Do individuals adopt non-compensatory decision making heuristics?

Preliminary evidence from health-care

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ABSTRACT

Utility theory assumes that when presented with alternative scenarios, individuals adopt a compensatory decision-making process. That is, they consider the levels of all the attributes, and, based on these levels, choose the scenario that yields the highest utility. However, very little work has examined this assumption. The psychology literature indicates that respondents often employ simplifying rules of thumb in decision-making, employing 'fast and frugal heuristics'. This paper describes an attempt to explore this hypothesis, making use of readily available data. Particular attention is given to the 'Take-The-Best' (TTB) heuristic, a boundedly rational decision rule in direct conflict with the economic axiom of continuity (compensatory decision making)

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INDICE

1. INTRODUCTION

[T]he deviations of actual behaviour from the… [expected utility] model are too widespread to be ignored, too systematic to be dismissed as random error…"

Tversky and Kahneman (1986)

According to a most influential tradition, economics is "the science of rational behaviour" and, beyond dispute, optimisation theory is widely considered the best way to represent it. Most economic analyses continue to focus on maximisation and on what movement towards that goal entails. Yet, as Leibenstein (1979) observed more than two decades ago, "it is rare to find anyone arguing that maximisation is a universal description of behaviour... it is an assumption that it is most frequently stated rather than supported." Suppose then that people fundamentally and individually "misbehave" as Tversky and Kahneman (*op.cit*) indicate they do. Suppose they do not maximise. In which way then do they actually make decisions about economic matters? A new frontier of exciting ideas awaits us.

As we discuss throughout, the overwhelming behavioural evidence against a literal interpretation of the rational model as a universal model of choice makes attention to the process of decision making and formation of values critical. While the consumer's wiring may produce patterns of behaviour that in many cases can be approximated by the standard model, when we approach the consumer from a different angle, asking direct and unusual questions about beliefs and values, we find alarming variations from the standard economist's story. Preferences play a role, as may maximisation, but they seem to compete with other heuristics for defining and solving the cognitive task (Payne, Bettman and Johnson, 1988; Gigerenzer and Goldstein, 1996, 1999). The purpose of this paper is anew claiming for the need to realise a union between psychology and economics when analysing consumer choice behaviour. Psychology can teach us, economists, important facts about how human beings differ from the way we traditionally describe them.

This paper is structured as follows. Section 2 considers the concept of rationality, and its interpretation within both Economics and Psychology. It is shown that there is a growing body of evidence challenging the standard economic model of (unbounded) rationality. Whilst there are a number of alternative forms of bounded rationality proposed in the literature, we concentrate in Section 3 on the so-called "fast and frugal heuristics" for decision-making and their potential as an alternative approach to explain individuals actual choices. This is a new and exciting theory developing in Psychology with potentially direct relevance to Economics. One of the main tenets of this theory is the challenge to the classical assumption of compensatory decision making in advocating that individuals adopt simple ("fast" and "frugal") heuristics. All in all, these approximate optimal behaviour and therefore make them, the respondent/subject, smart. In Section 4, we first review the existing evidence in the health economics literature about non-compensatory choices. Then we propose an alternative "*fast and frugal*" way of analysing data from discrete choice experiments enabling for non-compensatory choices as opposed to the conventional (compensatory) regression approach. Some preliminary results from on-going work are pointed out. We declare some concerns about the approach encouraging future research. We close with some conclusions in Section 5, agreeing with Schwartz (2000) that science often progresses by combining disciplines that previously seemed ill-matched and therefore economics could, or maybe should, progress by merging with psychology.

2. RATIONALITY IN ECONOMICS AND PSYCHOLOGY

2.1 Rational choice in Economics

A critical issue underlying the discussion about rationality centres on what economists mean by the concept of rational choice behaviour. It is important to distinguish between two meanings, one quite broad and the other quite specific (Hogarth and Reder, 1987). In the broad definition of rationality economists are referring to a paradigm which supposes that the individual has a utility function whose arguments are defined as alternative uses of the resources which s/he is endowed. The quantities of these resources are interpreted as constraints on the possible choices available to the decision-maker so that rational behaviour consists of determining the set of resource quantities to be devoted to each of the possible uses as the solution to a constrained maximisation problem. Few, if any, psychological assumptions are needed.

Yet, for many applications the broad definition of rationality lacks specificity. It is therefore often replaced by the narrower definition of maximising expected utility (von Neumann and Morgenstern, 1944) which does depend on strong psychological assumptions. To say that a person maximises utility is to say that when confronted with an array of options, she picks the one she believes best serves her objectives.

In a contemporary view (Ben-Akiva et al, 1999), choice behaviour can be characterised by a decision process, which is informed by perceptions and beliefs based on available information, and influenced by affect, motives and preferences. Figure 1 depicts these elements. The darker arrows in Figure 1 explain the standard economic model for choice in which collected information on alternatives is converted, via some cognitive process, into perceived attributes that are then aggregate into a utility index which is maximised.

