LISBON
SCHOOL OF
ECONOMICS &
MANAGEMENT
UNIVERSIDADE DE LISBOA

MASTER OF SCIENCE IN
ECONOMICS

MASTER´S FINAL WORK

DISSERTATION

ENOUGH IS AS GOOD AS A FEAST:
A SIMPLE MODEL OF CHOICE OVERLOAD

ULAŞ IZMEN YARDIMCI

OCTOBER – 2018

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SUPERVISOR:

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ABSTRACT

The fundamental assumption of neoclassical economic theory is the rationality of economic agents. Nonetheless, in time, systematic deviations from this assumption has been observed. A number of such deviations pertains to the decision-making process and one of them is the rather seemingly contradictory burden originating from the abounding number of alternatives available. Suboptimal behavior caused by this burden that is called "choice overload" has been observed in field and laboratory experiments and subsequently introduced into some modern economic models. This dissertation provides a simple model for choice overload. By breaking the phenomenon into three parts, the novelty factor, the evaluation cost of choices, and the anticipated regret, it examines the elements that constitute choice overload. Subsequently, this work provides an example of the role choice overload may play in the context of Prisoner's Dilemma.

Keywords: Choice overload, procedural rationality, Prisoner's Dilemma

JEL Classification: C7, D91.

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This dissertation provides a simple model for choice overload, that is suboptimal behavior originating from the abounding number of alternatives available in the decision-making process. It examines the elements that constitute choice overload by breaking the phenomenon into three parts, the novelty factor, the evaluation cost of choices, and the anticipated regret. An example of the role choice overload in the context of Prisoner's Dilemma is provided.

1. INTRODUCTION

The fundamental assumption of the neoclassical economic theory is the rationality of economic agents. The economic definition of the rationality is somewhat different from both the colloquial definition ("in a clear-headed manner") and from the standard dictionary one ("based on or in accordance with reason or logic," ("Rational", 2018) as Oxford Dictionaries defines it), and it is more specific and restrictive. Economic agents are rational in the sense that they have definite preferences defining their utility, they are goal-oriented, utility-maximizing and consistent. Mathematical treatment of rational agents further restricts the description of their economic behavior: consistency of the rational agent requires completeness, reflexivity, transitivity, and strong monotonicity of her preferences; she is assumed to act with complete information and to be able to evaluate uncertainties in perfect accordance with the probability theory.

Founders of economic theory were aware of the psychological factors underlying economic behavior. As remarked by Ashraf et al. (2005), Adam Smith presented psychological drivers for individuals' behaviors and Jeremy Bentham worked on "psychological underpinnings of utility" (Daniel, 2009). Nevertheless, the psychological

aspects got lost along the path, yielding to the requirement of abstraction in order to develop workable economic models. The cases such as the paradox of choice proposed by Maurice Allais, which contradicts the predictions of the expected utility theory (Machina, 1987), were seen as curiosities to be treated separately in the fringes of economic theory.

In spite of this restricted and seemingly unrealistic fundamental assumption of rational behavior, economic theory has been quite successful in explaining and predicting real life economic situations. Nonetheless, from time to time, particularly following major economic events such as economic crises not predicted by the economic theory or persistent problems unanswerable within its framework, the questioning of the basic assumptions became widespread. In rethinking the basis of economic theory, one approach is often to loosen the definition of rational agent, to qualify the rational behavior and to allow economic agents a richer set of permissible behavior, rendering them less rational and harder to include in economic models, but closer to observed human behavior.

Human behavior not captured by the prevalent economic assumptions of rational agents may have substantial economic consequences. The first influential work trying to pinpoint this issue and hence argue against one of the pillars of the economic theory was Simon (1957). His conception of bounded rationality and “satisficing” decision-making had a long-lasting impact on economic thought and paved the way to the behavioral economics. The concept of bounded rationality is an attempt to grasp the inherent limits to the human capacity of gathering and evaluating relevant information as well as imprecision of the information itself. These limits force economic agents to use a procedural rationality instead of a clearly defined substantive rationality and to make

satisficing decisions, well enough but not optimal in an abstract ideal world. Camerer (2003) presented some new directions for a better understanding of the limits on rational thinking, concepts such as framing "the effect of the explicit description of a game" and heuristics "mental shortcuts to be taken while thinking".

The road opened by Herbert Simon is taken by economists, psychologists and other social scientists who strive to understand decision-making processes of individuals and institutions, administrators and politicians, economic agents in a particular context such as consumers or investors. There is a large and still growing literature of theoretical works, mathematical models, and experimental studies aiming at characterizing the actual human decision-making process, determining its imperfections and investigating the possibilities of improving its outcome.

One of these imperfections or deviations from the standard rational economic behavior concerns the case where the economic agent faces a large number of alternatives to choose from. While purchasing a good at a supermarket, selecting an item from a list or at any moment where an individual makes a choice among alternatives, an additional alternative should not affect the decision negatively. The result may be positive when the added item is better than the previous ones, but even when this is not the case, the effect of bringing nothing new to the table should be nil. Schwartz & Ward (2004) argue against the foregoing claim; albeit the fact that choice is good, it does not follow more choice is advantageous. The revolutionary study of Iyengar & Lepper (2000) demonstrates the claim in three experiments. More choice is not always beneficial; it may even become detrimental to the decision-making process. When the alternatives become too many to compare, too complicated to evaluate, and the cost of thinking makes itself felt, the decision maker is said to be in a situation of "choice overload". In a case of choice

overload, decisions become erratic and non-optimal, often decision makers go for a default option which is usually inaction or choice deferral.

This deviation from the standard economic setup started to be worked on rapidly. The early work on the phenomenon began with experiments done by psychologists, consumer theorists, and behavioral economists. Both field and laboratory experiments were held to tie up the loose ends of the previous works. Researchers studied the effects of factors such as the number of alternatives given to the individual, attributes and complexity of alternatives, comparability of alternatives, time constraint, and individual preferences.

Once observed behavior has become generalizable and formalizable, a more theoretical approach was added to the line of works. Economists turned to rigorous mathematics and built up utility functions which take choice overload into account, usually in the form of thinking aversion and cost of thinking.

This dissertation examines the notion of choice overload. Chapter 2 starts with a retrospective study and literature survey, chasing the concept back to 350 BC and bringing it back to the 21st century. Chapter 3 presents a simple model where choice overload can be observed and calculated, and Chapter 4 moves forward to suggest some areas where this model can be implemented and used. Chapter 5 concludes with a summary.

2. LITERATURE REVIEW

2.1. Early Concepts of Choice Overload

Common sense dictates that having the opportunity to choose is necessarily good. Though it may be usually the case, it is also beyond doubt that to think and to choose from alternatives require a certain amount of time and is a costly consideration. The earliest problem regarding choice can be seen in the form of an ass: the dilemma of Buridan's Ass suggests that if an ass which is equally hungry and thirsty is placed equidistant to a pile of hay and a bucket of water, then the ass will die out of hunger and thirst. The idea dates back to Aristotle's treatise *On the Heavens* in which the Greek philosopher ponders on the physical forces that act on bodies. Criticizing the view that the earth is stationary because the forces that act on it cancel out each other, the thinker writes:

> (…) the man who, though exceedingly hungry and thirsty, and both equally, yet being equidistant from food and drink, is therefore bound to stay where he is (…)
>
> In: Aristotle (350 BC/2018), Part 13.

