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# Behavioural Procedural Models – a multipurpose mechanistic account

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**Abstract:** In this paper we outline an epistemological defence of what we call Behavioural Procedural Models (BPMs), which represent the processes of individual decisions that lead to relevant economic patterns as *psychologically* (rather than *rationally*) driven. Their general structure, and the way in which they may be incorporated to a multipurpose view of models, where the *representational* and *interventionist* goals are combined, is shown. It is argued that BPMs may provide "mechanistic-based explanations" in the sense defended by Hedström and Ylikoski (2010), which involve invariant regularities in Woodward's sense. Such mechanisms provide a causal sort of explanation of anomalous economic patterns, which allow for extra market intervention and manipulability in order to correct and improve some key individual decisions. This capability sets the basis for the so called libertarian paternalism (Sunstein and Thaler 2003).

**Keywords:** economic explanation, interventionist economic policy, epistemology

## Introduction

One of the final goals of Economics is the representation of the workings of economic markets at different levels of aggregation. The underlying assumption is that there are many "objective" economic mechanisms out there, some of whose features have to be grasped by economic theories and models. These mechanisms receive inputs from individual economic decisions. Agents may be rational (as in standard economics), quasi rational (Russell and Thaler 1985) or non-rational (as in many Post-Keynesian accounts). In any case they make decisions of

investment, saving, consumption, etc., and the results of their choices enter as inputs to feed some of the relevant economic mechanisms.

Economists, then, may build two different sorts of models: those that represent the markets and those that represent individual decisions whose results enter the market mechanisms as input. We call Decision Making models (in short, DM models) those that do not intend to represent any aspect of real economies (industries or markets), but focus on individual decision making.

Simon (1986) has distinguished between *substantive* and *procedural* DM models. *Substantive* models are only interested in the *results* of individual decisions (for instance, assuming risk or uncertainty, which of a set of lotteries will be picked up by an individual with well defined preferences and expectations). Instead, *Procedural* models depict the *processes* of decision making: the way in which people choose among alternative prospects. In this sense, Expected Utility Theory (EUT, von Neumann and Morgenstern, 1944), The Behavioural Model (Simon 1955) and Prospect Theory (PT, Kahneman and Tversky 1979) are all DM models. Although EUT is a substantive DM model, Simon's Behavioural Model is usually viewed as a procedural DM model. PT may be considered both substantive and procedural.

It is useful, however, to advance a further distinction between two different kinds of procedural models. Simon's Procedural Rationality models were intended to represent the way in which people actually perform the *calculations* that result in their particular choices. Simon thought that real people could not maximize but were able to do far more simple calculations designed as satisficing. In his view people have goals, face alternative means to reach them, and evaluate which of these means will be appropriate for reaching their goals in a satisfactory way (Simon 1955). Usually people do good enough calculations and this is why these representation models were called models of Procedural *Rationality*. This is a rather "illuminist" view of the individual process of decision making.

PT and many Behavioural Economic models are a different sort of procedural DM models. They represent individual decisions as *psychologically* (rather than *rationally*) driven. For instance, individuals whose preferences are represented as reflecting loss aversion (Thaler 1980; Kahneman, Knetsch and Thaler 1991; Tversky and Kahneman 1992) or taking decisions founded on mental accounts (Thaler 1985), are not making any kind of calculation when deciding. They are

rather reacting in a non deliberate manner to the information received. Behavioural Models that incorporate psychological resources to represent the way in which individuals make decisions under risk or uncertainty are *not* Procedural Rationality models. They may be called Behavioural Procedural Models (BPMs).

In this paper we restrict our analysis to BPMs – showing their general structure, and the way in which they may be incorporated into a multipurpose view of models, where the *representational* and *interventionist* goals are combined. This approach also fits a mechanistic view of models. Looking at the details our account explains the particular nature and functions of BPMs, clarifying what a proposition like this means

*A Behavioural economist S construes a BPM under restrictions R to approach an intended target W with purposes P.*

where R is the empirical restriction which demands that BPMs isolate *plausible* mechanisms: those which conform to the experimental results of Cognitive Psychology; W refers to the *psychological processes* of individual decision making that end in economic patterns, and P summarizes the two main purposes of BPMs: *explanatory* power, and the possibility of *intervening* in order to alter the resulting patterns in a desired way.

