UNIVERSITA' DEGLI STUDI DI PADOVA
DIPARTIMENTO DI SCIENZE ECONOMICHE E AZIENDALI "MARCO FANNO"

CORSO DI LAUREA MAGISTRALE IN ECONOMIA INTERNAZIONALE
LM-56 Classe delle lauree magistrali in SCIENZE DELL'ECONOMIA

Tesi di laurea

LE SCELTE DEL CONSUMATORE: TRA L'INFLUENZA DELLA MEMORIA E LE INFORMAZIONI OFFUSCATE DALLE AZIENDE

CONSUMERS' CHOICES: THE IMPACT OF MEMORY AND FIRMS' OBFUSCATION STRATEGIES.

Relatore:
Prof. GALAVOTTI STEFANO

Laureanda:
ZAMBOTTI ESTER

Anno Accademico 2017-2018

Il candidato dichiara che il presente lavoro è originale e non è già stato sottoposto, in tutto o in parte, per il conseguimento di un titolo accademico in altre Università italiane o straniere.
Il candidato dichiara altresì che tutti i materiali utilizzati durante la preparazione dell'elaborato sono stati indicati nel testo e nella sezione "Riferimenti bibliografici" e che le eventuali citazioni testuali sono individuabili attraverso l'esplicito richiamo alla pubblicazione originale.

Firma dello studente

Ringraziamenti

A conclusione di questo lavoro di tesi, è doveroso porre i miei più sentiti ringraziamenti alle persone che ho avuto modo di conoscere in questo importante periodo della mia vita e che mi hanno aiutato a crescere sia dal punto di vista professionale che umano.

Un ringraziamento particolare va al mio relatore Stefano Galavotti, che ha saputo seguirmi sapientemente nella stesura di questa tesi ed incoraggiarmi nei momenti di difficoltà. L'impegno che ho mantenuto durante il mio lavoro di tesi trovano giustificazione nella sapiente direzione profusa dal mio relatore.

Le parole per ringraziare la mia famiglia non saranno mai abbastanza, però vorrei che sapessero che il loro supporto è stato fondamentale. In particolare, un infinito grazie per esserci sempre stata e avermi insegnato ad affrontare le difficoltà, va a mia madre.

Un sentito ringraziamento non può mancare ai miei amici, con i quali ho trascorso questi anni di studio e che mi hanno fatto credere nella vera amicizia. In particolare, vorrei ringraziare Sara e Valentina perché ho trovato in loro una vera e profonda amicizia che mi auguro non finirà mai, Alessandro perché mi ha sempre fatto notare il lato positivo della medaglia, Chiara compagna di avventure ormai da troppi anni e Alessandra che mi ha instancabilmente accompagnato in questi due anni di studio, disperazione e disagio.

Non cito uno ad uno il resto degli amici, perché vi assicuro che sono talmente tanti che ci vorrebbe un'altra tesi, ma sappiate che siete tutti qui. Se ho raggiunto questo traguardo lo devo anche alla vostra continua presenza e al fatto che, anche quando io non ci credevo, voi avete sempre saputo che ce l'avrei fatta e mi avete sostenuta.

Grazie di cuore.

Ester

Abstract

L'obbiettivo di questo elaborato è quello di fornire una rappresentazione delle dinamiche di mercato tra consumatori e aziende quando, i primi sono dotati di razionalità limitata mentre le seconde sfruttano le limitazione cognitive dei consumatori per guadagnare maggiori profitti. Quando si parla di comportamento dei consumatori, solitamente le teorie economiche assumono che i consumatori siano completamente razionali nelle loro scelte, ma, nel mondo reale, i consumatori adottano procedure di decisione caratterizzate dalla razionalità limitata. In questo caso, le scelte dei consumatori sono sì le migliori in quel determinato contesto, ma non sono le migliori in assoluto.

In questo scritto, la razionalità limitata verrà considerata come una limitazione cognitiva e mnemonica dei consumatori. In particolare, verrà evidenziato, da un punto di vista teorico, comei consumatori dotati di razionalità limitata interagiscono con le aziende. Inoltre, verrà mostrato come le azienda reagiscono alle limitazioni cognitive dei consumatori in modo tale da incrementare i propri profitti. Infatti, vedremo come le aziende adottino strategie di offuscamento in modo tale da sfruttare le limitazioni dei consumatori e accrescere i propri prezzi e profitti.

Quando i consumatori fanno delle scelte d'acquisto, devono portare a termine tre compiti principali: l'acquisizione e il processo delle informazioni, la creazione di regole o strategie per valutare gli attributi del prodotto e la scelte di un'alternativa. Noi esamineremo le limitazioni dei consumatori nell'acquisire e processare le informazioni. Infatti, vedremo come le difficoltà dei consumatori nel fare scelte ottime sono dovute in parte alle limitazioni cognitive dell'individuo e in parte all'impegno delle aziende nell'offuscare o rendere più complesse informazioni rilevanti.

Prima di fare una scelta, i consumatori devono recuperare le informazioni dalla memoria. Tali informazioni sono sempre disponibili per essere recuperate ma non tutte le informazioni sono accessibili in ogni momento per il recupero. Infatti, l'accessibilità dipende dal contesto e dal momento: se un'informazione è disponibile in un determinato contesto, potrebbe non esserlo in un altro contesto, e se è disponibile in un dato momento, potrebbe non esserlo in un altro. Per questa ragione, i consumatori utilizzano spesso delle euristiche per compensare la loro mancanza di memoria. Un'importante euristica che considereremo in questo lavoro è il processo di categorizzazione dei prezzi.

Verranno analizzati diversi modelli per vedere gli effetti delle limitazioni cognitive sulle scelte dei consumatori e sulla configurazione del mercato. Per cominciare, verrà analizzato il modello sviluppato da Rubinstein (1993) che ha lo scopo di trovare un equilibrio di mercato

quando c'è eterogeneità nelle capacità di ragionamento dei consumatori. Prendiamo in considerazione un mercato formato da un'azienda monopolista e due tipi di consumatori: *sofisticati* (nelle capacità di ragionamento) e *ingenui*. I consumatori *sofisticati* riescono a comprendere a pieno la strategia di prezzo del monopolista mentre quelli *ingenui* hanno delle limitazioni nel farlo. L'obbiettivo del monopolista è chiaramente quello di massimizzare i profitti e, per fare ciò, utilizza uno strumento probabilistico atto a sfruttare le limitazioni cognitive dei consumatori più ingenui. Agendo in questo modo, il monopolista riesce ad attuare una sorta di discriminazione tra i consumatori e guadagnare maggiori profitti.

I risultati non cambiano quando estendiamo il modello ad un mercato formato da due aziende (un oligopolio) e con consumatori dotati di razionalità limitata (nel senso già spiegato precedentemente). Quando il mercato diventa competitivo e non ci sono più consumatori sofisticati, le aziende trovano comunque profittevole sfruttare le limitazioni dei consumatori ma, in questo caso, la competizione gli impedisce di guadagnare congiuntamente tanto quanto il monopolista. Verrà mostrato come le due aziende riescano sì a sfruttare le limitazioni cognitive dei consumatori traendone dei benefici ma, nonostante ciò, non riescano a raggiungere i profitti del monopolista.

Solitamente, i consumatori, per compensare le loro limitazioni cognitive, utilizzano delle euristiche come, per esempio, la categorizzazione dei prezzi. Questo significa che, data la loro memoria limitata, i consumatori, trovandosi a dover confrontare un prezzo con uno già visto in precedenza, ricorderanno la categoria contenente quel determinato prezzo. Ad esempio, se il consumatore è in grado di dividere i prezzi in due categorie, queste potrebbero essere "costoso" e "economico". Vedremo quindi come i consumatori cerchino di impegnarsi il più possibile nell'aumentare la categorizzazione dei prezzi più bassi in modo tale da forzare le aziende ad offrire prezzi minori. Le aziende, dal canto loro, sono portate a offrire il prezzo più alto per ogni categoria, dato che i consumatori non riescono a catturare la differenza di prezzo all'interno di una categoria. La competizione però, fa sì che tutte le aziende offrano un prezzo all'interno della categoria più bassa.

Infine, tratteremo l'argomento dell'offuscamento di informazioni da parte delle aziende. Le strategie di offuscamento possono essere di diverso tipo, per esempio possono essere volte ad aumentare i costi di ricerca di altre offerte oppure possono rendere gli schemi di prezzo più complessi in modo tale che risulti difficile per il consumatore capirli.

Ellison and Wolitzky (2012) analizzano tali strategie dal punto di vista dei costi di ricerca e hanno dimostrato come, per le aziende, sia sempre profittevole utilizzarle. Questo accade perché l'offuscamento incrementa i costi che il consumatore ha nel capire il prezzo

dell'azienda e inoltre aumenta anche l'aspettativa del costo che il consumatore pensa di trovare se cercherà ulteriori offerte. Questo permette all'azienda di fissare un prezzo maggiore senza temere che il consumatore ricerchi il prodotto dai concorrenti. Chiaramente, l'attuazione di queste strategie danneggia i consumatori, che devono affrontare costi e prezzi maggiori, mentre beneficia le aziende che possono aumentare i loro profitti.

Garrod (2008) analizza invece le strategie di offuscamento in termini di complessità degli schemi di prezzo, in un mercato dove alcuni consumatori sono sofisticati e altri ingenui. In questo modello, le aziende possono decidere se adottare strategie di prezzo trasparenti o meno. Nel secondo caso, esse applicheranno un prezzo osservabile e una tassa nascosta. La presenza di consumatori *ingenui* nel mercato fa sì che le aziende siano incentivate ad adottare strategie poco trasparenti, offrendo un prezzo osservabile molto basso ma tasse nascoste alte, in modo tale da sfruttare le limitazioni cognitive di tali consumatori. Al contrario, i consumatori più sofisticati incentivano le aziende ad adottare politiche di prezzo trasparente. Verrà evidenziato come, le diverse proporzioni tra consumatori sofisticati e ingenui, portano a diversi esiti nell'adozione di strategie non trasparenti da parte di tutte le aziende.

L'ultimo modello che prenderemo in considerazione, esamina le strategie di offuscamento in un mercato dove le aziende sono eterogenee nel loro livello di dominanza del mercato. Da tale modello risulterà chiaro come, le aziende dominanti traggono sempre benefici dall'utilizzo di tali strategie mentre, le aziende meno dominanti invece hanno benefici minori che dipendono da alcune configurazioni del mercato. Inoltre, verrà evidenziato come l'adozione da parte delle istituzioni di eventuali politiche di protezione dei consumatori, potrebbero essere meno efficienti di quanto previsto.

CONTENTS

Introduction

i) Content of the thesis

The aim of this work/thesis is to show how firms adopt strategic techniques to exploit consumers' bounded rationality. When speaking of consumers, usually economic theories assume that consumers are fully rational in their choices; however, in reality, consumers are often characterized by bounded rationality: they ignore some elements of the decision problem they face and/or are not able to fully understand the consequences of their actions. As a result, their final decision will, in general, be suboptimal.

In particular, this work will focus on a specific form of Bounded rationality, namely the cognitive and memory limitation of consumers. It will be highlighted how consumers with this type of limitations interact with firms from a theoretical point of view. It will also be shown how firms react to consumers cognitive limitations to increase their profits. In particular, firms adopt obfuscation strategies in order to take advantage of consumers cognitive limitations and increase their prices and profits.

This situation will be analysed both in a monopolistic and oligopolistic context. This will allow to clarify if there are any difference in firms' behaviour depending on the level of competition.

i) Main results

This work wants to emphasize how firms, exploit consumers' cognitive limitation to get benefit both in terms of less competition and of higher prices and profits. On the other side, consumers want to protect themselves despite their limitations by trying to understand firms complex price policies or obfuscation strategies.

When consumers make purchase decisions, they have to complete three main tasks: acquisition and processing of information, creation of rules or strategies to evaluate attributes, choice of an alternative. In this work, we are going to examine the limitations of consumers in acquiring and processing information. In fact, we will see how consumers' difficulties in making optimal choices are due in part to cognitive limitations of the individual and in part to firms' effort in obfuscating or making more complex relevant information.

Before making a choice, consumers need to retrieve information from memory. Information is always available for retrieving but not all information is accessible for retrieval at any given time. In fact, accessibility depends on contests and time: if information is accessible in one contest, it might be not in another and if it is accessible in one moment, it might be not in another. For this reason, consumers usually use heuristics to compensate for

their lack of memory. One important heuristic that we will consider in this work is the categorization process of prices.

We will analyse various models to see the effects of cognitive limitations on consumers' choices and market settings. We will start by a model that considers a market with a monopolistic firm and heterogeneous consumers, where heterogeneity is seen as a difference in the reasoning capacities. Consumers are heterogeneous in the sense that some of them are able to fully understand firm's pricing policy, while the other part has some limitation in doing it. Moreover, two different states of nature can occur. The intuition behind this model is that the monopolist gains from charging more competent agents a lower price when a specific state of nature occurs. In order to achieve this result, the monopolist chooses price randomly so that it would not be profitable for less competent agents to purchase the good in that state of nature. Thanks to the difference in cognitive abilities among consumers, the monopolist is able to do a sort of discrimination among consumers and get additional profits. The results of this model show that price setters can strategically use the complexity of the price scheme to improve their profits. Reality confirms that vision in the sense that price schemes are actually very complex, and this affects active consumers in the market.

We will see how the results just shown hold also in a market with two firms and only boundedly rational consumers. In fact, firms usually adopt pricing policies such that they are able to take advantage of consumers' bounded rationality and earn higher profit with respect to the Bertrand competition situation, even if they will never jointly reach the monopolist's profit. Moreover, in a competitive market, also firms who choose to be transparent and not take advantage of consumers' bounded rationality, benefits from the opaque situation created by non-transparent firms.

In order to face their cognitive limitations, consumers adopt heuristics to recall prices. The heuristics that is considered in our analysis is the grouping of prices into categories according to their perceived similarities. This solution allows consumers to remember, if not the precise price, at least the category in which they perceive it. When consumers have no memory at all, they categorize all prices in one category while, when they have perfect memory, they categorize each price in a different category reaching an infinite number of categories. It will be shown that, when consumers use price categorization, there is also price dispersion in the market.

When we consider a market with two firms and consumers who use price categorization, consumers' bounded rationality moves equilibrium outcome away from the Bertrand competitive outcome. The main result of this model is that, given that consumers can recall

only categories, firms are incentivized to charge prices at the top of the category; however, competition leads firms to price only in the lowest category. Moreover, as the number of categories increases (consumers put more effort in memory resources), firms' prices and profit decrease. This means that improvements in consumers' memory capacities leads to a decrease in the equilibrium prices that are always closer to the marginal costs faced by the firms.

The last argument that we will take into consideration is the firms' adoption of obfuscation strategies. In fact, firms exploit consumers' cognitive limitations and increase their issues e.g., by increasing their search costs or using complex price scheme. The analysis of some models will show that obfuscation is always profitable for firms because it leads to higher prices and profits. Firms have an incentive to adopt obfuscation strategies, such as using non-transparent prices, because this results in a lower competition and let firms set prices above marginal costs and earn positive profits. Moreover, policies aimed at protecting consumers may not be as effective as expected. This is due to competition and differences in firms' prominence level. In fact, the positive effect of the introduction of the protection policy is offset by the increase in the obfuscation level of less prominent firms.

ii) Structure of the work

This paper is organized in three chapters as follows:

In the first chapter, we introduce the concept of consumers behaviour and, in particular, of consumers' bounded rationality. We will consider limite memory as a source of consumers' bounded rationality and see its role in consumers' choices. Furthermore, we will make a brief analysis of memory structure and its mode of operation. Finally, we will explain the way memory affects consumers' tasks and intentions.

In the second chapter, we will focus on consumers' memory for prices. Specifically, we will show various models that analyse some consumers' cognitive limitations. We will consider different market settings such as heterogeneity or homogeneity among consumers and monopolistic or oligopolistic firms.

In the third and last chapter, we will put our attention on firms. In fact, we will see how firms react to consumers' cognitive limitation, increasing their level of complexity in price scheme. In fact, firms adopt different kind of obfuscation strategies to confuse consumers, lower competition and increase their profits. Also in this section, different model will be shown to support the thesis that firms have always an incentive to use obfuscation.

CHAPTER 1

CONSUMER BEHAVIOUR AND THE IMPORTANCE OF MEMORY

1.1 Consumer behaviour: some basic concepts

Consumer behaviour analyses how consumers or group of consumers act when they have to make purchasing choice in order to satisfy their needs. When we study consumer behaviour we need to analyse many characteristics concerning individuals and groups of individuals in order to take accurate decisions about the techniques to target and segment consumers. Consumers can be categorized for their demographic features such as age, gender, income, occupation, family structure, culture and so on; or for their psychographic characteristics that we can identify as personal interests and how they spend free time, in other words, lifestyle and personality. Psychographic features are difficult to estimate because personalities and tastes are not objectively measures.

