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Risk of loss: towards an agent-based model

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RISK OF LOSS: TOWARDS AN AGENT-BASED MODEL[1]

Sommario

Il mondo finanziario è sostanzialmente diviso in due: da una parte ci sono gli esperti, dall'altro i profani; e, molto spesso, è un sistema che funziona: in molto pochi (e molto folli) decidono infatti di curarsi da soli, mentre la maggioranza avvalora questa divisione tra profani ed esperti, o specialisti, andando dal medico in caso di un malessere, e ottenendo una diagnosi e una cura che farà uscire il profano dallo stato di malessere in cambio di una prestazione economica.

La cosa strana è, però, che in ambito economico le cose non vanno proprio così. Per presentare meglio la questione degli esperti e dei profani li considererò in ciò che hanno in comune, la loro base cognitiva umana, e ciò che li separa, la conoscenza dell'oggetto. Cercherò quindi di valutare l'effetto di una maggior conoscenza sui rispettivi modi di gestione del rischio, come viene chiamato l'imprevisto in ambito economico, e le decisioni che ne derivano.

Esperti e *profani* rappresentano, in questo articolo, due diversi modi di approcciarsi alla complessità: un approccio *top-down*, con la sua strategia di opporre alla complessità altrettanta complessità, nella forma di un elaborato impianto teorico, e un approccio *bottom-up*, con la rispettiva strategia di gestire la complessità mediante una semplicità (che è, sostanzialmente, figlia della complessità, come avremo modo di vedere).

Verrà quindi preso in considerazione il concetto di *arroganza epistemica* applicato alla pratica di una scienza, come quella economica, in cui

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i punti di vista e le correnti sono sufficientemente numerosi da molto spesso *obbligare* le parti in causa ad appellarsi a tale meccanismo di difesa, di cui vedremo gli effetti nelle dinamiche di potere facenti leva sulla docilità umana.

Questo articolo è sostanzialmente da intendersi come un tentativo di adattare una modellizzazione ecologica *agent-based* ad un campo che ha, a mio parere, tutte le carte in regola per mostrare, perlomeno in teoria (ma cercherò di utilizzare, ogni volta che mi sia possibile, ricerche pratiche, sulla scorta del premio Nobel Daniel Kahneman e delle ricerche sorte negli ultimi anni in economia comportamentale) le potenzialità, da un punto di vista filosofico di epistemologia della complessità, per una maggior comprensione e sfruttamento del rischio come effetto del carattere emergente tipico dei sistemi complessi.
Vedrò dunque come ci sia, effettivamente, una possibilità costruttiva a partire dalla praticità del modello profano di gestione del rischio, cercando di rivalutare il suo modo *consapevolmente pregiudiziale e fallace* di procedere, cercando di opporre, all'utilizzo di una conoscenza altamente complessa facente uso di raffinatezze logico-matematiche per il suo procedere, dietro cui spesso si celano debolezze pratiche incolmabili, un apparato euristico *hard-wired* che si basi sul principio *less-is-more*, fonte di trasparenza, robustezza, e fluidità cognitiva caratteri la cui importanza è troppo spesso trascurata, specialmente nella ricerca econometrica.

Abstract

The financial world is basically divided in two: on one hand there are the experts, on the other hand the uninitiated. And, very often, it is a system that works: in very few (and very crazy) decided in fact to heal themselves, while the majority supports this division between secular and experts or specialists, going to the doctor in case of an illness, and getting a diagnosis and a cure that will put out the profane state of malaise in exchange for a financial benefit.

The strange thing is, though, that in the economy not doing so. To better present the matter experts and laymen will consider them for what they have in common, their basic human and what separates them, the knowledge of the object. I will try to evaluate the effect of a greater knowledge on how to manage risk, as it is called the unexpected in the economy, and decisions arising therefrom, profane than the alternative.

Experts and laymen in this chapter represent two different ways of approaching complexity: a *top-down* approach, with its strategy of opposing the complexity as much complexity in the form of an elaborate theoretical framework, and a *bottom-up* approach, with the respective strategy of managing complexity through simplicity (which is, basically, the daughter of complexity, as we'll see).