Elaborating on the purposes, it has been argued that BPMs' models involve invariant regularities in Woodward's sense, providing a causal explanation of anomalous economic patterns that allows for extra market intervention and manipulability in order to correct and improve some key individual decisions. This capacity sets the basis for the so called libertarian paternalism (Sunstein and Thaler, 2003). Finally, the paper argues that BPMs provide "mechanistic-based explanations" in the sense defended by Hedström and Swedberg (1998b) and Hedström and Ylikoski (2010).

## Behavioural Procedural Models as *Multipurpose* Models

What kind of models are Behavioural Procedural Models? The following are some common views about models:

Interpretations (Suppes 1960)

Definitions (Suppes 1970; Hausman 1992)

Representations (Giere 2004; Mäki 2009)

Mediators (Morgan and Morrison 1999)

The first two types of models are interesting but they do not fit well with Behavioural Models, and we will not elaborate about them here. A more promising way of conceiving models is to see them as *representations* of an intended target system. This view incorporates pragmatism and the role of the subject in the picture. Here is a compact formulation of a known version of the Representational View (Giere 2004):

***S** uses (builds) model **M** for representing **W** with purposes **P*** (1)

where W stands for the particular target that the model intends to represent and P sets some restrictions on the aimed representation (making explicit the respects in which the target is represented and the degree of accuracy aspired). Proposition (1) describes a general view about models which supposedly applies to any kind of model designed to capture an aspect of the real world. Even if the main inspiration comes from models in physics, (1) has also been applied to economics (Mäki 2009). One drawback of this view is that it bases too much of the practice of model building on just one purpose: representation. Making things worse, some interpretations of the representational view (Teller 2001) seem to *define* "model" in terms of this particular function. This exclusive focus on representation is what we call a *representational view*. In this paper we restrict our analysis to Behavioural economic models and show that although in fact they may be used to represent a given target, it is wise not to endorse the representational view. A more useful approach for an understanding of BPMs is Morgan and Morrison's view of models as *multipurpose* designs. Starting from their idea a more adequate view about the nature and role of BP models may be offered:

***S** uses (builds) model **M** for approaching **W** with purposes **P**,* under restriction ***R*** (2)

where "approaching" is a non-compromised (neutral) word that leaves open the question about the goals intended in designing M. In our account target W is clearly separated from the purposes P. While the target is to model the (psychological) processes involved in making some economic decisions, P specifies what epistemic and practical goals are exactly aimed at by approaching

this target in this way. We picked up two main objectives in the construction of BP Models: *explaining* (by representing) and *intervening*. Finally, R introduces restrictions on the way in which the processes of decision making should be modeled. As we will see in section 5, R amounts to the requirement that BP models must take into account the results of Cognitive Psychology in order to be *plausible*.

To clarify the way in which (2) applies to Behavioural Procedural Models, it is necessary to specify the general structure of M, the target W, to elaborate on the particular purposes P, and to make explicit the contribution of Cognitive Psychology in the construction of such models, particularly the way in which its incorporation sets restrictions on W (the Target) and P (the Purposes).

## The contribution of Cognitive Psychology to the way in which decisions are made

Cognitive Psychology claims that in making decisions people may use two different cognitive systems (Kahneman 2003): an intuitive system (S1) and a more rational system (S2). Experimental research shows that S2 exercises an effective control on S1 only under some special circumstances. In most cases in which people have to make choices under real circumstances, they use elements of their intuitive system, which may be classified as *propensities* (for instance, "loss aversion", "overconfidence" and "mental accounts") and *heuristics* (like, "default rule", "fifty – fifty", "representativeness").

Loss aversion is the most appreciated theoretical resource among Behavioural economists and it is used in a majority of models (for illustrations of this use, see Camerer and Loewenstein 2004, and Ho et. al 2006). Loss aversion is implied by the utility function U(x) of Prospect Theory (Kahneman and Tversky 1979), which has the following properties: it is a) concave above the reference point (second derivative negative for $x \geq 0$), b) convex below the reference point (second derivative positive for $x \leq 0$), and c) steeper for losses than for gains ($U'(x) < U'(-x)$, for $x \geq 0$), which means that people attribute greater value to a given item when they give it up than when they acquire it.

