

# Theoretical Appraisal of Satisfactory Decisions: Uncertainty, Evolutionary Ideas and Beliefs, and Satisfactory Time Use

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**Abstract**—Unsatisfactory experiences due to an information shortage regarding the future pay-offs of actual choices, yield satisficing decision-making. This research will examine, for the first time in the literature, the motivation behind suboptimal decisions due to uncertainty by subjecting Adam Smith's and Jeremy Bentham's assumptions about the nature of the actions that lead to satisficing behavior, in order to clarify the theoretical background of a "consumption-based satisfactory time" concept. The contribution of this paper with respect to the existing literature is threefold: firstly, it is showed in this paper that Adam Smith's uncertainty is related to the problem of the constancy of ideas and not related directly to beliefs. Secondly, possessions, as in Jeremy Bentham's oeuvre, are assumed to be just as pleasing, as protecting and improving the actual or expected quality of life, so long as they reduce any displeasure due to the undesired outcomes of uncertainty. Finally, each consumption decision incurs its own satisfactory time period, owed to not feeling hungry, being healthy, not having transportation...etc. This reveals that the level of satisfaction is indeed a behavioral phenomenon where its value would depend on the simultaneous satisfaction derived from all activities.

**Keywords**—Decision-making, idea and belief, satisficing, uncertainty.

## I. INTRODUCTION

RATIONAL decision theory models of choice assume that decision-makers know of behavior alternatives mapped upon the outcomes of actual choice options. In these models, the measurable possibilities of the payoffs are considered different from uncertainty [1], [2]. However, these models may fail in certain cases. None of these models provide an explanation for the reasons behind the change in expected outcomes after the choice has already been made. For instance, the existence of systematic biases in the decision made in these models can be criticized since it demonstrates that the models do not separate beliefs and choices according to optimal beliefs, hence the decision error making tendency could expected to be continuous [3]. In reality, the world compromises the conflicts and disagreements resulting from those unpredictable events that are connected to cognitive and environmental factors, security issues that inevitably influence (and orient) the human microcosm. Be that as it may, it remains to decipher the main determinants of unexpected variations in the outcome of a choice and their significance to

the decision-maker when uncertainty prevails.

The definitions of certain concepts used in the decision theory have to be clarified in order to answer this question and furthermore to gain an overall understanding of the satisfactory decision. The primary intent of this work is to investigate the connection between mental determinants of a decision, the roles of possession and time perception to a decision-maker when the payoff of a consumer choice is biased (i.e. a consumption shortage and/or inconsistencies between utility and satisfaction). To this end, the methodology of this work is to inquire into the existing literature to shed light on the necessary concepts to be used in decision making under uncertainty and their forgotten interpretations through selected authors. Adam Smith's and Jeremy Bentham's respective ideas regarding surprising events and on displeased experiences, as the pioneers in this field of research [4]-[6], are incorporated into the theory of bounded rationality by subjecting our findings into the satisficing type of decision-making. This methodology enables the reader to access refined information by condensing, summarizing, and integrating this vast literature on action into a single work with the intent of informing and conceptualizing from a historical perspective.

Accordingly, the first part of this paper is dedicated to clarifying the relationship between the role of the possessions and two mental factors of the decision, that is, ideas and beliefs, with their emotional counterparts, when uncertainty prevails. In the second part, the satisficing approach to decision-making is introduced so as to better demonstrate the temporal aspect of a satisfactory decision under uncertainty. Finally, our findings from both analyses necessitate distinguishing the perception of a satisfactory decision from that assumed by the theory, which in turn allows us to introduce the consumption-based satisfactory time concept to economic literature.

