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An Economic Approach To The Self : The Dual Agent

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Abstract

This paper extends the notion of the rational agent in economics by acknowledging the role of the unconscious in the agent's decision-making process. It argues that the unconscious can be modelled by a rational agent with his own objective function and set of information. The combination of both the conscious and unconscious agents is called the "dual agent".

This dual agent presents rationally biased behaviors that may not disappear through aggregation, and could be potentially measured.

It also provides a theoretical approach to the emotionally-driven actions.

On the social sciences side, the paper pleads for a wider use of substantive rationality in the understanding of human behavior.

JEL Classification: B41,D01, D81, D82.

1 Introduction

The rational agent hypothesis is at the heart of economic theory. Developed among the neo-classical school during the middle of the nineteenth century, this hypothesis states that economic agents are rational, meaning that they choose their actions in order to maximize their utility. By systematically disregarding all non-rational behaviors, the theory has allowed economics to abstract itself from the vagaries of human nature and, as such, has been a powerful tool in the reshaping of the discipline as a natural science.

While other social scientists were adamant in their quest to model human nature, economists created a world in which agents are perfectly rational, always optimize to the best of their knowledge and make no systematic errors.

Critics of this "perfect rational man" have been lurking in the economic literature for more than 50 years. They rightly point out that models based on such assumptions have blatantly and repeatedly failed to foresee any market

crash or other economic disruption from the theoretical equilibrium. They stress the fact that economics should acknowledge the findings of other social sciences and build on them, rather than going on assuming improbable hypothesis.

This stream of criticisms has materialized in the behavioral branches of both economics and finance, which seek to suggest mathematical alternatives with firm psychological foundations to rational assumptions.

However, it ignores the fact that psychology suffers from its own evils. The empirical approach adopted by the discipline condemns its theories to be regularly rejected or amended according to new empirical findings. Moreover, by focusing on procedural rationality rather than substantive rationality, it ignores a convenient way and potentially useful tool to think about the unconscious.

Models based on fully rational microeconomic behavior usually yield results that are much richer, deeper and more interesting than those achieved by behavioral models. This is probably why despite its grossly caricatural assumptions, the rational agent is still so much in favor in economics.

If there is some kind of unconscious process undergoing within the psychic activity, its presence should be fully assessed by economics. If the unconscious can be seen as a separate agent that has his own set of information, his own utility and the ability to act in a way distinct from the conscious, then this agent should be encompassed alongside the conscious agent, and his influence should be analysed within the scope of economic theory.

To put things differently, economics may have been wrong in assuming one monolithic conscious agent. It has gone one step too far in its quest of simplification, and by assuming that one body should be the home of one rational mind. It does not follow, however, that its global approach is wrong.

In this paper, we step back and show that the 'failure' of the rational agent hypothesis to predict irrational behaviors can simply be explained by the omission of an additional, unconscious agent, within each individual.

An other, related contribution of this paper is to explore how economics can relieve itself from this one assumption of the neo-classical literature, and consider the economic agent as being composed of two rational agents, the conscious agent and the unconscious agent.

The paper is structured as follows. The next section presents the general setup of the model. Introducing the unconscious within an economical model requires an extensive presentation of the acception of the unconscious agent we are considering, as well as of his operating process. Section 3 developps the model : it specifies the context, the objectives of both the conscious and unconscious agents, and the resulting action of the combined - so-called "dual" - agent. Section 4 presents the results of the model. Section 5 puts the results in perspective. Section 6 concludes.

2 General setup

This paper will describe two agents, the conscious and the unconscious, and their possible interactions within a single economic agent. In this section, we present the general specificities of each of these agents.

2.1 Conscious and unconscious agents

The conscious agent considered here is the neo-classical rational agent. He apprehends the parameters of the reality through noisy signals. He is rational in the sense that he chooses his actions to optimize his welfare given all the information at his disposal.

Since this agent will turn out to be quite familiar, I will rather dwell on the modelisation of the unconscious agent.

2.1.1 General acceptions of the unconscious

In its very general meaning, two type of actions can be qualified as being “unconscious”.

First, actions that are not originating from the conscious mind, but that punctually emerge to the conscious mind, such as dreams, slips of the tongue, etc. These actions are conscious, but are said to be unconscious in that they reflect the activity of the “Unconscious” popularized by Sigmund Freud[8]¹.

A second, more straightforward acception of unconscious actions are those actions that are literally “un-conscious”. They refer to the activity that is decidedly beyond the grasp of the conscious mind. This could refer to a purely “physiological” or “neurological” unconscious, so to speak, the unconscious that purely governs our mental and/or physiological processes, such as breathing, hunger, instincts, reflexes, etc.

Relevance of these acceptions If we were to focus on the first definition of the unconscious, and exclusively consider the part of the mind that is not conscious, but can become conscious at some point, we could reduce the economic agent to the traditional rational agent, whose perception of reality is only impaired by his imperfect information about the parameters of the reality.

