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ORIGINAL PAPER

Self-organization of social hierarchies studied with Monte-Carlo simulations; self-destroying join-believe-fight system as an inevitable outcome

Peter Stallinga[1,2,3]

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Abstract
Monte-Carlo simulations were used to describe the interactions between cellular automata, socio-economic 'agents', in society. In a first simulation we repeat work in literature of a system of independent agents. We repeat the finding that the strongest agent will confiscate all wealth. In a second simulation we show how agents can prevent against such theft, or steal better, by joining forces. So-called join-believe-fight (joining, believing unquestionably in the narrative of the faction, and fighting other factions). We now take cooperations between factions of joined agents into account. The final outcome is that society obliterates libertarians (those that are reluctant to join forces) and winds up in a situation in which all surviving agents are joined in a single faction. However, it is reasoned that then fights within this single faction will start, since this end situation resembles the starting point of entire society; the single faction has become entire society and the game recommences. It is a snake that bites its own tail and goes around forever attacking.

Keywords Monte-Carlo simulations · Social hierarchy · Cooperation · World government

✉ Peter Stallinga
peter.stallinga@gmail.com

1 FCT-DEEI, University of the Algarve, Campus de Gambelas, Faro 8005-139, Portugal

2 Center for Electronics, Optoelectronics and Telecommunications, Campus de Gambelas, Faro 8005-139, Portugal

3 Ossónoba Philosophical Society, Faro 8005-139, Portugal

Introduction

Since the classic book of Thomas Hobbes, *Leviathan* (1651), society has an unwritten 'social contract' with its leading class. For that reason he is considered the father of political philosophy. The idea of Hobbes was that if human beings were given total freedom they would be in a constant state of war. Citizens must therefore give up some of their freedom to enter into this contract with each other, to protect the interest of all. The Leviathan is the 'beast' with at its head the sovereign who is taking all the decisions and is exempt from scrutiny. The body is composed of all the people that voluntarily join. The second version of his book (1668) is composed of three parts:

I. Man. Man distinguishes himself from the animals by reason and the use of verbal communication. Men outside society would be in a perpetual state of war. *Fight*. In a so-called 'state of nature'. The need for a social contract exists.
II. Commonwealth. The Leviathan. Nourished by trade and at the head the sovereign leader takes sovereign decisions. Citizens *join*.
III. Christianity. The basis for the Leviathan (ethics) is Christianity, the ideology which followers must *believe*.

In a simplistic 'society' without the inter-personal relations (i.e. social aspects), in a 'state of nature', humans would constantly fight, just like the animals. Many researchers have since then studied and simulated this one-on-one fighting aspect of societies. This is "as if it were a many-body physical system such as a gas. Just as random collisions between gas molecules give rise to macroscopic properties such as temperature and pressure, random encounters between individuals in an economic system might determine large-scale phenomena such as the distribution of wealth" (Hayes 2002). Or as Slanina writes, "This […] lead to the view of economic activity as a scattering process of agents, analogous to inelastically scattering particles" (Slanina 2004). Random events between two agents in the system seen as an (ideal) gas. At each event a process takes place. The cumulative effect of these processes determine the macroscopic distributions. The link between (statistical) physics and economy then easily made (Chakrabarti and Chatterjee 2003; Chatterjee et al. 2003; Yakovenko and Jr. 2009; Boghosian and Marcq 2015; Boghosian et al. 2017), though the transferable quantity does not need to be something valuable; it might as well be status, or power (Dugatkin 1997; Hemelrijk 1999; Hickey and Davidsen 2019).

These simulations are often inspired by nature or attempting to describe it (Hogeweg and Hesper 1983; Bonabeau et al. 1999; Silk 2002). Or the link between nature and human society is made (Scheffer et al. 2017), but most interesting is the effect of statistical-physics-like interactions in human societies (Ben-Naim and Redner 2005; Chatterjee et al. 2003; Ben-Naim et al. 2006; Odagaki and Tsujiguchi 2006; Tsujiguchi and Odagaki 2007; Chakraborti et al. 2011), especially economy (Ballot and Weisbuch 2000; Slanina 2004) and an entire area of Econophysics exists (Mantegna 1999). Other such examples are the work of Hickey and Davidsen (2019), Bonabeau et al. (1995, 1999), Odagaki and Tsujiguchi (2006), Tsujiguchi and Odagaki (2007) and Ben-Naim et al. (2006), Dugatkin (1997), Ispolatov et al. (1998), who apply it to assets on the market, just as Boghosian et al. (2017) did, the latter who mention that classically a yard-sale-model of assets winds up in complete inequality (all of the wealth in a single agent) (Boghosian and Marcq 2015), something that we ourselves had found out by a different technique, not of bi-agent interactions (battles), but by optimization of total production with income difference as an incentive to produce (Stallinga 2019). In the area of Economy we are trying to find an explanation for the observed Pareto distribution (a.k.a. power law) or inequality Gini coefficient (Boghosian and Marcq 2015). Boghosian and coworkers managing it. Recent work shows how a system of exchangeable quantities winds up in this distribution. In many cases people find highly skewed distributions. If not winner-takes-all as mentioned above, societies often come close to this (Scheffer et al. 2017), with a skew Pareto (Chatterjee et al. 2003) or Gibrat distributions (Sutton 1996) as examples, but also statistical-physics-predicted exponential Boltzmann-Gibbs functions sometimes found (Chatterjee et al. 2003; Yakovenko and Jr 2009) as well as other functions (Patriarca et al. 2004; Slanina 2004).

These simulate societies as a set of independent agents that battle for the resources/power/prestige, and the interactions determine the outcome of the distribution function. One of the differences between the approaches is how the battles are evaluated, either by the additive rule or the multiplicative rule (Hickey and Davidsen 2019). In the former the adjustment of the status of an individual after a battle is done by adding or subtracting a fixed amount, it does not depend on the current value of the combatant's strength. The alternative is the multiplicative method. Here the strength transfered is proportional to the strength of the combatant involved. In spite of the complexity, what all these models have in common is that they approach the agents as independent, thus fully representing an ideal gas with collision events taking place between *two* particles, even though clusters of like-agents can be observed (Chakraborti et al. 2011).

In this work cooperation between multiple agents is added to the system and that increases the complexity of the system to a large extent. Society is much more than a set of loose agents. To what extent do agents cooperate? To address the real world: Can we form a world-government? Some kind of international world order, a Hobbesian commonwealth of nations. We will see that indeed the tendency is for joining forces. However, it can never result in a situation in which *all* humans unite for a single cause. That is a situation that cannot be achieved. Or to stay in physics terms: the gas can condensate, but never into a single crystal.

Definition of concepts

We first make some definitions about the various systems of the re-distribution of wealth (where the concept of wealth was already described in earlier work, as manifestation of possession of energetic products (Stallinga 2020)).