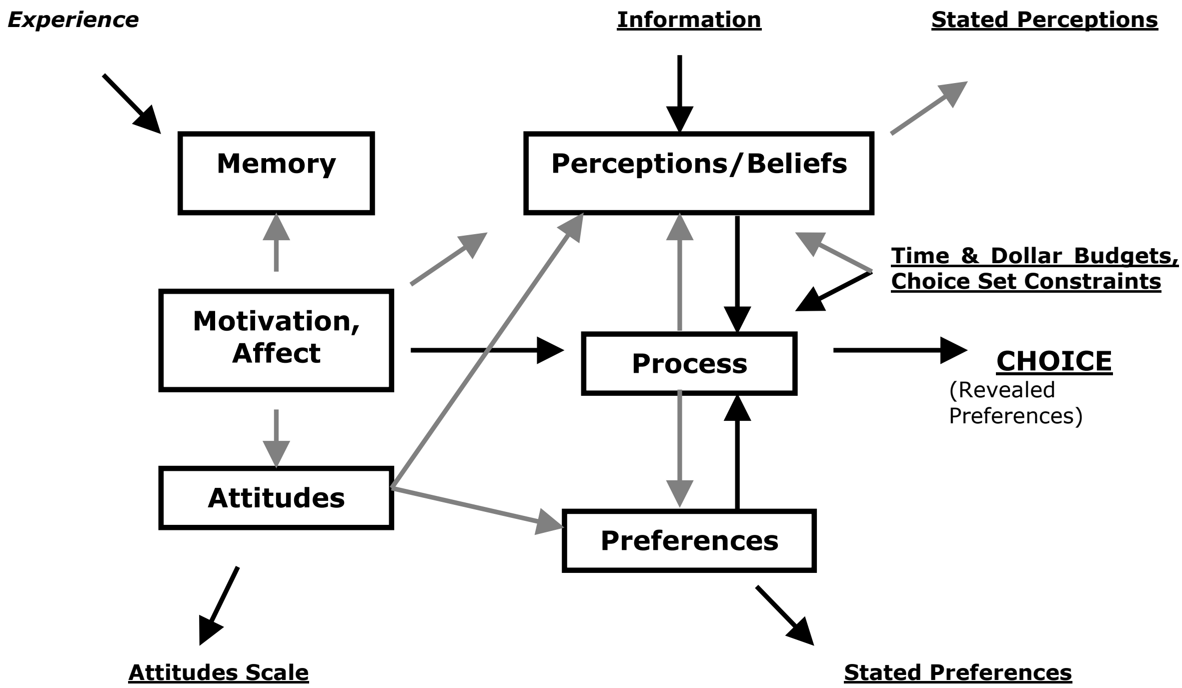

Figure 1 The Choice Process. Source: McFadden, 2001

However, the procedures by which what McFadden (1999) calls the "Chicago man" [1] arrives at his choice are not essential for most economic applications and the decision process is a black box. This seems to have been more the area of interest for psychologists.

Economic opinion spans the spectrum from those who believe that unbounded rationality and the Chicago man is the literal truth to those who believe that failures of rationality appear systematically and predictably in economic decisions. It is probably the reality that most economists think of the Chicago man as an abstraction or approximation not really expected to work perfectly.

[1] Since the postulated behaviour includes the ubiquity of maximising behaviour associated to Becker (1976) and the structure of beliefs associated to Lucas (1987).

While mathematically beautiful and prevailing in contemporary economics, since with additional assumptions it leads to straightforward and convenient procedures for Cost-Benefit Analysis, the Chicago-man model appears unnecessarily strong. The standard arguments for unbounded rationality (Conslik, 1996), despite their great influence, seem too extreme to be convincing as there is a long history among economists of questioning its behavioral validity and seeking alternatives (Thaler, 1991)

Moreover, a growing array of psychological findings – mainly of experimental nature - has documented systematic departures from the classical dictates of perfect unbounded rationality when making choices (Allais, 1953; Rabin, 1998; Selten, 1991). Hence, although one cannot help but admire this idealised view of decision-making, its greatest weakness is that it does not describe the way real people behave. Then McFadden (1999, p. 5) wonders:

"What is it with economists and Chicago man? Why is it that when economists are confronted with behavioural evidence against this model, they shuffle their feet, mumble excuses and go on doing what they have been doing?"[2]

It is to this psychological literature that we now turn.

2.2. Beyond the "Chicago-man": the psychology of choice behaviour

The complex psychological issues underlying choice behaviour have forcefully been brought out by a mountain of penetrating studies dealing with consumer decisions in which the mental tasks put to people are often simple, at least relatively to many economic decisions, whereas their responses are frequently 'way off'. The experimental studies by and Kahneman (1973, 1974, 1981, 1983) on cognitive anomalies, i.e. circumstances in which individuals exhibit surprising departures from the Chicago-man model, have both fascinated and dismayed economists. This evidence suggests that the magnitude and nature of the error that individuals make in making decisions are themselves systematically related to economic conditions. For example, there are purchases for which consumers may have little experience or training (e.g. health services). For these, the deliberation and other costs of the expertise may be large relative to potential benefits, hence individuals appear to make inefficient choices as if they were myopic, something "certainly disconcerting from the view of generally accepted theory" (Arrow, 1986).

[2] See Kreps(1990), Varian (1992) or MasCollel et al (1995) and Williamson (forthcoming)

What is it then that psychology has to offer as a supplement to the economists' standard model of utility theory? It is the idea that choice does not merely depend on the "objective" conditions, but also on the "internal nature" of the decision-makers. The anomalies identified in cognitive psychology suggest directions for improved theory.

Unlike neo-classical economists, the primary focus of psychologists is to understand the nature of the decision elements, how they are established and modified by experience and how they determine values. Psychological views of the decision process are dominated by ideas that behaviour is local, adaptive, learned, dependent in context, mutable and influenced by complex interactions of perceptions, motives, attitudes and affect (see Figure 1).

The most serious problem psychologists find with the classical economic definition of rationality is that, beyond the simple problems used in most research, it makes unrealistic demands of the mind. They argue that decisions are often the result of application of attitudes and moral principles. In their view, humans often approach decisions as problem-solving tasks, seeking exemplars that suggest simple choice rules and reduce cognitive effort (Payne et al., 1993). Subjects have trouble handling information and forming perceptions consistently. They make "severe and systematic" errors by using decision "heuristics" or rules of thumb that "reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations" (Tversky and Kahneman, 1974).