Centuries later, Persian thinker al-Ghazali set up a similar setting for a different notion, coming closer to choice theory. Al-Ghazali (2018 version), contemplates about human decision-making, considering a man who faces equally attractive partners and cannot choose both of them. The philosopher asserts that free will comes into play in such scenarios.

Although the paradox takes its name from the French philosopher Jean Buridan, he does not use the setting explicitly. Working on moral determinism, Buridan hints at the deferral of the choice in the case of choice overload, writing,

> (…) should two courses be judged equal, then the will cannot break the deadlock, all it can do is to suspend judgement until the circumstances change, and the right course of action is clear.
>
> As cited in: Levy (2016), p. 94.

Neither Aristotle nor al-Ghazali nor Buridan were economists or even were thinking in economic terms. Nevertheless, the resemblance of their different utilizations of the paradox with the notion of choice overload is clear. In the paradox, the ass does not have a strict preference for an item over the other, and that leaves him motionless. Choice overload does not imply a lack of strict preferences that causes deferral of the choice. However, as the number of alternatives grows larger, the burden of evaluation becomes heavier, and the decision maker may refuse to think further. Thinking aversion may cause inaction and choice deferral even when there is a strictly preferred alternative hidden among others before the full evaluation. Contrary to the often-unstated assumption about the rational economic agent, preferences are not automatically and clearly known in advance, and lack of knowledge about our preferences may be very similar to the lack of preference.

2.2. Introduction of Choice Overload

Until recently, the common-sense notion of "the more, the better" has been supported in many psychological works. An early illustration of this is Langer & Rodin (1976) where it is found that existence of choice improves alertness, active participation

and well-being. Zuckerman et al. (1978) exemplify that, when given the chance to choose, people would possess more self-determination compared to people who are told what to do, hence be more intrinsically motivated. In a similar fashion, Deci & Ryan (1985) identify that choice augments intrinsic motivation since it enhances the sense of self-autonomy. Even when the choice is self-evident, the addition of extra and redundant alternatives has positive effects on people (Langer, 1975).

Iyengar & Lepper (2000) point out that in all the above-mentioned studies and in many others proposing that choice is inherently good, the number of alternatives is relatively small (generally between two to six). Furthermore, the experiments are designed in a way that participants are given either some choice or no choice at all. However, following the notion of "the tyranny of small choices" as referred by Hirsch (1976), Schwartz (2004) put it, "(…) the fact that some choice is good doesn't necessarily mean that more choice is better" (p. 3).

In order to put the choice overload hypothesis to test, the seminal paper on choice theory, Iyengar & Lepper (2000), carries out both field and laboratory experiments in which the contexts are subjective and unfamiliar to participants. The subjectivity of contexts ensures that, since there are no "right" or "wrong" choices, participants seek to choose what they think is the best for themselves, an indication of their preferences. Furthermore, while designing the experiments, unfamiliar contexts are adopted to retain participants from sticking with a personal favorite, hence by-passing the choice process.

In the first experiment, a tasting booth of either six or twenty-four different types of jam is displayed in a supermarket. On one hand, the extensive choice assortment (which offers twenty-four different types of jams) seems more attractive than the limited choice assortment (which offers just six different types of jams), attracting nearly 50 per

cent more people to stop and have a look at the table. On the other hand, this initial attractiveness does not continue to influence customers. Though people are told that they can taste as many jams as they desire, there seems to be no distinctive difference between the number of jams tasted in both conditions. Subsequently, participants are given a $1 discount coupon which will be effective if they purchase a jam. Participants of either condition have to go to the corresponding aisle to purchase a jam where they face all the flavors that the company provides. The effect of choice overload is observable in the subsequent purchasing behavior. Just as 3 per cent of participants who encountered the extensive choice set use their coupons to purchase a jam, whereas 30 per cent of participants of the limited choice set buy a jam.

The second experiment takes place in an introductory social psychology class of a university. As a part of the class, all students have to watch the movie "Twelve Angry Men." The experiment takes the form of an extra-credit assignment about the movie, which will award students two extra points for their next midterm. Students are explicitly told that the assignments are not going to be graded and that to earn the extra credits all they have to do is to complete the assignment regardless of the quality. Students are given either six (limited choice condition) or thirty (extensive choice condition) essay questions from which they have to choose one and write a two-page essay regarding the topic. Overall, 65 per cent of students handed over the assignment. This time, the effect of choice overload was clearer. From students who had to choose from the limited choice set, 74 per cent handed in the essay while this percentage decreases to 60 per cent in the case of the extensive choice set. In addition to this, the quality of essays differed greatly. Unaware of the choice conditions and hypotheses of the experiment, two raters graded the essays. The condition effect being significant, students of limited choice performed

better (with mean 8.09 and standard deviation 1.05) than their extensive-choice colleagues (who scored an average of 7.69 with a standard deviation of 0.82).

One unanticipated result of the experiment, when viewed from the framework of classical models, is that the same essay question is replied with better quality if it was chosen from the limited condition rather than the extensive condition. Iyengar & Lepper (2000) claim that this is a direct result of motivation. Since students are made believe that their writings were not going to be graded, the study shows that the overabundance of choice does not necessarily boost the intrinsic motivation and may even decrease it. It also asserts that while choosing from a limited set, people tend to analyze the situation rationally, evaluating the outcomes of each choice, and choosing the best for them; namely adopting an optimizing strategy. Meanwhile, people who have to choose from an extensive set are apt to use heuristics to overcome the choice overload (Payne et al., 1988, 1993) and ending the choosing process when they find any choice that is good enough, i.e. working a satisficing strategy (Mills et al., 1977).

The last experiment included in Iyengar & Lepper (2000) is set in a laboratory setting where three groups are formed: a limited-choice group, an extensive-choice group, and a no-choice group. The display is of chocolates where the limited set contains six and the extensive set contains thirty different types of chocolates of the same brand. One half of the no-choice condition group is shown the same six chocolates in the limited condition and the other half is shown the same thirty chocolates which is available in the extensive condition. The participants are told that the experiment was a marketing research and then directed to choose a chocolate. Afterwards, all participants are given a questionnaire which examines different aspects of the choice-making process, assessing whether it was enjoyable, difficult and/or frustrating, determining the expected satisfaction with the

choice, and identifying whether the participant was an optimizer or a satisficer. Following the questionnaire, choice-condition groups are given the chocolates they chose, whereas participants in the no-choice condition group are given a random chocolate which was not chosen originally. After participants tasted their chosen chocolates, another questionnaire is given to measure the sample satisfaction, perusing satisfaction and regret participants feel, and perceptions about the number of alternatives. At the conclusion, participants are required to complete a simple demographics questionnaire and asked to go to the final room where they would collect their $5 compensation money. In the final room, they are allowed either to take the compensation money or to leave with a box of chocolates worth 5 dollars.