Using the concept of *epistemic arrogance,* stemming from economic's practice of a science in which the points of view and the currents are sufficiently numerous to very often *force* themselves to such arrogance as a defense mechanism, we'll see its effects as a dynamic of authority-power, laying on *human docility*.

This paper is substantially to be understood as an attempt to adapt the ecological *agent-based* modeling to a field that has, in my opinion, all papers in order to show, at least in theory (but I will try to use, whenever I can be, practical research, based on Nobel laureate Daniel Kahneman's research and sprung up in recent years in behavioral economics) the potential, from the philosophical point of view of epistemology of complexity, for a greater *understanding* and *exploitation* of the risk, providing major chances of comprehension and exploitation of risk intended as

an effect of *emergence*, the main complex system's feature.

So I'll see that there is, indeed, a constructive chance from the convenience of the secular model of risk management, trying to re-evaluate the way it consciously *ruling fallacious* to proceed; this has been made trying to opposing, at the use of a highly complex knowledge making use of logical-mathematical sophistication to its progress, a *hard-wired* heuristic system, that is based on the principle of *less-is-more*, a source of transparency, robustness, and cognitive fluidity: characters whose importance is too often overlooked, especially in econometric's research.

Some premises

Before gutting the subjects listed above, it is my intention to make some assumptions, pointing out, by the conciseness of the seven points that I am going to list, aspects that will be prolegomena to the following speech and, at the same time, a summary of my theoretic position.
Here these seven points:
- instability is a widespread phenomenon in the world in which we live and it is closely linked to its systemic complexity;
- instability is a source of systemic unpredictability and is not to be considered as an exception to a stable world;
- "to predict the outcome of a complex system" is an oxymoron: what is unstable is not predictable;
- instability is a source of chance;
- the human agent exhibits a bounded rationality, thus non-linear behavior;
- the human agent is naturally able to take advantage of these chances, naturally approaching instability in a constructive manner and not trying to deny it;
- the best weapon against complexity is simplicity: it makes no sense to oppose complexity to complexity.

Having said that, we can start.

1 - Two aspects of human cognition

> The increasing complexity and interconnection of the global economy and financial markets call for a radical paradigm change in the actual economic thinking. The 2007 financial, the following economic stagnancy, and the slow economic recovery of Western Countries have shown all the weakness of standard economic theories and standard economic policies. [Cristelli, 2014, p. VII]

Let's start with a fact, that takes note of what I've have just said about the human agent, in one of the premises point: it always performs a *bounded* rationality, which is located in the ecology of belonging, from which it is formed, and destroys the rules of "good inference" dates from the classical logic.

The man, in fact, is an animal inherently flawed, but its nature, it is clear, is not to be rejected as an error to be corrected. After centuries in which man has in fact sought to create a sophisticated system of rules of formal logic and reasoning to label as wrong and to avoid any argument that infringe such laws, it has come recently to consider the fallacious nature of the human animal as a value and trying to re-evaluate the practical alternative to a logically correct reasoning, namely heuristics.

> My main take was that a fallacy does not necessary lead to a bad outcome. [...] This is due to the fact that an argument is fallacious with relation to a standard or to a set of standards. In turn, the setting of a standard depends on the resources the agent involved has. This is basically the so-called resource-based approach to fallacy introduced and popularized among logician and cognitive scientists by John Woods and Dov Gabbay. [Bardone, 2011, p. 30]

This is the meaning of *homo heuristicus* introduced in the last twenty years by Gerd Gigerenzer and colleagues [Gigerenzer et al., 2011], aimed to refute the so-called "principle of total evidence" introduced by [Carnap, 1947], for which it is always best to consider all the data available, or, to put it in gigerenzian terms, *more-is-more*.

I agree with [Gigerenzer, 2008]: on certain occasions, mostly in the face of *practical* decisions, surprisingly *less is more and more is less* or, said in another way, heuristics are often more powerful than a complete

knowledge of the conditions and, above all, their full involvement in decision-making.