The amoral definitions are given in Fig. 1. Imagine a society divided into groups of people, 'agents', A. These agents can cooperate and join in groups, or 'factions', F. In the labeling, the group that is in control, if any is in control at all, is F_1; the faction making the decisions of the transfer of wealth indicated by arrows:

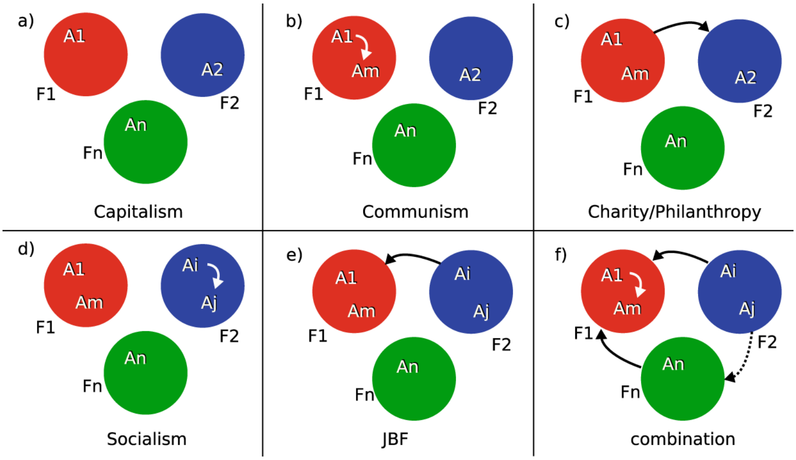

Fig. 1 Politico-economical systems in the framework of this research. A are agents, F are factions (clusters of agents). The top left red cluster F1 has the power and takes the decisions in the transfer of wealth (indicated by arrows). **a** In capitalism all agents are independent. **b** In communism a set of agents voluntarily distributes wealth between themselves. **c** In philanthropy agents voluntarily transfer wealth to other agents. **d** In socialism wealth of other agents are transferred to third parties. **e** In join-believe-fight (JBF) wealth is confiscated from other agents. Many real societies are combinations. Example is **f** A combination. For instance, nazism was socialism combined with fascism: wealth is confiscated in name of socialism and partly kept for the decision makers, but in soviet communism also wealth was redistributed within the communists, also against people's will

- In **Capitalism** is every agent fully free without any links to other agents other than by (free) trade. In reality, thus, every 'group' should consist of only one agent, since every agent acts for itself independently. $F_i = A_i$, and no one controls the wealth flow.
- In **Communism** a subset of agents $A_i \ldots A_j$ of a faction F decides to redistribute their wealth (energy) *between themselves*, on basis of "From each according to his ability, to each according to his needs" (Marx 1875). Other groups of agents have nothing to do with this decision, nor with the redistributed wealth. An example is a family; in a classic (sic) family the man works and the woman takes care of the house. Each do their share of the work and each gets according to their needs. The outside world did not interfere in this autonomous unit of the family.
- In **Philanthropy** or **Charity** a subset of agents F_1 decides to give away part of their wealth to another group.
- In **Socialism** the group of those in power, $F_1 = A_1 \ldots A_n$, redistributes the wealth of agents within *another* group F_i. Interfering in other people's lives.
- In **Organized theft (JBF)** does the group of those in power, F_1, confiscate the wealth of another group and distribute it amongst themselves. These other groups can of course also be organized in a similar way, but at the end of the day the group $F_1$is stronger and manages to transfer wealth from these groups. We call this join-believe-fight (JBF) in this work.

History has shown that society often winds up in JBF in the above sense of the word. In this analysis one should not be misled by words of politics and politicians—words do not count—one should only look at the *actions* and *outcomes*. Words and ideas are merely used to convince people to join. Or, as Carl Jung said, “People do not have ideas. Ideas have people”. Ideas are nucleation points around which groups can unite, just like water needs something—for instance pieces of dust—to condense on, to form raindrops. Ideas are the dust people can condense on. This way people can be joined to oppress and steal.

We came up with an adequate name for this self-serving organized theft system. A term based on the concept that people simply have to unquestionably agree, to believe, and to join in the fight, or as the famous Italian fascist motto goes, “*Credere, Obbedire, Combattere*” (“Believe, Obey, Fight”), which well summarizes the above. Similar to Orwell’s summary of (allegedly) communism, “Ignorance is strength” (believe), “Freedom is slavery” (obey), “war is peace” (fight). It is “join without asking questions and fight”. In a summary, the system described here is well defined by the acronym JBF, join-believe-fight. It has three elements:

1. Definition of a ‘cause’ that defines the group and its enemy (‘us’ and ‘them’); the cause cannot be questioned and must be believed (*credere*). Its veracity is therefore irrelevant and so is morality. About this veracity, Hobbes wrote in his second version of his *Leviathan*, “*auctoritas non veritas facit legem*”, which means authority, not truth, makes law. People/countries can join this cause.
2. No opposition is allowed (*obbedire*); opposition would make a person part of ‘them’. One must unquestioningly believe the narrative of the group.
3. Fighting the others (them), with an imagined moral right to eradicate them and/or confiscate their wealth (*combattere*).

How can it be that it happens over and over again? And nobody protests. Well, some do, but they unavoidably wind up being marginalized in society—‘cancel culture’ to purify society—or eventually in gulags or concentration camps, which would already give you a hint at why nobody protests. Agents are simply self-preserving biological entities. And can thus easily be modeled by biological survival-of-the-fittest concepts. Undeniably, opposing the narrative is not good for your genes, but even simply *not* joining it or ignoring it is bad for your genes, as will be shown here. Such genes would readily and silently disappear from the genetic pool. Showing loyalty to the leader *can* be beneficial to your survival chances. Of course, you have to pay tribute to the leader, but maybe together you will be able to confiscate the wealth of a third party, and after handing over your payment to the leader, you may actually make profit; you’d have more than you’d have if you were isolated in the world. More so since isolated, unbundled, you easily become prey for others that do join in JBF groups. Eat or be eaten, is the law of the jungle.

It seems obvious and is expected that adhering to JBF is better for your survival chances than not adhering to it. Actually, really believing in the narrative that allegedly justifies JBF is even much better for your genes. It is a good idea to self-delude and believe in the narrative. As Donald Hoffman says, “Not seeing the world accurately is better for fitness” (Hoffman 2015). The alternative, not believing the narrative, is very bad for your genes in JBF societies. If you are not killed on the spot, you likely wind up in a prison of some sort. No reproduction path for you. Taking it face value: the fact that someone believes in the narrative thus does not mean the narrative is true; they might be self-deluded thinking it is true.

Everything is believed to such an extent that people are willing to give their lives (i.e., fight, '*combattere*') and those of their children to the agenda. And they are willing to denounce non-believing dissidents, even if they are their own family. The Milgram experiment has shown that people can actually bypass any moral analysis if an authority orders their actions. Thus, there is no reason to assume 'morality' is anywhere a determining factor in the course of things. Morality is a social construct and cannot be measured, it has no SI unit and thus does not objectively exist. What exist are survival rates; society is a biological system governed by biological laws, that are in turn based on physical laws. The species and units surviving simply those that produce most entropy. Morality itself can be seen as a join-believe-fight system. One is never to question the moral code of a society. One has to believe it, and fight for it. Look around in your own society. Which moral laws—which truths—are unquestionable?

Finishing this introduction, it has to be mentioned that the opposition to JBF is not what you may think. It is not 'democracy'. In fact, democracy is simply a useful tool for JBF to organize itself and better manage theft and suppression of the other group(s). It immediately creates an easy way how 51% can legally fleece the other 49%; once JBF reaches a threshold it accelerates rapidly into a singularity. Even below 50% it can easily democratically gyrate towards full control. In this view it is not surprising that the most famous fascist regime—that of Germany—was in fact installed democratically. The true opposition to JBF, the joining forces in groups or 'factions' as we will call them here, comes from liberals, or libertarians (or capitalists, see Fig. 1). Those that want to be independent and not join any group. It could also be anarchists, but they rather do not want to have any rules of society. As we will see, these libertarians do not have a good survival strategy and will be eliminated from the genetic pool.