This is the path followed by behavioral economics. Boons of irrationality are seen as punctually superseding the rational agent’s actions. The “Unconscious” is taken into account, but not modeled as a rational and permanent agent in his own right.

Alternatively, if we reduced the unconscious to the second part of the former definition, i.e. if it were the part of psychic activity beyond the reach of the conscious mind, the parameters of the reality the unconscious agent could react to through his action would be radically beyond the knowledge of the conscious

¹I am aware that this statement is a gross simplification of Freud’s notion of the Unconscious, and that Freud’s own theories have been refuted by various psychoanalytic schools. However there is no need here to detail this further.

agent. Both the conscious and unconscious agents could, and would indeed, coexist in radically independent worlds.

Our purpose would be trivial, the action of the resulting economic (combined) agent being the sum of two distinct and independent actions performed by two distinct agents, endowed with radically different knowledge and clearly defined fields of competence. Besides, in such a context, the action of the unconscious would be of slight interest to the economist.

An alternate definition of the unconscious A more economical definition of the unconscious should start with recognizing that “unconscious actions”, or the actions of the unconscious agent, are not distinct from those of the conscious agent.

Whatever the actions these two agents, conscious or unconscious, can take separately, there is only one physical agent that will act. Therefore we cannot treat these two agents separately.

The best economical approach should therefore be to describe the unconscious as a second, permanent and fully rational agent, acting alongside the conscious, yet distinct from the latter in his utility, his perception of reality, and necessarily constrained in his actions. It is the approach I shall take in this paper.

2.1.2 Utilities

Should the utilities of the conscious and the unconscious differ? Technically speaking, they should not.

The utility of the unconscious agent The unconscious agent’s objective is to optimize the individual wellbeing. This is obvious when, among various other tasks, he performs all the physiological functions that guarantee the individual’s survival at their best routinely.

This wellbeing is guaranteed on the basis of a body of past knowledge, inherited or acquired through time by the individual. This body of past knowledge is continuously modified by events, so that it evolves through time.

However, being a mix of genetic heritage, physiological regulatory processes, instincts, reflexes, social conditioning, among other relevant factors, it will be strongly backward-looking.

The utility of the conscious agent I have just mentioned that the unconscious agent optimizes the wellbeing of the individual. But experience informs us that this objective is shared by the conscious agent.

Naturally, this often turns out to be a more subjective than objective wellbeing. To preserve our health, we should definitely eat less, drink less, drive more carefully, or quit smoking. But our subjective wellbeing somehow imposes

that we eat or drink as much as we like of what we like, drive too fast and go on smoking².

Specifically, the conscious could, and indeed must, have exactly the same utility as the unconscious agent.

Survival or wellbeing ? Should the conscious and the unconscious agent pursue the mere survival of the individual, or his wellbeing? One could argue it should rather be the individual's mere survival. Yet this would be too limited : the survival being a wellbeing *a minima*, it can be seen as the "least desirable" of all other "preferable" outcomes. Such a setup is, in itself, the guarantee that the survival of the individual will be, at worst, satisfied.

The need for further refinements So both the conscious and the unconscious agents must have the same utility, the preservation of the individual wellbeing.

Yet economics predicts that when the same set of information is shared by two rational agents having the same utility, their actions should be identical. In order to explain distinct behaviours between the two agents, we must allow for some difference of information to emerge between the conscious and unconscious agents.

In this paper, it is not the utility per se that distinguishes both agents, but the way each agent perceives it respectively, given his information. This will become more evident by specifying further each agent's characteristics and their resulting grids of lectures.

2.1.3 Functions and grids of lecture

I will assume that the difference in information between conscious and unconscious does not arise from the parameters of the reality, but rather from the way they are processed by each agent. This directly derives from each agent's function.

Function of the unconscious agent I will suppose that the defining role of the unconscious is to scan the information – both internal and external - collected through the body perceptive modes.

The unconscious may then recognize and respond to the parameters collected, before eventually transmitting all or part of them to the conscious.

This setup allows the unconscious to respond to a set of relevant characteristics before the conscious being even aware of a situation. It also allows for the conscious to be endowed with most, yet not all, of the parameters of the reality listed by the unconscious .

This general setup is in line with the current acceptance of neuronal processes.

²It might be argued that some want to suppress themselves altogether. This could arguably and unfortunately be seen as a mere extreme version of the above conducts.

Nowadays, the brain is seen as a machine set to represent attributes and mental objects. Our perceptive modes are a mere collection of mental processes seeking to extract the relevant information to the representation they are supposed to elaborate. Neuron networks, which share the same encoding information properties, then process this information. As such, they constitute representational systems of external and internal information. To illustrate this point, let us analyze two practical examples.

Function of the conscious agent The conscious is able to group and recognize these characteristics, name them, and organize them in multiple subsets forming one coherent set.

Two practical examples Let us suppose you are standing in front of a building. This is what your conscious sees. Yet he has only been able to reach to this conclusion thanks to a recognition process performed by your unconscious. So that in front of this building, your unconscious has collected a list of parameters telling him that he is in front of "a shape" that is "static", "big", "rectangular", with "dark holes", "tiles", "inhabitants", etc.