However, psychologists' opinions on the underlying nature of rationality are far from uniform, leading to very divergent research agendas. On the one hand there is the "heuristics-and-biases" program launched by Tversky and Kahneman (1974). Within this program, heuristics were often invoked as the explanation when errors were found in human reasoning[3]. Tversky and Kahneman (1974) repeteadly asserted that these heuristics are quite useful but sometimes they also can fail to maximise preferences and are too sensitive to context and process to satisfy rationality postulates formulated in terms of outcomes. Then they have been deemed irrational. Clearly, this tradition does not at all imply that economists should abandon the Chicago-man model as a normative one. Rather it explores how people depart from perfect rationality and when heuristics can be blamed for poor reasoning

On the other hand, Gigerenzer and his colleagues from the ABC research program (1999) see heuristics as the way the human mind, taking advantage of the structure of information, can arrive at reasonable decisions. They argue that the "heuristics-and-biases"

[3] Primarily one of the three main: representativeness (judgement influenced by what is typical), availability (judgement base on what comes easily to mind) or anchoring and adjustment (judgement relaying in what comes first)

theory fails not by being wrong but by being indeterminate and imprecise as after three decades of research that approach has generated only nebulous proposals for simple choice mechanisms often viewed as a hindrance for sound reasoning (Gigerenzer and Todd, 1999).

The ABC approach defends that the alternative to the traditional notion of rationality is by no means irrationality, but rather the notion of bounded rationality (Simon 1955, 1957, 1959, 1982, 1992). Here bounded refers to inherent limits on rational thought, depending on the organism and its environment. Decision strategies that hinge on mere bits of well-chosen information about one's surroundings pack a surprisingly powerful wallop, especially when time and knowledge are supply in short supply. " People satisfice - look for good enough solutions- instead of hopelessly searching for the best" (Simon, 1990)

Conlisk (1996) gives three main reasons for incorporating the bounded rationality hypothesis into economic models. First, as we shall see, there is abundant empirical evidence that it is important. Second, models of bounded rationality have proved themselves in a wide range of impressive work. Third, deliberation about an economic decision is a costly activity and good economics requires we entertain all costs. Nonetheless, for the time being there is no definite evidence that would establish the bounded rationality assumption.

When trying to minimise cognitive effort, the decision-makers may, of course, use a plurality of decision rules rather than following the prescription of utility maximisation as has been assumed by mainstream microeconomics. Empirical evidence has shown that some of the decision rules applied are used subconsciously and cannot easily be communicated[4], which however does not invalidate the use of a plurality of decision rules. Thus, two main forms of bounded rationality have been identified. On one hand there is Simon's concept of satisficing (a word originated in Northumbria (England, Scottish Border) for "to satisfy"). Satisficing is a method for making a choice from a set of alternatives encountered sequentially when one does not know much about the possibilities ahead of time. In such situations, there may be no optimal solution for when to stop searching for further alternatives. Satisficing takes the shortcut of setting an adjustable aspiration level and ending the search for alternatives as soon as one is encountered that exceeds the aspiration levels (Simon, 1956a, 1990). A typical example could be human mate choice. Here, one chooses a person that fits one's real criteria for success rather than irrelevant ideals suggested by well-meaning acquaintances, given limited time for investigation of each possible pattern and some risk that the other person will reject one's offer of union. Different rules have been proposed to solve this or similar search problems (Ferguson, 1989; Lippman and McCall, 1976; Fiske

[4] Cf. Bem (1972); Nisbett and Wilson (1977); Fishchoff, Slovic and Lichtenstein (1980).

and Kalas, 1995). For instance, one could sample a certain proportion of the "candidates" and choose from this sequence. The optimal number to sample is 1/e (37%). Following this "37%" rule finds the very best candidate about 37% of the time (Ferguson, 1989)

Alternatively, there are fast and frugal heuristics that use little information and computation to make a variety of kinds of decisions. Fast and frugal models are considered to represent bounded rationality in its purest form. They are intended to capture how real minds make decisions under constraints of limited time, knowledge and computational resource. A typical example is found precisely in a health context. When a doctor in an emergency room has to make a decision whether a heart attack patient should be treated as a high or low risk case she does not know the values of the patient on all relevant attributes not can she always take the time to measure these (Gigerenzer at al, 1999).

We shall discuss more extensively below the latter and their potential as an alternative to traditional regression (compensatory) approach to analysing stated preferences discrete choice experiments (hereafter SPDCE).

3. TAKE THE BEST: CHOOSING THE FAST AND FRUGAL WAY

Psychologists have argued that the key to understanding choice behaviour lies in comprehending how decision-making strategies are well-matched to particular task environments (Gigerenzer et al., 1999; Payne et al., 1988, 1993). Expecting people's actual behaviour to conform to classical rational norms requires believing that the human mind is a "Laplacean demon" (Winsatt, 1976): a super-calculator with unlimited time, knowledge and computational power. Arrow (1986) discusses how much the computational power attributed to agents has increased as economic theory has evolved. Conversely, Gigerenzer et al (1999) propose replacing the image of an omniscient mind computing intricate utilities with that of a bounded mind reaching into an adaptive toolbox filled with fast and frugal heuristics: fast because they do not involve much computation and frugal because they only search for some of available information.

As with regression analysis, fast and frugal models are formed on the basis of the structural relationships between the attribute and the judgement. However, they are easier to understand and are psychologically more plausible than regression models because they are more compatible with humans' cognitive limitations (Kahneman, 1973; Miller, 1956; Newell and Simon, 1972) and flexible use of information.

Todd and Gigerenzer (1999) categorised heuristics in terms of the particular principles they employ. They distinguish the following three classes:

1. **Ignorance-based decision making**: This a class of very simple heuristics based on the basic cognitive adaptation of recognising environmental features. They exploit the often implicit information in the failure to recognise something.