We also need to consider that, besides their characteristics and preferences, consumers behave differently and change their consumption choice according to the specific situation they are in at the moment of purchasing. They may use different criteria to evaluate products or services depending on the situation (Solomon et al., 2006).

When consumers take choices, they usually do not rely just on their personal preferences and ideas but they also consider opinion and behaviours of their friends and family members. In fact, people form also sub-group within the society according to their common values, culture and beliefs. Consumers acquire a lot of information from other consumers, more than from advertisements; most of the times it is important for them to buy things that let them feel part of the group and that do not cause rejection from it.

Usually a consumer is identified as the person who purchases goods or services according to his preferences but many times, there are other people involved. It can happen that the purchaser is a different person respect to the user; there can be another person that influences the buyer giving him advices even if he does not purchase or use the product and, finally, we

can consider a consumer also a group where there is one specific person that takes the purchase choice and the products acquired are used by all the group.

Because consumers are different but they can have some features in common, it is common to use a market segmentation in order to facilitate the communication and the purchasing choice of consumers. Solomon et al. (2006) suggest that market segmentation needs to follow some rules because of different features of consumers:

> "While consumers can be described in many ways, the segmentation process is valid only when the following criteria are met:
> • Consumers within the segment are similar to one another in terms of product needs, and these needs are different from consumers in other segments.
> • Important differences among segments can be identified.
> • The segment is large enough to be profitable.
> • Consumers in the segment can be reached by an appropriate marketing mix.
> • The consumers in the segment will respond in the desired way to the marketing mix designed for them." (Solomon et al., 2006, p. 9)

1.1.1 Consumer rationality

When dealing with consumer behaviour, we usually imply that consumers are rational when they make choices. With rationality, we mean the actions of the individual orientated to the achievement of specific purposes, considering the comprehension of the relation between actions and consequences. We can define the rational behaviour in two ways:

1. *Procedural*: the adoption of the appropriate means to achieve the given goal, taking into account possible constraints.
2. *Substantial*: the achievement of the best possible result, considering possible constraints, using the appropriate means.

The definition of rational procedural behaviour requires that the economic agent has its own purpose and adopts all appropriate means to reach it. The substantial definition has the same requirements and, in addition, it requires that the agent identifies the best possible result and that he effectively achieves it, except for the case of fortuitous events that are not under the individual's control. Therefore, the consumer's choice can be rational in a procedural point of view but not in a substantial one. When this happens, the economic agents adopted a *satisfying behaviour* (Gaffeo et al, 2011).

Substantial rationality is difficult to find in reality because it requires too many information respect to the cognitive capacities of individuals or the procedures to achieve optimal results are too complex to be adopted.

When speaking about rationality, it is important to consider two fundamental conditions: knowledge and information. Any decision problem can be analysed only starting from knowledge and information owned by the individual.

Knowledge is necessary to associate consequences to actions. Knowledge in this sense can be complete or incomplete. Information determines the appropriate set of consequences associated with each action showing to the individual in which state of the world the action occurs. In fact, the consequences for each actions are different according to the state (conditions) in which the action takes place.

Regarding information, we distinguish between two fundamental decisions types: decisions in conditions of certainty, when the information about the state is perfectly known, and decisions in conditions of uncertainty, when it is not known in which state the action will take place.

The rationality principle establish that the individual chooses the action whose consequence is the best for the achievement of his purpose. Once identified the most relevant consequences, the individual needs to rank the consequences according to his preferences and then choose the action whose consequence realizes the desired purpose.

In order that an economic agent is able to reach an optimal choice in a reasonable time horizon, it is necessary to assume that he has available at the same time:

1. *Complete knowledge* of the consequences of each action
2. *Certainty* about the state of the world
3. *Unlimited capacity* to compare coherently all possible consequences of the actions

When one or more of this assumption fail, we enter in the field of *satisfaction*. There is a satisfying instead of optimal choice when the agent, acting in an action-consequence scheme, uses procedures characterized by *bounded rationality*, which ignores some of the actions or of the consequences relevant for the purpose of the agent. In this case, the choice is the best in that contest but is not the best overall. In fact, most of the decisions that individuals take in reality are based on an incomplete knowledge of the consequences. Choices are usually satisfying rather than optimal and that means that we are in the field of bounded rationality.

1.2 The role of memory in consumer's choices

We have assumed that consumers are rational and, given the fact that each alternative has a different utility, they are able to choose the alternative that maximizes their satisfaction according to their preferences. If we consider how, in reality, consumers behave when they have to make choices, we need to enter in the field of bounded rationality. This is because consumers have limited capacity to consider and compare all possible alternative and that implies that we entered in the field of satisfaction rather than optimization. Limited memory is one of the main constraint of individual capacity to process information (Bettman et al, 1998).

The understanding of the limited capacity of memory has led to an impact on consumer decision making process because, now, we need to redefine the way we see the consumer from an optimizing decision maker to a satisficing one, due to his limited cognitive capability (Weber et al., 1995).

There are many steps to face before a purchasing choice can be effectively made by a consumer. First, it is necessary to convey the information of products to consumers so that they can understand the goal of marketers and choose a brand toward another. We know that consumers are different from each other's but we can divide them into segments according to their difference in information exposure habits and consumption styles. This market segmentation, based on different media exposure habits of consumers, has influenced the way advertising is done. In addition, we also need to consider individual characteristics. Usually individuals let themselves be exposed to information they agree with and elude the other. This imply that consumers receive just a small part of the mass of information to which their market segment is exposed to. Moreover, the attention level of each individual is important to transmit information and be sure that the consumer will attend to them. Consumers can perceive some information while ignoring others due to their personal characteristics and to their encoding and understanding ability of the message that information drive. Given that, information needs to be credible and believable, consequently also the source of this information has to be credible (McGuire, 1976).

Once we have delineated the part of information that the consumer has accepted, we need to focus on its retention. The impact of information needs to be delayed in time when the consumer has to take a purchasing choice rather than at the time of its acquisition; so it is relevant to know if the message contained in the information will be persuasive until the purchasing moment. For this purpose, forgetting plays a crucial role to understand the rate of retention over time of the information accepted and understood by the consumer. McGuire in its paper assert that:

> "In general the forgetting curve is negatively accelerated; that is, most decay of memory occurs soon after learning, with successively less in absolute terms being forgotten during successive equal time intervals. Forgetting seems to approach its asymptote at an exponentially, negatively accelerated rate; also, the asymptote may be greater than zero, so that even after an indefinitely long period of time, there may still be some small residual recall. Many conditions affect the rate of forgetting, including individual and group differences in memory capacity, the type of material, the way in which the original learning took place, and the conditions of the post-learning interval. Many of these relationships have implications for how information can be communicated to consumers with more lasting effects" (McGuire, 1976, p. 308)

With the concept of forgetting, we introduce also the concept of memory and the distinction between short term memory and long term memory. It is important to analyse the structure of memory to understand how individuals can retrieve information stored in memory when they have to make purchasing choices.

Effectively, memory is involved in many stages of the decision process such as the creation of the possible alternatives, the identification of the utility of different outcomes and the forecast of the probability that each outcome realizes.

Peculiar phenomena have been explained by the memory process: for example, following Tversky and Kahneman's (1973) theory, individuals usually evaluate the frequency of events by their availability, in other words, by the facility and frequency with which the individual retrieves the event. Errors can be attribute to a reconstructive memory problem that we can explicate as the incapacity of restore the state of knowledge an individual had, before the addition of new information (Weber et al., 1995).

It is possible to distinguish between episodic memory for particular events or experiences and semantic memory of abstract information such as rules derived from previous experiences.

Tulving (1972) has defined episodic and semantic memory as following:

> "let us think of episodic and semantic memory as two information processing systems that (a) selectively receive information from perceptual systems or other cognitive systems, (b) retain various aspects of this information, and (c) upon instructions transmit specific retained information to other systems, including those responsible for translating it into behaviour and conscious awareness. The two systems differ from one another in terms of (a) the nature of stored information, (b) autobiographical versus cognitive reference, (c9 conditions and consequences of retrieval, and probably also in terms of (d) their vulnerability to interference resulting in transformation and erasure of stores information, and (e) their dependence upon each other." (Tulving, 1972, p. 385)

The reception and storage of information concerning temporally dated episodes or events and the connection of these events is a task that belongs to the episodic memory. The episodic memory can store only the perceptible features of such information and it does so using autobiographical reference to the contents that are already present in episodic memory store. Decay and involuntary transformation of information are quite usual in the episodic memory. Moreover, there can be a phenomenon called encoding under which information in semantic

memory can influence the way perceptual information is stored in the episodic memory; at the same time, there may be independence of the episodic memory from the semantic one.

For what concern semantic memory, Tulving stated that:

> "Semantic memory is the memory necessary for the use of language. It is a mental thesaurus, organized knowledge a person possesses about words and other verbal symbols, their meaning and referents, about relations among them, and about rules, formulas, and algorithms for the manipulation of these symbols, concepts, and relations." (Tulving, 1972)

In contrast to the episodic memory, the semantic memory is not able to register perceptible features of information hence autobiographical referents but it can only register cognitive referents of input signals. Semantic memory can also retrieve information not stored in without changing its content even if, every time there is a retrieval, this retrieval becomes an input in the episodic memory. In this case, decay and involuntary transformation of information are not so frequent as in the episodic memory. While the episodic system is mostly dependent of the semantic one, the contrary does not happen; the semantic memory is independent in registering and storing information because diverse input can lead to the same storage consequences.

1.2.1 Memory effects on choice macro-structure

When consumers take decisions, they use a range of different processing operations on the information that are available. As stated by Biehal and Chakravarti, we can categorize the operations in four type:

> "(1) attribute processing – i.e., comparing a set of brands on an attribute, (2) paired comparison – i.e., comparing two brands on one or more attributes, (3) brand processing – i.e., processing one brand across several attributes, and (4) wholistic comparisons – comparing overall brand evaluations without reference to specific brand features." (Biehal and Chakravarti, 1986, p. 382)

These four operations are usually used by consumers with various degrees and sequences. In order to make this clear, we will now introduce a simple example. Suppose that a consumer is asked to choose among eight brands that are described on five attributes. The first phase of the choice is characterized by four attribute processing operations that are developed through the sequentially comparison of brands on the four most relevant attributes. We assume that after this first stage, the consumer eliminates five brands and will process the remaining three brands. The consumer now will make its final choice after performing two paired comparison operations on the attributes of the brands still in competition. The macro-structure of this choice can be represented by three perspectives. First, to make a choice the consumer used six operations in total: four attribute processing and two paired comparisons. Moreover, he used two types of operations have been used: attribute processing and paired

comparisons. Finally, the two contiguous stages of the decision process are delineated by the temporal order in which the operations took place (Biehal and Chakravarti, 1986).

Biehal and Chakravarti assert that:

> "Choice macro-structure refers to (1) the number of component processing operations, (2) the variety of processing operations, and (3) the temporal ordering of the operations in the course of choice" (Biehal and Chakravarti, 1986, p. 383)

These three features, regarding macro-structure choice, can be influenced by memory in different ways. When consumers make choices that involve both memory and external information, two different stores of information must be processed. Memory can already have some natural organization of information, e.g., a brand-based organization. When the organization in memory is not coherent with the external information, there can arise some difficulties. Two scenarios are possible in this situation. On one side, a larger number and variety of processing operations may be required to the consumer to handle the choice. On the other side, some parts of the information may be ignored by the consumer so that the choice results easier and the number and variety of operations are reduced.

Moreover, Biehal and Chakravarti (1986) stated that "memory organization could facilitate certain retrieval strategies more than others". In fact, they discovered that, when product information is obtained through directed learning, there is high accessibility of this information in memory and it is retrieved in a brand-based view. This implies that the within-brand process is the predominant part of the initial phases of memory-based choices. When product information is obtained by non-directed learning is usually less accessible except for specific elements of memory information that will influence the processing of the following choice.

1.2.2 Memory effects on choice micro-structure

Processing operations can be analysed in their deeper details with a micro perspective. We can distinguish two main aspects: the *processing level* and the *processing span*. The former concerns the level of abstraction used to process information and the level of complexity of the processing components that is the level of attentional capability request to process a given quantity of information simultaneously. The latter refers to the way the individual processes memory and external sources of information, in other words, it analyses if they are processed in a separated or combined way when the individual makes a choice (Biehal and Chakravarti, 1986).

Keeping track of processing, aside from the fact that the information is external or in memory, requires a part of the cognitive capability. Furthermore, when choices are memory-based, some attentional capability needs to be used to keep information in memory while it is processed. This means that, given the fact that short term memory has a limited attentional capability, in memory-based choices there is less information attended and less simultaneous processing of information respect to externally-based choices. Also the complexity of choice processes is affected: there will be less complex attribute comparisons across multiple brands and more complex paired comparisons

Another difference between external and memory based choices is the fact that, in the latter, it is necessary a retrieval of information from memory to process brands. When choices are made using both external and memory based references, the difficulty increases because there is need of a continuous shift from one memory control mechanism to another. To make this task easier, consumers tend to compartmentalize processing so that the processing span is reduced and external and memory information are process separately and no longer in a combined way. The same occurs when there is low accessibility of memory information: the processing of external and memory information is done separately.

1.3 Memory structure

In order to comprehend how consumers use information when making a choice, it is relevant to understand how this information are preserved in memory (McGuire, 1976).

Memory structure is divided in three main components, as we can see in Figure 1.1: the sensory register, the short term store and the long term store.

The sensory register is the component in which stimuli coming from the environment are registered. usually information in this component of memory is visually registered and then decay after a period of time.

For what concern the short term store, we can say that information are registered and then decay and entirely disappear after a period of time. In this case, respect to the sensory register, the time required for information to disappear is longer and it depends on the subject-controlled processes. Usually in the short term store information are registered in the auditory-verbal-linguistic (a-v-l) mode and in this case the loss of information requires about 15-30 seconds (Atkinson and Shiffrin, 1968).

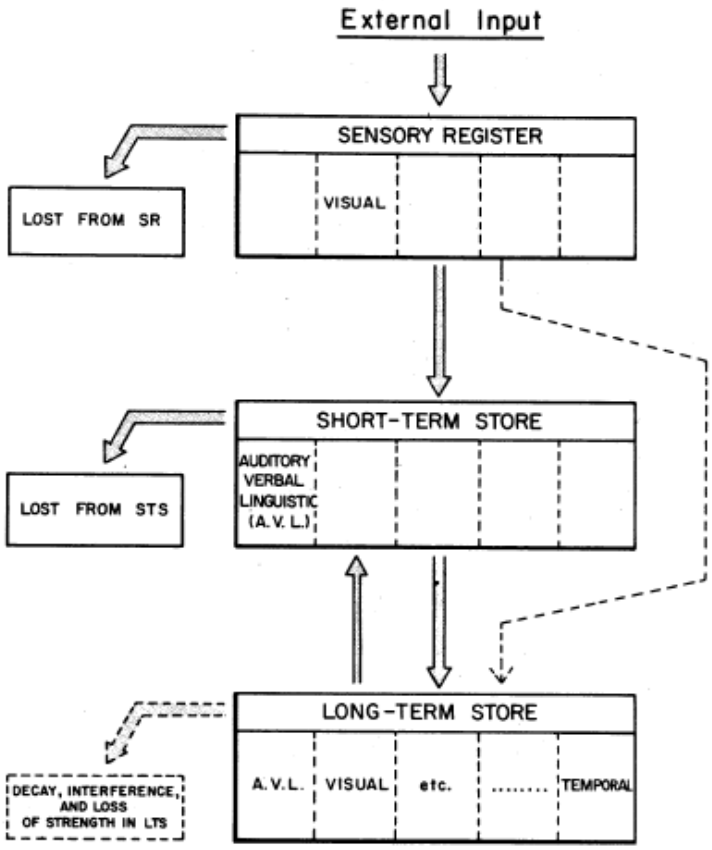
We emphasize that the short term memory has limited process capacity; the number of information that can be processed at one time is limited because of the limited attention capability that is required to rehearse such information. Another concept we will illustrate is the transfer time needed to convey information from the short term store to the long term store. If there will be a later need of recalling information, the transfer form short to long term store requires five to ten seconds, while, if it is enough the recognition on information, transfer takes just from two to five seconds. This is because, in spite of recall, recognition does not imply reconstruction, it is just the act of distinguish the information needed from the others (Bettman, 1979).

Finally, we take into consideration the long term store. In this store, there are registered mainly concepts, such as events, objects, rules, attributes of items, temporal sequence information, spatial aspects information, data, and the associations between them. Another kind of information stored in the long term store are the memory schemas. We defined a schema as an internal structure that classifies information basing on previous experience with the external world.