Hendrick et al, 1968 showed that when alternatives are complex, decision time is longer for a person who chooses from two equally attractive and two unattractive options than a person who chooses from four equally attractive options. However, the decision times measured in Iyengar & Lepper (2000) contradict the earlier findings. It takes nearly three times longer for participants in the extensive-choice condition to choose what they want to taste rather than their limited-choice condition counterparts. The number of alternatives is perceived as “too many” by the extensive-choice group, whereas the limited-choice group find it “about right.” Furthermore, the observed behavioral strategies underlying the choice process, differ from what Mills et al (1977) claim, as they suggest that satisficing strategies are used in cases of extensive-choice conditions, but the questionnaire results from Iyengar & Lepper (2000) tells us that in both cases participants apply a satisficing strategy and do not expect that their choices would enrapture them. Surprising to some, extensive-choice group evaluated their choice process more enjoyable, but more difficult and more frustrating at the same time. When sample-

satisfaction measures are compounded into two, as "enjoyment score" and "regret score", and a single satisfaction score is calculated by subtracting the "regret score" from "enjoyment score", overall satisfaction scores are much higher for participants in limited choice condition. It is notable that "enjoyment scores" of participants in extensive-choice condition is greater than participants in no-choice condition. Finally, as predicted, subsequent purchasing behavior is highest for the limited-choice group and lowest for the no-choice group: 48 per cent of the limited-choice group prefers the box of chocolates over 5 dollars, while the ratio falls to 12 per cent for the extensive-choice group, and falls even more to a 10 per cent for the no-choice group. No substantial difference is noted among groups in terms of expected satisfaction and participants of both limited- and extensive-choice conditions reported that they made a moderately well-informed choice.

These findings lead to the conclusion that even though the overabundance of choice may seem desirable and even enjoyable, it has negative effects on subsequent satisfaction and motivation.

2.3. Subsequent Studies

Iyengar & Lepper (2000) is the first paper that put the choice overload at the center of its focus and makes an effort to understand the underlying factors and outcomes of it. A recent meta-analysis by Chernev et al. (2014) analyze 99 studies which were done in the area, the first (and the earliest) being Iyengar & Lepper (2000). The literature can be divided by their main focus. There are experiments conducted in order to highlight the psychological premises and consequences of choice overload, which constitute a subtopic of experimental psychology. Some studies, while belonging partly to the field of experimental psychology, examine a rather economical aspect of the subject and deal with consumer behavior. Once a literature is formed around the phenomenon, meta-analyses

congregated the experiments conducted and works done (Scheibehenne, 2010; Chernev et al., 2014). After a fair amount of experiments are carried out, a number of economists started to adopt a mathematical approach and worked on models which incorporate choice overload.

2.3.1. Experimental Studies

According to Diehl & Poynor (2010), there exists a burden of overabundance of choices because of the effort and stress of trying to find the best match in a larger set. In three studies with birthday cards, PC wallpapers, and camcorders, bigger assortments lead to higher expectations about the outcome and thereby decrease the satisfaction due to "expectation-disconfirmation." What is more, it is observed that choosing the same object from a larger set as opposed to a smaller one yields less satisfaction.

Among the experimental studies, Shah & Wolford (2007) investigate the choice overload as a function of the number of alternatives. An experiment conducted in a college reveals that the tendency of students purchasing a pen increases as the number of alternatives goes from 0 to 10. As the number rises further, the purchasing behavior decreases. Thereby, the study asserts that buying behavior, as a function of the number of alternatives, exhibits an inverted-U-shape.

By studying the relationship between decision time, regret, and choice overload, Haynes (2009) demonstrates that people who are given a large set to choose from under a limited decision time find the decision-making process more frustrating and more difficult. Besides, as expected, choice overload makes people less satisfied and more regretful with their choices. In line with Haynes, even if time pressure is not a factor, Inbar et al (2011) demonstrates that larger sets induce a feeling of rushing during the

decision process, and that the more a person feels she has rushed, the more regret she feels with her choice.

Various researchers studied different aspects of the subject. Sela et al. (2009) claim that choice overload entails people to choose "options that are easier to justify," hence choosing by virtue rather than vice. While deciding on which ice-cream flavor to purchase, people choose fruit flavors over cookie flavors more when they are presented with a larger assortment. Likewise, in an experiment consisting of printers and MP3 players, when the choice set is relatively small, participants prefer MP3 players whereas they choose printers when the assortments size is bigger. Fruit flavored ice-creams and printers over cookie flavored ice-creams and MP3 players reveal that hedonism is replaced by utilitarianism. Another perspective is given by Greifeneder et al. (2010) which assert that choice overload is closely related to choice complexity. Considering the number of attributes describing the alternatives as a variable of choice complexity, two experiments, which contain pens and MP3 players as items and designed in similar fashion with the literature, show that the large number of attributes yields choice overload, whereas small number of attributes does not.

2.3.2. Studies on Consumer Behavior

Once the anomaly has been observed in experiment repeatedly, researchers utilize the phenomenon for a better understanding of the ways consumers behave. An early work, Broniarczyk et al. (1998), considers the traditional grocery stores of the early 1990s who were losing sales to "alternative format retailers" such as Walmart. In order to compete with such retailers, grocers had to lower their stocks keeping units (SKUs). However, they were afraid to do so since lowering SKUs would mean smaller assortment size. The

study shows that, unless they eliminated the best-selling goods or lowered the category space, grocers would not lose more shoppers and reduce operating costs.

Gourville & Soman (2005) bisects the assortment type as “alignable” and “nonalignable” where the former assortment types differ by only one dimension and the latter by many. Carrying out two studies with Panasonic and Sharp microwaves, and Nikon and Canon cameras, the work argues that increasing the assortment size proves advantageous for alignable items, however forms a choice overload for nonalignable ones.

In another study, Chernev & Hamilton (2009) focuses on the relation between assortment size and option attractiveness. Experimenting with various services such as sandwich shops, CD retailers, and dating services, the examination suggests that if the objects that a company provides seem more attractive, smaller assortments are always preferred. Osnos (1997) shows that companies started observing the choice overload phenomenon and strategized accordingly. One example being Proctor & Gamble which reduced the number of alternatives its shampoo Head & Shoulders provides, from 26 to 15, and increased their sales up to 10 per cent in turn.

2.3.3. Meta-analyses

There exist two major meta-analyses regarding the topic. On one side, numerous research studies supporting choice overload and, on the other, studies that find no evidence of the phenomenon or instead advocating that the larger the number of alternatives, the higher the satisfaction. These results were brought together in Scheibehenne et al (2010) for the first time. The analysis of 63 conditions from 50 published and unpublished experiments concludes by indicating that the mean-effect size

is practically zero. In addition, it argues that there exists a bias towards choice overload in published studies.

In contrast, a more recent review, Chernev et al. (2014) report on 99 observations. By identifying the moderators of the impact of assortment size on choice overload (which are choice set complexity, decision-task difficulty, preference uncertainty, and decision goal), it argues that the overall effect size is significant.