The simplest exemplar in this class is the recognition[5] heuristic which, in the context of a task assessing which of two objects has a higher value it can simply stated: "If one of two objects is recognised and the other is not, then assume that the recognised object has the higher value". Thus this heuristic can only be applied when one of the two objects is recognised, i.e., under partial ignorance. Nevertheless, strong experimental evidence has been found for this decision-making rule. Goldstein and Gigerenzer (1999) draw the surprisingly conclusion that using this heuristic a person who knows less than another can make systematically more accurate choices. This so-called less is more effect is borne out by their data, which they interpret as indications of the empirical validity and theoretical significance of fast and frugal heuristics

2. **One-reason decision making**: Heuristics in this class search for reasons (attributes in a more economic jargon) beyond mere recognition and use only a single piece of information for making a choice. A variety of heuristics in this category, including the Minimalist, Take The Last (TTL) and Take the Best (TTB) have been proposed and studied (Gigerenzer and Goldstein, 1999; Czerlinski et al., 1999 and Martignon and Hoffrage, 1999). As the TTB heuristic centers our empirical analysis falls in this category, we shall postpone further discussion here.

3. **Elimination heuristics**: This class of heuristics is most appropriate in categorisation tasks. They use cue/ attributes one by one to whittle down the set of remaining possible choices, stopping as soon as only a single category remains. QuickEst (Hertwig et al, 1999), for quick estimation, and Categorisation by Elimination (Berretty et al., 1999), for quick categorisation when information takes time to search for, are examples of heuristics using the elimination approach.

Next we concentrate on the second type above mentioned, one-reason decision-making, in particular in TTB. These heuristics assume non-compensatory, or conflict-avoiding, strategies for choice, which imply the idea of limited, rather than unlimited, substitutability between attributes defining the goods/services. Under a non-compensatory

[5] It should be remarked that mere recognition needs to be distinguished from degrees of knowledge and what is referred as "familiarity" such in , e.g. Zajonc (1968) or Gigerenzer (1984). The sense of the word "recognition" in the approach presented here is that of "never-seen-before".

rule[6] trade-offs among all attributes cannot be defined. It is not possible to state exactly which improvement in one attribute of a choice alternative just compensates for a given deterioration in another attribute to keep the respective choice alternative equally attractive. Indeed, empirical work supports the general conclusion that subjects find it rather difficult to weight and "trade-off" in a compensatory manner… information that does not require "in the head" transformation is preferred in the interest of cognitive economy" (Slovic and MacPhillamy, 1976). The observation that people often try to avoid trade-offs and focus just on one reason has been documented numerous times both in Economics (e.g. Einhorn, 1970, 1971; Seidl and Traub, 1996, Lockwood, 1996) and Psychology (e.g. Baron, 1990; Hogarth, 1987; Payne et al, 1993)

Taking an extreme stance, a decision may be based even on only one attribute or reason, whatever the total number of attributes found during the search. There is a sound reason why a person might base a decision on only one reason rather than on a combination of reasons: combining information from different attributes requires converting them into a common currency (namely, utility), a conversion that may be expensive if not actually impossible. Some things do not have a price tag and cannot be reduced to and exchanged for any common currency (Elster, 1979). When reason cannot be converted into a single currency, the mind has little choice but to rely on a fast and frugal strategy that bases its decision on just one good reason.

One such strategies is known as Take The Best (TTB) because its policy is "take the best, ignore the rest". It is the kernel of Probabilistic Mental Models (PMM) theory[7] introduced by Gigerenzer et al (1991). In a SPDCE, TTB can be described as follows (excluding the recognition principle[8] as it plays no role here since we assume that all scenarios are recognised) (adapted from Hoffrage and Martignon, 1998)

STEP 1: Search Rule - Choose the attribute with the highest validity that has not yet been tried for this choice task. Look up attribute values of the two scenarios.

STEP 2: Stopping Rule: If one scenario has a positive attribute value (in terms of relative gained utility) and the other does not (i.e. either a negative or an unknown value), then stop search and go on to Step 3. Otherwise go back to Step 1 and search for another attribute. If no further attribute is found, then guess.

STEP 3: Decision Rule (one-reason decision-making) Predict that the scenario with the positive attribute value has the higher value on the criterion thus choose it

[6] See Seidl and Traub (1996) for a menu of decision rules, both compensatory and non-compensatory.
[7] See McClelland and Bolger (1994) for a short introduction.

According to Take the Best participants have an adequate representation of the rank order of the attribute *validities* in reference classes they had repeated experience with, called a cue[9] family hierarchy after Brunswick (1955). Attributes will be activated in the order of their decreasing validities. If the "best" (i.e. the most valid) attribute discriminates, then the scenario favoured by this attribute is chosen, and further search is terminated. If the best attribute does not discriminate, then the next best attribute is considered and so on. The decision maybe wrong, yet none of the remaining attributes, nor any combination of them, will change it. Put differently, TTB is a non-compensatory strategy. Indeed TTB is a special case of the lexicographic decision rule (Fishburn, 1974) as it only considers the most important attribute, deliberately ignoring other possibly existing information about the rest. Hence this heuristic does not conform the classical economic view of human behaviour (e.g. Becker, 1976) where, on the assumption that all aspects can be reduced to one dimension (e.g. utility), there is always a trade-off between commodities or pieces of information. That is, the heuristic violates the Archimedian (non-compensatory) or continuity axiom, which implies that for any multidimensional object x (x_1, x_2, … x_n) preferred to x' (x_1', x_2', …, x_n') where x_1 dominates x_1', this preference can be reversed by taking multiples of any one or a combination of x_2', x_3', …, x_n' That is, a loss in one bundle can always be compensated by gaining in the other bundle (see Borsch, 1968).