While this is a serious simplification of real society, we study it because in simplicity one can often understand dynamics. It for sure is a significant improvement over earlier work of non-interacting agents done in literature (Hickey and Davidsen 2019). The above introduction to the simulations serves merely as a justification why we can simulate society as we do, as a set of self-interest automatons, without taking the possible moral aspects into consideration. Once again, morality does not exist, since it has no SI unit. Second, morality cannot be quantized (and thus never simulated). Third, in history it has been shown that morality never interfered with politics (see the quote of Mencken, "The urge to save humanity is almost always only a false-face for the urge to rule it"). We thus continue and assume below that agents are rational and amoral; they are automatons, genetically programmed with self-preservation and auto-propagation. JBF is defined as joining forces as a strategy for survival. A winning strategy, as will be shown.

One might argue that humans can join forces not only to beat the others, but also to merely increase productivity; in other words, JBF without the bellicose part, as in collectivism (JB). This is true. However, we simulate a confrontational society (as a continuation of earlier work of Hickey and Davidsen (Hickey and Davidsen 2019) and most other simulations in literature, as explained in the first simulation). Moreover, when resources are getting depleted, co-operational societies will inevitably become confrontational societies and those are JBF, as will be shown. Or as Friedrich Nietzsche writes (Nietzsche 1996),

> It is vain reverie and beautiful-soulism to expect much more (let alone only then to expect much) of mankind when it has unlearned how to wage war. For the present we know of no other means by which that rude energy that characterizes the camp, that profound impersonal hatred, that murderous coldbloodedness with a good conscience, that common fire in the destruction of the enemy, that proud indifference to great losses, to one's own existence and that of one's friends, that inarticulate, earthquake-like shuddering of the soul, could be communicated more surely or strongly than every great war communicates them.

Or in other words, "*Krieg muss sein*" (war has to be).

Results

In the following, automaton Monte-Carlo-type simulations will be presented, numerically showing the effects mentioned above. It will be shown that joining forces (JBF) is an effective way to optimize an individual agent's wealth. Yet, such self-serving will entail digging its own grave, since in the long run, this system cannot but defeat itself. Simulations of wealth distribution have been done before. In earlier work (Stallinga 2019), the author made a computation to find optimum income distribution. Remarkably, this optimum was found to be one in which one person gets everything. This seems a common outcome in such simulations. Driving forces—at least in these simulations—always seems to make the system tend to a Kronecker-delta distribution.

Methods

The system was simulated on a 64-bit computer with a Linux Mint operating system, running programs written in Free Pascal using the Lazarus integrated development environment (IDE), although any simple compiler will do. All these are Open Source and thus the preferred tools in an academic world. The programs included graphical output routines based on the personal graphical toolbox of the author, PSTool, that outputs in Encapsulated Postscript of Adobe™. The programs are shown in the Appendix (apart from the graphical output routines). In case the reader wants to use other graphing software, for instance a spreadsheet (like OpenOffice Calc or LibreOffice Calc) it is suggested to create a comma-separated-value (CSV) file by adding these lines:

At the variable declaration part:

```
fm: TEXT;
```

In the *beginning* of the code of a routine/procedure:

```
assign(fm, 'myoutput.csv');
reset(fm);
```

Everywhere variables need to be saved something like:

```
writeln(fm, i, ',', f[i].w);
```

And don't forget to close the file at the *end* of the procedure:

```
close(fm);
```

The relevant information is then available in a file called myoutput.csv. In the above case the faction number and the wealth of that faction, separated by a comma.

The method started by declaring arrays a and f of structures (in Pascal called 'records') of agents and factions, respectively. Each structure contains the actual properties of an individual agent or faction. Possible fields of such structures are

- S: Strength of an agent. Used for first simulation only.
- w: Wealth of an agent or faction. The latter being the sum of the wealth of faction members.
- f: The faction number the agent belongs to.
- g: The gene coding how much an agent is inclined to join with others.
- l: Whether the agent is libertarian or not.
- R,G,B: Not functional, but simply the color of the faction (for graphical representation), indicating red, green and blue fractions (0…1).

The simulations are linked to the mathematics described in the text as for instance a_i, the *i*th agent, is in the program implemented by the structure element a[i] of array a. This agent has properties ('fields' of the structure as they are called in programming jargon) of wealth w (w), and the faction f number (or 'integer' as it is called in programming) implemented by f. The dot (.) indicates the field. So, if the program addresses a[i].f this is an integer (a whole number) indicating the faction number f the agent i belongs to, in mathematical terms in the main text below described as $a_i.f$. Another example, f[i].w is the total wealth of faction i (which is the sum of the individual wealths of all agents belonging to that faction).

These agents and factions (sets of joined agents) were then used in an iterative way to interact, simulating a fight for wealth. At each iteration randomly two agents were chosen. In case the concept of factions was present (starting from Simulation 2) the factions of these agents were determined (and made sure they are different). These agents or factions were then battling it out based on probability functions, a probability fun was calculated of the first agent/faction winning based on its strength compared to the other. A random number p (0…1) was then generated and if this number was smaller than the probability fun, the agent/faction was considered the winner. The simulations described before are without cooperation (Simulation 1), with agents joining in factions (Simulation 2), and with the gene g of propensity of joining factions or not, the latter called liberals (Simulation 3).

Simulation 1: independent agents

In a simulation about social status in society, a concept that can easily be mapped to wealth—for 'status' we can read 'wealth'—Hickey and Davidsen also found that the final distribution of status is that one person has it all and the rest have nothing, a Kronecker-delta distribution (Hickey and Davidsen 2019). This simulation takes a fixed group of N people, each with a certain starting status S_i. Then fights are simulated in which status is transferred, a fraction δ of the loser's status is transferred to the winner. The probability that agent i winning over agent j is given by

$$p_{ij} = \frac{1}{1 + (S_j/S_i)^{\alpha}}, \quad (1)$$

with α a general simulation parameter, here $\alpha = 1$. The final solution (for a number of iterations going to infinity) of a simulation starting with all $S_i = 1$ is

$$S_i = \begin{cases} N, & i = x \\ 0, & \forall i \neq x \end{cases} \quad (2)$$

with x a random number between 1 and N. See Fig. 2, where horizontal is the status S and vertical the fraction (or percentage) p of agents that have that status. It shows an inevitable outcome that all status (or wealth) resides at a single agent and the rest have nothing; (nearly) a Kronecker-delta distribution around 0 (one agent remains at $S = N, p(N) = 1/N$, far outside the region shown). The parameter δ only determines the speed of convergence to this final inevitable outcome.