2.3.4. Models of Choice Overload

As the choice overload became a recognized phenomenon thanks to the experimental works and qualitative discussions of pioneering studies, a number of economists adopted a rigorous approach aiming at characterizing the subject within a choice theoretical framework. Various studies suggest different models where the choice overload is driven by distinct factors. Most of these works have extended the classical decision theory to preferences over menus, following the footsteps of Kreps (1979). Considering not the choice among objects, but the menus of objects, Kreps (1979) likens the problem to the choice of a restaurant. A diner will have to choose what she is going to have from the menu of a restaurant eventually, but which restaurant to go to in the first place? It is assumed that the choice of the restaurant is based on the menu it offers, hence the diner has to choose from the menu of menus. Forming a set of all meals and a set consisting of all non-empty subsets of all meals (a menu of menus), choosing a menu then amounts to a complete and transitive relation on the set of all meals which satisfy "revealed preference." Kreps (1979) ponders on a complete and transitive relation on the set of menus, which does not satisfy "revealed preference". This relation is not rational in the classical economic framework; however, a diner – while preferring a menu which offers only steak to a menu which offers only chicken – may well strictly prefer a menu

consisting both steak and chicken to two different menus which offer only steak and only chicken, out of uncertainty which yields a "desire for flexibility."

Kreps (1979) suggests that "desire for flexibility" calls for bigger sets and rationalizes this "uncertainty of future tastes" motive by a domination relation. On the other hand, there are studies differing from Kreps (1979) by giving different explanations why an individual may prefer smaller sets than bigger ones. Analyzing preferences over lotteries, Gul & Pesendorfer (2001) define commitment and self-control in economic terms. A person has a preference for commitment if she strictly prefers a subset of a set to set itself and has self-control if she can resist to temptation. An agent having a preference for commitment is strictly worse-off when an object is added to a set, since the newly added alternative is a temptation which may alter the behavior of the decision-maker and/or require costly self-control (Gul & Pesendorfer, 2005). Dekel et al. (2009) provide a generalization of the work done in Gul & Pesendorfer (2001), allowing the alternatives other than the most tempting ones to lower utility. In contrast to Dekel et al. (2009), Gul & Pesendorfer (2005) suggest that only the most tempting alternative may lower utility. All three works share a similar structure and advocate that people may prefer smaller sets of objects to abstain themselves from tempting alternatives.

Regret may also be a cause for individuals to favor smaller sets rather than big ones. Independent of the subject of the problem, any decision comes with a portion of regret. Whether it is an important matter or an insignificant one, from choosing where to live and whom to marry to what to eat and what to wear, an individual expects a certain amount of satisfaction before deciding and afterwards experiences a certain level of satisfaction as her choice lives up to the expectation or not. Just like satisfaction, she also perceives the feeling of regret, both ex-ante and ex-post. The model in Sarver (2007) is

in line with this claim. In accordance with the previous works, Sarver (2007) investigates preferences over menus. Since ex-post regret is due to comparison between the object selected and other alternatives available, an individual may desire to choose from a fewer number of alternatives, thereby lowering the probability of making a "wrong" choice. Sarver (2007) coins the term *regret preference* and shows that this preference actually reveals how much the individual values the number of alternatives. Similar to temptation models discussed above (Gul & Pesendorfer, 2001, 2005; Dekel et al., 2009), Sarver (2007) argues that an additional item to the menu decreases the utility of the individual, this time because of the increase in regret.

Another possible explanation for choice overload may be the "cost of thinking" while making a choice (Ortoleva, 2013). Although the concept is nothing new to the field, its earlier usages under the name "cost of contemplation" (Ergin, 2003; Ergin & Sarver, 2010) differ greatly from that of Ortoleva (2013). Both these studies which employ the term "cost of contemplation" include agents who decide on the level of contemplation required for the choice-making process. Ergin (2003), following the footsteps of Kreps (1979), argues that the individual favors bigger sets and builds up a model which turns out to be equivalent to that of Kreps (1979) if the contemplation cost is zero. In the model offered in Ergin & Sarver (2010), the individual may actually favor bigger sets, but only when there are other factors like temptation alluring the individual. The model in Ortoleva (2013) opposes the claim that individuals prefer bigger sets when there exists a costly work of thinking; an individual prefers a smaller set to choose from in order to avoid the cost of thinking associated with the larger set.

Ortoleva (2013) divides the problem into four parts. First, it introduces the concept of "thinking aversion" by bisecting the preference: a genuine preference which assumes

the cost of thinking is zero and an actual preference which considers how hard the choosing process will be. Second, the work characterizes how a thinking averse agent behaves. What is dubbed as *Thinking-Averse representation* is defined as genuine preference minus the *Anticipated Thinking Cost* which also can be seen as the agent's evaluation of the thinking cost associated with the set. The following part is the applications of the result of previous studies to this new model. Lastly, the paper examines the anticipated thinking cost function more closely and states two probable interpretations of it: one being the cost of finding out the best item in the menu (given preferences of the agent) and the other being the cost of finding out actual preferences of the agent.

These works treating the choice overload phenomenon using a sophisticated mathematical apparatus reveal that this behavioral aspect can be rigorously characterized in a choice theoretical framework. Simplified models based on such a characterization may be used to demonstrate and illustrate the outcome of choice overload in theoretical or real life situations, or they can be implemented in larger case-specific models. The following chapter presents a simple model which incorporates choice overload and that can be integrated into more solid models. It also illustrates how the final equilibrium is affected by choice overload in a game, using the essential setup of the most elementary but also perhaps the most well-known game of the game theory, namely the Prisoner's Dilemma.

3. THE MODEL

Unlike most of the other models of choice overload, this study considers choices over objects rather than menus of objects or lotteries. Throughout the discussion, an analogy of a consumer who wishes to buy a laptop will be utilized whenever helpful.

Consider an economic agent, who faces a decision problem. Assume that she is given n choices and let $C_1, C_2, C_3, \ldots, C_n$ be her choices with $\mathcal{C}$ being the set of all choices given to the agent:

(1) $$\mathcal{C} = \{C_1, C_2, C_3, \ldots, C_n\}.$$

Even though the economic agent is presented with n choices, there always exists another one, an inherent option which is the default option and that may be interpreted as refusing or postponing to choose, deferring, sticking with the status quo of an object already owned, etc. Usually, the default option is not presented to people explicitly, however, we know that we can choose to buy nothing. The laptop shopper has n different laptops to choose from or she can defer the choice and stick to her old laptop. Hence, the economic agent has actually $n + 1$ options. Naming the default option as C_0, the agent now has to choose from the set $\mathfrak{C}$ where,

(2) $$\mathfrak{C} = \mathcal{C} \cup \{C_0\} = \{C_0, C_1, C_2, C_3, \ldots, C_n\}.$$

Now, a utility function can be defined on the set of choices, since choosing a specific item will give the agent some level of utility, and any effect of the choice process on the agent can clearly be monitored by the utility function. So, let:

(3) $$U : \mathfrak{C} \to \mathbb{R},$$

be the utility function. Notice that the utility function in this model is not the usual well-behaved, continuous function, but a function with a discreet domain, containing only finitely many items. On the other hand, since the function assigns each C_i (for $i = 0, 1, 2,$

…, *n*) a real number, it enables us to rank the alternatives which is essential for a decision problem.