Information registered in the long term store, unlike in the other two component of memory, does not decay. In fact, as we have seen previously, in the sensory register and in the short term store, after a certain period of time, information decay and become lost, while in the long term store, information is kind of permanent in the sense that it does not decay but it can be modified as result of new information. For long term store, we do not consider just the a-v-

l mode but also all other sensory modalities. There can also be information that do not belong to the sensory modalities, for example the temporal memory (Atkinson and Shiffrin, 1968).

Figure 1.1: Memory structure



Source: (Atkinson and Shiffrin, 1968)

The decision of transfer of information among the three components is mostly under the subject control. The flow of information between the components takes place by copying information from one component to the other without the removal of that information from its original store until it is passed the time of decay of that specific store. As we can see in Figure 1.1, information enter first in the sensory register and it is analysed and the selected information are transferred to the short term store and then, in the period in which information is inside the short term store, it can be transferred to the long term store. It can also happen that there is a transfer of knowledge directly from the sensory register to the long term memory and there is the hypothesis that information get back from the long term to the short term store.

1.3.1 Memory control processes

In order to regulate the stream of information, that goes in and out of memory and from one store of memory to the other, individuals use control processes (Bettman, 1979).

Atkinson and Shiffrin (1968) defined control process as:

> "The term *control process* refers to those processes that are not permanent features of memory, but are instead transient phenomena under the control of the subject; their appearance depends on such factors as instructional set, the experimental task, and the past history of the subject. A simple example of a control process can be demonstrated in a paired -associate learning task involving a list of stimuli each paired with either an A or B response (Bower, 1961). The subject may try to learn each stimulus-response pair as a separate, integral unit or he may adopt the more efficient strategy of answering B to any item not remembered and attempting to remember only the stimuli paired with the A response. This latter scheme will yield a radically different pattern of performance than the former; it exemplifies one rather limited control process. The various rehearsal strategies, on the other hand, are examples of control processes with almost universal applicability." (Atkinson and Shiffrin, 1968, p. 106)

The main role of the control process in the sensory register is the determination of which information need to be conveyed to the short term store. There are many type of control process and we will now list some of them:

1. *Rehearsal* is a strategy used to analyse a stimulus when it enters in the STS. Rehearsal is employed to maintain information in the STS and transfer them to the LTS. It is mainly an allocation of processing capability realized when the individual goals and tasks require it. For example, a consumer does not remember a price because he repeats it constantly rather because he associates the price to something he already knows.
2. *Coding* is the process through which the subject structures information so that it can be rehearsed. There are different type of encoding strategies such as mnemonics, associations, images and so on that are used to make the transfer of information to memory as easier as possible (Bettman, 1979).
3. Another important control process is the *transfer* process that controls which information and in which form are stored in memory. The priority is usually given to information that are coherent with the goal of the individual or to information that are easy to store. Depending on individual expectations and tasks, it will be decided what to store and in which form; when the individual does not have clear expectations about how he can use the information, he will use an easy transfer strategy while for situation where there is novelty and surprise or are inconsistent with expectations, there will be high priority for storage.
4. *Placement* refers to the place of storage of items. By place, we do not mean a physical location but the association structure elaborated during the item's processing. This structure depend on how items are presented to memory: items are shown by category, also the association structure will be in categories. Placement is contingent to the memory system and the way items are coded.

5. Finally, *retrieval* is responsible for information accessibility. When an individual forgets some information, it is not seen as a loss of items but as a malfunction of the retrieval task to maintain information in the LTS. This is a retrieval problem that is fundamental in the impulse purchase; suppose for example that a consumer is in a shop and he remembers that he need an item but does not remember which item, his permanence in the shop and the sight of a related product can trigger remembrance. We just illustrated a case in which an individual cannot remember an item until the occurrence of an event that gives the hint required to retrieve it. This situation happens when the individual does not immediately use the right retrieval strategy probably because he was looking in the wrong part of memory, because he was finishing the time to search or because of the loss of one's pace during the search. This last situation, in which the individual is not capable of keeping track of an item place in order to retrieve it, is due to the limited capacity of the STS.

Given the fact that every subject is different from each other's, everyone uses different techniques and mnemonics to register information and remember them; these techniques are controlled by the subject therefore there are infinite different type that are difficult to classify. We are able to do such classification because permanent memory plays a crucial role in the control process; in fact, even if these techniques are controlled by the subject, they still depend upon memory structure. We propose a partition of control processes depending on their relation with the sensory register, the short term store and the long term store (Atkinson and Shiffrin, 1968).

Repetition plays an important role in memory processes, even if it is not so determinant for everyday memory; it is still used a lot. In fact, every repetition re-creates the short term sensory trace so that the loss of information is delayed in time. The question arises, which is the highest number of items that an individual can preserve in memory using the rehearsal? This is contingent to the rate of STS (short term store) decay and form of the trace restored by the repetition. In order to have the maximum number of items rehearsed, it is important to have an ordered repetition.

We will now introduce an example to explain this concept. We assume that the loss of an item from STS requires 1,1 seconds but it can be saved (not decayed) if the repetition starts before the decay process is concluded. We also assume that repetition of each item requires 0,25 seconds. Given this last hypothesis, if the rehearsal of the items follows a fixed order, it is possible to keep in memory a maximum number of five items for an unlimited time. Conversely, if the rehearsal occurs in a random order, not all five items would be maintained in STS because one or more of them would clearly decay. We deduce that, when the individual faces situations

in which he has to depend mainly on its repetition capacity in STS, items will be rehearsed following a fixed order and not a random one.

Generally, information, while staying in the STS, is transferred from STS to LTS in different degree; control process determines the amount and form of the information transfer. The transfer of information can be weak and subject to interferences if the transfer occurs while the individual is focus on repetition; it can also happen that the individual distract himself from the repetition process to coding operations so that the information transferred would be stronger. By coding operations, we mean the process by which the individual alters and/or adds to the information in the STS as an effect of the LTS search.

1.4 How memory affects consumers' tasks

Consumers take decisions every day at different levels and in a variety of environments. They have to decide whether to spend or save money, which store to visit, which brand they prefer and evaluate the trade-offs among products attributes; and they have to do that in different contexts such as watching advertisement, ordering from a catalogue or visiting a store. Moreover, also the availability and the usage of external memory, such as store displays, may be different depending on the task. This imply an increase in the difficulty in the analysis of memory research because different tasks mean different results. In fact, specific tasks require particular processes in order to complete them. We will now present some consumer tasks performed outside and inside the stores (Bettman, 1979).

Tasks completed outside the store can be divide in three principal types: acquisition and processing of information, creation of rules or strategies to evaluate attributes, choice of an alternative.

Information can be acquired from different sources such as commercials on television, advertisements and word of mouth. The acquisition of information can occur through an active research done by the consumer or because the consumer has been exposed to such presented information. it is relevant to understand if information is stored in memory and, given that, what is stored.

The information storage depends on the interest that the consumer has in such information and on the ease of processing it. Processing is influenced by the organization and the size of the information and other activities that the consumer is doing while the information is presented. This latter influencing activity has different impact on processing depending on the type of information source. Print ads and conversations that are under the consumer's control for what concern the rate of processing needed, have less influence on processing. On

the contrary, in situation in which the consumer has less control over the processing rate, such as for television or radio, the impact on processing of competing activities might be greater. Processing, hence the rate of retention, depend on how the information is presented, visual versus auditory, and how many times the information is repeated.

What information is stored is influenced by the use the consumer wants to give to it. Information can be used to make the consumer remember something when he is inside the store; e.g., the reminder could be a brand that needs to be recognize once in the store. This case imply recognition. Otherwise, the consumer could choose before arriving to the store and this imply the need of recall. So, the type of memory required, recognition or recall, depends on the use the consumer wants to give to an information.

For what concern the second task, the creation of rules to evaluate attributes, it is necessary to have information on attributes and to identify the trade-off among them. In order to develop strategies, it is useful to look at sources such as advertising, friend and family, product-testing magazines. When the individual weights attributes, he needs to use recall rather than recognition because normally the store does not contain explicit rules. Hence the consumer needs to recall evaluative and belief information from its memory, especially those rules essential to combine information.

Last, the third task, the choice of the alternative, depends on individual preferences. Normally the choice of the alternative is made inside the store, but when it is made outside the store, it implicates recall in order to match brands with criteria. When the choice is incremental as the consumer acquires new information i.e. from ads, recall has a higher impact. It is relevant to know the way in which attributes and information are stored in memory because it influences the comparison of alternatives; are information recalled by attribute and across brands; or by brand and across attribute? Also external memory plays a role in the choice outside the store when there are display and advertisements. In this situation, the recall of the alternative's attributes might be easier but it is still relevant the recall of the factors to weighting these attributes.

Tasks carried out inside the store imply the presence of external memory in the environment. Consumers can evaluate brands by their packages, attributes and by the displays available inside the store. Inside the store, consumers complete two type of tasks: they develop rules or strategies to evaluate attributes and choose an alternative.

When weighting product's attributes, a consumer uses primarily recall because he cannot recognize those rules using only external memory. Despite that, also recognition plays

a role because, thanks to packages and other external components, the consumer can remember the criteria he needs to use. In any case, recall is still the major strategy used.

For what concern the choice of an alternative, the level of past experience is relevant. In a routine task, it is easier to recall response to it because of recognition of what happen the in the previous experiences. Recognition alone, is never enough for the consumer to make a choice. In fact, even if processing alternatives implies the use of recognition to select the brands to be further processed among all brands, the recall of rules and criteria is still required to make a choice. The contest, where the consumer learned about brands the first time, might influence recognition and recall.

In the next section, we will analyse in greater details the factors affecting recall and recognition.

1.4.1 Factors influencing recognition and recall

Before making a choice, consumers need to retrieve information from memory. Information is always available for retrieving but only after it has been comprehended and encoded into long term memory. On the other hand, not all information is accessible for retrieval at any given time; consumers are able to retrieve just a part of the total information available. So, even if information is always available, not all of it is always accessible. In fact, accessibility depends on contests and time: if information is accessible in one contest, it might be not in another and if it is accessible in one moment, it might be not in another. There are two main variables influencing accessibility: how many competing information have been assimilated in the same context domain, and the size of the retrieval cues (self-generated and externally generated) performed in one moment.

Factors influences memory by defining the access to a certain amount of category rather than how many items within a category can be recalled. For example, when product information are organized by brand, is more probable that consumers forget entire brand respect to attributes within a brand. So, when most of the information are locked into a given category, the whole category is expected to be recalled (Lynch and Srull, 1982).

All the variables that influence accessibility and retrievability will also affect the input examined during the choice. In order to study the retrieval process, is useful to make a comparison between recall and recognition. Recall occurs when an individual has to remember information acquired in a previous moment while, recognition, occurs when the individual has to identify information previously acquired among a set of possible choices. Recall involves two stages: the retrieval of a specific item form memory and the recognition of a previously

presented item among a set of different items. On the contrary, recognition involve just the second stage, while avoiding the retrieval stage necessary for recall. Given that recall involves two stages and recognition just one, it is easy to deduce that recognition is better that recall because for recall there are two stages where a failure can occur while there is just one stage for recognition.

For what concern recognition, words that occur with low frequency are recognized more than high frequency ones; on the other hand, the contrary happens for recall. This happens because since low frequency words are not common, it is easier to distinguish them from the others (recognition is easier); while, high frequency words are familiar, so it is easier to reconstruct and recall them. These findings have effects on the kind of brand chosen contingent to whether the choice is made inside the store hence led by recognition or delineated outside the store hence led by recall (Bettman, 1979).

Recognition and recall depend also on the expectation consumers have about the task they have to perform. When consumers encode information, they may do it thinking about some specific tasks. This means that consumers make choices at the time of encoding so the expectations of recognition and recall is determined a priori. The level of difficulty of a task may determine whether consumers use recall or recognition: recall might be used for easier tasks while recognition might be employed for more complex tasks.

For what concerns rehearsal, it is shown that it positively affects recall and recognition. Bettman (1979) stated that:

> "The basic findings are that recall and recognition increase as a function of presentation frequency and that there are decreasing increments in memory performance as repetition increases (i.e., later exposure appears to add less and less to performance). Even rote repetition without more elaborative processing may improve recognition or recall (Chabot, Miller, and Juola 1976; Nelson 1977). Finally, for a single series of stimuli, it has been shown that recall performance is better when a given number of repetitions is spaced or distributed rather than massed." (Bettman, 1979, p. 48)

The transfer of information to LTS requires two to five seconds for recognition and five to ten seconds for recall. This implies that, when information are presented to the consumer in a way that he cannot control, such as television or radio commercials, the effects of these information on memory varies whether the consumer uses recall or recognition.

The contest in which the consumer makes a choice, even if it is strongly related to a specific item, can improve the retrieval process only if, the first time, that item was encoded in terms of that contest. In fact, if the contest is different from the original one, recall and recognition are negatively affected because, even if the information is available in memory, the wrong contest makes that information not accessible. In order to have recognition inside the store, advertisements must present information in a contest that matches the in-store one, e.g.,

the package of a product has to appear in the advertisement so that the consumer can recognize it once in the store.

1.4.2 Marketing implications

The type of processing that delineates consumers' choices, can influence where and how information has to be presented to consumers. Recognition is usually preferred to recall and the processing of information occurs inside the store, when consumers have inadequate knowledge or experience or have other reasons to consider the choice difficult. On the contrary, when consumers have enough experience or knowledge or perceive the decision as an easy task, the processing of information occurs outside the store and consumers use recall rather than recognition. This happens because consumers tend to take decisions outside the store, hence using recall, only when the choice is easy and familiar (Bettman, 1979).

For what concerns where information should be provided, it can be done inside or outside the store. Inside the store, information are provided through packaging and displays that are used as an external memory for the consumer so that he can use just recognition instead of recall. Respect to information provided outside the store, when information is presented inside the store, there is more time available for processing information; it is also easier to compare brands attributes from packages rather than recall information from memory when information is provided through advertisements.

Given the feature we just mentioned about providing information inside the store, we will now introduce under which conditions marketers will provide information in this kind of environment. We already saw that consumers tend to make in-store choices when they do not have much experience or knowledge or when they face difficult tasks. In this situation, marketers would focus on providing in-store information when they have to present a product class that requires low experience or difficulty in the choice. If the product is a new brand or is supposed to have some differential advantage, marketers could provide in-store information even when consumers have experience. In-store information is provided also when markets believe that consumers are processing information inside the store or when they want to stimulate such processing.

We know that, when information are provided outside the store (i.e., advertisements on radio and television), consumers primarily need to count on their memory. In this case, marketer will present information outside the store under opposite condition respect to the in-store case. We know that consumers tend to make choices outside the store when they perceive the task as easy or when they have prior experience or knowledge. Given that, marketers will provide

information outside the store when consumers have prior knowledge about their product class. In any case, it is recommended to use a combination of both in-store and out-of-store strategies to reach more consumers since they differ in their level of prior experience and perception of tasks difficulty.

For what concern how information should be provided, we need to consider two main aspects: the facilitation of recognition and recall and the presentation of information to special group of consumers. Regarding the first aspect, in order to facilitate recognition, it is necessary to provide to the external memory, such as packaging and displays, to the consumer. Clearly, recognition involve a previous presentation of information so that it can be identify later. This implies a previous presentation of information outside the store followed by the recognition reported on the packages or on the displays inside the store. For this to work, information on packages and displays has to be identical (or at least similar) to the one presented outside the store. A technique to do that can be done by using visual information, hence by showing the package in the advertisement or by providing the contest showed in the ad inside the store near the product. When visual information cannot be used, description of the packages or slogan is a powerful instrument. Consumers use recall for easy choice, when the presented information are easy to understand and consistent with their already existing knowledge. So, in familiar situations, consumers tend to use recall in order to apply new information to the existing beliefs about that product class. In order to improve recall performances, it I useful to adopt visual imagery.

Normally, the more time is available for processing, the more information can be assimilated and stored in memory. Depending on consumer's ability to organize information in blocks, given that recall requires five to ten seconds to record a block of information in memory, if the available time of processing is of 15 seconds, it is clear that, later in time, two or three blocks can be recalled. Recognition, instead, requires two to five seconds for every block of information, so, at a later time, in 15 seconds, the consumer can recognize a maximum of eight block of information.

The capacity of the consumer to organize information, the organization of the advertisement and the level of prior experience, knowledge and interest about the information presented, influence the amount of information acquired during the limited time of an advertisement. If the advertisement organizes information into chucks in a coherent way respect to the organization of the consumer, then more information can be processed per unit of time hence more chunks can be stored in memory. Also prior knowledge and interest of the

information provided enhance the number of chunks memorized because consumer integrates the new information with the existing one. Bettman (1979) concludes that:

> "Therefore, there is a great effect on memory of the size of the "vocabulary" of chunks in memory. The greater the number of such chunks, the faster information can be processed" (Bettman, 1979, p. 50)

Since time available for processing is relevant to store information, when marketers needs to provide a huge amount of information or when information is complex, it is recommended to use a media that does not have a limitation in processing time or to expand the time for processing according to consumers processing needs.