## II. UNCERTAINTY AND MENTAL PATTERN OF DECISIONS IN THE WORKS OF SMITH AND BENTHAM

### A. Adam Smith on Uncertainty

Adam Smith [7] made important remarks regarding the dynamism of the mental component of the decision, such as in which way the logic and the methodology of the mental judgment may impel the human action [8]. He uses a behavioral-psychological methodology in which *wonder*, *surprise*, and *admiration* are three sequential sentimental moments which have distinct sentimental propriety. These

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three-fold sequences of sentiment are used by Smith when he explains the existence of uncertainty. Briefly speaking,

- 1) Smith considers the mental occurrence of wonder as the first moment before losing the mentally calm state associated with the nature (law, order and security). The occurrence of wonder could be explained by apprehension of an unexpected danger.
- 2) The distinguishing feature of surprise from its predecessor is simply that the initial mental state, based upon the ideas and beliefs, collapses. The unknown information cannot be explained by the usual logic of mental judgment<sup>1</sup>. The continuum between the realities imagined from the past through to the predicted future, is temporarily lost. The decision-maker interprets the new situation to mean that the future state can no longer be as it was once believed; hence, the experience of pain.
- 3) Motivation then becomes a simple wish to return to the initial mental calmness, a desire that itself necessitates comprehension of the reason behind the surprising event. The new calm state of mind gives birth to a special type of serenity derived from recognizing the amazing natural-harmonic motions of nature; so-called admiration.

According to Smith, uncertainty would exist whenever the habit of the imagination, determined by the association of the ideas for the observed objects, to pass from the conception of the one to that of the other be interrupted. In this relationship, the idea and belief supposition in Smith's uncertainty prescription points out that surprise and admiration moments would underpin the existence of uncertainty in a different manner. That is to say, according to his behavioral aspects of uncertainty, the ideas are more likely represented as the successiveness of the events, while the beliefs are simply the trust in the sequence of these events and in desired outcomes of the decisions. More in detail, the ideas conceived before making a decision consist of the knowledge of the mechanism (the way of operating) behind the anticipated sequential events. This knowledge is originally learnt from similar past experiences, where the satisfactory outcomes of a choice will essentially depend on the constancy of the ideas (as the anticipated sequential events) while arriving at the desired end. Thereby, uncertainty is intrinsically related to the problem of the constancy of ideas and not related directly to beliefs. The fact is that, beliefs are necessarily corrected retroactively by new ideas, owing to new information "provided" by uncertainty.

From the moral point of view, uncertainty has a special role in works of Adam Smith. The economic actors driven by an internal struggle between their impulsive, fickle and indispensable passions, and their impartial spectator [9] the economic behavior is mainly motivated by self-interest [10]. As a distinguishing normative character of Smith's analysis, uncertainty or "deception" plays a central role in defining his ideal typology because active, sober, creative entrepreneur's behavior include error-making tendency: the invisible hand

<sup>1</sup> The philosophy represents this invisible chain allows the binding together of all these disjointed objects.

brings the sentiment of error-making as the uncertainty to the actors [11]. Thereby, uncertainty is a necessary condition for the development of the science and so the commerce [12].

As a necessary consequence of behavioral and moral aspects of uncertainty, wealth increases (owing to an improvement in the nature) as long as uncertainty (as an error-making tendency) decreases within the economy. Recognition of pain and suffering brought about by uncertainty yields higher welfare levels reached at the time of each market at equilibrium. Thus, possessions are resulting from morally corrected decisions and their creation must respect this triple mental process whenever uncertainty exists.

The overarching question is then to know whether possessions could also be used to mitigate negative effects of uncertainty on a healthy state of body and mind.

#### *B. Jeremy Bentham on Uncertainty: the Role of Possessions*

Every decision, according to Bentham, is mainly motivated from the outset, where the individual seeks pleasure and doesn't resist feelings of pain [13], [14]. Bentham doesn't directly refer to uncertainty in his theory of motivation. However, uncertainty can only be analyzed through his optimistic assessment of happiness [15]:

- i) Any undesired experiences, whether due to uncertainty or not could automatically be categorized as the cause of pain by Bentham. In this sense, Bentham doesn't give prior importance to the role of uncertainty while constructing his theory of action. More specifically, *pain* exists every time expectations are suddenly destroyed by an unexpected event which, in turn, future pleasures are erased.
  - ii) Uncertainty, according to Bentham, seems to be corresponding to emotional inconstancy over a certain period, that is caused by an undesired experience for which an instantly calculated past value for the (expected) future pain and the pleasure taking place before the action therefore, are proven not to be *true*. Beliefs that exist based upon experiences create ideas in the form of pleasure of imagination and expectations are, indeed, wrong.
- Bentham ideas emulate those of Adam Smith. However, Bentham seemed aware of this contrast in methodology in his optimistic assessment of happiness, that it rests specifically in the continuum of pleasure, and subsequently introduced the concept of hope to deal with this problem.
- iii) At any given moment, there are always some pleasures of expectation and desire 'in action', and they may serve to act as a counter-balance to an intense pain that is simultaneously being suffered, for example, every time that a pain of disappointment gives place to the dawning of a new hope. Thus, hope eliminates fear; the desire endowed with a peculiar dimension of 'fecundity' becomes a generator of wealth and welfare [16].
  - iv) In fact, possessions are representing as the source of hopes which symbolize not only the source of any sort of pleasure, but also as an insurance against avoiding any pain connected to future security issues. Consequently,

pleasures of hope exist if the trust in already present consumable choice options (and their envisaged pleasures as the beliefs), at this very moment of disappointment, is strong enough to overcome the negative effects of anticipated or unanticipated undesired future experiences on a future healthy state.

In Bentham's estimation, possessions mitigate the negative effects of uncertainty on the future health of body and mind. However, it is important to ask what the criteria is for satisfactory outcomes of a choice when possessions are not enough to improve the future state, due to deprivation, as in this case, [or] a lack of resources. The answer does not reveal itself in the works of Jeremy Bentham. However, if needs could not be satisfied, because of a lack of resources, a feeling of hope would never be strong enough to initiate the pleasure of expectation at this very disappointing moment, resulting in ill-being. At the limit of Bentham's decision analysis, this possibility raises the question of the meaning and ultimate criteria for satisfactory decision-making where uncertainty exists.

### III. SATISFICING DECISION-MAKING

In neoclassical economic thought, feelings of desire or pleasure are used when defining utility. Following Benthamite tradition, utility determines happiness as the sum of the pleasures created [17]. Utility is mainly attributed to the capacity to satisfy an individual's needs and desires by means of acquiring material possessions. A decision is conditional on the existence of a one-to-one mapping relationship between the intensity of a desire and the intensity of the satisfaction resulting from the realization of this desire. In other words, it necessarily requires satisfaction to be the sole object of desire [18].

The only way that the uncertainty concept can be analyzed within the neoclassical decision-making pattern lies in the utility theory. Even if the neoclassical utility theorists were to hold pleasure as the proxy of the fulfillment or the anticipated satisfaction of a desire, there indeed seems to exist a temporal distinction between utility and satisfaction on which the uncertainty perceptions of Adam Smith and Jeremy Bentham lie. That is to say, uncertainty would only be any sort of dissatisfaction stemming from the difference between ex-ante and ex-post utility. This type of uncertainty may only be explained by the Smithian idea and belief in inconsistency (i.e. dissatisfaction due to unexpected changes in sequences of ideas connected to the environment) or precisely by Benthamite disappointment (i.e. dissatisfaction due to the insufficient pleasure felt from expected possession or consumption).

In this respect, a more convenient explanation would be to assume that a decision can be identified as optimal or sub-optimal after a trial. Whenever new information regarding an expected payoff of a previous choice is gathered, a decision-maker would determine a new decision strategy. That is to say, previous expectations (as believed outcomes of the past choice) could instantly be replaced by new ones, as the extension of the old one, in the way of reaching as close as

possible to the desired payoff. This satisficing type of approach to decision-making allows individuals to satisfy their needs as soon as they possibly can by eliminating undesirable conditions due to uncertainty.