When choosing which laptop to buy, the economic agent does not "judge a book by its cover", i.e. she does not solely base her decision on facings and names of laptops, but rather inquire about various aspects of them. Facing, brand, processor, RAM, memory, graphics card, sound card, screen size, resolution, battery life, weight, and color are just some of the features to consider while purchasing a laptop. For this reason, C_i may be thought as denoting a set of features or as representing the object itself, which is more than just a name, but a vector listing the characteristics of the object. To design a well-defined model, the features should be comparable from object to object, and the qualitative features should be included using appropriate binary variables.

The essential universally comparable feature of economic objects is the price. The price has a number of distinguishing characteristics. It is one of the most important parameters of economics. It is the only feature common to every item on the market. It is a simple and obvious signal to agents, easy to perceive and easy to compare. Thereby, as a simple and non-ambiguous feature, it provides a pivotal comparison point and it should be singled out in the set of features attached to alternative *i*.

In order to single out the effects of consideration of monetary cost, we assume that the utility function $U(C_i)$ can be written as $U(C_{-i}, P_i)$ where C_{-i} denotes the vector of all variables except the price, and the P_i is the monetary cost or the price of the choosing *i*th alternative. We assume also that $U(C_{-i}, P_i)$ is additively separable in such a way that

(4) $$U(C_i) = U(C_{-i}, P_i) = U^c(C_{-i}) - U^p(P_i),$$

that is, the total utility the agent will obtain by choosing alternative *i* is the utility she will obtain from every aspect but the price of alternative *i* (which will be called the *no-price utility of alternative i*) minus the disutility from the foregone amount of the price of *i*.

Classical economic theory dictates that the choice problem then amounts to

(5) $\max U^c(C_{-i}) - U^p(P_i)$ subject to a given budget constraint $(i = 0, 1, 2, \ldots, n)$.

Let us turn our focus to the default option C_0. Since C_0 is an element of the domain $\mathfrak{C}$, the utility function U assigns a real number to it, taking its no-price utility and price as inputs, which will be denoted by D:

(6) $$U(C_0) = U^c(C_{-0}) - U^p(P_0) = D.$$

We call this D the *default utility*. The default utility may be zero when the choice is among alternatives which the agent does not have any substitute for. Since she has nothing and pays nothing, both components of the utility function are zero, yielding a zero utility. If the agent is choosing among alternatives which she has a substitute for, e.g. she may be looking for a better laptop than hers, then the no-price utility is non-zero, implying a positive D. The price component may also be non-zero, as for the case of a rented apartment or a mobile plan. In any case, elementary consideration of rationality implies that D is greater than or equal to zero.

C_0 is the default option, and D is the utility she has from the default option. While evaluating the available alternatives, they will constitute a "starting point" for the agent: Comparisons will be made with the default option at the beginning of the decision process. If none of the alternatives excites the agent's attention, i.e. no utility higher than D is reached, then she will opt not to choose anything and stick to C_0.

Classical theory tells us that the economic agent instantly evaluates the alternatives with the maximization operation indicated at (5), compares the maximum

utility with D, and then decides either to switch or to defer. Still within the broadly neoclassical framework, but using a procedural conception of rationality, we may consider an agent evaluating the alternatives one by one and deciding to switch from D to C_i if

(7) $$U^c(C_{-i}) - U^p(P_i) > D \iff U^c(C_{-i}) - U^p(P_i) - D > 0.$$

During the evaluation process, the switch does not have to happen once. Considering the alternatives, if the agent finds out a better alternative j, then she will switch from C_i to C_j. When the focus is on the case of deferral, a single switch will suffice to end the analysis. If the aim is at exploring the whole process of the evaluation, taking the last alternative switched as the default option indicates a straightforward way of expanding the analysis.

Nevertheless, the choice overload phenomenon has an effect on the choice problem. The impact of choice overabundance may be introduced by modifying the switching condition in (7) as follows:

(8) $$U^c(C_{-i}) - U^p(P_i) - D > \mathcal{E},$$

where $\mathcal{E}$ is the *choice overload effect*.

The concept of "choice overload" implies that $\mathcal{E}$ should be positive. In general, $\mathcal{E}$ can be either negative or positive and even when it is positive, it may have a negative component. Consider an economic agent who values novelty greatly, in which case $\mathcal{E}$ may be a negative number. Solely the characteristics of the alternatives or the desire to acquire something new may boost the person towards picking a non-default option. On the other hand, a positive $\mathcal{E}$ implies that the existence of the alternatives has some level of toll on the agent, i.e. the choice process gets more difficult with the available options.

Classical theory ignores the existence of choice overload. Nonetheless, every choice holds its own complexities including, but not being limited to, the difficulties associated with obtaining information about the options, perusing and comparing the information, and the cognitive toil involved in the decision process.

The next section is devoted to investigating $\mathcal{E}$ in order to have a deeper understanding of the role choice overload plays in the model.

3.1. OVERVIEW OF THE CHOICE OVERLOAD EFFECT

The economic agent in the model has all the information about set $\mathfrak{C}$ and its content, that is to say, she knows what her choices are, including the default option. What she does not know is the necessary endeavor to compare the alternatives and to choose the best for her. This model tries to materialize the mental work associated with the choice process.

$\mathcal{E}$ can be broken down to three components. The choice overload effect depends on the novelty factor ν, the evaluation cost of choices γ, and the anticipated regret ρ.

The novelty factor ν incorporates the openness to change and the benefits of having alternatives. Every person value change to a certain degree. Consider a dim world where there exists just one type of laptop. Accordingly, a person either does not have a laptop or owns the same laptop as everyone. When a new laptop hits the marketplace, there arises a hype around the new laptop. Even if this laptop is not as good as the old one, there would be people buying it – just for the sake of novelty and change. Additionally, to have options and to be able to choose brings a sense of freedom. The economic agent is not told what to buy or do, but she can decide on her own preferences. Accordingly, the mere existence of alternatives possesses an inherent positive utility.

Any choice of any form comes with the evaluation cost of the available choices, which is denoted as γ. Since it is assumed that all information regarding the options is given to the agent, the evaluation of choices does not include the level of difficulty of obtaining the information and processing it. Although, in reality, this is usually not the case, the evaluation cost γ in the model is essentially related to the complexity of comparing items. The evaluation and the associated cost are very sensitive to the nature of the choice. If the decision problem is about relatively simple and unidimensional objects that do not have complicated features, then the cost associated with comparing the alternatives will be relatively small. On the other hand, when the features to be taken into account are many and ranking accordingly gives conflicting results that makes weighting various features both necessary and ambiguous (as in the case of deciding on a car or on a house), the evaluation cost becomes larger.

Another interesting remark about a side effect of the cost of thinking is that when certain aspects of the alternatives are simple to determine and easy to compare, they are over-employed in the evaluation process due to the tendency of evasion from complexity. One such aspect is the price. People tend to rank the options comparing just the price tags and then choose accordingly. For another example of such behavior, let us turn to the laptop shopper. Assuming she is not an expert on laptops, given her limited knowledge, she will most likely to make her choice comparing CPUs and RAMs. Compatibility of the components and the overall quality of other components may be quite important, but as they cannot be determined effortlessly and summarized with an easily comparable numerical value, they are underused in the evaluation processes, yielding the choice to be subpar.