There are many different ways of defining and measuring loss aversion. For instance, Kahneman and Tversky (1979) defined it as the mean or median of $-U(-x)/U(x)$ for $x \geq 0$, and Tversky and Kahneman (1992) estimated the

coefficient of loss aversion (CLA) as 2.25. This means that if a person finds 1 dollar on the street and this finding gives him a utility equal to 1, by losing this same dollar he suffers a disutility of 2.25. [1]

Several different propensities and heuristics have been identified in many different experimental settings. Do these findings have any relevance to economics? The answer to this question is not obvious. Initially all of these findings were only incidentally connected with economics. Many heuristics were discovered by the Heuristics and Biases Program (Tversky 1974; Tversky and Kahneman 1974; Kahneman and Frederick 2002; Kahneman and Frederick 2005) and were related to the formation of probability judgments. Loss aversion has in principle nothing to do with economic theory, though it is clearly present in a context where exchanges take place (Knetsch 1989; Kahneman *et al.*, 1991). Although transactions are at the basis of economics, it has to be proven that loss aversion has some bearing on the generation of relevant economic phenomena, such as saving, consumption and investment.

On the other hand, standard economics has modelled agents as rational and in doing so it has provided formal representations of preferences and expectations based on S2. As long as some standard models were found empirically inadequate, it was tempting for those economists familiar with the results of cognitive psychology to explore the possibility of avoiding conventional failures, modelling agents' preferences and expectations using resources taken from the elements of the system S1. The presumption that this project will be successful is highly uncertain given that, in principle, there is no reason to believe that any of the propensities and heuristics mentioned above may affect the generation of specific economic phenomena. The task of a Behavioural Procedural Model is to explore this possibility.

Reliance on the resources of cognitive psychology imposes a sort of methodological constraint on BP models. According to traditional economics, when building a model one can start by assuming almost *any* postulate (its particular content may be as arbitrary as one wishes it to be). Conventional Models are substantive decisional models and are constrained only by logic and mathematics. In contrast, Behavioural Procedural Models are designed to represent processes of decision making. To achieve this, they are constrained by *psychological* knowledge acquired through experimentation. The commitment to use only resources that are compatible with the results of cognitive psychology as

explanatory factors is sometimes expressed as a philosophical compromise to realism [2]. In this regard, it is important to note that the usual claim according to which BPMs are realistic or more realistic than conventional models only means that the representation of the agent's preferences and expectations cannot be incompatible with the available background knowledge provided by Cognitive Psychology.

## The general structure and intended target of Behavioural Procedural Models

The intended target W of a BPM is to identify and make explicit the particular psychological process that results in (or contributes to) a pattern invested with economic relevance. For achieving this goal the contribution of Cognitive Psychology is crucial in helping to give shape to the particular structure of BP models. The purpose of this section is to render this structure more explicit. At a very general level, the constructive procedure of BP models may be described as follows: given some known anomaly of a standard economic model, an alternative (Behavioural) model is constructed in order to account for the anomalous pattern. For this purpose the model makes the decision process explicit by incorporating two kinds of factors: (a) those properly psychological (heuristics and propensities) and (b) relevant conditions of the environment which send signals to the individuals and impact on their psychological makeup, influencing their decisions in a typical form. We call the factors included in the two categories *basic* and *triggering* factors, respectively.

By "basic" factors we denote propensities or capabilities that (a majority of) individuals have. They are provided by selected items of the Intuitive System S1 of Cognitive Psychology which is an essential part of the Behavioural economists' toolbox. Basic factors are not active at any moment. Besides, not every event or component of the environment has an impact on them. Thus, the conditions that trigger the selected elements also have to be guessed. On one hand, the model has to make explicit which basic factors are involved in the generation of the pattern, and on the other hand, which variables trigger such a pattern. The joint action of basic and triggering factors should be able to generate the pattern demanding explanation. Unfortunately, no set of general a-priori rules is available in order to identify the particular basic and triggering factors which are relevant for the special problem under analysis. This is a very

creative process, which explains to some extent its autonomy and its role as mediators [3]. Briefly stated, BPMs are designed to build a connection between given economic patterns and some particular factors that might lead to them. More specifically, the process described in BP models has the structure described below:

**Triggering Factors | Basic Factors | Anomalous Pattern**

A successful Behavioural model shows that some triggering conditions activate some basic psychological factors, and the given pattern results from their joint action.