When marketers decide to provide information to specific groups of consumers, they have to consider the possible differences in memory properties and capacities. For example, if marketers decide to segment consumers according to age, they need to consider that elder people have different memory capacities respect to younger ones, in particular, their performance is less satisfying. These findings affect the choice process; it is evident that elder people have more problems in using recall. Moreover, given their slower memory and visual search speed, they might have more difficulties when marketers provide them information that require fast processing, such as advertisements that contain a huge amount of information, and when there is high probability of distraction. Given these characteristics of elder people, it might be useful to present information inside the store or through print ads, so that time is not a limitation and recognition is preferred to recall.

1.4.3 Memory for intentions

In order to predict the future behaviour of consumers it is essential to consider the intentions that lead them to act in a determinate way and hence to have a specific behaviour. However, we can observe that the examination of process mechanisms underlying the link between intentions and behaviour normally is not done because the aim is to predict behaviour. In fact, this is a limitation hence we require to focus on memory in order to explain why some intentions are not achieved (Shapiro and Krishnan, 1999).

We need to distinguish between durable and low involvement products; usually when buying a durable product, the consumer views the purchase as the primary task while to buy a low involvement product it has to interrupt another purchase viewed as primary task. In fact, durable goods, unlike low involvement ones, are linked to the cognitive and emotionally sphere of consumers. Speaking of which, Shapiro and Krishnan emphasizes the fact that:

> "The study of memory for previously formed intentions is important in low-involvement situations for the following reasons. First, many shopping trips can be characterized as fill-in trips,

> wherein a stock-out or a special occasion prompts consumers to buy several products from various stores (Kahn & Schmittlein, 1989). For such shopping trips, consumers are unlikely to spend a lot of time searching for information or elaborating on the purchase, which has implications for memory. Second, for many shopping occasions, the intention to buy a product is formed outside the store; hence, whether or not an intention is remembered later is a relevant question because if it is not remembered, it cannot be transformed into behaviour. Third, although many consumers rely on shopping lists, it is estimated that in the majority of instances (70%), consumers do not make lists for shopping (Peterson, 1987) and instead trust their memories. It is important to also note that in low-involvement situations, the appropriate referent behaviour is an intention to buy a product because the brand decision is made within the store." (Shapiro e Krishnan, 1999, pp 169-170)

Because of this various memory-based situations, there can arise some failures in the purchasing process. It is possible that the consumer forgets the intention i.e. the individual does not remember to go to the store; or he remember the intention at the wrong time. Another reason of failure can occur when the consumer remembers the intention at the right time but he does not remember the motives that push him to form that intention hence to go to the store i.e. what he needed to buy at the store. It is important to consider these failures because they let us comprehend the link between memory processes and the realisation of intentions that can be used by marketing managers for product purchase models.

There are two fundamental components of memory for intentions: prospective component and retrospective component. The former refers to the action of remember to remember and the latter to remember what to remember. In order to complete an intention to purchase some goods, it is necessary that the consumer uses both the prospective and retrospective components in a specified interval of time. In other words, the consumer, when passes the store on his way home, needs to remember that he had an intention and what was the content of that intention (the product he wants to buy). It is relevant to underline the fact that, to successfully convert intentions into actions, it is essential that the remembrance of intention and its content happens when the consumer can act on them (in a specific interval of time that we identify as the driving home). More specifically, prospective memory necessitates that the intention is remembered in a specified interval of time, while retrospective memory requires that the content of the intention is remembered when the consumer is remembering prospective memory.

According to Shapiro and Krishnan (1999), prospective and retrospective memory (remember to remember and remember the content of the intention) are not correlated. This leads to the conclusion that firms should not link specific products purchase to their store because, even if this link can lead consumers to form the purchase intention, since retrospective memory is independent of prospective memory, the purchase of the product might not occur. In fact, a consumer might remember that he needs to buy a product but he might not remember this intention at the right moment (e.g., even if the product linked to the store led to the creation

of the intention, the consumer might not remember that intention when passing by the store). For that reason, the consumer might buy the product in another place so he does not visit the store or he visit the store but only when the promotion is ended so when it is too late. On the other hand, passing by the store might trigger the remembrance of the intention to buy something inside the store but the consumer could still not remember the content of the intention, i.e., which specific product to purchase.

Prospective memory might be affected by the remembrance of an intention, either self-initiated or from external reminders, that occurs before a performance interval i.e., period of time during which the individual has to remember the intention and perform it. A stronger influence on prospective memory might be given by external reminders focused on the action that the individual has to do. This happens because, through these kind of reminders, the attention of the individual is concentrated on the connection between the target event and the action.

We saw how, in consumer behaviour, memory has not to be considered as preceding intentions and purchase but as an explanation of the motive why intentions are transformed or not in purchase behaviour. Since consumers' intentions are determined before the purchase, the implication of memory is observable at least in situations in which there is low involvement, when consumers do not make shopping lists and when consumers want to purchase different goods from different stores. It is important to understand when and in which measure memory failures affect the non-realisation of intentions. In order to clarify why some intentions do not turn into behaviour, it is useful to consider factors related to memory such as encoding, delay and retrieval. Encoding operations are responsible for the link between intentions and content while, during the performance interval, individual may use retrieval for both self-initiated and external cue. When intentions are not transformed into actions is not because the intentions have changed but because of memory failures. In fact, intentions are translated into actions if the consumer remembers the intention in the right moment. For example, in low involvement purchasing, the consumer might be distracted by other tasks in addition to the intention of purchasing.

Retrieval might imply two types of failure: prospective failure, that is the failure to remember the intention; and retrospective failure, the failure to remember the content of the intention. When an intention is connected to another, retrieval performance is enhanced. The link between intentions, are further elaborated during the encoding process and, during retrieval, they positively affect the performance by helping cue each other also when the individual is distracted by different tasks.

In a contest of low involvement purchase intentions of multiple products, it is more probable that the intentions of purchasing these products is formed outside the store and the specific brand choice is made inside the store. This implies that what matters for the intention is the product rather than the brand. When we consider durable goods, the situation changes. In this case, the brand is more relevant respect to the product. Anyway, for this kind of goods, memory is not highly involved because it is a high-involvement purchase and hence it is the primary task carried out by the consumer. However, it is possible that the consumer has a secondary intention of purchasing an optional feature; in this situation memory might play a major role.

We saw how the two component of memory, prospective and retrospective, are independent from one another. This implies that, any action directed to fix memory failures, has to be connected to the specific component in which this failure takes place. For example, in-store displays benefit the retrospective component of memory because it gives a reminder of what to buy but it does not influence prospective memory because it is not a reminder of going to the store. Also information from specific stores that are connected to a particular goal such as weekend barbeque, let consumers remember the intention. On the other hand, reminder such as "need to go to the store after work" will benefit the prospective component but not the retrospective one because there in not a reminder of what to buy. Given that, it is clear that, advertisements and in-store information, needs to be linked to each other and coherent.

CHAPTER 2

CONSUMERS' MEMORY FOR PRICES

2.1 Consumers' memory limitations

Usually, in the economic theory, agents are different in their preferences or because they possess different information (Piccione and Rubinstein, 2003). In this chapter, we will analyse a situation in which agents differ in their memory capabilities and how this differences affect their choices. The consumer behaviour theories have always considered preferences, environment and tasks as variables used to associate information and order alternatives to arrive at a final purchase choice, if we introduce bounded rationality and consider memory as a limitation for consumer behaviour, understanding consumer's choices becomes more difficult. Clearly, when memory is involved in consumer's decisions, some specific inputs needs to be retrieved at the choice time. The input recall requires a lot of effort and usually consumers do not retrieve the exact input, so the choice process becomes harder to manage (Alba et al., 1991).

In the literature, a *stimulus-based choice*, is defined as a decision made by the consumer when all the relevant information are present and available at the time of the choice. On the other hand, a *memory-based choice*, occurs when all the information needed to take a decision must be recalled from memory. Mostly, consumers have to deal with what we call *mixed choices*. In this situation, there are information already present in the environment and some other need to be recalled from memory. An example of mixed choice can occur when a consumer visits a store, looks at the price and quality of a product, then visit another store and decide whether to buy that product in the second store or return to the first one. Situation that are purely stimulus-based are very few in reality, so, it is clear that memory plays a major role in the decision process of consumers.

Traditionally, there is the assumption that consumers' behaviour is influenced by prices because it is supposed that consumers know all products' prices charged by firms. In few words, the traditional economic theory assumes that consumers have complete information about prices offered in the market. However, this assumption is not always valid in reality. In fact, consumers usually tend to forget prices of items they have encountered or purchased. Recent economic thinking believes that information about products' quality and prices is asymmetric

across consumers and firms, and that quality and price are co-dependent (Monroe and Lee, 1999).

Researchers have tried to understand the extent of consumers' abilities to remember prices and found that only a very small part of them is able to recall accurately prices. Normally, consumers make decisions following what they know rather than what they remember. This means that, when evaluating a product, they unconsciously base their decisions on price information to which they have been exposed before even if they do not remember prices. Information accessible in memory are usually measured by what consumers can consciously remember. Consumers form a reference price scheme based on prices they have encountered in their past purchase experiences. Consumes usually evaluate products such as "expensive" or "cheap" basing their judgments on their reference price scheme. Thus, even if consumers do not remember the exact price of a product, they are still able to judge prices according to categories such as "expensive", "inexpensive" or "bargain". In order to do that, consumers need to have a previous knowledge of prices of similar goods in memory and, even if they cannot recall single prices, they can recall the categories containing them. This knowledge of the range of prices that forms a category, is the basis of consumers' internal reference prices scheme.

Given the fact that memory is important in consumer behaviour, we will analyse the effects of differences in memory capabilities and information processing among consumers. Clearly, these differences could improve firms' benefits if they understand how to take advantage of this situation.

In order to exploit the situation in which consumers have different cognition capacities, firms apply sales so that they are able to price discriminate among consumers and give a discount to the ones who have higher capabilities (Ellison 2006). Piccione and Rubinstein (2003) explained this concept through a model in which difference among agents is given by the number of prices they can remember. They constructed a market model in which prices fluctuate in a pattern that can be recognized only by the consumers who have high-cognitive abilities. In this way, the firm price discriminates so that it charges a lower price to more competent consumers. This happens because the firm alternates between regular and sales prices in a manner such that only more competent agents can recognize the pattern, hence purchase the good only when it is on sale. On the contrary, consumers with low-cognitive abilities, are not able to understand this pattern of prices, hence is forced to purchase randomly, paying a time-average price. By doing that, the monopolist reaches higher level of profit.

To understand better this concept, we will introduce a model demonstrated by Rubinstein (1993), in which, difference among consumers is given by the ability to process

information comprised in prices set by a monopolistic firm. The difficulties in recognizing and processing a price arise because prices are not considered just as the number posted on the product but is composed of many other elements e.g., payment arrangements and warranties. Given this meaning to the price, implies that the estimation of the total price becomes a difficult task for consumers. Rubinstein (1993) has been clear on the way he considers the differences in information processing capabilities:

> "While differences in information may be modelled by differences in partitions of the relevant space, differences in the ability to process information may be modelled by differences in the constraint on the family of partitions available to the individuals." (Rubinstein, 1993, p.474)

In spite of other models in which differences among consumers is reflected in the information they possess about the state of nature, in the following section we will propose a model of Rubinstein (1993) in which consumers' differences is given by their ability to get information regarding prices set by the firm.

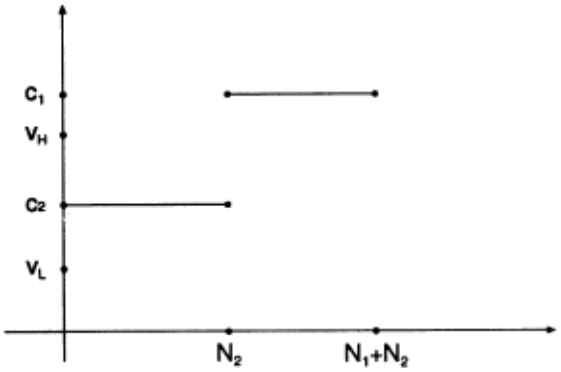
2.1.1 A model with heterogeneous consumers

In this section, we will describe the model developed by Rubinstein (1993) that is aimed at finding an equilibrium structure when there is heterogeneity in the reasoning capacities of consumers. The intuition behind this model is that the monopolist gains from charging more competent agents a lower price when a specific state of nature occurs. In order to achieve this result, the monopolist chooses price randomly so that it would not be profitable for less competent agents to purchase the good in that state of nature.

Let there be a market composed by a monopolist firm that produces a single good and N consumers, each of whom wish to consume just one unit of the good. Furthermore, suppose that there are two states of nature H and L that influences the economic parameters. The probabilities of the states H and L to occur are respectively π^H and π^L. Only the monopolist knows which state of nature effectively realizes. We assume that there are two types of consumers in the market: N_1 consumers of type I and N_2 consumers of type II, such that $N = N_1 + N_2$. When state L occurs, the monopolist faces a production cost c_L equal to zero whichever is the consumers' number and identity. On the other hand, when state H occurs, the monopolist's marginal cost depends on the type of consumer that buys the good. When he faces consumers of type I, its production cost is c_1 while, when facing consumers of type II, its production cost is c_2. Consumers buy the good if and only if they get some benefits. Benefits are measured by the surplus obtained from consuming one unit of the good at the price p. To get a benefit, the surplus needs to be positive. Surplus for state H is given by $v_H - p$ while

surplus for state L is given by $v_L - p$, where v_H and v_L are respectively the willingness to pay for state H and L. we also assume that $c_1 > v_H > c_2 > v_L$ as is shown in Figure 2.1.

Figure 2.1



Source: (Rubinstein, 1993)

Events in the market are structured in the following way:

1. For every state of nature, the price policy, that is a specification of a lottery of prices, is announced by the monopolist. With this announcement, the monopolist commits to supply any quantity of the good that consumers demand, at the price resulting from the lottery after the state of nature has been revealed. For this reason, each rational consumer, after the realization of the price, has the same beliefs regarding the state of nature.
2. The state of nature is chosen by Nature and the monopolist's offer is determined based on the commitment already done.
3. Consumers get to know which state of nature has been selected and, given the posted price and the pricing policy, they decide to accept or reject the monopolist's offer.

We can say that this model is a typical Stackelberg leader-follower situation. In fact, we can relate the monopolist to the leader who makes the first move by choosing the pricing policy and consumers to the follower who decides whether to accept or not the monopolist's offer.

When state H occurs, given that the production costs for consumers I type is higher than their willingness to pay ($c_1 > v_H > c_2 > v_L$), it is not profitable for the monopolist to sell to this type of consumers. So in state H, the monopolist would like to sell only to consumers of type II. We know that the monopolist is the only one who possesses information but he cannot share this information with only a part of consumers because, as stated before, information about the real price can be shared only through the price mechanism. The seller is not able to discriminate among individuals just with the mechanism price unless there is a further heterogeneity among

consumers. In this scenario, the expected profit of the monopolist is $\Pi^* = \pi^L N v_L$. The monopolist can reach an arbitrarily close profit to the expected one by employing the following strategy. In state L, he charges the price $v_L - \varepsilon$ (with probability one) and, in state H, he charges a very high price. The result of this strategy is not efficient. In fact, this leads to underproduction (or not production at all) in state H, even if it would be more profitable for both the monopolist and the consumers of type II if the monopolist would produce and sell the good just to type II consumers at a price: $c_2 < p < v_H$.

Now, we will add consumers' heterogeneity to the model. This heterogeneity is made such as type I consumers are capable of determining just one cutting point; that is to say that they can divide the price space only in two connected sets and they can relate to each sets the order "buy" or "don't buy". To be more clear, consumers of type I, can make choices such as: "buy iff $p \leq p^*$", "buy iff $p < p^*$", "buy iff $p \geq p^*$", "buy iff $p > p^*$", "always buy" or "never buy". On the contrary, consumers of type II, can determine two cutting point that divide the price space in three connected sets. This implies that this type of consumers can make decisions such as "buy (or do not buy) the good if the price lies in a determined interval and do not buy (buy) the good if the price lies outside the determined interval".

Events when there is consumers' heterogeneity are structured in this way:

1. The monopolist announces the pricing policy
2. Consumers choose a partition depending on the constraint given by category they belong
3. Nature chooses the state and hence the price is revealed
4. Consumer get to know which state of nature has realized and get information about the cell in the partition they chose. This last information incorporates the realised price and given that, consumers take the decision of whether or not to buy the good.