However, and despite its flagrant violation of traditional standards of rationality[10], TTB (and more generally PMM theory) have been successful in integrating various extant phenomena in inference from memory and predicting novel phenomena (Gigerenzer, 1993; Juslin, 1993, Hoffrage, 1994). Rieskamp and Hoffrage (1999) were the first authors to address the empirical question of whether people use simple non-compensatory heuristics such as TTB. Their data suggest that TTB might play a role in probabilistic inferences. Bröder (2000) reports that when search for information is costly, about 65% of the participants choices were consistent with TTB, compared to fewer than 10% with a linear strategy. Czerlinski et al (1999) compared its performance with other strategies and linear models in 20 real data sets collected from different real-world domains. TTB was to be well able to compete with linear models, performing only four percentage points below multiple regression. Moreover, when cross-validated simple heuristics (e.g. TTB) even outperform sophisticated linear models. TTB is robust due to its simplicity, not despite it. According to Bröder (2000) "Its smart simplicity protects Take the Best from the danger of overfitting and "squeezing" spurious information out of the data."

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[8] See Goldstein & Gigerenzer (1999), "The Recognition heuristic: How Ignorance can make us smart" in Gigerenzer et al (1999) pp. 37- 72 for a complete explanation of ignorance-based decision-making.

[9] We should remark here that attributes are often referred as "cues" in psychology. Nonetheless, we have opted for keeping the usual nomenclature employed in the SPDCEs literature.

4. AN ALTERNATIVE "FAST AND FRUGAL" ANALYSIS OF CHOICE DATA

Following the evidence reported above, this section is aimed to throw some light on this debate assessing the empirical validity of the TTB. After reviewing the state of the art when it comes to testing for compensatory decision making (primarily the dominance rule) in health care, we look at the potential of TTB for explaining people responses to SPDCEs as opposed to the traditional (compensatory) regression approach.

4.1. Background: evidence of non-compensatory decision-making in SPDCEs.

The theoretical underpinnings of SPDCEs contain elements of the Chicago-man model where preferences are assumed to satisfy some desirable axioms (Varian, 1992; MasColell et al, 1995). A crucial assumption is that of compensatory decision-making processes, which imply the existence of a preference ordering capable of being mathematically represented by a utility function. For this to hold, continuity of preferences is needed meaning that, for any pair of goods, there always exist some level of improvement in one of them which can compensate an individual for a deterioration in the level of the other whilst his utility remains in the same level. Put differently, unlimited substitutability between attributes is required. This property has been claimed at the core of the economist's concept of value, because substitutability establishes trade-off ratios between pairs of goods/attributes that matter to people (Freeman, 1994)

A methodological issue that has received little attention to date in the literature on SPDCEs is whether this assumption can be empirically falsified. If evidence of non-compensatory decision making is found the estimated effectiveness of policies to improve welfare may be influenced (Earl, 1983). Scott (forthcoming) gives an example of how. Consider a policy aimed to reduce waiting times. If some individuals have a minimum target reduction in waiting-time which is not achieved, then an classical effectiveness study may overestimate the policy impact. The reason lies on the assumption that any reductions in waiting time, including those below the target, will increase utility. Further research seems therefore of great relevance.

Some studies using SPDCEs for eliciting health and health care preferences have identified many situations where individuals appear not to trade-off between either attributes or scenarios. That is, apparently they are adopting non-compensatory strategies for choice. For instance, one study of local versus central orthodontic clinics found that **every** individual

[10] Variants of this heuristic also violate transitivity, one of the cornerstones of classical rationality, (McClennen, 1990)

made responses consistent with non-compensatory decision making for waiting time (Ryan and Farrar, 1994). Propper (1995) reports that fewer than 30% of responses exhibited some sort of limited substitutability between money and waiting time on UK national health services waiting lists. In eliciting women´s preferences for surgical versus medical management of miscarriage, Ryan and Hughes (1997) found 15% of respondents always preferred surgical management over medical management of miscarriage. In Bryan et al (1997), two thirds of respondents chose on the basis of the probability of the knee problem being completely resolved in the treatment of knee injuries. Ratcliffe (1998) in a study looking at patients' preferences for liver transplantation services found that 15% of respondents consistently chose the live centre with the highest chance of success regardless of the level of other attributes. Looking at women´s preferences for alternative surgical treatments for menhorragia (hysterectomy and conservative surgery), San Miguel et al. (2000), found a relatively high proportion (56%) of responses exhibiting some type of **non-compensatory** decision-making processes, with 76% of those preferring conservative surgery in all scenarios presented. More recently, Ryan and Bates (2001), in eliciting preferences for follow-up rheumatology care in the Grampian area of Scotland (UK), found that 31 out of 200 patients always chose the scenario with their preferred staffing (either a junior doctor or specialist nurse). Scott (forthcoming) examine the implications of this assumption in the context of a discrete choice experiment studying stated preferences for different models of out of hours care provided by General Practitioners. The results indicated that 45% of individuals exhibited evidence of non-compensatory behaviour.

A number of reasons have been alleged to explain non-compensatory choices.

Some authors claim they proof that preferences may be lexicographic with regard to some attributes (Bryan et al 1997). If this were the case, consideration should be given to the appropriate manner to deal with such preferences. To date, seemingly lexicographic responses are removed from further analysis. Whilst this is correct from a theoretical standing, from a policy perspective, it would preclude those individuals from welfare gained/lost computation and thus from a Kaldor-Hicks criteria (Kaldor 1939, Hicks 1940) potentially informing policy recommendations.