Benartzi and Thaler (1995) offer a specific example of a Behavioural procedural model built along these lines. The basic motivation for building this model is the existence of an anomalous pattern: the so-called Equity Premium Puzzle (EPP). The EPP is the difference between the return in stocks and the return on a risk-free asset (for instance, treasury bills). In the USA, for the last 100 years EP has been around 7 points. It is called a puzzle because this difference is too large to be explained by standard economic models. In fact, the standard risk-aversion explanation is highly implausible. Mehra and Presscot (1985) found that in order to explain the puzzle in a traditional way, a coefficient of risk aversion should be close to 30 although the actual estimation is close to 1.

Modelling individual preferences as having *loss aversion* and assuming *myopia* as the triggering variable, Benartzi and Thaler (1995) manage to obtain the anomalous pattern. The structure of their argument is the following:

| **Triggering Factor** | **Basic Propensity** | **Anomaly** |
|---|---|---|
| Frequency with which information is received (myopia) | $v(x) = \begin{cases} x & \text{if } x \geq 0 \\ 2.5\,x & \text{if } x < 0 \end{cases}$ | Equity Premium Puzzle |

The model is developed in a paper titled "Myopic Loss Aversion and The Equity Premium Puzzle", making reference to the main three concepts involved in the process: myopia, that is the triggering factor; loss aversion, that is the basic factor represented in the middle of the equation, and the anomalous pattern demanding explanation.

## Intended *Purposes* of Behavioural Procedural Models

In this section we approach BPMs as multi-purpose designs. This interpretation is in line with the one stated by Morgan and Morrison (1999) and Knuuttila (2004), among others, and allows us to go beyond the representational account of economic models.

Behavioural Economics does not offer a unified alternative theory as a substitute candidate for conventional economics. Those who build Behavioural Procedural Models focus rather on particular conventional theories that face significant anomalies, and try to reach two main purposes [4]:

a) To give *explanations* of both the anomalous economic patterns and the gaps between them and conventional (rational) results.

b) To help to correct the anomalous patterns allowing individuals to approach the results that would be reached if the ideal (rational) behaviour prevailed.

### *The Explanatory Purpose*

As already pointed out, conventional model building starts by assuming *any* postulate to model those individual preferences and expectations that take part in the processes of decision making, no matter how arbitrary they may seem at first sight. The already existing background knowledge about the way in which people make decisions in "real" (complex) circumstances is considered irrelevant. Only logic, mathematics and the assumptions' suitability for obtaining results matter. We think it is an acceptable principle for model building as long as the only purpose of the model is to attain predictions about the final outcomes of individual decisions. This is another way of saying that conventional decision models are *not* procedural but just *substantive* decision models.

What if the purpose is explanatory rather than predictive? In order to attain this goal Behavioural Procedural Models have to make those "real" processes of decision making explicit. Particularly, they only have to include representations of the decision processes that are consistent with the results of well grounded scientific research. We will say that the representation of a process of decision making is *plausible* if and only if it is consistent with the results of other social sciences (in particular, psychology). This definition suggests a way to avoid talking in terms of realism. Behavioural economists, such as Camerer or Thaler,

who claim their models are "realistic" or "more realistic" than conventional models, are ultimately claiming that they are plausible (or more plausible) representations of the processes of decision making.

Behavioural economists claim that Procedural Models are invested with *explanatory* force, because they incorporate *plausible* representations of decision processes. Of course, non Behavioural procedural models may also be explanatory (provided that they take advantage of empirical resources other than those provided by Cognitive Psychology). BPMs are only a particular kind of plausible explanatory models.

A model that successfully connects a psychological propensity or a particular heuristic plus a certain triggering factor with a given pattern p, does *not* prove that these factors are actually producing p in these particular circumstances. All it shows is that this might perfectly be the case. Their aim is to show what could possibly generate a given economic pattern. This means that BP models provide plausible possible explanations of economic patterns.