Or let us suppose you are stuck in a traffic jam. Your car is at the stop, just behind a big truck. Once again, this is only what your conscious sees. To come to this conclusion, your conscious has processed a list of characteristics provided by your unconscious, stating that there is "something", "in front of you", "rectangular", equipped with "wheels", "small mirrors" on each side, a "metal plate" with a "number" written at its back, smoke coming from a "metal tube", etc.

From the above lists of characteristics, the conscious extracts the information that this "thing" in front of you is a "building" or a "truck". From the context, he deduces that these mirrors must be some "rear-view mirrors", the metal plate a "licence plate", the metal tube a "muffler", and that this object in front of you with its "wheels", "rear-view mirrors", "licence plate", and "muffler", must be a "truck". Following the same logic, he has deduced that this "rectangular" and "static" shape, with its "roof", "walls" and "windows" must be a "building".

Implication and limitation The fact that the conscious treats some information collected by the unconscious has one important consequence.

It implies that the unconscious agent must be an always operating-agent : its action must be continuous. This in turn justifies the stance taken in this paper. The very fact that the conscious should be aware of the reality is the very proof that the unconscious is performing his function : listing the parameters of the reality, analyzing and transmitting them to the conscious.

However, these sole assumptions are not sufficient to induce any difference between the conscious and unconscious' actions. To induce a real difference between each agent's specific actions, we must suppose that they perceive the same reality in two distinct ways, and, consequently, treat the incoming information differently.

A classical distinction In this paper, the critical difference between the conscious and unconscious agent lies in their respective perception of time. This distinction can be drawn from the very role of each agent.

The unconscious agent scans and reacts to parameters of the reality, before eventually passing on some of this information to the conscious agent.

He is also bound to maintain some specific equilibria within the body on a permanent basis. Each and every second, vital operations are performed, that cannot be postponed. Whereas the conscious agent can take time into account, and delay some of its action, the unconscious agent is bound to act on a permanent basis, so to speak. So that the laps of time on which each agent, conscious and unconscious, operate is radically different, and that we can safely assume that the unconscious short, medium and long term are infinitely shorter than the conscious ones.

The unconscious role is also to spot and react to potentially harmful situations, some of which are predefined, and some of which are acquired through mostly early and/or repeated experiences. In order to perform this function, he cannot discard any element of information. Whereas the conscious agent acts as a selecting device and tends to discard information once it has been processed, the unconscious agent never discards what he perceives as potentially relevant.

Two specific agents Two specific and very different agents emerge from these assumptions.

In terms of information, the unconscious is clearly more informed than the conscious. He has access to a much wider and deeper perception of the parameters of the reality than the conscious.

Yet it does not follow that the unconscious is better informed than the conscious. Indeed, the unconscious lacks the "time dimension" associated with the conscious activity. Naturally, strictly speaking, the unconscious takes time into account, but his time span is much shorter than the conscious' one.

We will therefore treat the unconscious as a "static" agent, and the conscious as a "dynamic" agent.

This clearly suggests that, although the unconscious presented here can indeed be seen as a rational agent, the way it processes its information will trigger radically different actions from those of the conscious.

2.2 Mutual awareness

How do the conscious and unconscious perceive one another within the dual agent? In the present paper, I have supposed that the conscious and unconscious agents ignore each other's presence. This stance requires some explanations.

The conscious agent The conscious is, by definition, the least informed of the two agents. This directly results from the role of the unconscious, which scans the parameters of the reality before transmitting *eventually some of them*

to the conscious. In this setup, the conscious is bound to ignore many of the parameters the unconscious is dealing with, and that are specific to his activity.

For example, the conscious will ignore most of the physiological processes the unconscious is performing constantly. Actually, there is no reason to assume that the conscious is aware of the fact that an other - and possibly more informed - agent exists along his side.

The unconscious agent The unconscious is the most informed of the two agents in terms of scope of information. Yet it does not follow that he is fully and perfectly well informed. This results from the unconscious' grid of lecture. Because the unconscious ignores the time dimension of events³, he has no reason to suspect that an alternate grid of lecture exist, nor that the conscious, being a dynamic agent, should know more than he does.

Two mutually-ignoring agents The overlapping nature of the unconscious and conscious knowledge - the set of parameters, actions, even utilities, could lead the unconscious to ignore the conscious' action, and vice-versa. Because the difference between conscious and unconscious lies within their respective perception of time, they have no reason to suspect that the other agent perception could be more accurate than their own.

This concludes the presentation of the general setup of the model. I have specified the unconscious agent modeled here, and shown that he can be seen as having his own set of information, his own utility, and his own action. He can therefore be considered as economically rational, and different from the conscious agent. I have furthermore mentionned that the conscious agent can be seen as the neo-classical rational agent. Let me now see how these two rational agents can be modeled as one single agent, the "dual agent".

