,

$$H = -\frac{1}{2}\sum_{i>j}^{n}\{J_{i,j} + J_{ij}\}\eta_i\eta_j - \sum_{i}^{n}\beta_i b_i\eta_i\,, \qquad (17)$$

where $C_{i,j} > 0$ and G_{ij} is positive or negative depending on each pair of states $(i,\, j)$.

At this moment China is one unified country, which means in particular that $C_{i,j} > |G_{ij}|$ for all pair of states with negative G_{ij}. Therefore $\eta_i = +1$ for each state. Moreover, it also implies $b_i < q_i C_{i,j}$, where q_i is the number of states state i interacts with. Within this model, three possible scenarios can be oulined as regards China's stability.

1. Chinese unity is preserved.
   Rich states will maintain their economic growth with the central power turning to a capitalistically oriented federation-like structure. This means turning all ϵ_i to -1, with $\eta_i = \epsilon_i$. Meanwhile, the additional development of poor states is required in order to maintain the condition $C_{i,j} > |G_{ij}|$ where some G_{ij}s are negative.
2. Some rich states break unity.
   Central power is unchanged with the same political and economical orientation, making heavier limitations over rich states' development. At some point the condition $b_i > q_i C_{i,j}$ may be achieved for these states. These very states will then get a lower "energy" if they break off from Chinese unity. They will shift to $\eta_i = -1$ in their alignment with the rest of China which has $\eta_j = +1$.
3. Chinese unity is lost via fragmentation.
   In this case, opposition between various states becomes stronger than the central organisational cooperation, with $C_{i,j} < |G_{ij}|$ with some negative G_{ij}s. The situation would become spin glass-like and China would then undergo a fragmentation process. Former China would become a highly unstable part of the world.

8. The Risky Actor Driven Dynamics

In principle, actors are expected to follow their proper relationships, i.e., to minimize their local "energy". In other words, actors follow normal and usual patterns of decision. But it is well known that in real life these expectations are sometimes violated. Then, new situations are created with a reversal of ongoing policies.

To account for such situations we introduce the risky actor, who goes against his well-defined interest. It is different from the frustrated actor who does not have a well-defined interest. Up to now, everything was done at "$T = 0$". However, a risky actor chooses coalition associated to $\eta_i = -1$, even though his local field h_i is positive. Therefore, the existence of risky actors requires a $T \neq 0$ situation. The case of Rumania, having its own independent foreign policy in the former Warsaw Pact may be an illustration of such risky actor behavior. Greece and Turkey in the Cyprus conflict may be another example.

Once $T \neq 0$, it is not the energy which has to be minimized, but the free energy,

$$F = U - TS\,, \tag{18}$$

where U is the internal energy, now different from the Hamiltonian and equal to its thermal average and S is the entropy. Minimizing the free energy means that the stability of a group of countries depends on the respective size of each coalition but not on which actors are actually in these coalitions.

At a fixed "temperature", we can thus expect a simultaneous shift of alliances from several countries as long as the size of the coalition is unchanged, without any modification in the relative strenghts. Egypt quitting the Soviet camp in the seventies and Afghanistan joining it may illustrate these non-destabilizing shifts.

Within the coalition framework temperature could be viewed as a way to account for some risky trend. It is not possible to know which particular actor will take a chance, but it is reasonable to assume the existence of some number of risky actors. Temperature would thus be a way to account for some global level of risk taking.

Along the lines of ideas developped elsewhere [6, 11], we can assume that a level of risky behavior is profitable for the system as a whole. It produces surprises, which induce actors to reconsider some aspects of the coalitions, themselves. The recent Danish refusal to sign the Maastricht agreement on closer European unity may be viewed as an illustration of a risky actor. The net effect has been indeed to turn what seemed to be a trivial and pathetic administrative agreement into a deep and passionate debate between European countries with respect to the European construction.

The above discussion shows the implementation of $T \neq 0$ within the present approach of coalitions should be rather fruitful. Further elaboration is left to future work.

9. Conclusion

In this paper we have proposed a new way to understand alliance forming phenomena. In particular, it was shown that within our model Cold War stabilty was not the result of two opposite alliances, but rather the existence of alliance induced exchange, which neutralized the conflicting interactions between allies. This means that to have two alliances or just one is qualitatively the same with respect to stability.

From this viewpoint the strong instabilies which resulted from the dissolution of the Warsaw Pact are given a simple explanation. Simultaneously, some hints are obtained about possible policies to stabilize relationships between nations, worldwide. To this end, the importance of the European construction was also underlined.

We have also given some ground to introduce non-rational behavior in country behavior, especially with the notions of "risky", "frustrated" or "neutral" actors. A "risky" actor acts against his well-defined interests while a "frustrated" actor acts randomly since he does not have a well-defined interest.

At this stage, our model is still rather primitive. However, it opens some new roads to the exploration and to forecasting of international policies.

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