Others argue that some aspects of the measurement procedure may lead to (secondary) choice inconsistencies (Dolan and Kind, 1996). For instance, van der Pol and Cairns, (2001) have found evidence that the levels chosen for the attributes might influence time stated preferences [11]. Further, according cognitive psychologists non-compensatory

[11] However, within a policy context, attributes should be realistic and plausible (Ryan, 1999). Thus, while a well-designed may be able to identify areas in the indifference map where individuals are trading and a well-behaved utility function can be represented, such levels could not be policy relevant.

choices are more likely to arise the greater the number of alternatives included in the choice set (Payne et al., 1992) and, likely, the greater the number of attributes. Future research should pay more attention to design issues and its influence on individuals responses.

Furthermore, there are (primary) inconsistencies indicating respondent's intrinsic limitations (Dolan and Kind, 1996). Preference elicitation experiments are cognitively challenging thus it seems plausible that people may simplify the choice task by applying some heuristics or "rules of thumb" (Kahneman et al, 1982). This is the hypothesis hold in here: non-compensatory choices rise because of the bounds of human rationality.

4.2. A new attempt for a test

Whilst the approach proposed in this paper to studying non-compensatory choices is being subject to extensive study by psychologists (see Gigerenzer and Goldstein, 1996, 1999; Czerlinski et al, 1999; Gigerenzer et al 1999; Martignon and Hoffrage, 1999), it seems quite innovative in the health economics literature. It is hypothesised that people adopt *simple heuristics that make them smart* (Gigerenzer et al 1999). More precisely, we suspect that many people, for a variety of reasons, might base their decision in just one good enough reason, making use of the so-called Take The Best (TTB) heuristic.

SPDECs seems an adequate framework to test this hypothesis. Succinctly this methodology involves presenting individuals with choices described in terms of characteristics and associated levles. For each choice they are asked to choose their preferred scenario (Louviere et al, 2000). Thus, if individuals the task is complex or cumbersome they might simplify employing some "rule of thumb". For instance, if cost is included as an attribute[12], some people might always choose the cheapest option, irrespectively of the levels for the rest of the attributes.

To assess TTB's adequacy as a descriptive model of human choice, as with Dhami and Harries (2001), we propose comparing its performance, in terms of proportion of correctly predicted choices, with that of the gold standard, the traditional (compensatory) regression approach used when analysing SPDCEs responses.

[12] This is the usual practice as, in a classical (compensatory) framework, it allows for indirect estimation of individuals' willingness to pay for improvements in the rest of the attributes by simply dividing the estimated coefficients for each one by the one obtained for cost.

In calculating the TTB predictions, following Brunswick (1955), it could assumed people will look at the attributes in the same order they state if asked in the questionnaire to rank by importance order the menu included in the questionnaire. If the most value ranked attribute happens to discriminate between options, further search is halted and a decision is made. If the level for this attribute turns out to be the same for the two alternatives presented, then it is assumed the individual will consider the second best ranked attribute. Again, if the level differs between option a decision will be made based on this attribute; if not, further attributes will be considered until a decision can be arrived at[13].

As the regression technique employed, many econometric models have been developed, hand in hand with empirical application, since thirty years ago McFadden (1974) made the paradigmatic methodological breakthrough in "Conditional Logit Analysis of Qualitative Choice Behaviour). Following his recommendation for a framework enabling to forecast behaviour in new settings, much research effort is being devoted to increasing the behavioural realism of discrete-choice models. Much less restrictive choice models, e.g. the mixed logit developed by McFadden and Train (1997), are now available. However, a great majority of empirical studies go no further than the simple multinomial logit model and occasionally the nested logit. Further, to date applications in the health care arena usually restrict to the random effects probit. Therefore, let us assume the model chosen is the latter[14]. Then a choice prediction could be calculated assuming that for a predicted probability of choosing option B greater than 0.5 the individual will prefer this option rather than A.

A first insight to whether the use of simplifying heuristics is worthwhile further considering could be studied by simply analysing through the number of attributes employed by individuals when completing the questionnaires (so-called frugality of the choice task). To do so, the choice according to the TTB must be calculated for each individual and each choice task in the sample, keeping records on the position in the rank for the attribute halting search and leading to a decision. A frequency histogram may then be quite revealing. If we would observe a uniform distribution for the number of attributes employed, this could be interpret as evidence favouring a compensatory environment (i.e. set of attributes). That is, people would be in this case taking account for and trading-off all the attributes. Conversely, if people were using the TTB heuristic, hence adopting a non-compensatory decision making process, the picture should be a quite a different one: much higher frequencies should be observed for just one or two reasons leading to a choice.

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[13] If it were the case that none of the attributes discriminate between options, the individual would be randomly assigned a choice as it is assumed s/he just guesses. However, experimental design techniques should ensure this situation will not happen.

[14] See Greene, 2000 for a detailed account of the model specification and estimation procedure

A more formal parametric test for non-compensatory information could also be carried out further informing our conclusions. Hoffrage and Martignon (1998) argue that when cue weights are non-compensatory, then linearly combining cues gives the same performance as processing cues in a lexicographic manner. They illustrate this with the following example. Imagine the task of comparing two numbers written in the decimal system, that is, as linear combinations of powers of 10. For instance, to establish that 357 is larger than 318, we can check the value of the first digits on the left, and, since they coincide, move to the second digits, which differ. At this moment we make the decision that the number with 5 as the second digit is larger than the number with 1. Similarly, any other base system has non-compensatory weights and thus would allow for this type of strategy.

In more formal terms, a non-compensatory strategy could be defined as follows. Consider an ordered set of $\underline{M}$ attributes $\underline{x}_1, \underline{x}_2, ..., \underline{x}_M$. Loosely speaking these attributes are non-compensatory for a given choice strategy if every attribute $\underline{x}_j$ outweighs any possible combination of attributes after it, that is, $\underline{x}_{j+1}$ to $\underline{x}_M$.