3 The Model

I shall from now on call "conscious" and "unconscious" the two rational economic agents, and "the dual agent", the individual seen as the combination of these two agents within a single individual. I will present the context faced by the conscious and unconscious agents, before specifying their information sets and utilities. I will then present the full model of the dual agent, along with its optimization⁴.

³Or alternately, because his own actions take place in a much more immediate time dimension than those of the conscious.

⁴To simplify the matter, the dynamics of the model is left for further research.

The reality Conscious and unconscious actions suppose an external situation in which actions take place. We will call this the "reality". Because we are modeling rational agents, this reality must be described quantitatively by means of parameters.

These parameters can refer to various elements: social interactions, sets of behaviors, agents, costs, external conditions, interactions, all that constitute the environment the dual agent⁵ faces, to which he is confronted. The only necessary condition here is that these parameters can be measured quantitatively, to be included in the utility function of the agent.

I will call θ this set of parameters describing the reality. The reality θ is a vector:

$$\boldsymbol{\theta} = (\theta_1, \dots, \theta_n) \quad (1)$$

Each parameter θ_i could actually be seen as a vector of characteristics that fully describes θ_i . However, this refinement is not necessary and will therefore be ignored.

The conscious The conscious is the familiar rational agent : he chooses his actions to maximize his wellbeing, to the best of his knowledge. If alone, he would choose the action that optimizes the wellbeing W :

$$W(a, \theta_1, \dots, \theta_n) \quad (2)$$

Note that this wellbeing solely depends on the agent's action and the parameters of the reality. Were the conscious fully informed, his optimization would trigger the optimal action a^{opt} . For the sake of simplicity, I will assume this action to be a linear combination of the parameters of the reality, so that a^{opt} will be a linear function of the parameters :

$$a^{opt} = \sum \alpha_i \theta_i$$

The optimal action is the weighed sum of the parameters of the reality, where the α_i can be seen as transformers : they translate the quantitative parameters of the reality into an action.

Insofar as the conscious is not fully informed, it can at best grasp a mixed signal of the θ . This set $\tilde{\theta}$ is defined as:

$$\tilde{\theta} = (\theta_1 + \varepsilon_1, \dots, \theta_n + \varepsilon_n) \quad (3)$$

where the ε_i are independently and identically distributed.

Benchmark case A benchmark case will be defined as the optimization of the conscious, if he were the only agent acting within the dual agent⁶. Indeed, if alone, the "conscious" agent would optimize his expectations such that

$$E^c W(a, \theta_1, \dots, \theta_n)$$

⁵And of course, the unconscious and the conscious.

⁶And relaxing the assumption that the parameters of the reality are first processed by the unconscious.

and would therefore set his action such that

$$\begin{aligned}
 a &= E^c a^{opt} = \sum \alpha_i E^c \theta_i \\
 &= \sum \alpha_i (\theta_i + \varepsilon_1) \\
 &= a^{opt} + \varepsilon
 \end{aligned} \tag{4}$$

where ε is the overall mistake induced by the conscious' incomplete information:

$$\varepsilon = \sum \alpha_i \varepsilon_1$$

As mentioned above, this is the standard optimization of the rational agent, where imperfect information can lead the agent to take erroneous decisions.

The unconscious Recall that, in the present setup, the unconscious' distinctive role is to list characteristics perceived in the world that surrounds each individual, i.e. dual agent. He performs this action by collecting the information of the body's various perceptive modes. So that the unconscious does not perceive the world as the conscious does, but first and foremost, as a pure list of parameters.

Besides, because he is a "static" agent, the unconscious, although rational, significantly departs from the conscious in his wellbeing. He does not consider situations as they occur to the conscious, but as a set of small units of meaningful elements, that he can - and must - recombine and interpret freely, before comparing them to a specific set of predefined "harmfull" situations.

The unconscious must therefore be modeled as an agent reacting to a re-created and distinct situation from the actual one, so that the situation the unconscious is facing can be characterized by its own subset of parameters θ^u .

θ^u is defined as:

$$\theta^u = (\theta_1^u, \dots, \theta_n^u) \tag{5}$$

These parameters are the set of elements recognized as meaningful by the unconscious while analyzing the reality.

The unconscious systematically and continuously analyzes the present context and confronts it to his own parameters. In turn, the recognition of part or all of these parameters within the present context will trigger the unconscious' reaction.

However, because the unconscious decomposes the reality in small units and interpret them according to his own grid of lecture, these parameters may be dismissed by the conscious, so that $\theta^u \neq \theta_i \neq \theta$.

Conscious and unconscious are therefore endowed with disymmetric sets of information. The conscious perceives the reality through the fog induced by his incomplete information, while the unconscious keeps on analyzing the reality according to a mainly backward-looking grid of lecture.

Once the θ^u are recognized, the unconscious will seek to maximize a wellbeing $W^u = E^u W$.

$$W^u(a, \theta_1^u, \dots, \theta_n^u)$$

This wellbeing depends on the situation spotted. Here again, because the unconscious is backward-looking and mostly reacts to past situations, W^u can be seen as an obsolete wellbeing, inducing actions that actually optimize real but past situations. His actions are therefore bounded to be suboptimal in the present context.