The monopolist can take advantage of the differences between consumers to get more profit. He seeks to obtain a profit arbitrarily close to $\Pi^* = \pi^L N v_L + \pi^H N_2(v_H - c_2)$. In order to do that, the monopolist sets ε_L and ε_H so that $\pi^L \varepsilon_L > \pi^H \varepsilon_H$. Moreover, the price strategy chosen is the following: when state H occurs, the monopolist charges the price $v_H - \varepsilon_H$ with probability one; when instead state L occurs, the monopolist charges the price $\frac{(vL + vH)}{2}$ with low probability and the price $v_L - \varepsilon_L$ with high probability. When such a strategy is employed, nothing changes for consumers of type II because they are able to divide the price space in three connected sets: $\{v_L - \varepsilon_L, \frac{(vL + vH)}{2}, v_H - \varepsilon_H\}$ and hence he purchases the good only for high or low prices. For consumers of type I such a partition is not possible. Furthermore, if a price $\frac{(vL + vH)}{2}$ is charged, this type of consumers would incur in a loss (because such price is higher than their reservation

value). Given that, consumers of type I have two choices: purchase the good for a price lower or equal to $v_L - \varepsilon_L$ or for a price higher or equal to $v_L - \varepsilon_L$. Remembering that $\pi^L\varepsilon_L > \pi^H\varepsilon_H$, consumers prefer to set their partition price as not higher than $v_L - \varepsilon_L$. In conclusion, if the monopolist chooses ε_H and ε_L small enough, he can get arbitrarily close to the maximal profit $\Pi^* = \pi^L N v_L + \pi^H N_2(v_H - c_2)$.

From this model, we understand how a monopolist can take advantage of consumers' heterogeneity regarding the differences in the processing capacities correlated with economic factors such as prices. The monopolist is able to do a sort of discrimination among consumers and get additional profits. In order to do that, the monopolist creates a trap for consumers of type I. This trap consists in offering, with a very low probability, a high price in the state of nature L. Consumers put their effort in trying to escape from this trap and this leads to a deviation of their computational resources from the most important task. So, consumers fail in identifying under which condition it would be profitable for them to purchase the good at a high price. On the contrary, consumers of type II understand the true state of nature that has realised because they fully understand the monopolist's pricing strategy. In this way, they do not get fooled by the trap and they understand which are the conditions under which it is convenient to purchase the good at a high price.

This model assumes bounded rationality of agents, but this does not imply that they are not able to reach an optimal strategy. In fact, bounded rationality implies that consumers are limited in some aspects but, at the same time, are more sophisticated in others. In our case, consumers are limited in their capacity to recognize prices, but they do not have aby constraint in reaching the optimal strategy necessary to get to the partition used to perceive prices.

The results of this model show that price setters can strategically use the complexity of the price scheme to improve their profits. Reality confirms that vision in the sense that price schemes are actually very complex, and this affects active consumers in the market.

2.1.2 An extension of the model: competitive market and homogeneous consumers

When studying bounded rationality, usually researchers focus more on consumers rather than on firms. This happens because firms interact more with the market, and they decide prices in a competitive environment. Firms tend to apply more and more complicated price policies that are always harder to understand for consumers. Many studies assert that, in order to simplify their decision process and try to maximize their surplus, consumers use heuristics. In this section, we will develop an extension of the model presented in the previous section (Rubinstein, 1993).

In Rubinstein's (1993) model, the monopolist takes advantage of consumers' different abilities of processing information to gain extra profits. Differently from the previous model, now we will consider a market in which there are two competing firms and only boundedly rational consumers. We do not consider other types of consumers, such as rational consumers, because they are able to escape the trap set by firms showed before. Bounded rationality is given by the fact that consumers are able to divide the price space only in two partitions with one cut-off price. Because of this limitation, consumers are not able to extract valuable information from firms' price policies about the state of nature (Mojtahed, 2012).

In each state of nature, firms have different but constant marginal costs; we consider a duopoly in which firms have the same cost structure. In the high state of nature, firms' marginal costs are greater than consumers' reservation prices. This means that firms want to sell their product only in the low state of nature, otherwise they would incur in a profit loss. We will show that, because of competition, the market equilibrium outcome will be such that firms are not able to earn positive profits.

The assumptions of Rubinstein (1993) showed in the previous section are adapted here to our needs. Let there be two firms $I = \{1, 2\}$ that produce one homogeneous product in two state of nature $S = \{H, L\}$. consumers in the market are homogeneous and desire to purchase one unit of the product. All agents in the market have the prior belief that state H occurs with probability π_H and state L occurs with probability $\pi^L = 1 - \pi^H$, but only sellers know which state of nature realizes. It is assumed that, given the prices announced by firms, consumers need to receive a strictly positive surplus. Consumers' reservation price in the high state of nature H, is v^H and in the low state of nature L, is v^L. Consumers' surplus from consuming one unit of the good, and given the price p_i the price charged by firms, in either states of nature, is $v^s - p_i$. When the low state of nature L occurs, both firms produces the good at the marginal costs c^L. when the high state of nature occurs, firms' marginal costs are $c^H > c^L$. We further assume that $c^H > v^H > v^L > c^L$. When firms set different prices, the firm that charges the lowest price gains the

whole market while, when firms set identical prices, the market demand is equally divided among the two firms.

Events in the market occur in the following way:

1. Firms announce their price policies which are determined by a probabilistic device. Once policies are declared, firms are committed to supply the good to all consumers at the announced prices in both states of nature
2. Given the cognitive limitation of consumers, they decide their partition and cut-off price. Remember that consumers can divide the price space only in two partitions whit one cut-off price.
3. Sellers get to know the state of nature that will happen and commit themselves to the prices determined in the first step.
4. Basing their decisions on their informational capacities, consumers choose from which firm they want to purchase the product.

This is a two-stage game, where first, firms declare prices, and, in the second stage, costumers decide whether to accept or reject firms' offers. In making their choices, consumers are affected by their cognitive limitations which we will explain next.

Given that $c^H > v^H > v^L > c^L$, it is easy to see that, when state of nature H occurs, firms incur in a profit loss is they sell the product to consumers because firms' marginal costs in state H is greater than consumers' reservation value in that state ($c^H > v^H$).

Consumers, on the contrary of sellers, do not have any information about which state of nature has realized, they try to understand it basing on the firms' price policies. Remember that a price policy p_i of firms i is a set of prices for every state of nature. Given that consumers do not know which state of nature has happened, they could accept a price that is too high and they would incur in a loss. To solve this problem, consumers uses heuristics such as categorization, they divide all possible prices in categories and assign an action to each of them. Clearly, the more precise is the categorization, the more consumers are able to understand which state of nature has realized so that they can reach an optimal choice.

In this model, we assume that consumers are able to divide the price space into two connected categories with one cut-off price. Hence, they can decide whether to "buy" or "not buy" the product if the price is respectively below or above their cut-off price, or they can decide to "always buy" or "never buy" whichever is the price. We consider homogeneous consumers in the sense that they have the same capacities to divide the price space into two categories using one cut-off price. It is useful to note that, once consumers have decided the cut-off price, whichever price is offered by firms below the cut-off point, is perceived as equal

by consumers. This means that price competition below the cut-off price is not important for firms. Here the cut-off price is not exogenous but it is chosen by consumers after the firms' price policy announcement and before the state of nature realizes. The cut-off price can lie between any two prices in the price space given by the price policy.

We will now show the equilibrium when firms set prices independently. Imagine that firms, in state of nature L, can charge a price lower than consumers' reservation value $x_i = v^L - \varepsilon_i^L$, or a price higher than consumers' reservation value $y_i > v^L$, and in state H, they charge a price $z_i = v^H - \varepsilon_i^H$. we call y_i a mine-price because if consumers purchase the product at that price they incur in a loss. Every firm i has a strategy that include a price policy P_i consisting of price(s) p_i^s for every state of nature and in the choice of a random device α_i. given firms' price policy, consumers decide their cut-off price that has to be between two prices in the firms' price space. We know that firms, in state f nature H, incur in a profit loss if they sell the product to consumers; so their optimal strategy is to set price z_i the highest possible, hence the closest to consumers' reservation value. It is possible to fix ε_i^H to ε^H because in state of nature H, firms do not benefit from competition, hence they will charge the same price. The next proposition, developed by Mojtahed (2012), illustrates the equilibrium when firms do not devise their price policy:

> **PROPOSITION 2.1**: "There exist a Nash equilibrium in price policies P_1 and P_2 where both firms set their prices to $p_i^L = c^L$ in state L and $p_i^H = v^H - \varepsilon^H$ in state H and make a payoff of $\Pi_i^* = \frac{1}{2}\pi^H(p^H - c^H)$." (Mojtahed, 2012, p. 35)

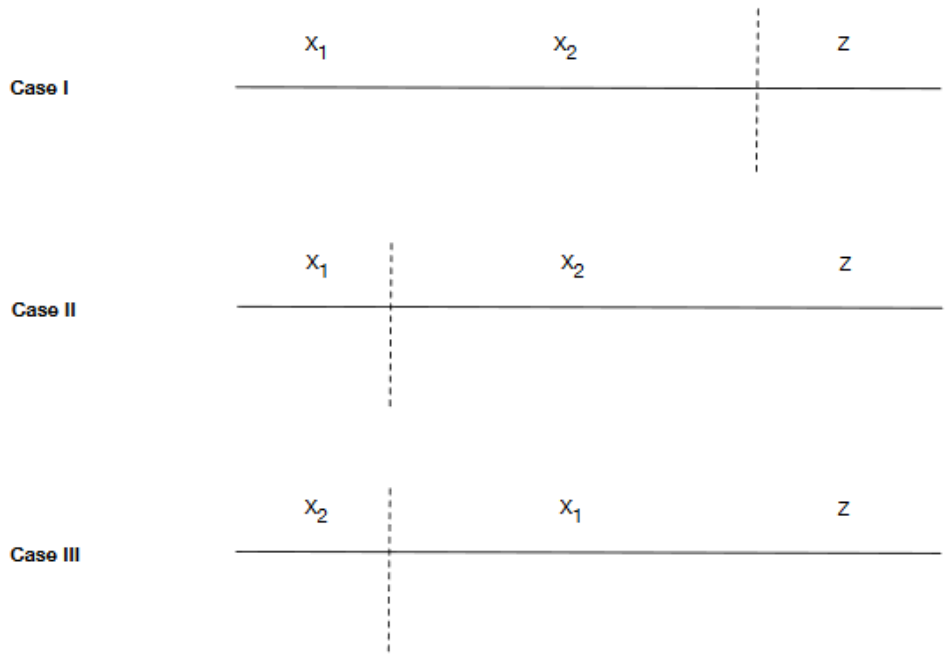
Now will follow the prof of this proposition. Assume that firms design the price policy such that they set prices x_1 and x_2 in state of nature L and z in state of nature H. As shown in Figure 2.2, in this situation three cases will arise.

In the first case, consumers will choose a cut-off price between x_2 and z. For every price that falls above z, in the high category, consumers will believe that state of nature H has realized, hence they will buy the product, as long as the price is lower than their reservation value. Instead, if the price falls below z, in the low category, since there has not been a mine-price announcement, consumers will believe that state of nature L has realized, hence they will buy the product either form firm 1 or form firm 2 with the same probability, as long as the price is lower than their reservation value.

In the other two cases II and III, consumers will choose a cut-off price that lies between x_1 and x_2. Depending on whether $x_1 > x_2$ or not, for every prices that lies in the low category, consumers will believe that the state of nature L has realized, hence they will purchase the product from the firm with the lowest price (form firm 1 in case II and form firm 2 in case III)

and reject the offer of the other firm. This implies that, the firm that has been rejected, has the incentive to charge a price below the cut-off point. Given that firms do not know consumers' cut-off price choice, and that firms decide prices simultaneously, both firms will charge a price equal to marginal cost as optimal strategy. This leads firms to earn zero profit in state of nature L because, due to competition and uncertainty regard the cut-off point, they are not able to exploit consumers' surplus like in the monopolist's case. Moreover, when state of nature H realizes, firms incur in profit losses. In fact, since $c^H > p^H$, firms cannot gain from selling to consumers but they are not able to prevent them from purchasing the good. This implies that firms earn a profit that is equal to half the loss from selling in state H. This is the same result of the Bertrand price competition, where firms, in order to gain the whole market share, end up to undercut each other's prices. In this situation, the price policy is made such that there is a price in each state of nature and this implies zero losses for consumers because they are able to understand which state of nature has realized.

Figure 2.2: firms use simple price policies



Source: Mojtahed, 2012

In the situation analysed above, firms were not able to take advantage of the cognitive limitation of consumers. Now, we will introduce the case in which firms are able to do that using a random device and performing better results. In Rubinstein (1993) we showed that, when there is a monopoly, the firm charges a price equal to $v^H - \varepsilon^H$ in state of nature H, and

uses a random device over prices $v^L - \varepsilon^L$ and $\frac{(v^L + v^H)}{2}$ in state of nature L, so that it can maximize its profit. This happens because, by using the random device, the monopolist is able to prevent some consumers to buy because they are afraid to incur in a loss due to their capacity to divide the price space only in two categories. In fact, consumers of type I could decide just one cut-off point between $v^L - \varepsilon^L$ and $\frac{(v^L + v^H)}{2}$, or between $\frac{(v^L + v^H)}{2}$ and $v^H - \varepsilon^H$. The monopolist set ε^L, ε^H and the random device such that $\pi^L\varepsilon^L > \pi^H\varepsilon^H$. Firms can set the mine-price higher than the reservation price in state of nature L, but for simplicity and continuity we will follow Rubinstein (1993) and set it equal to $y_i = \frac{(v^L + v^H)}{2}$. In a competitive market, firms will keep constant the price when the high state of nature H realizes, but they will reduce or increase the price when the low state of nature L occurs. Mojtahed (2012) shows this idea through the following proposition:

> **PROPOSITION 2.2**: "There exists an asymmetric Nash equilibrium in price policies P_1 and P_2 where firm one employs a price policy p_1^*, described by setting c^L with probability $\alpha_1 \in \max \{\frac{2\varepsilon^L + (v^L - v^H)}{(v^L - v^H) - 2\varepsilon^L}, \frac{\pi^L(v^L - v^H) + \pi^H\varepsilon^H}{\pi^L(v^L - v^H)}\}$ and $\frac{(v^L + v^H)}{2}$ with probability 1 - α_1 in state L and $v^H - \varepsilon^H$ with probability one in state H, and the other firm set her policy p_2^*, by setting c^L in state L and $v^H - \varepsilon^H$ in state H with probability one, and earn the payoff of $\Pi_i^* = 0, \forall\, i \in I$." (Mojtahed, 2012, p. 37)

The proof of this proposition will now follow. Assume a situation in which a firm sets a mine-price y_1 and a random device over his prices in state of nature L, while the other firm uses a price policy as we saw in *Proposition 2.1*. This leads to the creation of four possible cases depending on where consumers decide to put the cut-off point. Figure 2.3 shows the four possible placements of the cut-off prices. Assume that, in the first three cases, firm 1 set prices x_1 and y_1, and firm 2 set the prices x_2 (with $x_1 < x_2$) in the low state of nature L and z in the high state H. In the first case we assume that consumers set the cut-off price between y_1 and z. If the price is higher than the cut-off point, hence it falls in the high category, consumers know that state of nature H has realized and they purchase the product because they think that the price is fair for that state of nature. Instead, if the price is lower than the cut-off point, hence it is in the low category, consumers are not able to understand which state of nature has actually realized. In this situation, consumers do not purchase the product because they are afraid to buy at the mine-price y_1 and in that case they would incur in a loss because y_1 is higher than their reservation price. So consumers in this situation will reject firms' offer because (see Appendix *Proposition 2.2*):

$$\alpha_1 > \frac{2\varepsilon^L + (v^L - v^H)}{(v^L - v^H) - 2\varepsilon^L}$$

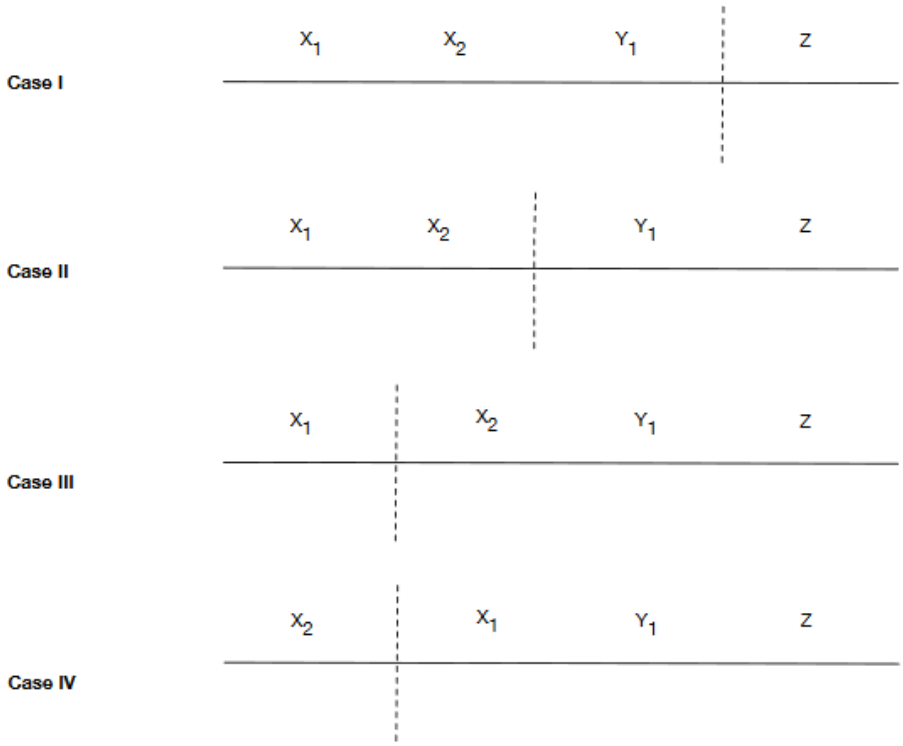
In the second case consumers set the cut-off price between x_2 and y_1. When the price is lower than the cut-off point, hence it is in the low category, consumers will deduce that state of nature L has occurred and they will purchase the product. On the other hand, when the price is higher than the cut-off point, hence it falls in the high category, consumers are not able to understand which state of the world has realized.

$$\alpha_1 > \frac{\pi^L(v^L - v^H) + \pi^H \varepsilon^H}{\pi^L(v^L - v^H)}$$

Firm 1 set α_1 the maximum between the two probabilities just shown such that later is better for consumers. Using this price policy, firms are able to avoid selling the product in the high state of nature H and, hence avoid the profit loss.