#### A. Satisficing under Uncertainty

A shortage of the necessary information, due to human cognitive limits or to the environmental structure, for determining the best strategy for the satisfaction of a given need implies that the decision-makers are boundedly rational. Insufficiencies of information cause the choice of an inadequate strategy before action is made, called *information surrogate* (in the strategy set) or *uncertainty* [19]. Therefore, uncertainty only exists whenever a decision-maker has realized that a chosen strategy is sub-optimal. The shortage of necessary information is interpreted in return as the source of "erroneous" prior beliefs regarding the desired outcomes of a choice. Simplified decision-making approach by satisficing decision-making assumes that:

- i) In any moment of decision-making, existing choice options included in the strategy set are classified as either satisfactory or unsatisfactory, according the desired levels of outcomes (cardinal utilities) relative to an agent's actual aspiration level [20], [21].
- ii) Thus, a decision-maker may choose one of these choices without reasoning whether the solution may or may not be optimal. A decision can be identified as optimal or sub-optimal after the trial. The idea is that every strategy is simple, computationally tractable, and rational, although selecting a strategy may not always be rational [22].
- iii) The selection of an *acceptable* or *satisfactory* solution that meets an agent's minimum *aspiration-level* or *threshold*, a threshold, under which solutions are deemed *unacceptable* is called satisficing [23].

Thus, each choice aims to minimize the undesirable difference between desired and realized outcomes but not to maximize the payoff. Assumption analysis of satisficing decision-making behavior has five basic features:

- 1) The knowledge (information) regarding the future state of nature for actual possible choices is incomplete.
- 2) Two-step decision-making processes: first to consider the possible outcomes for the satisfactory outcomes and later determine alternatives for obtaining plausible outcomes.
- 3) Decision-maker *learns* how to reach a satisfactory end (goal) by dynamically updating the strategy set (behavior alternatives): Adaptive behavior by *information gathering*.
- 4) Information gathering is not costly; it is used for minimizing the cost of actions.
- 5) Decision-maker's aspiration level may differ from one moment to another. Consequently, "good enough" instead of "best" choices (moves) are categorized as satisfactory.

Updated beliefs owing to the information-gathering, phase-generated learning processes, are the touchstone for the new classification of existing choices as satisfactory or unsatisfactory, within the actual strategy set and for the actualization of an aspiration level with regards to an expected

payoff.

### B. Decisions Made under Uncertainty

Since the organism, like those in the real world, has neither the senses nor the wits to discover an "optimal" path-even assuming the concept of 'optimal' to be clearly defined- we are concerned only with finding a choice mechanism that will lead it to pursue a "satisfying" path, a path that will permit satisfaction, at some specified level, of all of its needs [24]. The satisfying type optimization-decision can be tested by identifying how the principle of satisfaction preceded the choice mechanism, while the environmental structure influences an organism's external and internal constraints via its perceived power, energy storage capacity...etc. The "environment" is the considered organism's "living space". Hence, it will depend upon the "needs", "drives" or "goals" of the organism, and upon its perceptual apparatus.

Adaptive behavior for the given environment respects five assumptions:

- i) All activities (as actions) could be classified within two categories as working and not working. Working activity consists of labor supply and buying market goods. Not working corresponds to consumption.
- ii) Consumption is source of energy and consumption creates total time spending between these activities.
- iii) Resting (i.e. leisure) is the time that measures difference between total time and activities.
- iv) Knowledge (as information) determines the share and type of activity and resting time.
- v) Satisfaction depends on three parameters:
  - 1) Consumable possessions and the limits to acquiring new possessions.
  - 2) Minimizing energy spent (i.e. time) on a working activity.
  - 3) Information gathering capacity.

Regarding these five principles, decision patterns under uncertainty at satisficing approach could be defined as follows: at any moment of realization that the decision is wrong, the organism updates its current choices as possessions, which allow for a solution to be found by minimizing the energy spent (i.e. working activity), defined in the satisfactory strategy set, depend on the new level of aspiration. An increase in the range of choices or in available information can simply be represented by changes in behavior, alternatives which make life better.