The dual agent The combination of the conscious and the unconscious is the "dual agent".

Being a combination of two agents, this dual agent reacts to two sets of parameters : the parameters within the reality that are processed by the unconscious, on the one hand, and those significant to and processed by the conscious, on the other hand.

Therefore the dual agent will, as a single agent, optimize a combination of two wellbeings: W and W^u , the wellbeing of the conscious and the unconscious respectively:

$$(1 - \beta) E^c W(a, \theta_1, \dots, \theta_n) + \beta W^u(a, \theta_1^u, \dots, \theta_n^u) \quad (6)$$

where β is the weight of the unconscious in the process of choice. I also assume that W^u is quadratic in the $(\theta_1^u, \dots, \theta_n^u)$.

Why Game Theory does not apply Stating a single, combined, utility for two agents may seem awkward. Game Theory would model these two agents as each having his own action and playing one against the other.

However, in this model, only one agent, the "dual agent", is playing. Yet this single action must nonetheless be the result of a combination of two utilities, and two individual and independent actions.

First, because it is unclear whether conscious and unconscious should be aware of one another. Indeed it is my assumption in this paper that they ignore one another. Second, because given their respective perception of time, these two agents have no reason to suspect that their action should be different.

The dual agent's action is therefore the result of the combined actions of the conscious and the unconscious, and this result cannot - at least in the context of this paper - be reduced through Game Theory.

Timing Of course, the timing of the action could be refined.

Each agent could act separately or sequentially, and in turn observe the result of these two actions. Alternately, the unconscious could blur the parameters of the conscious with his own parameters, thereby modifying the conscious' wellbeing.

Yet these situations would be equivalent, and are indeed more conveniently modeled through a single, dual agent's wellbeing, that combines both the conscious and unconscious agents' wellbeings.

The unconscious as a blurring agent To keep things simple, we have totally distinguished the conscious and unconscious perceptions of reality. It would actually be more accurate to consider the unconscious has been able to blur the perception of the conscious.

This corresponds to replacing the conscious' perception of the parameters

$$\tilde{\theta} = (\theta_1 + \varepsilon_1, \dots, \theta_n + \varepsilon_n) \quad (7)$$

by a blurred combination

$$\tilde{\theta}' = (\theta_1 + \lambda_1 \theta_1^u + \varepsilon_1, \dots, \theta_n + \lambda_n \theta_n^u + \varepsilon_n) \quad (8)$$

In this context, an analysis would lead to a net gain of information for the conscious, by re-establishing the true signals $\tilde{\theta}$.

The parameter β The parameter β describes the "power of intrusion" of the unconscious in the dual agent's utility.

When $\beta = 0$, the action boils down to the standard benchmark case, in which the dual agent is the rational, conscious, agent.

When $\beta \neq 0$, the higher the β , the more permeable the dual agent action is to the unconscious analysis of the reality, or alternatively, the more does the reality fit the unconscious grid of lecture.

β is therefore dependent on the parameters θ and θ^u , and in turn, on the personal history of the dual agent. As such, it can evolve over time.

Formally, the action taken is thus a combination

$$\begin{aligned} a &= (1 - \beta) E^c a^{opt} + \beta + \sum \gamma_i \theta_i^u \\ &= (1 - \beta) (a^{opt} + \varepsilon) + \beta \sum \gamma_i \theta_i^u \\ &= (1 - \beta) (a^{opt} + \varepsilon) + \beta \left(\sum \gamma_i \theta_i^u - a^{opt} \right) \\ &= a^{opt} + (1 - \beta) \varepsilon + \beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i) \end{aligned} \quad (9)$$

Let me now examine this equation in detail and presents the results of the model.

4 Results

Equation 9 shows that the action of the dual agent can be broadly defined as being the sum of two terms : an optimal social action, and a bias to this optimal social action.

The optimal social action The first term, a^{opt} , is the optimal action the conscious would have chosen had he been the sole agent involved, and had he been fully informed of the reality. It can be defined as the "optimal social choice".

The bias The last two terms taken together, $(1 - \beta)\varepsilon + \beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i)$, can be seen as an overall bias to this optimal social choice.

Terms of the bias The first term of the bias, $(1 - \beta)\varepsilon$, is the usual white noise.

It is unavoidable and results from the usual conscious' lack of information about the parameters of the reality. It represents the overall noise that blurs the conscious' choice, and produces a sub-optimal and totally random outcome.

The second term of the bias, $\beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i)$, represents a pure action of the unconscious. Unlike the first term of the bias, it is not random, and represents a systematic bias with respect to a^{opt} .

Because the unconscious optimizes a reward, this term should not be sub-optimal. Yet the reward of the unconscious, R^u , does not merely optimize the real, actual situation faced by the agent, but rather a set of past - or "atemporal" - situations reactivated by the present situation. It only seldom represents an optimal action vis-à-vis the present situation, as seen by the conscious, but should rather be seen as an effective loss for the conscious. Its impact on the dual agent's action will depend on the weigh given to R^u within the dual agent's optimization.