In the special case of a weighted linear model with a set of weights $\underline{\beta} = \{\underline{\beta}_1, \underline{\beta}_2, ..., \underline{\beta}_M\}$ a strategy is non-compensatory if for each $1 \leq \underline{j} \leq \underline{M}$ we have $\beta_{\underline{j}} > \sum_{\underline{k} > \underline{j}} \beta_{\underline{k}}$.

In words, a linear model is non-compensatory if, for a given ordering of the weights, each weight is larger than the sum of all weights to come. Hence, once run the regression and obtained the estimated coefficients, we could run this parametric test for compensatory information compare the size of the largest one with the sum of the rest. If the sum can exceeds the largest coefficient, this could be interpreted as not evidence enough against a compensatory model. If, on the contrary, the sum of all the estimated coefficients but the largest cannot outweigh the latter, then we could cautiously draw the conclusion that we are facing a non-compensatory set of attributes.

Furthermore, Hoffrage and Martignon (1998) propose the following theorem:

Theorem 1 NON-COMPENSATORY INFORMATION

The performance of TTB is equivalent to that of a linear model with a non-compensatory set of weights (decreasing in the same order of TTB´s hierarchy). If an environment consists of cues (attributes)*, which for a specified order are non-compensatory for a given weighted linear model, this model cannot outperform the faster and more frugal Take the Best if that order coincides with the decreasing order of validities (an analytical proof is given in the Appendix)*

That is, a linear model, such as the conventional Random Utility Model (Mcfadden, 1974), with a non-compensatory set of weights results in making identical predictions as Take the Best. The converse is also true: The performance of a lexicographic strategy is identical of that of a linear model with non-compensatory weights[15]. Therefore next we describe a non-parametric test to further evaluate the performance of the alternative models in terms of achieved agreement.

Agreement is conventionally measured in terms of the similarities of choice predicted by different individuals' model. Different indexes can be defined (Altman, 1991). Here Cohen's κ coefficient (Cohen, 1968), an indicator of the gross level of agreement corrected for chance (some concordance may be due just to chance), is calculated. This summary measure is employed when two "imperfect" tests (or observers) are classifying the same set of data into two or more exclusive categories (e.g. consultation A or B). It ranges between -1 and +1, with 0 being no agreement beyond that expected by chance, 1 being complete agreement, and -1 being contrary to agreement[16]. Hence if the kappa coefficients are both close to 1, this could indicate that TTB and multiple regression may be alternative ways of analysing SPDCEs responses. If the kappa coefficients are both less than zero, such variation could be due to the low reliability of the instrument used. If one coefficient is positive and the other one negative this could be cautiously interpreted as evidence favouring the analysis approach with a positive coefficient.

We are currently re-analysing data from one of the multiple SPDCEs developed by San Miguel while completing his PhD thesis (S. Miguel, 2001) in the "fast and frugal" way just described. The so-called "out of hours" experiment was designed following a previous study carried out by Scott et al (1998) looking at preferences of parents/guardians of children under 13 years old for different models of "out of hours" care (i.e. during evenings, nights or weekends) for childhood respiratory illness in the urban area of Glasgow and Aberdeen. Some preliminary results of on-going research suggest that the TTB algorithm outperforms multiple regression. Not only the proportion of correctly predicted choices is greater when using the TTB simple heuristic (81% versus 51%) but also agreement is by far greater as indicated by the Cohen´s kappa coefficient (0.6> -0.005). Moreover, according to the negative value of Cohen´s kappa for the regression model, its results could be explained just by chance. These suggestive, rather than conclusive findings encourage further investigation on the appropriateness of the traditional regression approach to analysing choice data.

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[15] It should be remarked that they are talking about *performance*. This does not necessarily mean the process has to be also identical.
[16] Usually it is considered that a value of κ less than zero implies worse than chance agreement, and <0.2 implies poor agreement, 0.21 – 0.4 fair agreement; 0.41 – 0.60 moderate agreement; 0.61 – 0.80 good agreement and 0.81 to 1.00 very good agreement.

4.3. Limitations and further research

This paper has attempted to provide a compelling set of arguments for an alternative *fast and frugal* way to analyse SPDCEs from a more psychological standpoint. In particular it has been argued that the use of these heuristics may explain finding some people who appear not to be prepared to trade-off attributes basing their choice in just a one good reason. Responses like these are difficult to dealt with in the Chicago-man framework as they may be violating the economic axiom of compensatory decision-making (continuity) enabling preferences to be represented by a well- behaved utility function.

While we believe that many of the considerations we did throughout are potentially very useful to studying individual economic choice behaviour, this belief need to be further tested. One particular direction for future work would be to set up a number of experiments to further investigate the empirical validity of these simplifying rules of thumb.

For instance, Gigerenzer et al (1999) fail to specify conditions that might lead to the use of specific fast and frugal heuristics, compromising the falsifiability of the approach. Difficult empirical results may be dismissed as resulting from the application of an as-yet-unidentified fast and frugal heuristic. The issue of heuristic selection is not entirely ignored by Gigerenzer et al. (1999) yet this is conceived of as a meta-level decision-making task, suggesting that one might use a (presumably) fast and frugal to decide which fast and frugal heuristic to apply in a given situation. This conception raises a few issues of concern.

Firstly there is the possibility of an infinite regress: How do we select the fast and frugal heuristic to decide which fast and frugal heuristic to apply in the first place?.

Secondly, and assuming the infinite regress is avoided, there is the possibility that the fast and frugal heuristic making the selection might not yield to the optimal fast and frugal heuristic for the original decision-making task.

Thirdly, the accuracy of a fast and frugal heuristic is often assessed in the literature by measuring how closely they match what people would have done had they actually try to maximise expected utility, then we wonder is it still this final aim?