### *The Interventionist Purpose*

A second crucial feature of BPMs is their ability to change individual economic behaviour (and, eventually, some aggregate results of individual behaviour). In this regard, it is important to note the normative dimension that is present in conventional economic models. Old fashioned "realists" who confronted Friedman's defence of mainstream economic models during the fifties and sixties of the past century (e.g., Melitz 1965, Archibald 1961), considered conventional models as descriptive (for them economics was *positive* economics); they didn't emphasize enough the possibility that mainstream economics could be mainly normative. Contrary to this view, contemporary Behavioural economists (e.g., Camerer and Loewenstein 2004, Kahneman and Tversky, 2000) admit that many conventional models which fail from a descriptive point of view are nonetheless *adequate normative* models (for more details, see Hands 2009).

The deviation from the ideal norm is now considered not just as anomalous behaviour, but as *irrational*: it is a deviation from an optimal trend. Behavioural Procedural models are designed to find out the causes of the deviated conduct. Anomalies not only have to be *explained*; if possible, they have to be *corrected*. In this respect, three features of the application of BPMs deserve

to be underlined: a) the importance of identifying the causes that lead to deviations; b) who will receive the prescriptions; c) the contribution of conventional models.

For achieving the purpose of correcting the anomalies, the joint action of both knowledge of the possible motives of human decisions as well as the normative dimension provided by conventional economics is needed. This kind of knowledge supplied by BPMs, that ensures compatibility with the available scientific knowledge to model preferences and expectations, is needed for *economic* policies. It informs about the key psychological factors that influence the anomalous decisions and how they should be manipulated in order to push individual choices in some particular direction. It is important for intervening in the actual economy so as to re-direct the deviated pattern towards an ideal point. Most conventional models invite contemplation on the part of the observers: things will fit in by themselves in the best conceivable way. Behavioural models invite active intervention.

The identification of the motives for the anomalous behaviour opens the door for some kind of *paternalism*. BPMs provide prescriptions for helping people to approach the ideal behaviour. Earlier we resorted to the notion of loss aversion in order to illustrate our general view about the interventionist function of BPM. Now we are going to provide some additional examples of how other available psychological tools may be used to perform interventions designed to move the reference point and change agents' decisions having economic relevance.

Kahneman and Thaler (1991) explore the economic consequences of compensation policy. Broadly speaking, they argue that the pattern of individual consumption and consequently the utility derived from it may be modified through a change in the *flow* of compensation individuals receive, keeping constant its total amount. Following the ideas of Scitovsky (1976), Kahneman and Thaler distinguish between *comfort* and *pleasure* goods. Comforts are things that people buy and then get accustomed to, not generating utility in the long run. In contrast, pleasures are things people do not adapt to, increasing their utility. They claim that people tend to spend in comfort goods what they consider their regular incomes and tend to buy pleasure goods with that part of their incomes that is considered as extra-payment. Both the *number* of extra-payments received and their *amounts* are key variables influencing *the patterns of their consumption decisions*.

Furthermore, Kahneman and Thaler (1991) assert that the pattern of consumption affects *the amount of utility* individuals get from one fixed amount of money. The notion of adaptation level plays a central role in their argumentation. They find that in order to enhance the intensity of a particular sensation, it should be made intermittent over time, and that a single experience is less likely to modify the reference level as long as it is viewed as unusual. Finally, sudden changes are evaluated as a distinctive departure from adaptation, whereas a very slow gradual change will drag the adaptation level along with it, and may not even be detected (Kahneman and Thaler 1991).

The implication of this analysis for economics is rather direct: to the extent that people become quickly adapted to a consumption pattern obtained by their regular level of remuneration, increases in wages will have no effect on utility in the long run. However, a flow of income that induces people to increase their expenditure in pleasure goods will not drag the adaptation level along with it. These findings suggest that in a given period people will get more welfare from a flow of compensation including some extra-payments (clearly differentiated from what they consider their regular salary) than what they get from receiving a single amount of money (even if the total amount of money is the same in both cases). Then it would be possible to "create more worker satisfaction without increasing the cost of the pay packages" (Kahneman and Thaler 1991, p. 341) [5].