The real power of this heuristic apparatus consists in the possibility to overcome the limitations of uncomputability and computational complexity of a method of logical-analytical type that can lead, through the exclusion of classical logical inference rules, to an increase of human knowledge: the case of abduction, with its ability to increase the knowledge of the agent is precisely possible because of his violating the inductive and deductive rules.

It is easy to see the spread of heuristics in many natural processes that work perfectly: from the choice of partners, to dogs that chase (and catch!) frisbees without apparently knowing the laws of physics that determine the trajectory; none of us, in fact, think of having to come in complicated calculations to catch a ball thrown in our direction; our solution is to rely on our senses-motor system, the most powerful computer in existence, which could well be followed by a simple heuristic type: fixed your eyes on the ball, start running, and adjust your movements so as to make constant angle between your eyes and the ball [Gigerenzer, 2008].

In this sense, an *heuristic choice* involves the actual complexity, rather than algorithmic one, in a decision-making system, deliberately excluding that cognitive surplus that does not act in accordance with the complexity of the world, but instead *will react with it*, blocking decision-making process, or, worse, leading to erroneous results and far from reality conclusions.

Another interesting interpretation of this facts is given by [Kahneman, 2013]. Kahneman's idea is that, in making a decision we can rely on two different types of decision-making systems: the first, which he calls *System One,* is fast, inexpensive in terms of cognitive resources and often breaks the rules of "good inference", relying mostly on what is commonly called "intuition" and which, in my exposition, I have defined as that heuristic *evolutionarily-shaped* apparatus on which we appeal often unconsciously; the second, the *System Two*, involves a detailed analysis and in some ways "cognitively busy" data available, using the *background* knowledge stored in the human mind, namely the result of learning process.

The two interpretations are encountered when we see that the System One, lazy and intuitive but fast and safe outcome, showing a cognitive fluidity greater than the second, which, although able to reflect more logical and systematic way, involving higher cognitive processes, it is subjected, in the face of a greater cognitive effort, to the same errors incurred by the System One. All of this, however, *at the same time* in which the System One, reached the end of the cognitive task, is able to retrace his steps (in a kind of feedback mechanism) and made its adjustments leading to a better outcome.

The System Two, complex and *dependent to the reference model*, therefore oppose to a systemic complexity (like the environment is) as many complexity, in the form of a heavy and seemingly sophisticated frame of knowledge.

Needless to say, the System One is represented in this paper, from the perspective of the *agent-based* modeling that I'm trying to exploit, whereas, the System Two is that reflective *top-down* part on the problems.

In economics, in particular, the apparatus of knowledge shared by the experts is called Standard Economic Theory. Now let's see how this theoretical framework operates, when it comes to making "predictions".

2 - How the expert "predict"

> [Howard Kunreuther] watched [...] that protective measures, both when they are promoted by individuals both when they are promoted by the government, they are usually designed in order to cope with the worst disaster really happened. A long time ago, at the time of the Egyptian pharaohns, the company always kept full account of the level of the rivers that periodically overflows and prepared on the basis of that experience, assuming that the flooding would not have exceeded the level observed already full. Today, as then, when we try to imagine a disaster, we do not come to mind that disasters of the past. [Kahneman, 2013, p.152, my translation]

The economy moves in the impossibility of prediction using specific *mathematical tools* and shows an high degree of formalization and an

annihilation of the perspectives of the agent thing that is characteristic of the mathematical formulation of a phenomenon.

Simplifying, there are basically two ways that experts use to predict an economic event, often used simultaneously, and both operating on one variable: the *analysis of time series* and the one of the *multiple linear regression*; the usage of both of these methods should, in theory, provide a sort of knowledge which is distributed on the timeline; the first method, the time series analysis, takes into account the past events for later use, through the second one, in order to obtain a future projection of the variables that you have partially stabilized using the analysis of past occurrences of the event.

Let's get one thing straight right away: from an epistemological point of view such an approach does not make sense, and not just because of the inability to predict the outcome of a complex system, but also for the following reason.