Finally, factors such a familiarity and the complexity with which the task is designed might influence the type of heuristic adopted, if any. This leads to a generalisation problem. It might be all the individuals adopt these heuristics or some people do and some other do not. In the latter case, what should it be the approach?

In a nutshell, in the absence of a broader set of experimental tests there is some reason to doubt that we make decisions by relying on simple heuristics that make us smart (as Gigerenzer et al´s (1999) title suggests). Rather it may be that people resort to simple heuristics to do the very thing they are *not* smart at.

5. CLOSING

Thirty years ago, McFadden's fundamental research on the econometric analysis of **random utility models** showed how productive it can be to blend the best elements of economic and psychological thinking. It seems then frustrating to observe that these two disciplines, despite their mutual concern with the study of human behaviour, have too often failed to engage one another in a constructive manner.

Optimisation is a beautiful and attractive fiction; it is mathematically elegant and one can draw on a well-developed calculus. However, there is also another sense of beauty: the aesthetics of simplicity. There is a wonder in how simplicity can produce robustness and accuracy in an overwhelming complex world. Boundedly rational fast and frugal heuristics described in this paper may produce this sense of wonder, offering a new opportunity for achieving this longed for goal.

As with Schwartz (2000), we believe that science often progresses by combining disciplines that previously seemed ill-matched and therefore economics could, or maybe should, progress by merging with psychology.

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Appendix 1 Example of a choice presented to patients.

- Imagine that during the night, your child is short of breath, wheezing and coughing and that you decide to call a doctor. You have several options about the care you receive. These differ according to *who* your child sees, *where* they are seen, the *time* it takes between making the telephone call and receiving treatment, and whether the doctor *seems to listen* to what you have to say.

- For each question below, you are asked to choose which type of consultation you would prefer for your child during the night (Consultation A or Consultation B).

1. Which consultation would you prefer? *(please tick box below)*

	Consultation A	**Consultation B**
Where your child is seen:	Emergency centre run by GPs	Your home
Who your child sees:	A GP who doesn't work at your practice/health centre	A GP who doesn't work at your practice/health centre
Time taken between the telephone call and treatment being received:	60 minutes	20 minutes
Whether the doctor seems to listen to what you have to say:	The doctor seems to listen	The doctor seems to listen

Prefer consultation A ☐ ***(please tick one box)*** ☐ **Prefer consultation B**

Appendix 2. The lexicographic rule

Formally this rule, in a binary choice task, can be presented as follows (Drakopoulos, 1994). Suppose there are two alternatives *x* and *x'* defined as two bundles of attributes:

$$x = (x_1, x_2, \ldots x_n)$$
$$x' = (x'_1, x'_2, \ldots x'_n)$$

then a lexicographic ordering implies

$$xPx'^{17} \text{ iff}$$

either 1) $x_1 \succ x'_1$

or 2) $x_1 = x'_1; x_2 \succ x'_2$

or 3) $x_1 = x'_1; x_2 = x'_2; x_3 \succ x'_3$

$$\vdots$$

or n) $x_1 = x'_1; x_2 = x'_2; \ldots; x_{n-1} = x'_{n-1}; x_n \succ x'_n$

where P is a *rational*[18] preference relation, $=$ is a indifference relation and $\succ$ denotes a strict preference relation.

In words, attribute x_1 has the highest priority in determining the choice. When the level of attribute x_1 in the two bundles is the same, attribute x_2 is considered and so on until the last attribute x_n in the bundles dictates decision.

[17] Or, in terms of utility, $u(x) \geq u(x')$

[18] In the classical model of consumer choice this means that the preference relation is both *complete* and *transitive.* See MasColell et al (1995) for an explanation Chap.1, pp. 6-7)

Appendix 3: Proof of theorem 3 (Hoffrage and Martignon, 1999)

[...] We now prove that Take the Best is equivalent- in performance-n to a linear model with non-compensatory weights, where the highest weight corresponds to the cue with the highest validity, the second highest weight to the second highest validity and so on. Consider an environment provided with a set of cues $Q = \{q_1, q_2, ..., q_M\}$ where $V(q_1) \geq V(q_2) \geq ... \geq V(q_M)$ and $V(q_i)$ is the validity of q_i. Define the score $s(O_j)$ of an object O_j by

$$s(O_j) = q_1(O_i)\frac{1}{2} + q_2(O_i)\frac{1}{2^2} + q_3(O_i)\frac{1}{2^3} + ... + q_M(O_i)\frac{1}{2^M}$$

We have to show that the lexicographic comparison of objects O_i and O_j implies that $O_i > O_j$ if and only if $s(O_i) \geq s(O_j)$

Proof: Assume that the best cue q_1 in Q satisfies $q_1(O_i) \geq q_1(O_j)$. If we only consider binary cues, this assumption implies that $q_1(O_i) = 1$ and $q_1(O_j) = 0$

Since $\frac{1}{2} > \frac{1}{2^2} + \frac{1}{2^3} + \frac{1}{2^4} + ... + \frac{1}{2^{\underline{M}}}$ the score $s(O_i)$ is larger than the score $s(O_j)$

For the reciprocal observe that it is impossible to have

$$q_1(O_i)\frac{1}{2} + q_2(O_i)\frac{1}{2^2} + q_3(O_i)\frac{1}{2^3} + ... + q_M(O_i)\frac{1}{2^M} > q_1(O_j)\frac{1}{2} + q_2(O_j)\frac{1}{2^2} + q_3(O_j)\frac{1}{2^3} + ... + q_M(O_j)\frac{1}{2^M}$$

unless $q_1(O_i) = 1$ and $q_1(O_j) = 0$, base on the same argument that ½ is larger than any sum of its lower powers. The same is valid if the first differing cue value occurs at some other column of the cue matrix.