A second example of the way in which interventions may move the reference point and change an agent's economic decisions is provided by Bernartzy and Thaler (2001), who examine how people choose among defined contribution saving plans, which combine different sorts of investments (e.g., bonds and equities). They provide evidence that individuals "make decisions that seem to be based on naive (or confused) notions of diversifications" (p.79), which may not be optimal. One such heuristic is the so-called 1/n strategy, which means that individuals "divide their contributions evenly across the funds offered in the plan" (Bernartzy and Thaler 2001, p.79). They find that "the array of funds offered to plan participants can have a surprisingly strong influence on the assets they end up owning" (p.96). Therefore, the way in which the options are presented to the decision-makers seems to matter. As a result, as long as standard economic theory provides a benchmark for identifying the best option, an opportunity for helping people by framing their decisions in the "correct" way is created.

As long as Behavioural Economics is suspicious of the capability of humans for learning, [6] its prescriptions are not directed to the agents themselves but to what we may call generically the observers (institutions, firms, governmental authorities), all those who are empowered to influence the agents' choices. [7] Remarkably, the role of conventional economics is also enhanced, because paternalistic interventions are made possible by the existence and the use of the results of conventional economics as a benchmark that has to be reached.

Thus, a full account of the multipurpose view of BPMs may be formulated as below:

*Let "$p_r$" and "$p_o$" be, respectively, the observed anomalous economic pattern and the optimal economic pattern ("r" stands for "real" and "o" for "optimal"). Behavioural Economists use model M for giving a plausible representation of a process of decision making with the purpose of explaining both $p_r$ and the gap between $p_o$ and $p_r$, and providing prescriptions for correcting the anomaly, helping $p_r$ to approach $p_o$.*

## Invariance, causality and manipulability

Until now we have avoided talking in terms of causality even if this notion was implicitly assumed in previous sections of this paper - for instance, when we said that the triggering factors *generated* a certain pattern-. In our illustration, the frequency in which information about returns is given to people leads to the anomalous pattern of the distribution of investment among stocks and bonds. It is time to talk explicitly about causality and elucidate the particular concept of causality assumed in this paper. This is a crucial step because the interventionist purpose is defensible as long as an appropriate notion of causality related to intervention and manipulability is available.

For a start, let's consider two correlated events: X (the height of a column of mercury of a barometer) and Y (the atmospheric pressure). The strong correlation among the variables opens the door to two interpretations: 1) the height of the column depends on the atmospheric pressure; 2) the atmospheric pressure depends on the height of the column of mercury. To decide which of the two regularities expresses a *causal* correlation we may use the notion of an interventionist counterfactual, which may be so defined: *if an intervention on X were to occur, this would be a way of manipulating the value of Y* (Woodward, 2002).

Applying this criterion we may decide which of the two statements written below justify an *interventionist counterfactual.*

- If the height of the mercury column were manipulated by human intervention, this would not bring about changes in atmospheric pressure
- If a change in atmospheric pressure were to occur, this would bring about a change in the height of the column of the mercury barometer

Clearly it is the second sentence (but not the first) which is true. This allows us to reach the conclusion that atmospheric pressure is the cause of changes in the height of the column of mercury, not the other way around. Something similar happens with the process modeled in Myopic Loss Aversion: changes in the variable taken as triggering factor generate changes in investment patterns, albeit the inverse is not valid.

An important property of causal regularities is that they are *invariant* under some (well determined) range of interventions. In opposition with universal laws - which have to be invariant under *any* change in their antecedent conditions, a causal regularity may have exceptions. Invariance is important because it leads us to *manipulability*. As long as a causal regularity is invariant, it involves the possibility of intervening into the cause to manipulate its effect. In Woodward's words,

> "Invariance ... has the virtue of capturing the idea that what really matters to whether a generalization describes a causal relationship is whether it describes a relationship that is potentially exploitable for purposes of manipulation and not whether it has the other features (wide scope etc.) traditionally assigned to laws" (Woodward 2002, p. S371).

The invariance of BPM's connections enables their potential use for manipulation of the results through intervention on the relevant causes. For instance, if an intervention on the reference point of the choice settings were to occur, it would be possible to manipulate the agents' preferences and choices. In many circumstances, imposing the reference point that the agents adopt when facing a given choice setting, the observer is able to determine in advance the option that (invariably) will be chosen by most of them. As shown in the equity premium puzzle, changing the frequency with which people receive information about returns, loss aversion is activated and the distribution of investment on bonds and stocks may be changed. In this case the model allows us to (a) manipulate the triggering factors and (b) get control of the resultant pattern.