To the dual agent however, this bias is part of his optimization, and cannot be seen as a loss. It is nonetheless inefficient on a social point of view, as being biased toward past personal events.

Nature of the bias What is the exact nature of this bias? The first intuition is that it results from and represents combinations and differences between, on the one side, parameters seen by the conscious and, on the other side, parameters seen by the unconscious.

While the parameters of the conscious are real and observable, the parameters of the unconscious are, at least partly, discarded or unobservable to the conscious, since by definition the θ_i^u are projections of the unconscious on the parameters θ_i . θ_i^u is therefore the result of an interpretation performed by the unconscious and, as such, uncomprehensible to the conscious. Besides, the γ_i are the translators of this interpretation into actions.

This overall bias can therefore be defined as an action performed by the dual agent, directly observable to the conscious. It is a departure from the optimal action, in that it would not necessarily be required from the situation as such. The conscious does not control it, since it is induced by an unconscious activity, and is the result from the "overinvestment" or "misinterpretation" of a present situation by the unconscious.

The emotive part of the agent's action The very broad definition of this bias has a huge impact on the result of the paper, and will be discussed later on.

Let me underscore that if this bias can be a material action, it is not necessarily bound to be so. It could very well be an immaterial action. It could be a slip of the tongue, for example, but it could also be a thought, an emotion, a feeling, an exclamation, etc.

Although it might not be fully adequate, let me for now call it "the emotive part of the agent's action".

Estimation of the bias This bias could be observable and quantitatively estimated. Recall however that the hypothesis of an imperfectly informed conscious does not a priori allow him to suspect the presence of a bias in his optimization.

Without prior knowledge of the unconscious, the conscious would deduce ex post - after revelation of the true parameters - that a suboptimal action resulted from his misestimation of the situation measured by $(1 - \beta)\varepsilon$. Repeated mistakes could lead him to the conclusion of a lack of estimation power.

However, the presence of the systematic bias $\beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i)$ could be measured by the correlation of the mistakes in a series of similar situations.

Indeed, measuring the average of his actions through an extended period of time and over a large sample of similar actions could lead him to eliminate random errors and measure an average action

$$\bar{a} = a^{opt} + \beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i)$$

Ex-post, when a^{opt} is revealed, the systematic bias could be measured.

We can even venture that the θ_i^u could be partly retrieved. By examining the biases over a sufficiently large sample of events, one could retrieve, *a minima*, some structural similarities among various situations, and postulate a structural form for a set of θ_i^u . This would help determine the form of the triggers inducing the unconscious reaction. However, this would, given our description of the parameters and the relevance of their structural interactions, require to abstract oneself from the contingencies of the present situation, and rather seek similarities within situations.

Last but not least, this bias in the action of the dual agent will not necessarily disappear when aggregating over agents. It will depend on the nature of the bias. Actually, if its trigger is a common scheme among individual, and not a personal feature, it will sum up over a population. This can give some rationale to some common seemingly irrational behaviors.

The following section briefly discuss and put in perspective these results.

5 Discussion

This paper innovates in showing that the action of two purely rational agents optimizing their own utility function within a single individual - the dual agent - results in an a perfectly optimal, rational action, and a bias to this rational action.

I shall briefly underscore the discrepancies between the dual agent and behavioral approaches, before detailing the impact of the paper depending on our assessment of the nature of the bias.

5.1 Dual agent vs. behavioral approach

It could be argued that this paper confirms the behavioral approach. After all, it suggests that realistic behaviors can, on an ad hoc basis, be decomposed into one optimal action and a bias, which is the exact stance taken by behavioral economics.

However, the dual agent approach departs from the behavioral one in many respects.

At the root of the dual agent's approach lies the conviction that, to be understood, a phenomenon needs to be considered rational, in the economic sense of the term. So that whereas behavioral economics will choose singularity over rationality, empirics over theory, and psychology over economics, the dual agent approach will take the opposite stance.

Singularity vs. Rationality While the behavioral approach chooses to preserve the traditional concept of a single agent and nuances his rationality according to a collection of empirically observed biases, the dual agent approach drops the assumption of a single agent governed by a single conscious, but opt for a full rationality of both agents.

Empirics vs. theory While the behavioral approach chooses to amend the theoretical economic rationality according to empirical findings, the dual agent approach seeks to determine the theoretical conditions under which two fully rational agents could be rational at the same time.

Economics vs. psychology While the behavioral approach sees the unconscious as being beyond the scope of rationality, the dual agent approach suppose the unconscious to be fully and economically rational.

And while the behavioral approach chooses to use psychology to inform economics, the dual agent approach shows that economics can inform psychology and, as we shall see later on, psychoanalysis.

5.2 An economic approach to the theory of choice

According to H. Simon⁷, economic rationality, the assumption that actors maximize subjective expected utility, supplies only a small, and often not essential, part of the premises in economic reasoning.