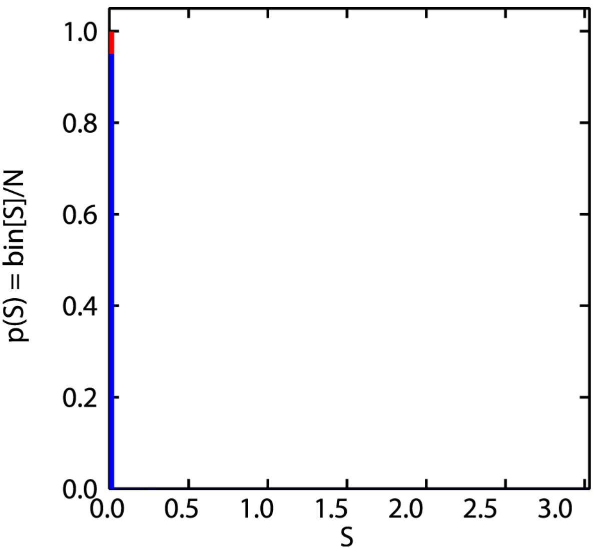

Fig. 2 Binning counting after simulations similar to the ones done by Hickey and Davidsen (Hickey and Davidsen 2019), horizontal is the status S and vertical the fraction (or percentage) p of agents that have that status. It shows an inevitable outcome that all status (or wealth) resides at a single agent and the rest have nothing; (nearly) a Kronecker-delta distribution around 0 (one agent remains at $S = N, p(N) = 1/N$, far outside the region shown). Two simulations are made with indistinguishable outcomes, one with δ = 0.4 and all S_i starting at 1 (blue), and one with $\delta = 0.5$ and S_i homogeneously randomly distributed between 0 and 2 (red). The outcome is the same. Bin size: 0.03 (100 S-bins), $p(i) \equiv \text{bin}[i]/N$. N = 100,000 and number of iterations equal to 1,400,000,000

Since there are no cooperations in this simplified model, it resembles the system of capitalism of Fig. 1. In capitalism all wealth will wind up with one agent, just as we had already seen before in a system of competition (Stallinga 2019).

We did not further investigate the behavior of the simulations in the same way as was done in the original work of Hickey and Davidsen (2019), because these results depend on the exact choice of parameters, parameters that are difficult to link quantitatively to reality. We instead add here a very important aspect to the simulations that was not included by them, namely the concept that agents can join forces (to beat stronger agents). It is what distinguishes humans from the a-social behavior simulated by Hickey and Davidsen.

Simulation 2: joining agents

We then simulate with the following molecular-dynamics algorithm. There are N agents, a_i. An agent has these properties ('fields' in simulation jargon, preceded by a dot):

- Wealth, w. The wealth determines an agent's strength, similar to the status S mentioned above.
- A genetic disposition g to join strong factions.
- the faction f it belongs to.

Agents try to optimize their wealth (we imagine motivated by the increased chances of offspring). There are N factions that can have a number of members ranging from 0 to N. Initially, all agents are in their own faction, $a_i.f = i$. A faction (a unison of agents) is determined by

- A set of member agents.
- Strength (total wealth), which is the sum of strength of agents, $f_i.w = \sum_j a_j.w \;\; (\forall j : a_j.f = i)$.

Actions that can happen at each iteration:

- An agent can switch factions, as described below.
- A faction can steal the wealth of another faction, as described further on, in the third simulation. The probability of success is given by the relative strengths of the factions involved. When transfer of wealth takes place, the share of the loot/payment of each member agent is proportional to the strength of that agent within its faction.

It is immediately obvious that joining a faction can be advantageous, for the simple reason that it is easier to defend against attacks from strong factions, if not for being better able to steal from others. Yet, in a Prisoner's Dilemma effect, joining a faction can lead to reduction of income, since a share must go to the alpha-agent with the highest strength; the instantaneous effect is a loss of wealth production. It is not included in the simulation here, but will be discussed at the end.

We need a function f that calculates the probability of an agent switching factions. This function, with input arguments the total wealth $w1$ of the old faction the agent currently belongs to and the total wealth $w2$ of the new faction after the agent jumped, must have a probability of 0 when $w2 \ll w1$ and 1 when $w2 \gg w1$. Parameter g determines how much wealthier the new faction must be for the agent to switch. It must moreover have some randomness and this is parametrized with β; for $\beta = 0$ the agent will always switch if the wealth-increase threshold g is met, for larger β there is an increasing chance the switch is not made, not even if it is profitable. This randomness parameter is equal for all agents, while g can be assumed an individual genetic property of an agent. The probability function we use is

$$f(w1, w2) = \frac{1}{1 + \exp\left[-\frac{(w2-w1)-g}{\beta}\right]}, \tag{3}$$

which is shown in Fig. 3. A random number from 0 to 1 is generated and if this number is smaller than the function value above, a transfer to the new faction is made. If g in the function above is zero, the half-way point of the function is at $w_1 = w_2$, an agent has then 50% probability to switch to an equal-power faction. If g is very large, the function is nearly everywhere zero, and switches are nearly never made, it'll take a long time to establish the final distribution. If g is negative, the function is nearly always larger than the random number, even when the new faction is much *less* powerful, and switches thus nearly always occur, thus randomizing the distribution constantly.

In this second simulation we do not do any transfer of wealth yet. We just simulate the behavior of agents, knowing that they want to belong to strong factions, with an outlook to either defend themselves from theft, or to steal from other factions. See Fig. 4 for the results for a simulation with $N = 100$, $g = 0.0$, $\beta = 0.01$. The left panel

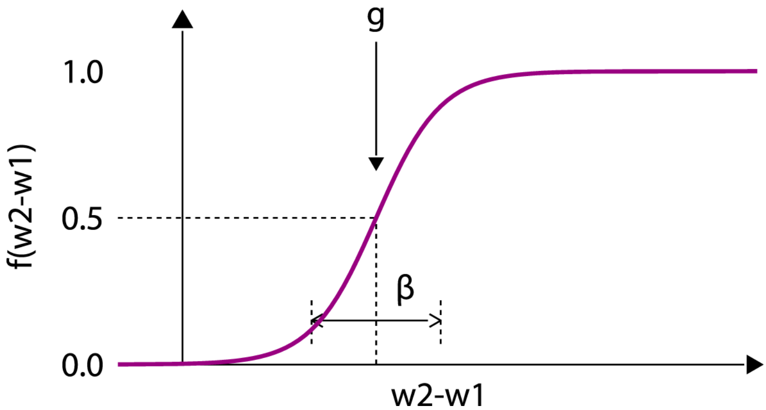

Fig. 3 Decision function for an agent to switch from one faction to another. The argument in the function is $w2 - w1$, the wealth of the new faction (with the agent) relative to the old faction. Parameters are the turning point g, determined by the inclination of an agent to join strong factions, and the scale parameter β. A homogeneous random value is generated (0…1); if the function is above this value, the agent switches factions

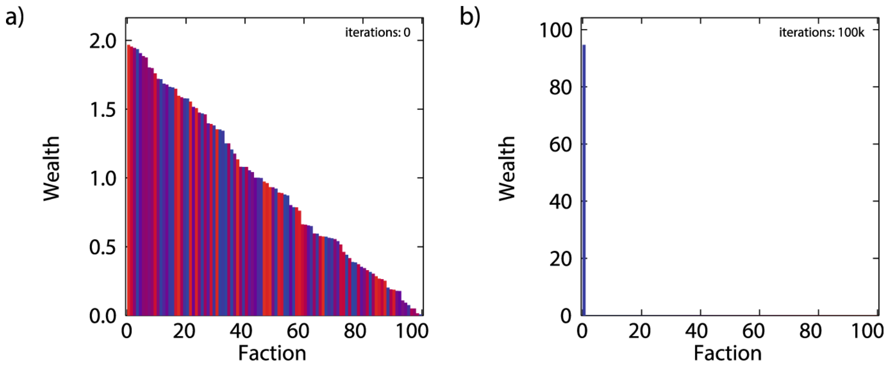

Fig. 4 Distribution of wealth of factions at **a** the beginning (random distribution with every agent in its own faction) and **b** the end of simulation. The color represents the faction number (full blue=0, full red=N). Simulation parameters: $N = 100$, $g = 0.0$, $\beta = 0.01$

Table 1 Skewness as defined by Eq. (4) for some distributions of wealth

Distribution	Skewness
Homogeneous	0.0
Triangular	0.5
Random	0.5
Kronecker-delta	2.0

shows the random starting distribution, sorted by wealth. The color codes the factions number, ranging from full blue (faction number 0) to full red (faction number N). The right panel shows the final distribution after the iterations. As can be seen, all agents join the strongest faction, which thus also winds up with all the wealth. Just like in the above simulation of independent agents, the outcome is inevitable, the only thing that changes is the speed at which things happen. This can best be visualized as the skewness of distribution of wealth over time.