First, from the point of view of the instability, the validity of a method, which is called *stress tests* or analysis of time series, it is practically nothing: from a cognitive point of view, in fact, analyze the way in which an anomaly (understood as a wrong analysis of the initial conditions of a system, such as the way in which it has changed its evolution and lead to a *crash* of the system) has an impact on a complex system, does not provide any additional knowledge for the future development of the system, and the reason should be easy to understand: the *anomaly*, in a complex system, it is a *single* and often *unique* event in its degree of entities in the history of the system. It would be like trying to predict the next economic crisis on the basis of the analysis of what happened in the previous one.

However, such an approach is in my opinion wrong, not only for what has been said until now about unpredictable nature of a complex system, which is also on the economy.

The main error, in this case, is procedural and has been epistemologically formalized already in the middle of the last century in the work of [Popper, 1954]; from the point of view of this work, the importance of this text is to show how every single prediction, particularly in the economic and financial field, falls within the "poverty of historicism": this fall is a particularly acute form of epistemic arrogance consisting in analyzing the course of the world (complex system) and convinced ourselves

of being able to predict the course of this complex system based on a knowledge of its dynamics which was obtained by an analysis of past events.

From a modern philosophical perspective all of this involves a quite simple consideration: if would be possible to predict events (including the development of an economic and financial system), these events would no longer been unexpected and, therefore, exist already, which is obviously impossible.

> The critical question is how can we plan, formulate strategy, invest our savings, [...] and generally make future oriented decisions, accepting that there are no crystal balls? This is a big challenge that must be faced head-on to avoid unpleasant surprises and the catastrophic consequences that come from the illusion that an accurate forecasting is possible, and that future uncertainty can be correctly assessed and effectively controlled. [Makridakis, Taleb, 2009, p. 840]

The answer that I could give to this problem is that, since the prediction is impossible on a practical level (but also partly theoretical, as we have just seen), we must avail ourselves of our role of ecological agents in a complex world: undressing this theoretical top-down framework, since we are dealing with a systemic non-linear artifact intended as a whole, in order to exploit some potential weapons at our disposal against the unexpected which we often forget: progress is at least non-linear, but we are able to exploit it through the heuristics of a simple *bottom-up* strategy, namely the agent-based model.

2.1 – A brief heuristic example: the less-is-more effect

Let's going on to practice, now. My intent is simply to show the actual practice existence of *less-is-more* effect and its ability to interact with unpredictability in a better more constructive way, more than the alternative used, namely *multiple linear regression*-. The main intend of this section is to show that, even staying in a forecasting model, although I have shown its inconsistency for a predictive science that wants to be constructive, we can get benefits simply by using a simple heuristic based on the principle of *less-is-more*, such as, for example, the *heuristics of the count*.

This is a very simple heuristic, which stems from a practice, that of *counting*, which can be traced at least in the last thirty thousand years of

human history and has mentioned in its application to the statistical sciences by [Dawes, 1979] and has then taken firmly in [Dana and Dawes, 2004].

> The dominant statistical practice in the social sciences is to assign weights to different predictors according to an algorithm, called " multiple regression ", now incorporated into conventional software. The logic of multiple regression is indisputable: find the optimal formula for putting together a weighted combination of predictors. However Dawes observed that the complex statistical algorithm adds very little value, if not none. You might as well select a range of scores some validity to predict the outcome and adjust the values so as to make them compatible [...]. A formula that combines these predictors with equal weights tend to be just as accurate in predicting new cases of multiple regression formula, which was sub-optimal in the original sample. More recent research has gone further: the formulas that assign equal weights to all predictors are often higher because they are not influenced by sampling rules. [Kahneman , 2013, p . 249]

In practice this method I am referring to, achieves a better outcome forecast by simply ignoring the variables that can complicate the calculation method based on this heuristic also of the *take-the-best*, be described, in all its simplicity, by three rules:

> 1 - Rule of search: Search within clues based on their validity.
> 2 – Rule of Stop: stop when you stumble in the first clue that could act as a dividing line between the elements under consideration (for example, the values of the clues can be 1 and 0).
> 3 – Rule of decision: infer that the object with the positive value (1) has a higher value. [Gigerenzer, 2011, p. 44]

To get to the point and close this limited practical gloss, the performance of these two heuristics in the forecast area, higher than the most widely used method of multiple linear regression (as you can see from the experiments collected in [Gigerenzer, 2011, p. 42]), is due to their simple abide by the principle of *less-is-more*, which can be understood as a more general, highly effective, heuristic.