The remainder of these premises, auxiliary empirical assumptions about actors' utilities, beliefs, expectations, to be made correctly, required, in his words, "an empirically founded theory of choice". This theory of choice in turn needed to specify what information decision makers use, and how they actually process it.

This has been the approach taken here. Considering the unconscious as a rational agent alongside the conscious in a simple model required to specify his information, and how he could process it.

To be understood, the unconscious must necessarily be seen as schematically unique and rational. If he is indeed rational, but still differs from the conscious in his action, then it must be that he sees alternate features within the same reality. This, in turn, means that he must process them differently.

The economical approach presented here establishes a minimal framework for the description of the unconscious as a rational agent. It provides a convenient way to establish and validate empirical psychological assumptions. This is the standard scheme in which a quantitative theory can make predictions that can be tested later on.

5.3 An economic approach to “irrational” behaviors

Two purely rational agents optimizing their own utility function within a single individual - the dual agent - resulted in an a perfectly optimal, rational action, and a bias to this rational action.

The rational behavior The optimal action is the perfectly rational action.

It is the accurate reaction of the dual agent to the parameters of the present reality. It is an action that is unbiased, and that perfectly responds to the parameters of the reality.

Actually, it is the standard reaction that everybody should adopt when confronted to the parameters of the reality. Given the same preferences and environment, we should all react to them in the same rational way.

The “irrational” behavior The second part of the action is a bias to this perfectly rational and optimal action. Being a bias to a rational action, it will be seen as irrational.

Of course, in the present setup, this bias is not irrational *per se*, since it reflects the action of the unconscious agent, who is rational in his own right.

However, it is not “factually” optimal, since it bears the mark of the unconscious perception. Indeed, it results from the difference of information between

⁷See Simon [22]

conscious and unconscious, and reflects the discrepancy that arises between mere facts, and the way we are interpreted by the unconscious via our own personal history.

Nor is it relevant to the present situation, since it reflects a mainly backward looking grid of lecture. It can therefore seem irrational, since it does not respond accurately to the parameters of the reality.

So that this apparent irrationality naturally follows from our assumptions, more specifically from the conscious and unconscious' respective grid of lecture.

5.4 An economic approach to emotions

Recall that the bias has been defined as an action performed by the dual agent, directly observable to the conscious but not controlled by him.

The emotive part of the action

Emotion It should be clear from the above that this perfectly fits the notion of emotion. Indeed, we do not "control" our emotions. Actions taken under emotional stress are most of the time seen as "biased", and "irrational".

So that except for a few specific situations, emotions can be seen as being a bias to the optimal rational and action rather than part of the rational action itself, that should mainly be emotionless.

Cognition We do not control our emotions, but neither do we control our thoughts. And, as a matter of fact, few thoughts are absolutely devoid of emotive content. Our thoughts are highly dependent on our personal history.

Behaviors Arguably⁸, the main difference between economists and emotion theorists lies in the fact that economists mainly try to explain behavior, whereas emotion theorists try to explain emotions.

This model does not distinguish between behaviors and emotions. Both could be part of the optimal, rational action. When facing a danger, it could be optimal and rational for any individual to be scared (emotion) and run (behavior). But other, more complex, situations could involve an infinity of behaviors or emotions, that would not necessarily be justified rationally.

So that emotions and behaviors could be part of both the rational action, and of the bias, and as such be explained by the introduction of a second agent, the unconscious, endowed with an alternate and specific grid of lecture of the reality.

⁸See Elster [7].

On individuality and collective unconscious Given a certain environment, we should all react to it in the same rational way. The optimal, rational action is unique, up to a white noise.

On the contrary, the bias encompasses all the features that constitute our personality : our thoughts, feelings, habits, tastes, etc. It is highly personal : actually, *it is* what sets us as pure, unique individuals.

However, the bias will not disappear through aggregation, since most of these phenomena can be induced by unconscious collective schemes. The economic activity or decision process being necessarily a part of psychic activity, one cannot distinguish one from the other.

A alternate look on emotion regulation A open question in human affective neuroscience today is to determine whether emotion regulation is a specific process, or if it is inherent to the emotion process.

Because the bias encapsulated the difference of information between conscious and unconscious, this model suggest that it will be regulated once the information gap will be filled, i.e. when the bias will be so strong that the information of the unconscious will be heard by the conscious.

Example We have all experienced fits of anger. How does anger evolve? At first, it is manageable. We reason ourselves. However, if the source of our anger does not disappear, we will eventually utter it out. We will shout until, at some point, our anger will disappear by magic.

The present model suggests that the anger is caused by a perception of the unconscious, is encapsulated in the bias to the rational action. When uttered out, the perception of the unconscious is explicitly

5.5 An economic approach to social interactions

The way we interact with others crucially depends on our perception of their behaviors.