We can define a skewness in the distribution of wealth as the sum of deviations from the average wealth of the factions,

$$\text{skewness} = \frac{1}{N}\sum_{i=1}^{N} |f_i.w - 1|, \tag{4}$$

with $f_i.w$ the wealth of faction i and where the average wealth at the simulations is normalized at 1. An example, a homogeneous uniform distribution has a skewness of 0, and a triangular distribution (similar to the one shown in Fig. 4 has a skewness of 0.5. The evolution of this skewness for simulations with a homogeneous, a triangular and a Kronecker-delta starting distribution (see Table 1) is given in the first panel of Fig. 5. Independent of the starting distribution—several were tried—one faction attracting is accumulating all the wealth, a Kronecker-delta distribution, which is the end situation.

We can change the parameters and see how fast the factions change and reach the final inevitable outcome of full fascism (one faction having all, a Kronecker-delta

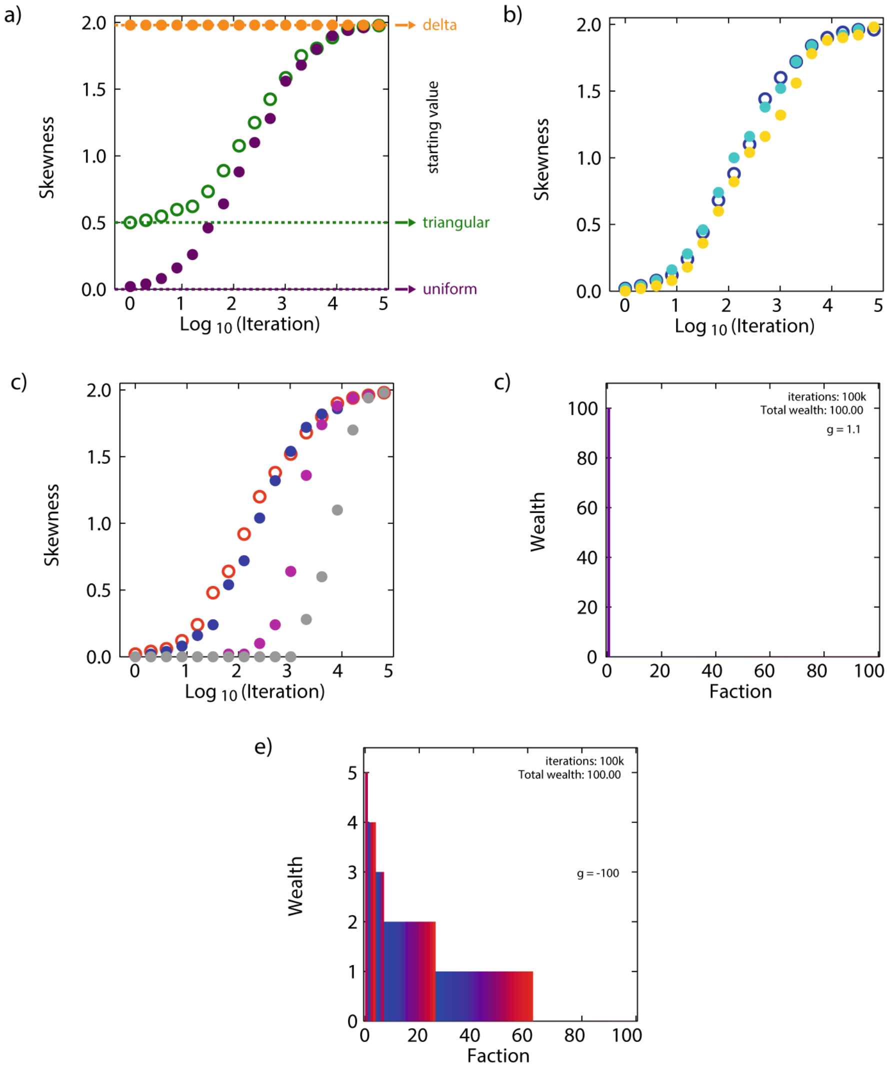

Fig. 5 First three panels: Evolution of the skewness of the distribution (defined in Eq. (4)) for various parameters (uniform starting distribution, $N = 100$, $g = 0$, $\beta = 0.01$, unless otherwise specified; all agents always have the same parameters). **a** Three starting distributions (Table 1), triangular (close to the random distribution of Fig. 4. Open green circles), uniform (everybody equal. Solid purple dots), and delta (one agent has it all. Solid orange dots). **b** Varying β : $\beta = 0.01$ (open blue circles), $\beta = 0.1$ (solid cyan disks) and $\beta = 1.0$ (solid yellow dots). **c** Varying g : $g =$ 0.0 (open green circles), 1.0 (solid blue dots), 1.05 (solid magenta dots), 1.1 (solid gray dots). The last two panels show the end situation for **d** $g = 1.1$ (a single faction) and **e** $g = -100$ (fully randomized factions), as explained in the text. The color indicates here merely the original faction number

function). Figure 5 shows some examples of varying parameters. In the second panel the β parameter is varied and this has no effect on the outcome, nor on the speed. The third panel shows how the g parameter determines to a high degree the time-scale at which the unification of agents takes place. For high g values, the agents have reluctance to join other factions, but will wind up doing so anyway. The last two panels show the end situation for $g = 1.1$ (a single faction) and $g = -100$ (fully randomized factions). The color blue-to-red indicates here merely the original faction number.

Simulation 3: adding liberalism

Until here no actual transfer of wealth is taking place between the agents. The mere threat of being robbed, or the outlook on possible robbing other factions make agents join. "*Et pluribus unum*", "*Eendracht maakt macht*", "Together we're strong", and other pro-JBF mottoes spring to mind. What happens if we unleash the accumulated power and let our factions rob and destroy other factions? For this we do not even have to make simulations. We can combine the above result of agents joining bigger factions (Fig. 5) with the earlier found simulation of battles between independent agents (Fig. 2) and know the result will be that in such battles between factions the biggest faction will come out on top and will be the only survivor, accumulating all the wealth. And in real human evolution, such a fetish for joining will thus be a winning gene.