The possibility of Libertarian Paternalism (Sunstein and Thaler 2003; Benartzi and Thaler 2001, 2007) lies in this capacity for operating (not only ideally, but also actually) on the triggering factors in order to change the reference point and induce agents to choose among alternatives in an anticipated way.

## Are Behavioural Procedural Models *Mechanistic* Models?

We saw that BPMs involve causal relationships that tell us about the counterfactual dependence between triggering factors and anomalous economic patterns: they inform us what would have happened with the dependent variable if a change in the independent variable had occurred. Nonetheless, causal relationships do not tell us anything about *why* a change in the independent variable brings about a change in the dependent variable. It is necessarily a *mechanism* to answer this question. Broadly speaking, a mechanism opens the black box of a causal relationship: it "tells us why the counterfactual dependence holds and ties the relata of the counterfactual to the knowledge about entities and relations underlying it" (Hedström and Ylikoski 2010, p.54).

The word "mechanism" has a clear meaning in many ordinary contexts. However, a vast number of recent literature on mechanisms has been developed and many different senses of the term have been advanced (Bunge 1997, 2004; Bechtel & Abrahamsen 2005; Bechtel 2006, 2008; Craver 2007; Darden 2006; Elster 1999; Glennan 1996, 2002; Hedström 2005; Little 1991; Machamer *et al.*, 2000; Woodward 2000, 2002, 2003; Torres 2009. For a general concept of social mechanism, see also Hedström and Swedberg (1998a, 1998b) and Hedström and Ylikoski (2010)). In what follows we restrict our scope to some specific properties of the notion of mechanisms, which are crucial for a justification of BE models as providing "mechanisms-based explanations".

First, it is worth noting that the concept of mechanism is intrinsically connected with the notion of *causality*. On the one hand mechanisms are formed by parts that interact with each other producing regular changes, and these interactions are characterized as invariant generalizations (Glennan 2002). A second important point is that mechanisms are *processes* that take place in real (concrete) systems, which may have a physical, biological or social nature. It is inappropriate to look for mechanisms in semiotic or conceptual systems whose component entities are related by logical (not causal) relations (Bunge 2004).

However, mechanisms involve a *particular type of processes* characterized by *stable* behaviour. It is precisely this stability which allows a distinction of processes that are mechanisms from those that are just sequences of events. Elaborating on this point, Glennan (2002) distinguishes between:

a) Fragile processes (sequences that have particular (occasional) configurations)

b) Robust processes (sequences whose configurations are stable)

The successive stages that constitute sequences may or may not be connected to each other in a stable way. For instance, as Glennan has pointed out, the chain of events that led to his first meeting with his wife was rather unique. These kinds of processes are what he calls "fragile". Fragile sequences are not regular: even small changes in the precedent conditions could result in unanticipated events. The process that starts with the hitting of a ball and ends with a broken window after impacting in many intermediate obstacles is not a stable set of elements. It does not exhibit the kind of behaviour that we designate as regular. Only robust sequences have a fixed (stable) structure and may therefore be considered mechanisms.

More importantly, mechanisms are associated with the idea of *explanation*. Taken by itself a causal connection shows that the cause produces the effect *without* telling us anything about *why* and *how* the effect is generated. The claim that we may explain X in terms of Y by just pointing out a causal relation in which X figures as effect and Y as a cause is in this sense somehow unfounded and it is usually labeled as a kind of *black-box* explanation. A *mechanistic-based explanation*, instead, *opens* the black box, showing "how the participating entities and their properties, activities, and relations produce the effect of interest" (Hedström and Ylikoski 2010). For intervention, causality is enough; for providing explanations, mechanisms are needed (or at least, desirable). In this regard, BPMs are not only successful in discovering new causes of economic anomalous patterns; they also provide a sort of mechanism-based explanation of them, incorporating basic factors selected from the toolbox of Cognitive Psychology.