In the third case, consumers set the cut-off point between x_1 and x_2. If firm 2 wants to sell its product, it has to set the price lower than the cut-off point. In the third and fourth case, the firm that sets the lower prices gain the whole market share. This situation gives uncertainty to firms, so they both decide to set the prices equal to their marginal cost and share the market. Is these two cases did not exist, firms would have charge a price close to the reservation value of consumers in state L like in the second case and would have gain some profit.

Figure 2.3: firm 1 uses a complex price policy while firm 2 adopts a simple price



Source: Mojtahed, 2012

As in *Proposition 2.1,* also in this case competition leads to less profit respect to the monopolist's case. In fact, competition prevents firms to take complete advantage of consumers' bounded rationality and make joint profit equal to the monopolist's case. The result of this model is linked to a real world phenomenon; firms usually form price policies such that they are able to take advantage of consumers' bounded rationality and earn higher profit respect to the Bertrand competition situation. This model has led to an important conclusion: also firms who did not adopt a complex price policy benefit from the opaque situation and not sell when the high state of nature H realizes. This happens because consumers are not able to distinguish between firms who adopt a complex price policy and those who adopt a simple price policy.

Results do not change when we extend the ability to adopt a complex price policy to all firms in the market. Competition forces firms to charge a price equal to marginal costs so it prevents them to earn any profit. Anyway, using complex price policies, firms can exploit consumers' bounded rationality and avoid to incur in a loss by selling in the high state of nature H. we showed that complex price policies leads to more benefit for firms even if they will never jointly reach the monopolist's profit.

2.2 How limited memory influences categorization and leads to price dispersion

Usually, in the literature, there is the implicit assumption that consumers have perfect memory and can perfectly recall every price they previously got in contact to and use them to make choices. We have already assumed that, in reality, consumers are not fully rational and, a way to address this bounded rationality can be done through memory limitations.

When consumers do not have perfect memory, it is not possible for them to perfectly recall information about prices and this happens with greater effect when they face environments with high levels of information. Moreover, when prices that need to be recalled are not just the simple posted prices but are include also other monetary variables such as warranties, memory limitation plays a crucial role. In order to face this constraint given by memory imperfections, consumers use heuristics to form price impressions. The heuristic that is reason of interest in our analysis is the grouping of numbers into *categories* according to their perceived similarities (Chen et al, 2010). Through these categories, consumers can make imperfect but practical approximation of reality. This can be classified as bounded rationality because it is a satisfying behaviour, consumers stop optimizing as soon as they reach a near-satisfying result (Baris and Kutlu, 2017).

We consider a particular aspect of memory limitation that is the fact that consumers cannot remember correct prices but they can recall the categories in which they collocated the prices. Firms face consumers who compare prices but can do so only by recalling the category of the encountered prices and not the exact prices (Chen et al, 2010).

When price categorization due to memory limitations is present, usually there is also *price dispersion*. Whit the term price dispersion, we mean the practice according to which in a market, different sellers charge different prices for the same good. Note that this practice is different from price discrimination. In fact, when a seller price discriminates it charges different prices to different group of consumers or in different geographical locations. Normally, there is price dispersion when consumers do not have perfect information, or in our case, they have different cognitive abilities (Hopkins, 2006).

Price dispersion can be found also when, in a pure strategy equilibrium, firms offer a single price, if consumers do not choose the optimal price categorization strategy. On the contrary, when consumers are able to reach an optimal categorization scheme, price dispersion tend to disappear. Given that, in order to force firms to offer lower prices, consumers try to put more effort in memory resources to encode lower prices (Baris and Kutlu, 2017).

We assumed that the limitation of memory is represented by price categories, given that, we can assert that there could be two extreme cases. On one side, there is only one price category and on the other side, there are infinite categories. When consumers have no memory at all, they categorize all prices in one category while, when consumers have perfect memory, they categorize each price in a different category reaching an infinite number of categories. The optimal use of memory depends on the costs and benefits of doing that. Intuitively, when costs of using correctly memory is lower, there will a more optimal price categorization. In that context, technology seems to improve memory utilization. In fact, through technology, information are spread faster and categorization is made simpler. On the other hand, factors as price instability and high inflation, lead to higher costs of memory usage, hence to a less optimal price categorization. Therefore, we expect that, in societies with low technology and high inflation, there is a higher influence of limited memory rather than in societies with high technology and low inflation.

2.2.1 A model of limited memory and categorization

Now we will introduce a model developed by Chen et al (2010), in which consumers create their optimal memory structure of prices offered by firms, employing a limited number of categories and we will see its effect on firms' competition level. For example, think about a consumer that visits a store and assigns a price to an "expensive" or "inexpensive" category. When the consumer goes to another store and compare the price in that store with the price in the previous store, he can only remember if that price was expensive or inexpensive but cannot remember the exact value of that price. Firms know this consumers' limitation, so they consider that when choosing their pricing strategies.

In the model, we consider a duopoly market, in which consumers have limited memory and firms compete to gain the biggest part of the market. Consumers compare the prices of the firms in order to take a purchase decision. Given their limited memory, consumers just recall the category containing the actual price. We will see how consumers have an incentive to dedicate more memory resources to encoding lower prices so that firms would be forced to offer more favourable prices.

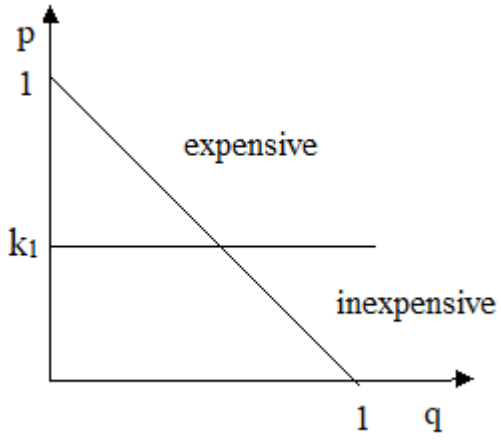
In this model, consumers' categorization strategies interact with firms' price competition in a way such that only small improvements in recall leads toward a perfect recall market outcome. This means that even when consumers have a small number of categories, the expected price and surplus for them is close to the situation in which there is perfect recall. This result suggests that firms' price competition compensates for the limitation in memory of imperfect recall.

Consider a market with two firms (1 and 2) that compete in selling a homogeneous good. We further assume that both firms have a marginal cost of production that is constant and equal to zero. Consumers in this market need a maximum of one unit of the good. We normalize consumers' reservation value to one without loss of generality. Clearly, consumers want to buy the good that has the lower price; hence, they compare prices before the purchasing choice. However, we know that consumers cannot recall perfectly prices because they do not remember the exact price but the category that contains it. We assume that consumers structure their memory with n+1 categories that serve to encode price information. Moreover, consumers categorize prices as long as they are below their reservation value (willingness to pay) and reject any price above it. Therefore, all the prices available are classified into n+1 categories such that any price is part of one and only one category (a price cannot be part of more than one category). Even if consumers have the memory limitations already explained, they are aware of that fact and they are able to act optimally under this constraint.

"Explicitly, let the set of memory categories be $\{C\}^{n+1}_{i=1}$ and assume without loss of generality that they are indexed in increasing order of prices (j > k implies that p > q for every $p \in C_j$, $q \in C_k$). Denote the set of cut-off prices as $\{k_i\}^{n}_{i=1}$, where k_i separates category i from category i+1. From our previous assumption on the order of the categories, we have that $k_1 < k_2 < \ldots < k_n$. Because the categories are exhaustive and mutually exclusive, k_i belongs to one and only one of them; we assume that each category is a set that is open to the left, which implies $k_i \in C_i$ for i = 1, …, n Therefore $k_{i-1} < p \leq k_i \Rightarrow p \in C_i$ Finally, for the sake of completeness, we define k_{n+1} and k_0 to be the highest and lowest possible prices charged by a firm, respectively (clearly, $k_{n+1} = 1$). Therefore, the category C_i is defined as the set of prices $[k_{i-1}, k_i]$ for i =1, 2, …, n+1." (Chen et al, 2010, p. 653)

If n=1, this means that consumers are able to partition prices in two categories with one cut-off price k_1. We can assume that consumers would classify prices according to how they perceive them: expensive or inexpensive. So there would be two categories, expensive and inexpensive, where k_1 is the price that divide the two categories and above which a good is considered expensive. This concept is shown in Figure 2.4.

Figure 2.4: Market demand structure with one cut-off price (n=1) and two categories



Source: reinterpretation of Baris and Kutlu 2017

Consumers' bounded rationality suggest that consumers partition prices into expensive and inexpensive categories in order to make it easier to deal with their limitations in recalling the exact value of prices and help themselves to make the optimal purchase choice. In spite of their limitations, consumers choose the set of cut-off prices that shape the categorization scheme in a way such that their expected surplus is maximized. Recognizing their limitations, consumers will try to reach the optimal categorization strategy in order to deal with their problem. For this reason, consumers in our model are *bounded*, in the sense that they have memory limitations, but, at the same time, they are *rational*, in the sense that they are aware of these limitations and they try to make the best purchase decision taking it into account. The model, using consumers' categorization, reflects an important aspect of human cognition: even

if consumers have limitations in memory, they are sophisticated in making optimal decision rules.

We can interpret the categorization process in the following way: when consumers decide to purchase something in a market, they face a lot of prices offered by different firms (moreover, the total price can be divided in several components). This obviously cause the imperfection of price comparison and this imperfection is captured in the heuristic of categorization.

There are two type of categorization: symmetric and asymmetric. In the first case, consumers classify prices of both firms into categories and, when comparing prices, they can recall just the categories so they compare the labels of categories. For what concern the asymmetric case, consumers compare the recall category of the price of one firm to the exact value of the price of the other firm.

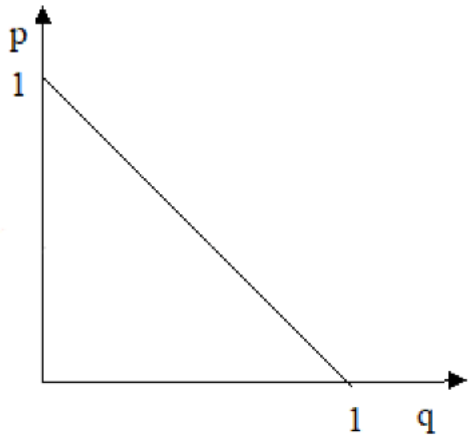
- *The symmetric categorization*

Now, we will analyse the situation of symmetric categorization of prices. The process is as follows. Prices offered by the firms are classified into categories by consumers. At the time of the purchasing choice, consumers recall the categories containing prices of both firms and compare such categories. The recalled price that is in the lower category, will be the chosen one, hence consumers buy from the firm that charges that price. If prices of both firms are in the same category, consumers' choice will be random; they will purchase from either firm with the same probability.

We assume that the parameter n is exogenously given and not chosen by consumers[1] and it shows the accuracy with which consumers recall prices (memory degree). When n = 0, that means that the degree of memory is equal to zero, hence consumers have no memory at all. We can see this situation in Figure 2.5, where all prices fall into one category. When n = 1, consumers are able to divide prices into two categories as we saw in Figure 2.4. The higher is n, the more consumers categorize prices into more precise partitions. As n increases, also recall ability improves hence recalled prices are always closer to the real ones offered by the firms.

[1] We did not assume that consumers chose the parameter n because that would add another stage to the model but would not change the result.

Figure 2.5: market demand structure with no cut-off prices (n=0) and one category



Source: Baris and Kutlu 2017

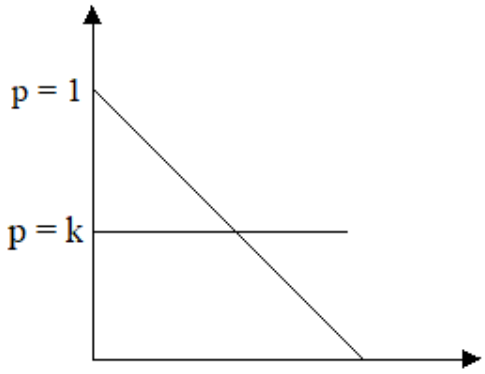
The events in the market occur as follows:

1. Given that there are n+1 categories, limited memory consumers will choose the optimal cut-offs prices $\{k_i\}^n_{i=1.}$
2. Firms, after knowing consumers' cut-off prices, choose their pricing strategy. It would also be possible the case in which, firms and consumers act simultaneously in choosing categories and prices, because the results of the model would not change[2].
3. Consumers decide which product to purchase depending on price realizations and the decision process already described.

Given the fact that consumer do not recall prices but only category labels, firms are incentivized to charge prices at the top of each categories. Considering the simplest case in which n = 1, where consumers divide prices in two categories; given the cut-off price at k, firms will always charge at most two prices k or 1. We show this situation in Figure 2.6. It is easy to find that the optimal equilibrium for both firms is to price at k. Both firms charging a price equal to 1 is an equilibrium only as long as $k \leq ½$. Knowing that, consumers, in order to maximize their surplus, choose k such that it is slightly above 1/2. In this way, they strategically force firms to charge the equilibrium prices in the low category.

[2] Is known that equilibria in sequential games are also equilibria in simultaneous games.

Figure 2.6: Market demand structure with two categories (n=1) where firms charge prices at the top of each categories



Source: interpretation of Chen et al. 2010

Chen et al (2010) show that there is a unique symmetric equilibrium in pure strategies, using the following proposition (whose proof can be found in the appendix):

> **PROPOSITION 2.3**: "When consumers optimally choose the cutoffs, there is a unique pure-strategy equilibrium. The optimal cutoffs are $k_i^* = (½)^{n+1-i} + \varepsilon$ for every i =1, …, n, where $\varepsilon \ll (½)^n$ $\forall n$ and $\varepsilon \to 0$.
> Both firms charge $p_j^* = k_1^* = (½)^n + \varepsilon$.
> Each firm makes positive equilibrium profits $\pi_j^* = (½)^{n+1} + \varepsilon/2$, which are decreasing in n."(Chen et al, 2010, p. 655)

The effects of competition in this market, in which consumers compare categories and not real prices, are that, in a symmetric pure-strategy equilibrium, firms end up charging prices at the top of the lowest category. In spite of the fact that firms produce the same homogenous good and sell the same homogeneous segment of consumers, they are still able to set prices higher than marginal costs and earn positive profits. Consumers' bounded rationality moves firms' equilibrium outcome away from the Bertrand competitive outcome. Given that consumers can recall only categories, firms are incentivized to charge prices at the top of the category but, competition, leads firms to price only in the lowest category.