The reason is very simple: by following this rule, you get a greater simplification of the model, streamlining of which has a practical parameter in the *transparency and robustness* of the model in question.

A model, in fact, that uses heuristics that restrict the free parameters used to *zero* (in the case of heuristics count) or *some* (in the case of heuris-

tics *take the best*) gains in transparency, thus improving the its ability to intuitive understanding on the part of the agent, and robustness, allowing the agent to apply human mental strategies useful for its understanding.

Transparency and strength, therefore, qualify as a very useful yardstick for the *agent-based* model on an *ecological basis* that I'm trying to define.

3 - The effect of "expert knowledge"

The time has now come to explain the concept already emerged of "epistemic arrogance" and its link with the top-down model that I am criticizing, always keeping in mind that we are moving in the field of economic prevision, for which I opted for a general undifferentiation between economy and finance, with specifications when I'm talking to one or other of the systems-, both faithful to the Standard Economic Theory.

This SEC is, according to what I'm saying, a case of *top-down* economic model widely accepted in the economic system, that sees the economic entity as an agent acting on the basis of a presumed rationality-able to weigh the costs and benefits of the given choices to stretch towards the more rational-.

The *epistemic arrogance* is therefore essentially a particular widespread fallacy in which the adept to the *top-down* model often incurs and from which is defined: this agent, blind to the idiosyncrasies of *biased* cognition (ranging from self-confirmation, the illusion of validity as well as other economic fallacies that *behavioral economics* has shown us already at least thirty years), proceeds "as if" his knowledge was free from these influences; the term "arrogance", is then derived from his use knowledge of the object (in this case the economy) with arrogance, closing his eyes to the experimental data that show how substantially and particularly in the financial environment, the economic agent has a lower performance of a chimpanzee throwing darts-.

However, the evidence provided by more than half a century of research are irrefutable: for the vast majority of fund managers, the choice of actions more closely resembles the roll of the dice that the game of poker.
[...] In any year, the funds of success have mostly happened by mere luck, be-

cause they have had a good roll of the dice. Researchers generally agree in maintaining that all traders, whether they know it or not (and some of them know), playing dice. The subjective experience of traders is that they make assumptions reasonable and sensible in a situation of great uncertainty. [Kahneman, 2013, p. 237, my translation]

Given, however, that there is no space for a term like "luck" in this paper, I would go one step further, arguing that, such a model based on epistemic arrogance is directly proportional to the amount of knowledge involved. Thus emerges another aspect of arrogance related to the arrogant's high level of specialized knowledge: the tendency to assign to this subject, generally inscribed in the Standard Model of Economic Theory, merits that do not belong to.

This is the case, widely used in economics and finance, the *self-fulfilling prophecy* [Merton, 1969], from which the model that I'm criticizing derives its practical validity; we can see this effect, as a sort of *feedback* from the markets toward building this *top-down* cognitive framework: investors, trusting in the knowledge-dominant predictor's expertise, with the approval of the media (both specialist and massive), acting *as if* the predictions made by this model were true, and taking investment decisions on their basis, the prediction come true as "imposed from above". So that at the end of this process, the economic establishment will enjoy increased self-confidence in his own abilities and forecasts, magnifying the epistemic arrogance of the establishment and *giving them the illusion* of acting in accordance with a fair predictive model.

> Financial markets have a unique feature: the study of the market influences itself because the results of the studies will be probably used in decision processes by the investors. […] In a market, if a large number of investors have the same expectations on the future value of the price and they react in the same way to this expectation they will operate in such a way to fulfill their own expectations. As a consequence, the theories that predicted theoe expectation will gain investors' trust triggering a positive feedback loop. [Cristelli, 2014, p. 128]

Let me be clear: all of this, from a theoretical perspective, can work, because basically what we have is an informative process forward and one backward, which feeds the confidence in the model, acting as a feedback process.