The last element affecting the choice overload effect is the anticipated regret ρ. As Landman (1993) writes:

> (…) [R]egret may threaten decisions with multiple attractive alternatives more than decision offering only one or a more limited set of alternatives… Ironically, then, the greater the number of appealing choices, the greater the opportunity for regret.
>
> In: Landman (1993), p. 184.

Regret may be ex-ante or ex-post. Ex-ante regret is the anticipated regret occurring during the choice process, rising from the thought of possibility of finding a better option. Ex-post regret is the post-decision regret due to the uncertainty towards the final choice. Since the human brain works continuously, after the purchase of an item, it wonders whether there were better alternatives which may or may not have been encountered. Though post-decision regret decreases the enjoyment of one's purchase, anticipated regret makes the decision-making process harder than it actually is. Anticipated regret may even lead to paralysis (Schwartz & Ward, 2004). The laptop customer, while evaluating the available options, may consider the probability of the existence of a laptop that suits her preferences better, i.e. the chance to expand the choice set $\mathfrak{C}$, which will prolong the decision process. However, even if she finds a better laptop after extending $\mathfrak{C}$, she cannot help thinking in the same way. Hence, she is left paralyzed. What is more, the cognitive toil and the absence of a tangible item dissatisfies her, meaning a negative utility.

Therefore, the discussion above suggests that the choice overload effect can be written as,

(9) $$\mathcal{E} = -\nu + \gamma + \rho.$$

3.2. INVESTIGATING THE CHOICE OVERLOAD EFFECT

When put as appropriateness "(…) to the achievement of given goals within the limits imposed by given conditions and constraints" (Simon, 1976), rationality, hence economics, do not intersect with psychology. Simon argues against the classical definition and proposes that there are two different kinds of rationale. One that corresponds to the classical definition, which is dubbed as "substantive rationality", the other being "procedural rationality" which is "the outcome of appropriate deliberation" depending on the "process that generated it." Since our model is based upon the cognitive toil caused by choice overload and focus on the decision process itself, it will incorporate certain aspects of procedural rationality.

The choice overload effect will be studied with two variables. During a choice process, the first salient characteristic of the problem is the number of alternatives available. In the model, the agent is faced with n options plus the default option, yielding a total of $n + 1$ options. Since the default option is unvarying, it will be innocuous to assume that the choice overload effect depends on n.

The other variable that affects $\mathcal{E}$ is the number of comparisons that are actually done. During the evaluation process, the economic agent may decide to continue the evaluation process or decide to defer at any time. Her decision will depend on the number of evaluations she has already made. This actual number of comparisons already made is denoted with k.

3.2.1. The Novelty Factor

The novelty factor ν represents how much the economic agent values novelty. For this reason, it is not a cost but a benefit to the agent, hence the negative sign in the formulation of $\mathcal{E}$. The factor is zero when there are no options but the default option, $\nu =$

0 when $n = 0$. To have an option or two rather than zero is valuable nearly always and everybody. When one has tens of alternatives, having a few more is not as important; marginal utility derived from the novelty factor drops quickly. Hence, ν increases drastically when n grows bigger from 0, but becomes essentially constant for larger values of n, as can be seen in Figure 1.

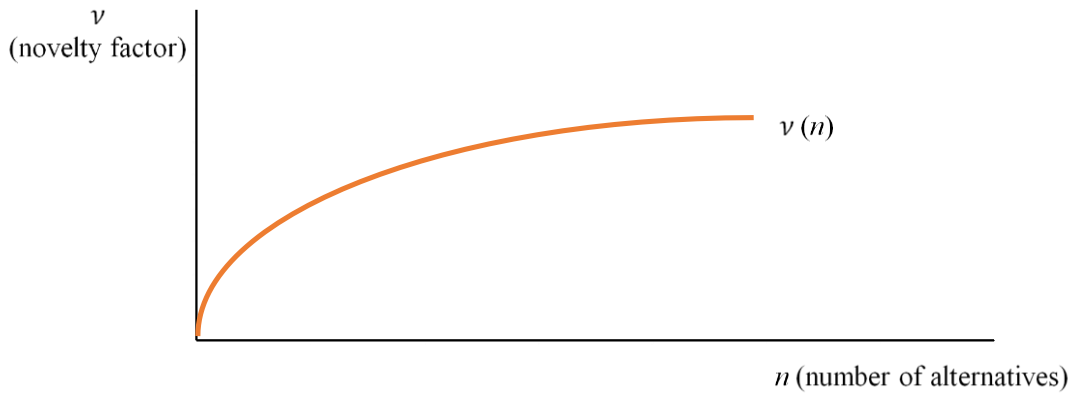

FIGURE 1- Novelty Factor as a Function of Number of Alternatives

Notice that since ν accounts for the benefits from the number of alternatives, it does not depend on the number of comparisons made, k.

3.2.2. The Evaluation Cost of Choices

As mentioned above, evaluation cost of choices has two interpretations. Both the anticipated and the actual evaluation costs depends heavily on the gravity of the choice. After the presentation of the available options, i.e. the set $\mathfrak{C}$, but before the decision process, the economic agent forms a belief regarding the amount of work she will do. This anticipated evaluation cost of choices is a function of number of choices n. On the other hand, the actual evaluation cost of choices depends not on the number of choices n, but on the number of comparisons k. Even if the agent faces a problem with 100 different

alternatives, if she makes only a couple of comparisons and decides accordingly, her actual evaluation cost is quite low. So, if $k = 0$, then $\gamma = 0$. γ is linear with k to a large extent, however as k grows bigger, γ may grow more rapidly, since comparing new items and holding old information about past comparisons gets more difficult – see Figure 2 below.

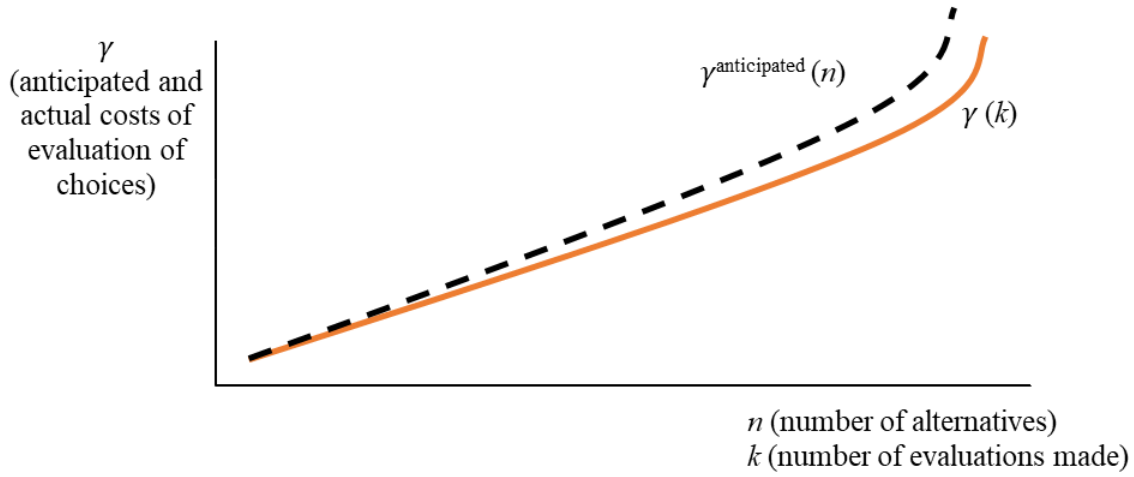

FIGURE 2- Anticipated Evaluation Cost as a Function of Number of Alternatives and Actual Evaluation Cost of Alternatives as a Function of Evaluations Made