A corollary of the proposition mentioned above is that for I = 1, …, n +1, the difference between consecutive cut-off is as follows:

$$k_i^* - k^*_{i-1} = (½)^{n+2-i}$$

it is easy to demonstrate that as i decreases, the difference between consecutive cut-off prices decreases. This means that, the more we get closer to the lower end of price range, the more the categorization becomes precise. Actually, as we move from low to high prices, the lower category is exactly the half of its successive neighbour ($|C_i| = 2|C_{i-1}|$). This result suggests that

consumers put more effort and memory resources in encoding low prices respect to high prices. This happens because consumers want firms to lower their prices as much as possible. We know that the consumers strategy is to set the cut-off prices such that $k_i^* = (½)^{n+1-i} + \varepsilon$ for every i =1, …, n; this ensures that, at each of the higher price levels, firms will undercut each other. In fact, when both firms decide to offer a price that is close to consumers' willingness to pay, it would be profitable for a firm to deviate, offering a price in a lower category, even if the undercutting amount needed in order to take away a part of consumers from the other firm is relatively big. On the contrary, when both firms offer lower prices, the undercutting amount needed has to be small to make the firm deviation profitable. This make it optimal for consumers to categorize with a wider partition in the upper end of the price range and to make finer partition as prices decrease. Following this strategy, in equilibrium, consumers force firms to charge prices only in the lowest category with the lowest k_i^*.

Moreover, as the number of categories increases (consumers put more effort in memory resources), firms' prices and profit decrease. This means that, improvements in consumers' memory capacities leads to an improvement in the equilibrium prices that are always closer to the marginal costs faced by the firms. In fact, as $n \to \infty$ (the number of categories tends to infinite), the model represents the perfect recall situation. Moreover, this is the case in which the equilibrium prices are equal to marginal costs; hence, the model leads to the standard Bertrand competition outcome when the degrees of memory are infinite.

Now we will extend the model to incorporate a group on uniformed consumers or in other words, loyal consumers. Consider a group of loyal consumers of size 2γ where, γ of these consumers buys the product from one firm and the other γ consumers buys the product from the other firm, but in both cases, as long as the price is lower than their reservation price. It is important to note that for this group of consumers, memory does not play any role because they do not compare prices across firms. The other group of consumers present in the model is a group of limited memory consumers $(1 - 2\gamma)$ with n degrees of memory, as we saw until now. Also in this case, we can find a unique symmetric pure strategy equilibrium: firms will charge the highest price in the lowest category as long as γ (the number of loyal consumers) is small enough (it is not too large). The fact that now in the market there is this group of loyal consumers, produces market differentiation between firms. A high number of γ implies that there is a more differentiated market and less competition between firms. Consequently, as γ increases, also the equilibrium price and profit of the firms' increases. The other results found in the symmetric model that includes only limited memory consumers, hold also when we add loyal consumers.

Now, we add, to the last version of the model, also a group of consumers fully informed and with perfect memory who can compare actual prices charged by both firms. Let there be a group of size 2α of informed and with perfect memory consumers, a group of size 2γ of uninformed/loyal consumers and a group of size $2\beta = 1 - 2\alpha - 2\gamma$ of limited memory consumers. With these features, the model cannot lead to a pure strategy equilibrium but to a unique symmetric mixed strategy equilibrium in which firms offer prices in an interval extending from the top of the lowest category. Key results already found in the previous characterizations of the model still hold.

- *The asymmetric categorization*

Differently to the symmetric case, in which consumers compare only the labels of categories, in this situation, consumers compare the recalled category for the price charged by the first firm that they visited with the actual price charged by the firm they are at. Events in the market occur as follow:

1. Consumers observe and encode prices at the first firm (we assume that the first firm is firm 1 for half consumers and firm 2 for the other half)
2. Consumers observe the price at the second firm and make a comparison with the recalled category that contains the price of the first firm, in order to decide which product to purchase. Consumers purchase the product from the current firm if the price observed is lower than or equal to the price recalled and it is lower than their reservation price.
3. If consumers did not buy the product in the previous stage, they get back to the first firm and buy the product there, if its price it is lower than their reservation price.

Through this structure of the model, it is possible to make price comparisons between the two firms when consumers have more information about one firm respect to the other. Clearly, information possess by consumers, about the price charged by the firm where they are at, are greater than information about the price observed previously in the other firm.

We consider the most general case of n+1 categories and a market composed by all three segment of consumer: limited memory consumers, uninformed/loyal consumers and fully informed and with perfect memory.

In this case, we will not go through the entire model but we will just show its conclusions. Results of this model shows that, as in all the previous characterization of the symmetric model, categorization becomes more precise as long as we get closer to the lower end of price range. Intuitively, consumers put more effort in encoding lower prices than higher prices and this results in firms charging lower prices. Firms profit in the asymmetric

categorization are lower than in the symmetric one for obvious reasons. In fact, in the asymmetric categorization model, consumers have more information about prices because they compare the recall price of one firm with the actual price of the other firm; on the contrary, in the symmetric categorization model they just compare price category labels from both firm. Asymmetric categorization leads to a fiercer competition between firms, hence, to a reduction of their profits.

Furthermore, as the degree of consumers' memory increases, also the expected equilibrium price increases. In fact, as n becomes bigger, consumers have more memory and this leads them to be more sensitive to price differences between firms. As n increases, consumers make less mistakes and purchase the product from the firm the actually charges the lower price and this reduces firms' profits from the limited memory consumers group. To face this problem, firms end up charging higher prices, on average, so that they are able to extract a larger part of surplus from the uninformed/loyal consumers. This means that, the more there are memory improvements of limited memory consumers, the more the average market price charged by firms is higher; and it is the highest when informed consumers have perfect recall. It is interesting how, even if consumers' cognition capacities increase, there is also an increase in prices. This is clearly due to the existence in the market of uninformed/loyal consumers that purchase whichever price the firm they are loyal to charges. We need to emphasize that, in any case, the expected price paid by limited memory consumers decreases as n increases because firms' profit does not vary depending on n, but uniformed/loyal consumers, on average, end up paying higher prices as n increases because firms need to compensate the loss from limited memory consumers. This happens because, limited memory consumers pay the minimum price charged by the firms while, the loyal ones, pay the expected price charged by firms which it is greater as n gets bigger. This conclusion is different from the symmetric categorization model in which, both limited memory consumers and uninformed/loyal consumers pay the same price that decreases as n increases. In the symmetric categorization, the improvement of memory generates a positive externality to uninformed/loyal consumers; while in the asymmetric categorization generates negative externality.

As it happens in the symmetric categorization, also in asymmetric categorization, the more the market gets competitive, the greater is the value that consumers have in investing more resources to encode information. Furthermore, whichever is the type of categorization (symmetric or asymmetric), the heterogeneity conditions of consumers and the type of equilibrium (pure or mixed strategies) we found that:

1. There is always a fine categorization as we get closer to the lower part of the price range. This suggests that, consumers with limited memory have incentives in allocating more resources in encoding lower prices so that firms are induced to charge lower prices.
2. Because of the interaction between categorization and competition, even a small improvement in recall capacities, leads the market outcome close to the perfect recall situation. The initial increases in the number of categories move equilibrium prices and consumers' surplus toward the case in which the number of categories are infinite.

We also confirm the expected result that consumers' heterogeneity, in particular the presence of uniformed/loyal consumers, leads firms' equilibrium profits to increase. On the other hand, the increasing of the number of categories decreases firms' equilibrium profits weakly.

We just analysed the similarity between the types of categorization and now we will introduce the differences. First, the environment in the asymmetric categorization is more competitive and undifferentiated respect to the symmetric one. Consistent to this, in the asymmetric categorization we can find a fiercer competition between firms and lower equilibrium profits. As an example, consider the situation in which there are only limited memory consumers: in the symmetric categorization, firms are able to reach positive profits while, in the asymmetric categorization, market outcome reaches the Bertrand equilibrium outcome in which the price is equal to the marginal costs and firms make no profits. The intuition behind this finding is that consumers in the second situation have better information because they use the actual price of one of the two firms to take a purchase decision instead of recalled categories.

CHAPTER 3

FIRMS' OBFUSCATION STRATEGIES

3.1 Obfuscation strategies and consumers' search costs

The traditional economic theory affirms that consumers choose the product with the lowest price when there are homogeneous goods. In practice, usually consumers are not able to choose the best price. This implies that firms have incentives to charge positive markups and partition prices in different parts e.g., posted price plus a fee (Grubb, 2015).

In order to make the best price decision, consumers need to follow some steps. First they must search for prices, then they have to choose the lowest price, and finally they must switch when there is a change in prices. Consumers usually fail in choosing the best price because the acts of searching and switching are costly. Taking into consideration these costs, it is traditionally assumed that consumers make search and switch decisions in an optimal way and that they initially choose the lowest price among those discovered. Evidences suggest that all we just said it is too optimistic. In fact, in reality, it seems that consumers search too little, they get confuse during their choices, and they do not switch as much as necessary from past choices or default options. These consumers' failures lead to positive markups charged by firms that do not diminish as firms' competition increases. In order to decrease competition, firms tend to obfuscate prices by using complexity so that price comparisons result more difficult for consumers.

When prices are complex vectors, consumers find it harder to compare them and identify the lowest one. The more a price is complex, the more consumers' search is limited. Consumers' search is limited not only due to the complexity of prices but also because it has high costs. The cognitive costs of evaluating offers might be increased by the price complexity, hence search becomes very costly. Firms take advantages from this situation by setting complex prices so that consumers' price comparison becomes more difficult and firms can earn higher profits. This practice is known as *obfuscation* and consists in making prices more complex and less transparent so that it is more difficult for consumers to make price comparisons. We can find obfuscation strategies in many real-world phenomena. A common example of firms' adoption of obfuscation strategies is given by low-cost airlines companies. In fact, airline companies

usually advertise a low price of the flight but, when consumers want to complete the purchase, they discover extra fees. At this point of the choice, consumers have spent too much time in searching for the best offer and probably decide to purchase the ticket despite the extra fees.

Models of search state that, normally, the existence of consumers' search costs raises equilibrium prices so it is clear that firms have an incentive to increase consumers' costs of learning competitors' prices. More unexpectedly, Ellison and Wolitzky (2012) showed that by making its price harder to find, a firm can increase consumers' expected cost of searching competitors' prices. This means that firms have the incentive to set complex prices not only because doing that increases the cognitive difficulties of consumers to make price comparisons but also because it increases their expected cost of further searching elsewhere and so they prefer to buy the product from that firm. Using obfuscation strategies is more profitable for firms because it leads consumers to purchase the good when they would otherwise continue searching.

Once the search is completed and the consideration set is defined, following the economic literature consumers should choose the firm that charges the lowest price of a homogeneous product. In practice, consumers fail to do that for at least two reasons. Consumers can be confused about product quality in the sense that they do not understand that products are homogeneous and assign quality differences to goods. Another source of consumers' confusion can be complexity of prices that prevents consumers from identifying the lowest price when they make price comparisons. Confusion, either about quality or prices, leads consumers to search less for a lower price (Grubb, 2015).

We are more interested on confusion about prices rather than about quality. Firms can choose the level of complexity of prices and decide whether to be transparent or to use an obfuscation strategy. Economic models show that firms tend to raise the obfuscation level as competition increases (Ellison and Wolitzky, 2012).

The reasons why it is rational for firms to use obfuscation strategies are quite obvious: in many models it is shown how consumers' search costs raise equilibrium price, hence it raises also firms' profits. Ellison and Wolitzky (2012) assert that:

> "Diamond (1971) first formalized the connection between search costs and price levels, noting that even an ε search cost could increase prices from the competitive level to the monopoly level because consumers will have no incentive to search if they expect all firms to charge monopoly prices. Several subsequent papers developed two other important insights: there is a more natural search problem when price dispersion is present, and price dispersion will exist in equilibrium when consumers are differentially informed." (Ellison and Wolitzky, 2012, pp. 417-418)

Ellison and Wolitzky (2012), in their model, consider a market with N firms that sell a homogeneous product and heterogeneous consumers with identical downward sloping

demands. There is a fraction μ of consumers that does not have search costs and learn all firms' prices. The other fraction 1 - μ of consumers has to pay a search cost for every price quote that they want to obtain. They show that all consumers that have positive search costs will search just once. Moreover, as the search costs for consumers' increases, also firms' prices and profits raise. In this model, obfuscation is considered in a simple way: consumers do not want to spend a lot of time shopping so they have a disutility that depends on the total time spent shopping, firms can decide the length of time consumers require to learn their prices. Consumers do not know the time required for learning prices before visiting the firm. In equilibrium, firms set their prices and make positive profits while consumers search until their expected benefit from a further search is higher than their expected cost of searching.

This way to see obfuscation can capture different real-world phenomena. For example, in face-to-face retail, firms can train their salespeople to talk to consumers for a given period of time before telling them the final price of a product. On the other hand, if firms do not decide waiting time directly, they can instead convey information about prices in a complex and not clear way to consumers and that would lead to an increase in the time consumers understand prices. Furthermore, the cost of the time used for learning firms' prices can be interpreted as the time needed to learn products' quality and therefore to learn the quality-adjusted prices.

Obfuscation seen as an action that raises the amount of time consumers need to learn firm's price implies that consumers will behave as if future search costs will be higher. This may happen for two reasons. First, because obfuscation raises the cost consumers have to face if they decide to search further. Second, because an increase in obfuscation would make consumers think that their expected search cost for future search is too high. In fact, when consumers are learning how much time they need to spend to find prices, making prices hard to find raises consumers' expectation about starting a new search elsewhere.

Ellison and Wolitzky (2012) showed that obfuscation is always profitable for firms. This is because, since consumers' expected cost of searching at a firms' competitor has been raised by obfuscation, firms can charge higher prices without fearing that consumers will search somewhere else after they have learned their own price.

In equilibrium, obfuscation must always occur unless consumers' search costs are so high that they want to buy the product at the highest equilibrium price when there is not obfuscation. As one may think, obfuscation damages consumers. This is because with obfuscation consumers have to face higher search costs that they would not have otherwise, and because they incur in higher prices. Obviously, higher prices benefit firms, but this does not happen when the level of obfuscation is so high that it makes the market collapse. Furthermore,

all firms benefit from obfuscation, also those who adopted transparent policies and did not use obfuscation strategies. This is because, if there is a high level of obfuscation in the market, consumers tend to search less and make less comparisons, hence also transparent firms benefit from it.

In few words, in equilibrium firms obfuscate prices, obfuscation make prices increase, and, even when there are some exogenous reductions in search costs that benefit consumers, they are partially offset by increases in obfuscation efforts.

3.2 Firms' obfuscation strategies with boundedly rational consumers

The economic theories have fully spoken about market models in which there are informational asymmetries between firms and consumers. Even if these models consider informational asymmetries, they do not consider the perceptual asymmetry between firms and consumers, because they assume that "the model itself is common knowledge". In the real world, usually firms and consumers have different abilities to understand the market model. Firms, contrary to consumers, have more frequent interactions with the market and pay more attention to it: this implies that firms are able to learn the market model and the market equilibrium better than consumers. Moreover, firms have the privilege to set prices, and this allow them to complicate the consumers task of understanding the real value of their products, by adopting complex price strategies (Spiegler 2006).

Spiegler (2006) presents two explicative examples of what we just said:

> "For instance, consider the problem of choosing where to open a bank account. Banks offer a large number of financial services. At the time we open the account, we do not know yet which subset of services will be relevant for us. The bank can complicate our decision problem by adopting different fees for different transactions, or different interest rates for different types of saving accounts. Likewise, when we purchase life or health insurance, we need to calculate trade-offs across a large number of scenarios. Insurance companies can contribute to the difficulty of this task by applying different reimbursement policies to different contingencies." (Spiegler, 2006, p. 208)

This examples show how firms can employ strategies that have a complex and multidimensional structure. This structure is hard to understand in its entirety for consumers, hence they try to simplify it in heuristics.

Spiegler (2006) found that when competition gets fiercer, firms respond with a higher level of obfuscation rather than with more competitive prices and this of course affects consumers' welfare. The obfuscation device used by firms in Spiegler (2006), is structured as follow: they price some contingencies in a competitive way and some other in a monopolistic

way. The competitive ones are necessary to attract consumers, while the other contingencies generate profits.

Moreover, when firms control both price and quality, if the number of firms in the market is sufficiently large, the outcome, in terms of expected surplus, is inefficient. The loss of efficiency increases as the competition increases and it is borne totally by consumers. This implies that an increase in competition has a negative effect on both consumer and social welfare.

It is known that consumers have to take purchase decisions that are always more complex. For example, in everyday choices such as in the supermarket shopping, complexity is given from various factors such as the presence of a large variety of substitutes, the changing of prices or the differences in measurement units in which quantities are presented. It is very difficult for consumers to avoid complexity when they face choice tasks. Furthermore, it is commonly thought that complexity faced by consumers is not only intrinsic of the task but it is strategically designed by firms to exploit consumers' bounded rationality and limited capacity of making correct price comparisons. Considering this, it is derived that choice tasks complexity limits the effective market competition. Profit-maximizing firms tend to increase consumers' choice complexity so that they can take advantage of consumers' bounded rationality to limit competition and earn higher profits. The market environment is fundamentally simple and, if consumers were fully rational, also prices would be simple, but firms, exploiting consumers' cognitive limitations, adopt obfuscation strategies to hinder a correct value comparison (Spiegler, 2016).