The way we perceive others' actions How do conscious agents perceive other people's action ? The answer is straightforward. As conscious agents, we perceive them as a mix of action, some of them fortunate, some others unfortunate. Among all these actions, some will be intended, some other will be unintended, may they be good or bad. Our conscious will be able to distinguish the active, intended part of others' actions, and differentiate it from what must be unintended.

But if we admit that conscious and unconscious ignore one another, how could the dual agent perceive other people's action?

Here, two cases can arise: either the unconscious perceives himself as "omnipotent" within the dual agent, or he perceives his action as modified by the conscious agent acting along his side.

One unconscious interacting with other unconscious If the unconscious believes that he alone - as the best informed agent - decides every single action, controls everything within the mind of the dual agent, then he must consider the behavior of others as being the pure optimization of a single, and perfectly rational agent, i.e. a fully "conscious" unconscious agent.

In this case, he will never see others' actions as a "pure accident". He will never see the bias in the other's behavior as unintended or irrational. He will rather treat it as being part of a wider optimization, that has a purpose, and even more so, is of critical importance to the other's utility.

One can infer from this that an unconscious perceives others' actions, whatever they may be, as fully intentional, and being part of their utility.

One dual agent interacting with other dual agents Alternately, if the unconscious knows he is not alone, he also knows that his action will be a bias within the dual agent's action. And by observing the biases of other people's actions, he can rightly interpret the biases in their actions as being driven by their unconscious.

He could easily infer, from every departure from purely rational actions, the revealed preference of the others' unconscious, and act in consequence.

Whatever the option taken, it should be obvious that the individual factual irrationality is by no means an irrational behavior to the dual agent. \$\$\$

5.6 An economic approach to psychoanalysis

The royal road to the unconscious The simple model presented here suggests that the most part of the unconscious activity takes place alongside the conscious activity, on a permanent basis. Basically, any material or immaterial action that departs from the pure rationality can be seen as bearing the mark of the unconscious.

Assessing the unconscious' action Considering the agent as a dual-agent would allow the observer to infer that, for any action that is both sub-optimal and systematically biased towards a specific outcome, this very bias is the sign of the unconscious' optimization.

Indeed, if for every action of the dual agent is \bar{a} such that:

$$\bar{a} = a^{opt} + \beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i)$$

there is a bias $\beta \sum (\gamma_i \theta_i^u - \alpha_i \theta_i)$ to the optimal social agent's action, a^{opt} .

To simplify the matter, whenever an action is associated with an emotion, this emotion could be analyzed as a bias induced by the unconscious agent within the dual-agent's action. Emotions are both the sign of the unconscious, and its first means of expression.

Dealing with the unconscious' action The bias resulting from the optimization of the unconscious is indeed observable by the conscious. It can therefore be dealt with.

Compensation If the dual agent could, with time, understand that he is facing a systematic bias in his actions, he could use this bias to overweigh his actions and compensate the unconscious bias. This approach does not imply any knowledge of the θ_n^u , but requires a constant effort to compensate for the bias, that is constantly recreated by the unconscious⁹.

Rationalisation A second approach would be to reduce the weigh of the unconscious within the optimization.

How can this be achieved? A system of trial and error could lead to guess the θ_i^u lying behind the unconscious optimization. This is the very purpose of an analysis, whether it is a psychoanalysis or other forms of personal analysis.

Reinterpreted in the context of this model, the purpose of such an analysis would be to inform the unconscious that his grid of lecture is not adapted to the actual context.

Retrieving the parameters of the unconscious Providing a methodology to actively and deliberately reduce the bias would prove our point by the same token, and if need be, validate our hypotheses. This requires some further hypothesis, and is left to be presented in a future paper.

This could be done by reducing the expression $(\gamma_i\theta_i^u - \alpha_i\theta_i)$, the difference of information between the conscious and the unconscious agents.

We can venture that, should emotions be regressed against the proper set of θ_i^u , they could be totally suppressed.

So that, if the rudimentary hypotheses of this model are correct, the royal road to a knowledge of the unconscious activities of the mind should not be dreams, as Sigmund Freud suggested¹⁰, but rather this emotive part of human activity, as revealed by the bias of the dual agent's optimization.

6 Conclusion

Modeling the unconscious as a second agent acting alongside the neo-classical rational "conscious" agent has proved to induce a bias in this "dual agent"'s optimization. This bias, although rational and optimal under the dual agent's perspective, is actually sub-optimal with respect to the actual context. Insofar as it is generated by predetermined collective schemes, it could persist despite aggregation.

The dual agent framework represents an alternative to the economic agent, and allows to consider its actions under a psychological angle. It provides a useful

⁹This ever-going correction is reminiscent of time inconsistency in monetary economics.

¹⁰See Freud [8].

theoretical framework to analysing emotionally-driven outcomes. Alternatively, it allows to consider psychological processes under an economical point of view.

The concepts that have been discussed here allow for a certain amount of extensions, both on theoretical and empirical grounds. On the theoretical side, the most obvious and immediate extensions are the introduction of dynamics, and interaction between conscious and unconscious, respectively. On the empirical side, tools to measure the bias in the dual agent's action should be developed.

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