3.3.3. The Anticipated Regret

The anticipated regret ρ of the agent may be interpreted as a function of the number of alternatives not evaluated, i.e. $n - k$, because it is those items which are not taken into consideration that constitutes the regret one feels. Thereby, ρ increases as n does, and decreases as k increases. Before the evaluation process starts, since n is given and constant where $k = 0$, there exists a ρ^* which is the starting level of anticipated regret. As the economic agent delves into the alternatives and makes comparisons, ρ starts to vary. In the beginning, ρ may not change drastically or even may increase due to arising confusion towards alternatives. However, from a point onward, ρ starts to decrease because the agent begins to form an opinion about the situation she is in. Finally, when

all alternatives are compared with each other, i.e., $k = n$, $\rho = 0$ or a small positive value. A residual value for anticipated regret may occur not because of insufficient evaluation of the alternatives, but because the agent may be uncertain about whether she made the best choice or even she may be uncertain about her own preferences. Figure 3 illustrates the relation between anticipated regret and number of alternatives not evaluated.

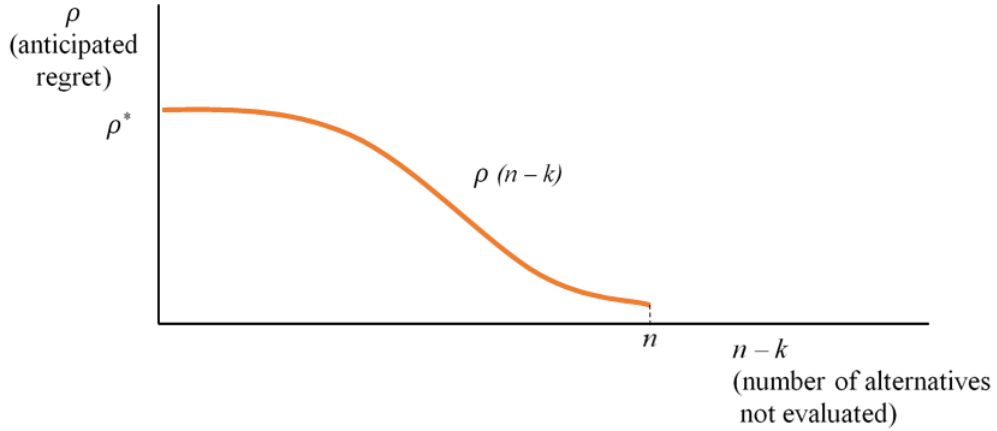

FIGURE 3- Anticipated Regret as a Function of the Number of Evaluation of Choices Not Made

4. A GAME THEORETICAL EXAMPLE

The analysis of choice overload can be done in numerous ways. Regardless of the method, in some cases, the nature of the subject of the model requires that choice overload must be taken into account. Once it is incorporated into a model, even the basic examples of economics may yield unexpected outcomes. Before illustrating such a case using an elementary example of game theory, let us consider traditional board games which require strategic thinking.

In games such as go, chess or checkers, in principle, all the information is knowable to players. The information is there but it may go unnoticed. What makes these games challenging is the overwhelmingly large number of options available and the huge amount of mental calculation and analysis required to gather the information in order to obtain an advantage over the opponent. Among the strategical approaches in such games, one stands out in the context of choice overload. During the game, instead of a conventional move which generates few and known counter moves, a player may choose a move which generates lots of possible counter moves. In doing so, the player disorients her opponent. The opponent, expecting the conventional move, may have already calculated the possible counter moves to that, but now faces a completely different set of alternative counter moves. Evaluating and comparing the elements of this new huge set eventually tires the opponent and makes her abandon the thinking process, laboring a mediocre move at best. Thus, in a chess game for instance, a player may opt for "positional play" and try to drag the opponent towards a "closed position:" This chess term may be translated into the choice theoretical framework as forcing the opponent into a situation of choice overabundance, where cost of thinking may cause sub-optimal decision.

Let us turn over now to the probably best known elementary example of game theory, the Prisoner's Dilemma, in order to illustrate how the phenomenon of choice overload alters the equilibrium point. Assuming that the structure is the same as in Tucker (1983), with only difference being the positive payoffs for the ease of exposition, consider Table I below.

TABLE I
A SIMPLE CASE OF PRISONER'S DILEMMA

		Player 2	
		Strategy I	Strategy II
Player 1	Strategy I	(1, 1)	(3, 0)
	Strategy II	(0, 3)	(2, 2)

It is easy to see that (1, 1) is the Nash equilibrium of the game, even though it is not Pareto efficient, and (2, 2) would make both players better off.

Now consider Table II, an extended version of the above game, with a third strategy of *doing nothing* added as the default option.

TABLE II
EXTENDED VERSION OF PRISONER'S DILEMMA WITH A DEFAULT STRATEGY

		Player 2		
		Strategy I	Strategy II	Strategy III
Player 1	Strategy I	(1, 1)	(3, 0)	(0.5, 0.5)
	Strategy II	(0, 3)	(2, 2)	(0, 2)
	Strategy III	(0.5, 0.5)	(2, 0)	(0, 0)

The usual, often unstated, assumption of game theory is that players have complete knowledge about the structure of the game and its payoff matrix. If these usual premises are assumed, the addition of the Strategy III has no effect on the outcome of the game. Strategy III is obviously an inferior strategy for both players, in fact worse than any other strategy. Hence, the Nash equilibrium will prevail and we will have a classic case of Prisoner's Dilemma, unnecessarily complicated by a third, irrelevant strategy.

In order to introduce the evaluation cost of choices γ into this game, it is assumed that the information about the payoff matrix is basically there, but it requires a costly process of evaluation. The payoff value of the Strategy III is clearly known by both players since it is the default strategy. On the other hand, the other strategies require a certain amount of computation, and hence, incur a cost of evaluation. To put it more clearly, consider the following payoff matrix in Table III,

TABLE III
EXTENDED VERSION OF PRISONER'S DILEMMA WITH A DEFAULT STRATEGY, PRE-EVALUATION

		Player 2		
		Strategy I	Strategy II	Strategy III
Player 1	Strategy I	$(3^2 - 2^3, 3^2 - 2^3)$	$(2 \times 5 - 7, \cos \pi)$	(0.5, 0.5)
	Strategy II	$(\cos \pi, 2 \times 5 - 7)$	$(2^2 - 2, 2^2 - 2)$	(0, 2)
	Strategy III	(0.5, 0.5)	(2, 0)	(0, 0)

This payoff matrix is exactly the same as the payoff matrix of Table II. All the information is still there, but hidden behind a curtain which necessitates a certain amount of thinking and computing.