However, to show how the underlying mechanism works, we make another simulation. We differentiate two types of agents. One type has the joining gene as described above, the other has the liberal gene. The JBF-agent joins a faction if it will make the agent stronger. The liberal agent abhors unison and wants to be independent. This is encoded by a decision function similar to the used above, an agent jumps factions, not when the new faction is more powerful, but when it is *smaller* in number, see Fig. 6. The function used is

$$f(n1, n2) = \frac{1}{1 + \exp\left[\frac{(n2-n1)-g}{\beta}\right]}, \tag{5}$$

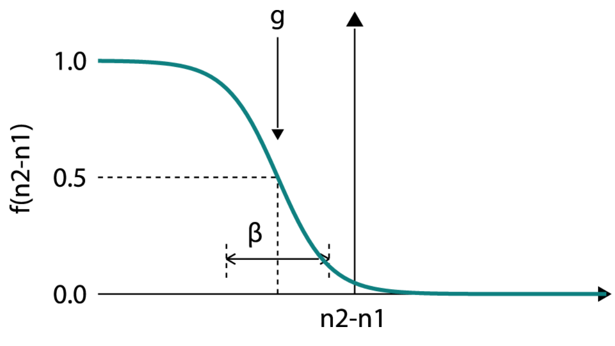

Fig. 6 Decision function for a liberal agent to switch from one faction to the other. The argument in the function is $n2 - n1$, the size of the new faction (with the agent) relative to the old faction. Parameters are the turning point g, determined by the inclination of an agent to jump to smaller factions, and the scale parameter β. A homogeneous random value is generated (0…1); if the function is above this value, the agent switches factions

with $n1$ and $n2$ the numerical size of the original faction the agent belongs to ($f_{a_i.f}.n$) and the size of the destination faction after inclusion of the agent ($f_j.n+1$), respectively. In fact, we can recycle code, and only have to add a flag l to an agent, to indicate if it is fascist or liberal, and a field n to a faction, indicating the number of agents within that faction.

We run the simulation and see that indeed fascists group together, and libertarians stay single, see Fig. 7 where blue are fascists and yellow are libertarians. Interestingly, for this small number of iterations ($N = 10^5$) often still a libertarian agent remains in the fascist faction.

We can now let the factions fight each-other and factually transfer wealth from one faction (set of joined agents) to another. This is done in this final simulation. In each iteration an agent transferring between factions can take place, with the probabilities for fascists and libertarians as given before (Eqs. (3) and (5), resp.) and also wealth transfer between factions takes place, in a way similar to the battles in the simulations of Hickey and Davidsen for independent agents. Two random factions *i* and *j* are selected (in reality two random agents are chosen and their factions determined). The probability of faction *i* beating faction *j* then still given by

$$p_{ij} = \frac{1}{1 + (f_j.w/f_i.w)}. \tag{6}$$

There is always a winner. The winner takes δ =50% of the total wealth of the losing faction. This loot is paid for and received proportional to the relative wealth of an agent inside its faction. (Note, as with the simulation of independent agents, a different value for the parameter δ causes a change in speed, but no change in final outcome). As can be seen in Fig. 8, only a single faction remains without any libertarian members. The fascists have looted all wealth of the libertarians. This is an inevitable outcome.

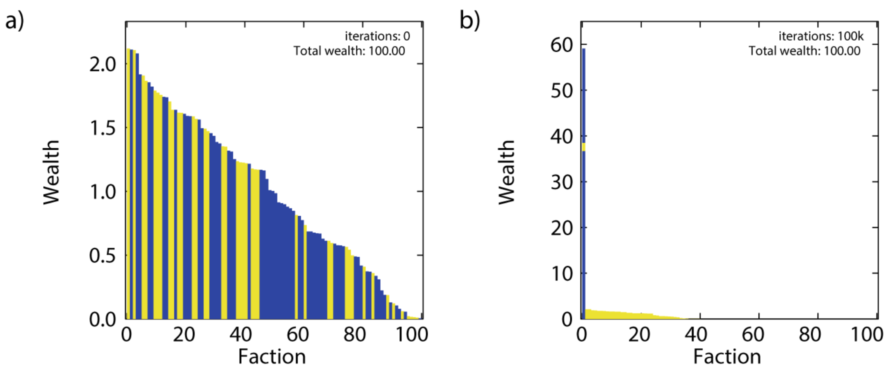

Fig. 7 (Sorted) distribution of wealth of factions at **a** the beginning (random distribution with every agent in its own faction) and **b** end of simulation. The color represents the agent type (blue=fascist, yellow=libertarian). All fascists have joined into a single faction and all libertarians stay alone. In this short simulation one libertarian has anyway joined the fascist faction. Simulation parameters: $N = 100$, $g = 0.0$, $\beta = 0.01$, 40% libertarians, 60% fascists. Using the decision function of Eq. (3) for fascists and (5) for libertarians

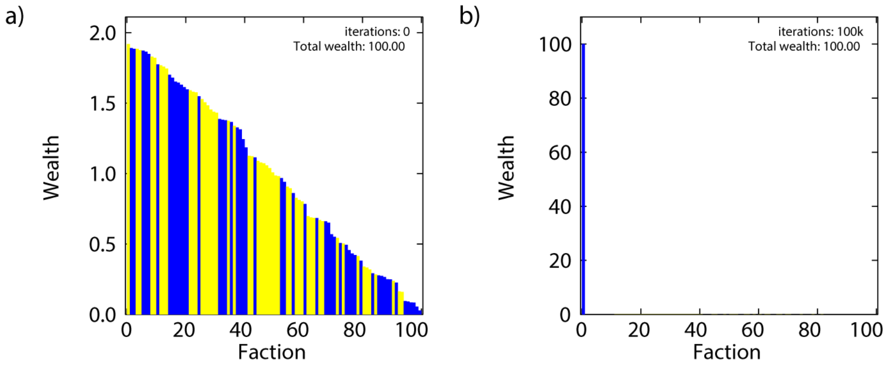

Fig. 8 (Sorted) distribution of wealth of factions at **a** the beginning (random distribution with every agent in its own faction) and **b** end of simulation. The color represents the agent type (blue=fascist, yellow=libertarian). In each iteration agents transferring between factions as well as factions fighting each-other is taking place. All fascists have joined into a single faction and all libertarians have lost all their wealth. Parameters $N = 100$, $g = 0.0$, $\beta = 0.01$, 40% libertarians, 60% fascists, δ =50%. Using the transfer decision function of Eq. (3) for fascists and (5) for libertarians and Eq. (6) for fights between factions

In conclusion, we have have simulated here societies with interacting agents in which these fight for resources/prestige/wealth. The first step was simulating a society where these agents do not yet cooperate, but do battle for each other's wealth. In this, the tendency is for one agent to wind up with all the resources, or prestige. This is shown in Fig. 2, and is a confirmation of the results obtained by Hickey and Davidsen (Hickey and Davidsen 2019). It is the most simple society with no social interaction between agents, and therefore of limited applicability to human societies. In the next steps, more advanced simulations are made. First we introduce the concept of joining of agents to be stronger, this with an outlook to be able to ward off attacks of stronger agents, or actually to be able to steal the wealth or prestige of agents, or group of agents. This we call join-believe (JB). No wealth transfer is taking place, yet. The result, shown in Fig. 4, is that all agents wind up in a single faction that thus also has all the wealth. The next step is adding the disposition of agents to join. They can be of two types: fascists, or libertarians. The former like to join, while the latter want to be independent. The result of this is that all fascists join in a single faction and thus have high strength, where libertarians are relatively powerless. (Fig. 7). In the final step we let the factions battle and transfer wealth in the full join-believe-fight (JBF) system. We now see that indeed the fascists wind up with all the wealth (Fig. 8).

Game theory in JBF

It is time to analyze the motivations of the agents. Above it was stated that agents will stop to cooperate and join, because there is no reason to do so when everybody is inside the faction and there is nobody left to rob. In other words, when it has turned into a zero-sum-game. This needs some further explanation, since it seems to be coming out of thin air.