Besides, the kinds of mechanism-based explanations afforded by BPMs represent an important achievement. To see why, consider the way in which Elster (1998) describes the workings of mechanisms. According to him, the kind of sequences that can be found in social and psychological events may be stated in this way: "when C, *sometimes* P" [8]. This means that under conditions C the observable

pattern P may or may not occur. Behavioural procedural models achieve a much stronger connection between the "antecedent" and the "consequent" conditions, which may be formulated in this form:

*When conditions **C** (basic propensities or heuristics plus appropriate triggering factors) obtain, a majority of people always (behave according to) **P**.* (3)

BPMs' connections among C and P are halfway between those afforded by traditional universal laws and those complying with Elster's requirement. BPMs connections are not truly universal laws because they do not apply to all individuals, but they rule the behaviour of the *majority* of the people.

## Conclusion

An epistemological defense of what we call Behavioural Procedural Models (BPMs) was outlined. Those models represent the processes of individual decisions that lead to relevant economic patterns as *psychologically* (rather than *rationally*) driven. Their general structure and their particular nature and functions were also clarified, arguing that they may be compatible with a multipurpose view of models, where the *representational* and *interventionist* goals are combined. Particularly, our account shows that BPMs isolate *plausible* mechanisms of processes of decision making, which conform to the experimental results of Cognitive Psychology. It was also argued that BPMs are successful in achieving explanatory power and involve invariant regularities in Woodward's sense, which provide a causal sort of explanations of anomalous economic patterns, which allow for extra market intervention and manipulability, in order to correct and improve some key individual decisions. More precisely, as long as BPMs help to find the causes of the undesired anomalies, they provide a clue for intervening in order to correct them. The intervention is possible because agents' decisions are framing-dependent. In this regard, what may be changed by intervention is the reference point from which people perceive alternative options. However, since these changes are not necessarily made by interventions on economic variables (i.e., classical intervention), BPMs do not strictly resort to economic tools. As the paper of Benartzi and Thaler on the Equity Premium Puzzle suggests, changing the frequency in which individuals receive information about the returns provided by the fractions of their wealth held in stocks and bonds may modify the future

amount they allocate to each kind of investment. Therefore, patterns that pertain to the domain of economics may be affected by factors which are not currently considered typical of standard economic theory.

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## Endnotes

[1] Other approaches are available. Köbberling and Wakker (2005) for instance defined loss aversion as the ratio between the left and the right derivative of the utility function at the reference point, i.e., U'(0 left)/U'(0 right). Similarly, Wakker and Tversky (1993) dened the loss aversion coefficient as k =U'(-x)/U'(x) for positive values of x. There are also in the literature different measures of the value of CLA. For instance, Schmidt and Traub (2002) estimate the CLA in approximately 1.43, and in Harrison and Rutström (2009) the CLA is 1.38. The claims of our paper neither depend on any particular definition of loss aversion nor any particular value of CLA.

[2] "Loss aversion is more *realistic* than the standard continuous, concave, utility function over wealth, as demonstrated by hundreds of experiments." (Camerer and Loewenstein 2004, p.4)

[3] "Models, by virtue of their construction, embody an element of independence from both theory and data (or phenomena): it is because they are made up from a *mixture* of elements, including those from outside the original domain of investigation, that they maintain this partially independent status." (Morrison and Morgan 1999, p.14)

[4] One of the most significant illustrations of this procedure is Shefrin and Thaler (1988). See also Camerer and Loewenstein (2004) for a vast number of cases of this type.

[5] "The general conclusion is that it is certainly possible to use the same amount of money to produce different amounts of utility! The suggestion is that, for an income stream that is sufficient to prevent serious deprivation ..., there

exists a positively skewed distribution of the income over time that will yield greater utility than an even distribution. In particular, taking a portion of the compensation and paying it in a lump sum would appear to make things better." (Kahneman and Thaler 1991, pp.342-343)

[6] Tversky and Kahneman (1986, pp. S274-S275) offer a more accurate classification of the many circumstances in which learning cannot take place.

[7] Many prescriptions of this sort may be found in Benartzy and Thaler, 2001, 2007.

[8] "Mechanisms are frequently occurring and easily recognizable causal patterns that are triggered under generally unknown conditions or with indeterminate consequences." (Elster, 1998, p. 46)

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