Now consider an extreme case of choice overload where even one option is too many for the players. In this case, the default option (Strategy III) of doing nothing prevails and the outcome is (0,0).

This scenario may also be interpreted as an extreme case of thinking aversion. The evaluation cost of choices is prohibitively large such that players rule out evaluating the payoff values attached to strategies I and II – sticking to the default strategy, III. Consequently, the outcome is (0, 0). This outcome is not only worse than the Pareto efficient solution (2, 2) but also worse than the Nash equilibrium (1, 1) of the Prisoner's Dilemma.

This situation may arise if each player is assigned a specific choice overload effect $\mathcal{E}$, as defined earlier. Assuming the players are alike, consider the novelty factor ν_1, the evaluation cost of strategies γ_1 and the anticipated regret ρ_1 of Player 1.

Let Player 1 dislike novelty and let anticipated and actual evaluation costs be the same and be directly proportionate to the number of strategies available. Lastly, let anticipated regret be the half of the number of alternatives which were not evaluated. Thereby:

(10) $\nu_1 = 0$,

$\gamma_1^{\text{anticipated}}(n) = \gamma_1(k) = 1 \times n$, and

$\rho_1(n, k) = 0.5 \times (n - k)$.

Furthermore, assume that before any evaluation, players have approximations about the payoffs and assign equal probabilities to every outcome of the game. As rough estimates

about the payoffs give gains ranging from 0 to 3, with equal probabilities, it is safe to say that Player 1 anticipates a gain of 1.5 units from the game before the evaluation. Finally, suppose that anticipated gain of doing nothing is 0.

Thus,

(11) $U_1^{\text{anticipated}} = 1.5$ and $U_1(Strategy\ III) = D_1 = 0$,

which yields

(12) $U_1^{\text{anticipated}} - D_1 = 1.5.$

Classical theory dictates that since there exists the possibility of gaining positive utility, Player 1 must enter the game. Nonetheless, when the choice overload effect is involved in, at the beginning of the game where $n = 2$ and $k = 0$,

(13) $\mathcal{E}_1 = 0 + 2 + 1 = 3.$

As $U_1 - D_1 < \mathcal{E}_1$ (1.5 < 3), Player 1 chooses the default strategy of doing nothing. The process is same for Player 2, hence the outcome (0, 0).

If the evaluation cost of strategies is incorporated in the payoffs, the additional paradox arising from the extreme thinking aversion is eliminated. Following the evaluation of the strategies, we have a new payoff matrix where the evaluation cost is deduced from the original values. The Nash equilibrium of the game becomes reachable, and we have a traditional case of the Prisoner's Dilemma. However, the question of whether the reduced payoffs of this new Nash Equilibrium is larger or smaller than the original outcome of extreme thinking aversion case remains open. The answer depends obviously on the relative magnitude of evaluation cost of strategies with respect to the payoffs.

Continuing the example above, after the evaluation where $n = 2$ and $k = 2$,

(14) $\nu_1 = 0,$

γ_1 (k) = γ_1 (2) = 1 × 2 = 2, and

ρ_1 (n, k) = ρ_1 (2, 2) = 0.5 × (2 – 2) = 0 (which implies no regret).

Thus, assuming the outcome of doing nothing is known in advance[1], the evaluation cost of strategies, which is 2 units for evaluating strategies I and II, should be subtracted from the initial payoffs of both players which yields the following post-evaluation payoff matrix in Table IV:

TABLE IV
EXTENDED VERSION OF PRISONER'S DILEMMA WITH A DEFAULT STRATEGY, POST-EVALUATION INCLUDING EVALUATION COST OF STRATEGIES

		Player 2		
		Strategy I	Strategy II	Strategy III
Player 1	Strategy I	(-1, -1)	(1, -2)	(-1.5, -1.5)
	Strategy II	(-2, 1)	(0, 0)	(-2, 0)
	Strategy III	(-1.5, -1.5)	(0, -2)	(-2, -2)

Once again, not only the strategies and the general structures of payoffs, but also the exact values of payoffs are known to the players (due to the evaluation process), the outcome of the game is once more the Nash equilibrium, but now the payoff of the post-evaluation Nash Equilibrium is (-1, -1). These payoffs are surely better than the post-evaluation doing nothing outcome which yields (-2, -2). However, it is substantial to realize that they are less than the outcome (0, 0) that could be reached without the costly evaluation of strategies. There may be a rationale of opting for a default strategy of doing nothing when promising strategies require costly evaluation process, more or less

[1] This assumption does not affect the following analysis. It only provides an additional rationale for choosing strategy III in the first place.

correctly anticipated beforehand, a rationale not captured by the standard assumptions about the rational agent.

Undoubtedly, if the evaluation cost of strategies is negligible with respect to the payoffs, the post-evaluation payoff matrix will be almost the same as before. In this case, the outcome of the game will be $(1 - \gamma, 1 - \gamma)$, or the Nash Equilibrium of the classical Prisoner's Dilemma, with payoffs slightly reduced by the evaluation cost.

As shown above, thinking aversion and choice overload may have a great impact when the perceived costs of thinking are large relative to the potential gains from the game. A rational agent may choose to think or not, to evaluate the strategies and pick one of them or to opt for a default option of doing nothing. She bases her decision on the anticipated evaluation cost of strategies and anticipated gain from the game.

5. CONCLUSION

Economics uses mathematical models to analyze the economic interactions of people. In these models, people are generally assumed to be perfectly rational: they have particular goals, conditions, limits, and they exert themselves to achieve those goals within the boundaries of the present conditions and limits. Hence, the economic agent in a model may resemble a device without any sense.

With the development of cognitive psychology and behavioral economics in mid-1960s, observable and repeated deviations from what economic models predict attracted much attention. Among these deviations, one was regarding the decision-making process. Simon (1976) argued that people do not exhibit a strict rationale as defined by economics, rather a procedural rationale which depended on the decision-making process itself. Camerer (2003) presented some new directions for a better understanding of the limits on rational thinking, such as framing and heuristics.

An intriguing anomaly in this context, a contradiction with the popular opinion and with the assumption of the rational economic agent, is the overwhelming burden of the abounding number of alternatives available while choosing. Each day, not only the areas in life which present people alternatives to choose increase in number, but also does the number of alternatives presented. Following what Hirsch (1976) referred as “the tyranny of small decisions”, Schwartz (2004) proposed that the “freedom of choice eventually becomes a tyranny of choice”.

The burden of large number of alternatives is dubbed as choice overload and has been studied in the new millennium. Starting with the substantial contribution of Iyengar

& Lepper (2000), laboratory and field experiments have been conducted to examine the phenomenon and economists have started to implement the idea into models.

This dissertation aims at providing a simple model of choice overload. By breaking the phenomenon into three parts (the novelty factor, the evaluation cost of choices, and the anticipated regret), it studies the constituents of choice overload. Thereafter, the work provides an example of the role choice overload may play in the context of Prisoner's Dilemma. It illustrates that the phenomenon may indeed have an impact on the decision-making process, the agent may well be better off to defer the choice or choose the default option when the effect of choice overload is powerful.

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