During this mental calculation processes, the motivation of a satisfactory action corresponds to appropriate actions (such as working and consumption) providing longer resting time, as much as possible: As a matter of fact, resting time becomes the source of happiness such as the leisure time used for recreation and for the continuation of actions. This time allows for cost-minimization. In other words, the organism uses the resting time for activities such as learning, adaptation and finding ways to increase his efficiency to get satisfaction. In fact, the pleasure of consumption gradually decreases or even turns into a feeling of pain whenever a desired consumption action is not accomplished. The logic underpinning this idea is that it is not possible to move from an undesirable painful state

to desirable pleasant state without an action, while the inverse of this statement is not true. The action is motivated by a decrease in pleasurable resting (leisure) time, due either to any expected event or not, in total time brought about by distress caused by pain or fear of feeling pain. A decision-maker would have a desire to extend the length of the resting time in a total period. The *hope* to abstain from actual distress requires adequate consumption. The strength of this hope, indeed, depends on the belief in the eliminatory power of real consumption choice options represented in the choice set.

### IV. THE THEORY: CONSUMPTION-BASED SATISFACTORY TIME

Satisficing approach reveals a distinct pattern of time in making decisions. No matter what type of action a decision-maker takes, working, not working, or resting, every consumption activity determines the amount of time. In other words, economic time is not exogenous and, on the contrary, it is internally created by each consumption activity. However, consumption is only realized during resting time; hence always pleasurable. Note that this perception of time is the not so different from the consumption time description given by the time allocation theory [25]. Furthermore, time allocation theory also assumes that there is mainly working and non-working time. Consumption requires time and it is considered as not so different from other components of time in daily life.

It could be argued that we cannot think about time without consumption or consumption without time. In fact, consumption never stops. We propose defining the concept of *consumption-based satisfactory time*. Respecting to our findings above, at that point, three additional hypothetical distinctions regarding standard theory had to be made:

- 1) Each consumption decision determines a specific period of time that consists of satisfactory leisure time owing to *not feeling hungry, being healthy, not having transportation...etc.*
- 2) Satisfactory leisure time value is the period that passes between two similar consumption moments. During this time, other achieved consumption activities, one inside the other, will give their own units of time and so on. In this sense, the utilities of satisfactory times are dependent on each other and successively connected to previous ones. In this sense, working time is not different from non-working time since both are part of these satisfactory times.
- 3) These two corollaries are together suggesting that consumption-based satisfactory time values for each activity also determine the level of life satisfaction for individuals. Thus, total satisfactory time is continuous and given by superposition of these satisfactory time intervals. Individuals benefit, each moment of life, from his or her already satisfied needs.

#### A. The Model

Supposing that an individual possesses  $M$  quantities of economic goods  $x_m$ ,  $m=1,2,\dots,M$ , classified within  $N$  consumption groups  $x_n$ ,  $n=1,2,\dots,N$ , so that  $x_{11}\dots x_{MN}$ .

**Proposition 1.** Total consumption-based satisfactory time

values would be obtained by adding up the temporal algebraic vectors

**Proof 1.** Let the time vector  $\mathbf{T}$  comprise of the satisfactory time between the last two consumptions of similar  $x$  in  $M$ . The position of this individual is given by the vector  $\mathbf{T}$  which can be carried out with the origin of the  $M$  dimensional space in a rectangular coordinate system at the time point  $(T_{11}, T_{21}, \dots, T_{12}, T_{22}, \dots, T_{MN})$ . Thus, the total consumption-based satisfactory time values for each consumption group could be obtained by following the equation:

$$T = \langle T_{11} + T_{21} + \dots + T_{M1}; T_{12} + T_{22} + \dots + T_{M2}; T_{1N} + T_{2N} + \dots + T_{MN} \rangle \quad (1)$$

**Proposition 2.** The temporal order between consumption moments could be calculated by subtracting each satisfactory time from the total time.