In a previous work we have argued that all physics is based on thermodynamics. And all biology is based on physics. Therefore, any agent in nature, also human society and economy, will follow the laws of thermodynamics (Stallinga 2020), most noteworthy the law of maximum entropy production (LMEP) (Martínez-Castilla 2010),

> A system will select the path or assemblage of paths out of available paths that minimizes the potential or maximizes the entropy at the fastest rate given the constraints.

Agents will optimize their own thermodynamic machine, and will try to get a hold on wealth of others, since that is thermodynamically favorable. In a zero-sum-game there is no thermodynamic incentive. The reason is described in this section.

In a simple society, people are independent agents. Humans evolved to a level of intelligence and found that interacting with other humans is advantageous. The first part (J, join) is cooperation. Adam Smith's Division of Labor (DoL) is an example. If people cooperate they can each specialize in parts of the production and thus produce more overall. Entire modern society is based on this concept, and trade and money are simply enablers of this DoL. One could say that Economy is the description of DoL.

In some cases the cooperation is hindered by the phenomenon called Prisoner's Dilemma. It would be advantageous to cooperate, but on an individual basis the decision is always to 'cheat' and break the cooperation. Prisoner's Dilemma is based on a fictitious story of two prisoners, accused of robbing a bank, that *individually* talk to the police. Their *individual* decision table shows that it is best for them to talk to the police, independent of what the other does, although on an overall basis their reward would go up if they'd cooperate with each other and not talk to the police.

Imagine there are two criminals, Albert (A) and Barbara (B), that both have been arrested for a bank robbery. They are kept in two separate cells so that they cannot talk with each other. The police tries to make them both confess. If both refuse to talk, they both go scot-free. To avoid this, the police is making propositions to both of them (independently): "If you confess, and your friend doesn't, we'll give you ten thousand euros where you friend gets 50 years in prison. If you both confess you'll both get 20 years in prison". The decision table for Albert and Barbara thus looks like this:

Confession	A yes	A no
B yes	A: 20 year prison, B: 20 year prison	A: 50 year prison, B: 10 keuro
B no	A: 10 keuro, B: 50 year prison	A: scot-free, B: scot-free

It is clear that the best option for Albert is to confess, independent of what Barbara decides to do. In the table the decision translates to a move from the right column to the left column. Either his sentence is reduced from fifty to twenty years, or he goes free and even receives a hefty premium of ten thousand euros. However, the same reasoning applies to Barbara, whose decision to cooperate with the authorities and confess lifts her reward from the bottom row to the top row in the table. They will thus both decide to confess, that while it is obvious that the optimum situation is the one in which they will both not confess; they'd go scot-free (with the loot). Because Barbara and Albert are not allowed to converse with each other, they'll both decide to optimize their *personal*, local situation, without worrying about the overall situation. This is the Prisoner's Dilemma.

Just as beneficial cooperation is often hindered by Prisoner's Dilemma, just as much society-advantageous *non*-cooperation can be hindered by the same Prisoner's Dilemma. Cooperation with fascist or communist regimes is detrimental to society, yet it is very difficult for a single person to take the decision and opt for non-cooperation. As seen, this is very bad for one's genes. In severe times it would imply an instant death penalty. At least an involuntary visit to a gulag or concentration camp lies in store. In moderate times a person is simply barred from any career in so-called 'cancel culture'. It is very difficult for society as a whole to lift itself out of destructive centralized government, because it would need for agents to act against their own immediate self interest.

Prisoner's Dilemma is a stay-in-the-way of implementing an optimized society. Yet, it is obvious that a society where cooperation flourishes would produce more (and thus also more entropy). A society that has cooperation in its genes will survive and destroy societies that do not have it. Prisoner's Dilemma is overcome by techniques described in Game Theory. Namely a strategy for playing a prisoner's situation repeatedly. It can easily be shown how cooperation is a natural winning strategy when a series of games is played. In fact, the still best strategy is called Tit-for-Tat, in which a player 'punishes' his opponent when that one is not cooperating. How does that work?

We could run the prisoner's game repeatedly and see what would be the best *strategy* for an individual. We enter here the realm of Game Theory. The Tit-for-Tat strategy is described as:

- Start with cooperating on your first move
- Copy what your opponent did in the last move for the current move.

That is, 'punish' your opponent's 'bad' behavior by copying his move. Probably while shouting, "Take that, you fool!" This apparently even works in noisy environments. In spite of its simplicity, it works best, better than all other strategies, even more sophisticated ones. In fact, more complicated 'fuzzy' strategies wind up being too complicated for the opponent to understand, who will opt for the safe way out and defect. See the book of Axelrod, *A Passion for Cooperation* (Axelrod 2023). It can best be described as "Fool me once and the shame's on you. Fool me twice and the shame's on me". Meaning that a person can be deceived only once. After the first time, the player will not cooperate.

This implies that even in a free-market where individuals can freely make individual selfish decisions, cooperation is a natural tendency, because it produces more goods. What is more, if there is a subset of such cooperative Tit-for-Tat people in an environment of people with other strategies, they will, on average, produce more goods, consume more and be able to have more offspring. All in all, they produce more entropy, and thus will be surviving in the fiercely-competitive gene pool, substituting uncooperative elements. Even in a society with unfettered capitalism does thus cooperation exist and thrive. Naturally. Without the need for a Central Committee. We can analyze this a little further.

The reward table for a single game is given below. In this Game Theory analysis, "cooperation" no longer means cooperation with an external agent like the police, but cooperation with *each other*. A with B. In the reward table below we recognize Prisoner's Dilemma anyway. On an individual basis the best decision is to not cooperate (for instance the reward of A switching to defection goes $3 \to 5$ or $0 \to 1$ depending on B cooperating or not), while on a collective basis it is better to cooperate, the sum-gain $\sum$ going from 2 to 6. The game naturally winds up in the bottom-right quadrant, in a suboptimal situation.

Cooperate A ↔ B	A yes	A no
B yes	A: 3 B: 3 Σ: 6	A: 5 B: 0 Σ: 5
B no	A: 0 B: 5 Σ: 5	A: 1 B: 1 Σ: 2

In a *series* of such games, what economy basically consists of, the Tit-for-Tat strategy is the best. It is a natural strategy of cooperation (J), and there is thus no need for any believe (B), other than one's self-interest, and certainly no fighting (F) is needed. Thus, even in a society with unfettered capitalism does cooperation exist and thrive.

Working this out a little further, beyond classic textbooks, we must point out that the above presumes that the entire system can make profit overall. In Prisoner's Dilemma there can be a positive gain for all players, and a net-positive overall gain (The Σ in the table). This represents an economy that is growing. In this situation, cooperation is beneficial; the top-left quadrant has gain 6, while the bottom-right only 2. In a zero-sum game, on the other hand, the gain of one is the loss of the other, and the game-theory decision-tables are different and the optimum outcome changes with it. All cells of the decision table must have a total of 0. For symmetry reasons, the diagonal of the reward matrix must then be zero. The other rewards we can normalize to 1 since we are only interested in the phenomenological description here, resulting in the following Game Theory decision table for a zero-sum-game (Σ: 0) society:

Cooperate A $\leftrightarrow$ B	A yes	A no
B yes	A: 0 B: 0 Σ: 0	A: +1 B: −1 Σ: 0
B no	A: −1 B: +1 Σ: 0	A: 0 B: 0 Σ: 0

Now, *cooperation is no longer a winning strategy*. Not for society as a whole—because it is in any case a zero-sum game and the total reward is always zero by definition—nor for an individual. The reward for A for switching from cooperation to non-cooperation goes as $0 \rightarrow 1$ or $-1 \rightarrow 0$ depending on B cooperating or not. *Cooperative society will break down the moment the collective society stops making profit*.