Well, why then, I argue, is this economic model (as well as the satel-

lite models that depend on it) definable as the main cause of the market's crisis?

Let me explain.

4 - How things really are

The problems of this approach emerge as soon as we shift our attention to the level of the agent, thus returning to see things as they are *in practice*: it's a matter of fact that human agents, and economic ones are no different, proceed in a non-linear way (they are also still complex systems, although of a particular type!) and the information they exchange directly depend from their own non-linearity.

There is, in fact, a distortion of information that passes between the agents involved, which primarily involves the agents themselves (in addition to the channels that convey) with that baggage of *bias*, on which I'm insisting about, which is the main humanizing character of every living creature that lurks behind aseptic name of "agent": from this point of view, the main characteristic of human beings that many models are used to formalized, the logical consistency in agent's choices, it is only a mirage.

With regard to the information, as I said, things are not so easy when you take into account the *framing effect* [Tversky and Kahneman, 1981], namely the cognitive characteristic inherent in every human agent: since its introduction in the field of psychology, it undermined the comforting idea of rational agent.

Not only that, in fact, uncertainty, insufficient and low-quality information, limited cognitive capacity and lack of time, together with value conflicts and ethical considerations make it the decision-making process difficult in reality; but also, and above all, the subject's ability transposing the message, especially for the importance that the way it is worded plays in the way it is presented by the medium.

This basically involves two consequences of great importance:
- that the message is almost never neutral, but it lends itself to exploitation by the sender, resulting in an increase of its power, relying on the *docility* [Bardone, 2011] of the cognitive recipient, with the

risk that this can be plagiarized in his decision, and
- that the subject enters constructively, though not intentionally, in the modification of the original information, with all of its idiosyncrasies, emotions and past.

In this theoretical framework, the existence of infections, often observed in financial crises, is a rational explanation. They are the consequence of the fact that certain interpretations are binding as highlights simultaneously in a large number of investors. [Orléans, 2010, p. 118, my translation]

Here is another aspect of the 2008 financial crisis (such as those that preceded it): to return to a psychological language, it can be seen as a result of a *large framing*, practical heir of the *top-down* model that you are criticizing here, where the information is conveyed from above, thus increasing exponentially the possibility of its distortion and exploitation for personal gain.

5 - The agent-based alternative

In light of what has been said until now, therefore, what can be predicated of such a top-down model is, contrary to what we hoped for, opacity and impenetrability both from an *agent-based* point of view and from an epistemological point of view, going to undermine the chances of conception of economic risk in a constructive way.

We can see a trace of what I'm trying to say in [Slovic, 2000], which noted that the public, the profane's way to manage risk is *a richer and more complete conception* than the experts; the latter, in fact, operating decisions and managing risk through statistics and algorithms in an attempt to give a comprehensive idea of all the data available, leave out emotionalism and subjectivity of agent that, far from being overcome by human error to get a more objective perspective, are rather what makes us fully human [Damasio, 1994] and, therefore, economics agents. The *agent-based* model is, therefore, essentially, a collection of this human wealth and an implementation in a knowledge-based model faced to action, which can fully manage a risk that is not only systemic but also of

values.

Trying to ignore, with a strong theoretical contribution in the model, this human characteristic, is having a corrupted point of view on "risk", producing lexical categories that have no reason to exist: the "risk", in reality, does not exist "out there in the world" , independently of our mind and culture, and that is just waiting to be measured [Slovic, 2000]. It is a product of the reference model: its practice, although analyzing real dangers, reifying and inserting them into categories such as "real risk" or "objective risk" is an *exercise of power* [Ibid.], inevitably dependent on the choice of units of measurement (the value applicable to an algorithmic analysis), preference of a risk rather than another and, in general, formalization of idiosyncrasies of a particular individual agent.