**Proof 2.** The length of total time is then equal to

$$|T| = \sqrt{(T_{11} + T_{21} + \dots + T_{M1})^2 + (T_{12} + T_{22} + \dots + T_{M2})^2 + \dots + (T_{1N} + T_{2N} + \dots + T_{MN})^2} \quad (2)$$

Each consumption moment could be measured by a scalar value  $|T| - |T_{MN}|$  and bigger differences imply older consumptions. Let  $T_{1n} \in \mathbf{T}$  and  $T_{2n} \in \mathbf{T}$  are the two different satisfactory time values created by the consumption the goods  $x_{1n}$  and  $x_{2n}$ , respectively. Herein, there would only be three possible temporal orders between these consumption-based satisfactory time values at a given point of time (algebraic denotations are shown in parentheses): Individual consumes

- 1)  $x_{1n}$  before  $x_{2n}$ ; ( $|T_{1n}| < |T_{2n}|$ )
- 2)  $x_{1n}$  after  $x_{2n}$ ; ( $|T_{1n}| > |T_{2n}|$ )
- 3)  $x_{1n}$  and  $x_{2n}$  at the same time; ( $|T_{1n}| = |T_{2n}|$ )

The consumption-based satisfactory time values are additive in a continuous order. More precisely, if temporal order refers to consumption case 1 or 2, another satisfactory consumption time interval would have to exist, seen between  $T_{1n}$  and  $T_{2n}$ . Assuming the third time interval is  $T_{3n} \in \mathbf{T}$ , therefore  $|T_{1n}| - |T_{2n}| = T_{3n}$  with  $T_{3n} \geq 0$ . Thus, temporal order 1 would in turn imply three order possibilities<sup>2</sup>.

- 1)  $|T_{1n}| < |T_{3n}| < |T_{2n}|$
- 2)  $|T_{1n}| < |T_{3n}| = |T_{2n}|$
- 3)  $|T_{1n}| = |T_{3n}| < |T_{2n}|$

*B. Axioms of Choice Theory*

Following the basic methodology on preferences system [26], the choice of the individual is not such that every infinitesimal movement around position  $\mathbf{T}$  is zero choice. Supposing that  $\mathbf{u}$  is a direction vector directed along the normal to  $L_\mu$ ,  $L_\mu$  is a linear variety with  $\mu$  extended

<sup>2</sup>These conditions for the order case 2 imply  $|T_{1n}| > |T_{3n}| > |T_{2n}|$ ,  $|T_{1n}| = |T_{3n}| > |T_{2n}|$  and  $|T_{1n}| > |T_{3n}| = |T_{2n}|$  respectively.

dimensions in  $M$ -dimensional space ( $\mu < M$ ). Let  $\partial\mathbf{T}$  be an infinitesimal movement around  $\mathbf{T}$ . Herein we see that the possible values of  $\mathbf{u}\partial\mathbf{T}$  are distributed around  $\mathbf{T}$  in a similar way to the preferences of the individual. More precisely, if  $\partial_1\mathbf{T}$  and  $\partial_2\mathbf{T}$  are two infinitesimal movements around  $\mathbf{T}$ , then the choice of the individual would be defined within

$$(\mathbf{T}\partial_1\mathbf{T}) \mid (\mathbf{T}\partial_2\mathbf{T}) \quad (3)$$

due to the fact that

$$\mathbf{u}\partial_1\mathbf{T} \mid \mathbf{u}\partial_2\mathbf{T} \quad (4)$$

The product of  $\mathbf{u}\partial\mathbf{T}$  defines the utility of the movement  $\partial\mathbf{T}$  around fixed point<sup>3</sup>  $\mathbf{T}$ . Therefore, the simultaneous satisfactory consumption possibility would imply two extra cases for inequalities (3) and (4). Let an infinitesimal movement of  $\partial_3\mathbf{T}$  be defined under the utility of this movement  $\mathbf{u}\partial_3\mathbf{T}$ , thus

$$(\mathbf{T}\partial_1\mathbf{T}) < (\mathbf{T}\partial_3\mathbf{T}) + (\mathbf{T}\partial_2\mathbf{T}) \quad (5)$$

since

$$\mathbf{u}\partial_1\mathbf{T} < \mathbf{u}\partial_3\mathbf{T} + \mathbf{u}\partial_2\mathbf{T} \quad (6)$$

or

$$(\mathbf{T}\partial_1\mathbf{T}) + (\mathbf{T}\partial_3\mathbf{T}) > (\mathbf{T}\partial_2\mathbf{T}) \quad (7)$$

due to this

$$\mathbf{u}\partial_1\mathbf{T} + \mathbf{u}\partial_3\mathbf{T} > \mathbf{u}\partial_2\mathbf{T} \quad (8)$$