We can extend it a little further and also analyze a three-party game (of players A, B and C) in a zero-sum game, with an asymmetry that one player (C) is stronger. In this situation it is natural for players to not cooperate with each other, but for both A and B to cooperate with the strong player C. We now see here another classic element of JBF: Agents join a strong leader, there where they could also join forces to topple the leader C. As long as it is advantageous for all, they will all do it. The advantage lies in the fact that the three of them can rob a fourth player D from another society, at which point JBF is in full swing. The zero-sum of this decision table turned into a positive-sum, where all agents of the faction (A, B and C) can have profit (imagine adding 6 to the sum).

C is the strong alpha-agent
('not cooperating' means cooperating with C)

Cooperate A $\leftrightarrow$ B	A yes	A no
B yes	A: +1 B: +1 C: −2 Σ: 0	A: +2 B: −3 C: +1 Σ: 0
B no	A: −3 B: +2 C: +1 Σ: 0	A: −1 B: −1 C: +2 Σ: 0

We recognize the original Prisoner's Dilemma in this, in which both agents A and B cooperate with the police C. This does not come as a surprise; the mapping to society is perfect. The agents might have joined forces and beaten the strong agent (top-left quadrant), in their own JBF. Or the three of them may join in a bigger JBF to rob a fourth agent D. Note that the 'decision' table of D, the robbed outsider, is simple: his table has only one column; whatever he decides has no impact. He is not even asked to join. And when he asks to join, the request is refused. That because it'd pull the rug from under the belief, which would cease to have a *raison d'être*. And it is thermodynamically unfavorable, because no one can be robbed if all agents are members of the same clan of thieves. Cooperation happens by grace of there existing something to gain from the cooperation. Nobody cooperates out of altruism.

Discussion

The join-believe-fight (JBF) idea presented in this work is loosely based on the three parts of the book of Hobbes who also describes the joining the commonwealth based on a belief (Christianity in his book), to *avoid* fighting.

The simulations of JBF presented here are a simplification of society. Yet, sometimes in simplicity we can understand patterns better, as is also the case in the current work. In a first step we repeated the simulations of Hickey and Davidsen of independent agents that were based on a simple animal kingdom without social interactions. We draw the same conclusion as they did, that all wealth (or 'status' as they call it) goes to the 'alpha male', the strongest agent of the herd. We then extended this idea and included human behavior of social interactions. These interactions consist of agents joining forces to be stronger to either attack or defend. This concept we call

JBF in this work, which is an adequate labeling (although the label itself is not relevant for the discussion).

We were not surprised when we found that joining forces results in being stronger and thus enables the confiscation of all wealth in society. We conclude that JBF is a winning strategy/gene. Had this been a real biological simulation, the libertarian gene would die out quite rapidly. Once again, the speed of convergence to this inevitable end situation is depending on the decision distribution parameters, and since we cannot easily quantify them on basis of the real world, we did not further study the speed of the dynamics.

Something very trivial yet important has to be mentioned here. The driving force behind the behavior of the agents—that we consider rational elements—is the optimization of the gain-lose probabilities of individual agents. These agents join because they expect to be stronger in attack as well as defense when joined in that way, as we have seen in the second simulation. In the third simulation we have seen that indeed joining-prone agents manage more wealth than libertarian agents, the latter being totally obliterated.

However, look again at the end situation. There is a single winning faction that has confiscated all wealth in the world. It thus resembles very much the society we started off with. We have a society-within-a-society! Therefore, it is to be expected, especially since no more gain can be obtained from robbing other agents and factions, that there will be factions-within-the-faction. In fact, even before reaching the single-faction stage, weaker elements in the faction have to pay tribute to the stronger agents in the faction, both in terms of wealth as well as status. Such as we have seen in the former Soviet regime, where *apparatchiks* fleeced the workers, as mentioned before. Agents start attacking agents of the same faction. And to help in this, or to defend against it, members of the faction will join in sub-factions. We will thus wind up in JBF-within-JBF. We thus conclude that full-scale JBF is not possible. The idea of forming a 'world government' that was mentioned in the introduction will never work. These JBF aspirations will not work; the idea of a united *entire* world is an unattainable illusion. That is because the JBF system will create its own antagonists amongst itself. Or, as the book of Karl Marx, *The Communist Manifesto*, ends, "What the bourgeoisie therefore produces, above all, are its own grave-diggers. Its fall and the victory of the proletariat are equally inevitable" (Marx and Engels 1895). We fully agree with that, when we translate it generally to "What JBF therefore produces, above all, are its own grave-diggers. Its fall and dismantlement are equally inevitable."

In this way the optimistic 'social contract' of Hobbes mentioned in the beginning is unattainable. A Hobbesian commonwealth can be established, and people will join—independent of what the core beliefs are of the commonwealth—but it is not that fighting is avoided this way, as Hobbes suggested. The fighting is rather combined and raised to a larger scale. No longer skirmishes between agents, but full-scale war. It is not for nothing that the British Commonwealth was arguably the largest theft syndicate in the world. Now referred to as shameful colonialism, it was a system of extraction of resources—wealth—from other states. Those not voluntarily integrating to the Commonwealth considered enemies to be attacked, subjugated and plundered. It did not work because the Commonwealth became so big that there was basically nobody left in the world to attack and plunder. And fights *within* the Commonwealth ensued. Those that managed to break free immediately labeled as enemies, now with a new belief system, “freedom and democracy”, yet the objectives were again the same old plundering goals of confiscation of resources. It is not as if we can educate—read indoctrinate—the modern citizen, as Kolontai wrote (Kravchenko 2022)

> I see how the Union is […] overcoming centuries-old obstacles, creating a new layer of history on which future generations will realize all the bold dreams of our youth. […] The new way of life of communism will *re-educate and re-create man*. The new person will have individual creative flair and talents to improve this way of life, where there will no longer be so many problems of the economy and the issues of relationships between people and the issue of the individual and the collective, i.e., a new morality, will come to the fore. For them, for that happy humanity, envy, jealousy, Intrigues and slandering will disappear. There will be no wars, no killings.

In view of this we can predict that nor will the commonwealth League of Nations—now called United Nations—manage to subjugate the entire world into a social contract of collectivism. Taken face value, the belief system now underpinning the join-believe-fight system is the self-referential belief that there is a Hobbesian *need* for a belief system, fulfilling part three of Hobbes’ *Leviathan*. We must believe because believing is good. Yet, as shown here, the idea that if we all join conflicts will be avoided is a Hobbesian naive illusion, because the incentive for joining disappears in a thermodynamic analysis; there will inevitably be flavors of the underlying belief that will start fighting each other.

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Data availability Not applicable.

Code availability The data are generated by the program is in the Appendix. All relevant parts of the Pascal programming code (without the graphical plotting parts) can be found there.

Declarations

Ethics approval and consent to participate No human participants were involved in the research. No ethical approval is therefore needed, nor consent from participants.

Consent for publication All authors agree.

Conflict of interest The author states that there is no conflict of interest. Neither financial nor non-financial.

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