Resulting from this vicious circle there's the mentioned rigidity, opacity and impenetrability of this model, which, facing with the agent's complexity, create a total lack of *cognitive fluency*, another essential requirement for a modeling based on agent's cognition [Alter and Oppenheimer, 2006; Cooper, Dimitrov and Rau, 2001] that we can have, conversely, through a *bias*-centric point of view on the heuristic nature of the agent.

All this would drive, in my intentions, to a methodological shift, leading to a widespread use of *qualitative methods and cognitive-bias-centric perspective* rather than a quantitative one; all of this in the management of a systemic unpredictability inscribed, as mentioned above, in the order of things: this is the profound sense of the model-based approach I'm hoping.

In economics, this has the practical implication of being able to avoid a research of values that is rather, in this view, a set of idiosyncrasies, emotionality, non-linearity and fallacy or, in other words, an *agent-based* perspective intended as a liberation of the Individual from the bondage of nowadays orthodox model.

Such a model, constructed around agent's humanity has also the ability to serve as a protection from the natural drift of the manipulation of human docility towards the self-confirmation, driven by the economic and financial power organized, conscious now, in the post-capitalist modern state, to be the main source of each individual agent's *possibility of choice*, within an economic model, like the present, highly self-referential, which create the conditions for the spread of speculative ac-

tivity disguised as insurance to the risk.

In the agent-based alternative, that is fundamentally an ecological model of human agent, the human apparatus, intended as the result from agent's hybridization with the environment [Magnani, 2009] is able to take advantage of the supplied heuristic with which it was designed, overcoming, then, the concept of *control of the unexpected*, which leads to a negative image of the emergency: in my opinion, in fact, the human agent is designed by nature to make the most of the most popular character in it, the *emergence* of course, so it makes no sense to speak of control of the unexpected, but rather its *exploitation* by man.

This should be the human purpose; and it is this what we are good at doing.

The unexpected, according to a natural perspective, it is a positive event; Western cultural superstructure has instead turned into something negative, to avoid inverting its value, to an alleged immobilizing negativity, with the approval of a certain part of science and we have the oppose to this, with a agent-based model choice.

Conclusions

[On this account] agent-based models have shown the weakness of standard theories of financial markets in terms of representative and homogeneous agents [...] and qualitatively shown the importance of concepts such as heterogeneity, herding and non-linear feedbacks, in order to address the complex dynamics systems and features of financial markets. [Cristelli, 2014, p. VIII]

We have seen, in this text, that a good management (or, more desirable "exploitation") of the systemic complexity, that is both natural and artificial, must involve "a micro projected to macro dimension" and not vice versa.

So, my ideal model of this ecological modeling is the one that can be able to build what, in this text, I laid the epistemological foundation: a science that models around epistemic agent par excellence, the cognitive agent, and which has the strength to rebuild his practice on qualitative

resources at its disposal, based on the agent in the world from it (and *with it*) shaped, rather than through the use of quantitative formalization of human existence. I think that a good starting point can be found in De Finetti's theory of subjective probability: although it has been often forgot by the contemporary research, I think that a combining of his framework with the bias-centric one I've presented in this paper could furnish a good practical vehicle to the future of behavioral economics and ecology.

The idea of *modeling on an ecological basis* of reality is the choice to re-think the agent as a subject placed in constant exchange of information with a dense environment, namely "density", intended as the natural characteristic of an environment that does not arise passively (not neutral) against the individual, but rather actively collaborating in the construction of knowledge is contained in itself, both in the acting subject.

In substance, it's a richer management of the unexpected the one that emerges from such modeling: a science, then, that declines its responsibility, including ethical practices, but especially including systemic and procedural against the unexpected, by modeling a more transparent, strong and smooth scientific framework of the unexpected; allowing, then, the agent to use all his natural epistemic skills in the management of a wealth of information that, a simply quantifying practice, like the Orthodox one, it just makes it opaque and unmanageable by a systemic ecological agent: namely, a subject intended as a open system operating at the micro level where the point of view of the complexity should be placed as a basis for a knowledge-practice (pseudo) predictive that we can fully define science.

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