The right hand side of the inequality (6) and left hand side of inequality (8) are shown by the displacement vectors  $\overline{\mathbf{u}\partial_3\mathbf{T}\mathbf{u}\partial_2\mathbf{T}}$  and  $\overline{\mathbf{u}\partial_1\mathbf{T}\mathbf{u}\partial_3\mathbf{T}}$ , respectively, starting from the fixed point  $\mathbf{T}$ . These effects, combined called total utility, consist of the sum of simultaneous movements given by these displacement vectors.

*C. Axiom of Superposed Utilities*

The definition of “axiom of superposed utilities” is as follows: All movements of  $\partial\mathbf{T}$  necessitate consumption of economic goods  $x \in M$  and create satisfactory time values  $T$ . The utility function  $U(\cdot)$  with  $U: (x, T) \rightarrow P_+^M$ . Suppose two consumption goods  $x_1$  and  $x_2$  would simultaneously be consumable. Thus,  $U(x_1, T_1; x_2, T_2)$  and  $U: (x_1, T_1) \times (x_2, T_2) \rightarrow P_+^M$  with both  $u_1: (x_1, T_1) \rightarrow P_+^M$  and  $u_2: (x_2, T_2) \rightarrow P_+^M$ . Utilities are superposed if the consumer prefers to consume both goods

<sup>3</sup> The values of the components  $u_1, u_2, \dots, u_M$  of  $\mathbf{u}$  explained are marginal utility values of the good 1, 2, ... M at point  $\mathbf{T}$ . Thus we have the direction of maximum values but not the size of these marginal utilities. Thus, in plan  $L$ ,  $\mathbf{u}\partial\mathbf{T} = \mathbf{0}$ , which is equal to  $u_1\partial T_{1n} + u_2\partial T_{2n} + \dots + u_{MN}\partial T_{MN} = 0$ .

simultaneously since

$$U(x_1, T_1; x_2, T_2) \geq u_1(x_1, T_1) + u_2(x_2, T_2) \quad (9)$$

The superposed utility axiom of this inequality does not violate the initial position axioms of choice, transitivity and the addition rules of rationality assumptions of neoclassical consumer preferences properties:

- 1) Axiom of choice: The position of an individual is given by  $\mathbf{t} \in \mathbf{T}$  and has two displacement possibilities such as  $\mathbf{y} \in \mathbf{T}$  and  $\mathbf{h} \in \mathbf{T}$ . There are three consumption (or exchange) possibilities for the commodities  $x_t, x_y, x_h$ . The choice is  $\mathbf{y} \succ \mathbf{h}$  since  $U(x_t, T_t; x_y, T_y) \succ U(x_t, T_t; x_h, T_h)$ .
- 2) Axiom of transitivity: Assume the third displacement is  $\mathbf{r} \in \mathbf{T}$  with  $x_r$ . If  $(\mathbf{t}, \mathbf{y}) \succ (\mathbf{t}, \mathbf{h})$  and  $(\mathbf{t}, \mathbf{h}) \succ (\mathbf{t}, \mathbf{r})$ ; the choice is  $(\mathbf{t}, \mathbf{y}) \succ (\mathbf{t}, \mathbf{r})$  since  $U(x_t, T_t; x_y, T_y) \succ U(x_t, T_t; x_h, T_h) \succ U(x_t, T_t; x_r, T_r)$ . The same is true in the case of " $<$ " and " $=$ ".
- 3) Axiom of addition: Assume the fourth displacement is  $\mathbf{s} \in \mathbf{T}$  with  $x_s$ . If  $(\mathbf{t}, \mathbf{y}) \succ (\mathbf{t}, \mathbf{h})$  and  $(\mathbf{t}, \mathbf{r}) \succ (\mathbf{t}, \mathbf{s})$ ; the choice is  $(\mathbf{t}, \mathbf{y}, \mathbf{r}) \succ (\mathbf{t}, \mathbf{h}, \mathbf{s})$  since  $U(x_t, T_t; x_y, T_y; x_r, T_r) \succ U(x_t, T_t; x_h, T_h; x_s, T_s)$ . The same is true in the case of " $<$ " and " $=$ ".

#### D. Maximization of Utility

Supposing that  $U$  is a differentiable function of the combination of at least two economic goods defined in the economic good vector  $\mathbf{x}$  and we consider all possible directional derivatives at a given point, in which of these directions does  $U$  change fastest and what is the maximum rate of change?

The gradient of the utility function at its initial position is  $\nabla U(\mathbf{x}, \mathbf{T})$  and the directional derivative (in direction  $\delta$ ) at this initial point is  $D(\mathbf{x}, \mathbf{T}, \delta) = \nabla U(\mathbf{x}, \mathbf{T})' \delta$  (the notation  $'$  denotes the transpose of a vector). This directional derivative indicates the slope of the utility function in the direction  $\delta$ . Specifically, if the differential of the consumption combination decision is  $d(\mathbf{x}, \mathbf{T}) = \delta d\alpha$ , where  $d\alpha > 0$ , the differential utility change is  $dU(\mathbf{x}, \mathbf{T})/d\alpha = D(\mathbf{x}, \mathbf{T}, \delta)$ . The idea is that of the consumption combinations for unsystematic partial measures taken over a period determine the consumption directions,  $\delta$ , making this directional derivative positive [27]. In this respect, rather than searching for combinations with positive directional derivatives, we characterize the direction vector,  $\delta$ , that maximizes the differential change in our objective. The locally optimal utility problem is expressed formally as

$$\max_{\delta} \{ \nabla U(\mathbf{x}, \mathbf{T})' \delta \} \quad (10)$$

The solution for  $\delta$  is,  $\delta^* = \theta \nabla U(\mathbf{x}, \mathbf{T})$  and  $\theta = |\nabla U(\mathbf{x}, \mathbf{T})|^{-1}$  for  $\forall \theta > 0$  where  $\nabla U(\mathbf{x}, \mathbf{T})$  is the gradient vector, whose elements are the partial derivatives  $\partial U(\mathbf{x}, \mathbf{T}) / \partial (x_i, T_i)$ ,  $i = 1, 2, \dots, n$ , and  $\theta$  is the length of the gradient vector. In this solution, the maximum value of the direction derivative and the Euclidean

length of the gradient vector occur when the unit vector has the same direction as  $\nabla U(\mathbf{x}, \mathbf{T})$ . It is assumed that the best combination always yields improvement in the utility function.

#### V. CONCLUSION

Adam Smith and Jeremy Bentham's works on decision-making together provide a perfect tool for making an adequate analysis of the problem of the not well-posed relationship between uncertainty and satisfactory action. However, Smith's and Bentham's analyses do not provide sufficient basis for the justification of the decision pattern whenever the choice possibilities are limited due to a shortage of possessions. The satisficing decision-making approach seems at first glance to be a solution to the problem of making satisfactory choices despite a lack of resources under uncertainty. Even so, the satisficing approach can be viewed as an incomplete model, since time is assumed to be two separate entities relating to the type of sentiment; as pleasure and pain are produced during different activities. The theoretical contribution of this paper to the literature is to define and prove the consumption-based satisfactory time approach: each group of consumption determines a specific satisfactory time period owing, for instance, to not feeling hungry, being healthy, not having transportation...etc. The utilities defined over these satisfactory times are codependent and continuous since they are successively connected to preceding ones. Thus, the time intervals are necessarily superposed since consumers always prefer to consume at least two goods simultaneously.

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