We will now introduce a modelling framework to understand the intuitions behind the difficulty of consumers' value comparisons. Consider a market in which there are two firms that produce any number of units of a good and choose simultaneously their prices or products quality. At the same time, firms also decide the description format to present the relevant quantity. In selecting these formats, firms define the share of consumers who have the ability to make value comparisons between firms' products. Intuitively, when a consumer is able to make value comparison he purchases the good from the firm with the highest-value product. On the contrary, when a consumer has cognitive limitations in making value comparisons, he randomly selects a firm. We will now introduce two scenarios that show different kinds of description formats:

1. Scenario 1: a format can be seen as a measurement unit that denominates the relevant quantity. For example, it could be the unit of volume that defines the price of a food product or the unit of energy that defines an electric appliance. Some consumers are not able to

convert units hence they cannot make value comparisons, for instance because they do not know the conversion rate.

2. Scenario 2: a firm can decide whether to exhibit the content of its product with a simple and transparent language that everybody would understand, or with a technical and specialized vocabulary that a non-specialist person would understand only if translated into easy terms. In the latter case, if the translation fails, the consumer is not able to make a value comparison of the products.

The difference in the two scenarios lies in where firms choose to locate complexity. In scenario 1, the complexity does not lie in the formats (there is not intrinsic complexity in the formats), but it arises only when firms utilize different formats. On the other hand, in scenario 2, formats can be ranked according to their intrinsic complexity. This difference between the two scenarios leads to different obfuscation incentives. In fact, in scenario 1, firms do not prefer a format with respect to another, because it is the coordination among firms' formats that matters. In contrast, in scenario 2, firms decide whether to use obscure or transparent language depending on the incentive they have to discourage or encourage product comparisons (given by the low-value or high-value product they offer).

3.2.1 A model of price transparency

We already saw how firms and consumers have different abilities to understand the market in which they interact. Clearly, firms are more incentivized to maximize profits because otherwise they might not stay in the market anymore due to other profit-maximizing firms that force them to exit the market. On the contrary, consumers do not have such pressures. This implies that firms exploit consumers' errors or limitations and try to increase these errors with obfuscation strategies that result in a softer price competition (Garrod, 2008).

The economic literature predicts that firms in competition would always give consumers all product information as long as it is costless and feasible to do so. The intuition behind this concept is that, when firms offer the best terms, they will reveal their product information and consumers understand that any offer from a firm that would not reveal such information results non beneficial for them. However, this scenario is based on the assumption that consumers are able to understand which firms are hiding information and that they should avoid them. Would firms be incentivized to hide some information if consumers do not have such cognitive capacities and visit firms even if they are not transparent? We will now analyse whether firms can profitably use obfuscation strategies to hide part of their prices when consumers have different cognitive abilities to form expectations of market prices.

Garrod (2008) introduced a model in which firms can decide whether to adopt a transparent or non-transparent strategy. When a firm adopts a transparent strategy, everybody (consumers included) knows its price. On the contrary, when a firm adopts a non-transparent strategy, the price is made of two parts: one is common knowledge, the other is a hidden fee which consumers can discover at some cost. When all consumers are able to form correct expectations, they do not want to visit a non-transparent firm because they would incur in a loss, so they visit the firm with the lowest transparent price. However, consumers are not homogeneous in the sense that there is a subset of consumers that are sophisticated and able to form correct expectations, and a subset of naïve consumers who do not know that firms hide some fees and simply visit the firm with the lowest observable price. Nevertheless, naïve consumers switch firm, at some cost, when they understand they have made a mistake and find a positive hidden fee in the total price charged by the firm they visited.

Garrod (2008) found that, when a portion of consumers have limited cognitive capacities, market prices are always higher than marginal cost because firms use obfuscation strategies to attract naïve consumers. This implies that prices are always greater than the perfect competition situation. The best possible scenario occurs when firms have constant marginal costs and unlimited capacities; in this situation there would be only one transparent firm that does not adopt obfuscation strategies.

> "Crucially, optimal pricing depends upon the transparent firm's incentive to attract naïve consumers after they have been fooled by low observable prices and consider switching. This means competition is most intense when the proportions of sophisticated and naïve consumers are relatively even" (Garrod, 2008, p.4)

Let there be a market in which there are n firms competing on prices in a one-stage game to sell a homogeneous good. Firms set a single price p_i^m, which is paid by consumers when they decide to purchase the good from firm $i = \{1, \ldots, n\}$. Firms decide whether to be transparent and set their prices as common knowledge or to adopt a non-transparent strategy. A non-transparent firm chooses to set a common knowledge observable price p_i and a hidden fee $\hat{p}_i$, such that $p_i^m = p_i + \hat{p}_I$; while a transparent firm set only the observable price p_i and not the hidden fee. More formally, firm i's price is:

$$p_i^m = p_i + I_{\hat{n}}(i)\, \hat{p}_i$$

where

$$I_{\hat{n}}(i) = \begin{cases} 0 & \text{if } i \notin N \\ 1 & \text{if } i \in N \end{cases}$$

where n̂ is the subset of firms that adopt a non-transparent strategy. All firms face a constant marginal cost c > 0, hence the profit function of firm i is $\pi_i = p_i + I_N(i)(\hat{p}_i - c)q_i$ where q_i is the quantity sold by firms i.

All consumers know the strategy adopted by each firm, whether it is transparent or non-transparent. The population of consumers is divided in a portion of consumers $\alpha \in [0, 1)$ that are sophisticated and, knowing which firm is transparent and which not, forms belief about firms' prices when choosing from which firm to purchase the product. However, the other portion (1- α) of consumers, does not use the information they have about firms' strategies to form prices' belief but they just visit the firm with the lowest observable price. A subset λ of naïve consumer become sophisticated if a firm suggest them to take into account also hidden fees. We assume that consumers' reservation value is always greater than firms' marginal cost: v > c. This implies that each trade will result in a surplus v* = v – c that will be divided between firms and consumers. The events in the game occur as follow:

Stage 1:

- Firms decide whether to adopt a transparent or non-transparent strategy. We define $\mu_i \in \{T, N\}$ the binary decision of firm i to adopt a transparent strategy T or non-transparent strategy N.
- Firms decide whether to warn or not warn consumers about the hidden fees. We define this binary decision as $\omega_i \in$ {warn, not warn}.

Stage 2:

- Firms set their prices p_i and, if they decide to adopt a non-transparent strategy, the hidden fee $\hat{p}_i$, simultaneously. The aim of firms is to maximize their profit given the vector M $=\{\mu_1, \ldots, \mu_n\}$ and W = $\{\omega_1, \ldots, \omega_n\}$ at no costs.
- Consumers get to know firms' observable prices $P^0 = \{p_1, \ldots, p_n\}$, but they do not know for sure some market prices $P^m = \{p_1^m, \ldots, p_n^m\}$. Only sophisticated consumer (α) are able to form beliefs about market prices $\tilde{p}^m$. On the contrary, naïve consumers (1 – α) are not able to form such beliefs and do not consider hidden fees, hence they select a firm basing on its observable price P^0.
- If there exists at least one firm that decides to warn consumers about hidden fees ω_i = {warn}, a fraction $\lambda \in (0, 1)$ of naïve consumers become sophisticated.
- Consumers select a firm (that we will denote as x) and observe the price p_x^m. If naïve consumers observe a positive hidden fee $\hat{p}_x > 0$, they form correct beliefs about market

prices $\tilde{p}^m$. At this point consumers can choose whether to purchase the product from firm x or switch to a transparent firm, if it exists, at effort e > 0.

At the beginning, there is a fraction of naïve consumers but, if they are misled, they all become sophisticated. Moreover, a portion λ becomes sophisticated before being misled if there is at least one firm that warn them about hidden fees. Therefore, the higher α and λ and the lower e, the lower the distance from a fully rational world.

During stage 1, firms have the possibility to warn consumers of their competitors' obfuscation strategies by advertising the fact that consumers should consider firms' capacity to add hidden fees on the observable prices'. We assume that the proportion of naïve consumers that is warned and becomes sophisticated is fixed and lower than the unity, so that we can consider the case in which some consumers may not see the advertisement or may not have the cognitive capacities to form correct expectations about hidden fees. This implies that when a firm decides to warn consumers about hidden fees, the proportion of sophisticated consumers within the market increases. We define α' as the number of sophisticated and warned naïve consumers within the market which is $\alpha' = \alpha + \lambda (1 - \alpha)$ if at least one firm sets $\omega_i = \{\text{warn}\}$, and $\alpha' = \alpha$ is all firms set $\omega_i = \{\text{not warn}\}$.

During stage 2, consumers enter the market, observe prices and search for hidden fees. The effort cost e consumers have to face, can be seen as the cost of switching to a transparent firm. We assume that, to observe the first hidden fee, consumers have not costs, while, they face a cost for every firm they want to switch to or search after that.

Sophisticated consumers are able to understand adequately the market because they do not have cognitive limitation that would prevent them to form correct beliefs about firms' hidden fees. This means that for them $E(\hat{p}_i) = \hat{p}_i$ and $\tilde{p}^m = P^m$. Sophisticated consumers understand that firms are incentivized to charge low observable prices to attract naïve consumers but set high hidden fees because consumer face an effort cost if they want to switch to other firms. Given that, sophisticates choose the firm with the lowest transparent price (i.e., min $\{P^m\}$) because they believe that it is the lowest market price. Suppose that there are m > 1 firms with min $\{P^m\}$, sophisticated consumers choose randomly among these m firms. Instead, if there are no transparent firms, they optimally choose a random firm and keep searching in the market as long as $P_x^m > E(P_i^m) + e \; \forall \; i$ (the price of the non-transparent firm they visited first has to be bigger than the expected price of the next firm plus the switching effort cost).

On the contrary, naïve consumers are limited in their ability to understand the market and recognize firms' pricing strategies. This implies that firms advertise low observable prices because some consumers do not have the cognitive ability to form correct beliefs about hidden

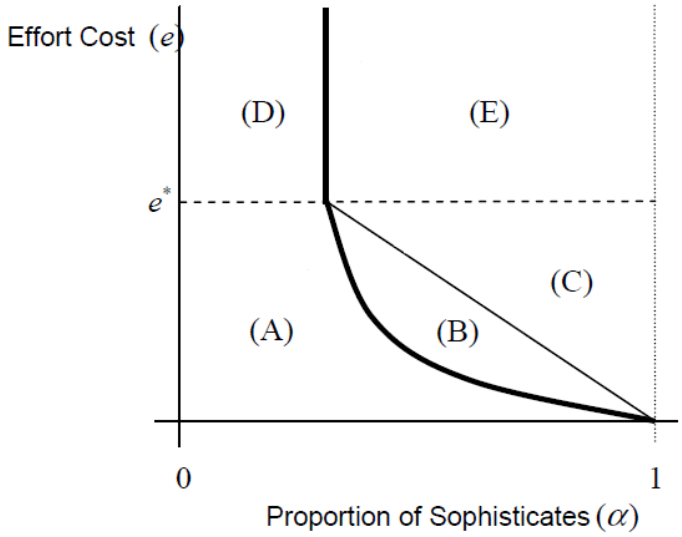
fees. Anyway, if non-transparent firms fool naïve consumers charging positive hidden fees, they instantly become sophisticated and form correct beliefs $E(\hat{p}_i) = \hat{p}_i$ and $\tilde{p}^m = P^m$. This can be seen as a learning effect of consumers. In fact, naïve consumers may change their expectations to correctly believe that non-transparent firms are more expensive. Clearly, it is still possible that consumers remain naïve after they experience at least one firm in the market. However, we assume that all consumers become sophisticated because thanks to this assumption we can assert that firms have the smallest incentive to set non-transparent prices, and it is a simplification of the model.

For naïve consumers, the act of searching is more complicated with respect to sophisticated ones, because there is the possibility that they visit a firm with a low observable price and then wish to switch to a transparent firm if they understand they made a mistake. Therefore, naïve consumers, making a mistake, choose the firm that charges the lowest observable price (min $\{P^0\}$). Suppose there are m >1 firms with min $\{P^0\}$, we assume that naïve consumers randomly choose among these m firms. If $\hat{p}_i = 0$, they observe no hidden fees and they do not become sophisticated so they buy the good believing that it is the cheapest in the market. On the contrary, if $\hat{p}_i > 0$, they observe positive hidden fees and become sophisticated. They understand that non-transparent firms charge higher market prices and they want to switch to the transparent firm that charges the lowest price as long as min $\{\tilde{p}^m\} + e < P_x^m$ (the expected price of switching to a transparent firm plus the effort cost of doing so is smaller than the price they pay at the current firm).

The main result of this model is that it is always profitable for some firm to adopt obfuscation strategies for any portion of sophisticated consumers $\alpha \in [0, 1)$ and as long as prices are greater than marginal cost. The difference in consumers' cognitive abilities provides different incentive to firms. The presence of naïve consumers leads firms to adopt non-transparent strategies by setting low observable prices and high hidden fees in order to exploit consumes' effort costs. On the contrary, sophisticated consumers lead firms to adopt transparent prices and undercut non-transparent firms in order to attract all consumers of this type.

Now we will see in greater detail the results of the model. In order to do so, we introduce Figure 3.1 that shows the equilibrium conditions for a finite number of firms for all levels of effort e and sophisticated α.

Figure 3.1: equilibrium conditions for a finite number of firms



Source: (Garrod, 2008)

When there is a large proportion of naïve consumers (area A and D in Figure 3.1), all firms in the market adopt a non-transparent strategy by setting the observable price equal to zero and hidden fees equal to the monopolist price. On the other hand, when the proportion of sophisticated consumers is sufficient large (area B, C and E), only one firm has the incentive to adopt a transparent strategy to attract sophisticates with lower market prices. The transparent firm does not attract naïve consumers because its observable price is higher than the observable price of non-transparent firms. In equilibrium, only one firm sets a transparent price strategy because competition for sophisticated consumers brings zero profit with respect to a positive profit that firms can obtain by supplying naïve consumers with non-transparent prices otherwise.

In area C and E, the transparent firm has not an incentive to lower its price to attract naïve consumers after they observe positive hidden fees and want to make a switch; the firm benefits more from supplying only sophisticated consumer at a higher price. This implies that, in this situation, transparent and non-transparent firms are not in competition directly. Therefore, non-transparent firms keep charging monopoly hidden fees while the transparent firm set a price that is marginally lower than the monopolist price.

In area B, the effort cost for consumers is low, there is a sufficient proportion of sophisticated consumers for a firm to find it profitable to be transparent, and a sufficient proportion of naïve consumers for a transparent firm to find it profitable to lower its price to attract them. This means that transparent and non-transparent firms compete directly for naïve

consumers. In this situation, firms face mixed incentives. Non-transparent firms want both to attract naïve consumers and prevent them to switch to a transparent firm, and exploit their effort costs by charging high hidden fees. The transparent firm, instead, wants to supply sophisticated consumers by marginally undercutting non-transparent firms' lowest expected price and, at the same time, it has an incentive to attract naïve consumers by lowering its price until the lower bound price, below which it would be profitable to serve only sophisticated consumers at a higher price.

We already saw how firms use obfuscation strategies to complicate consumers' choices despite fierce price competition. In this model, it has been analysed whether profit maximizing firms have an incentive to use non-transparent prices strategies when there are naïve consumers in the market. The attraction of naïve consumers by using non-transparent prices limits price competition and let firms set prices above marginal costs and earn positive profits.

3.3 Obfuscation in an asymmetric setting

Differently from the previous sections, now we will consider a market in which, in addition to differences among consumers, there are asymmetries among firms. Let there be a market where there are two firms that produce a homogeneous good and supply it to a mass of consumers each demanding at most one unit of the product if the price does not exceed his reservation value. Firms in this market differ with respect to their level of *prominence*. With the term "level of prominence" we mean the level of dominance of the market defined by the market power of each firm. Consumers, as in the model analysed in the previous section, are heterogeneous in the sense that they can be distinguished in sophisticated and naïve consumers. Sophisticated consumers are perfectly able to identify the firms' best offer and purchase the product at the lowest price. On the other hand, naïve consumers cannot evaluate and compare firms' offers, hence they purchase from one firm at random (Gu and Wenzel, 2014).

However, it is supposed that naive consumers will buy the product from the more prominent firm with a higher probability. This means that the prominent firm has the advantage of attracting a larger share of naïve consumes who find it harder to compare firms' offers. The shares of the two type of consumers are affected by firms' obfuscation level and consumer protection policy. In fact, more complex prices and lower levels of consumer protection result in a higher proportion of naïve consumers relative to sophisticated ones. Intuitively, the more stringent a protection policy is, the fewer consumers are fooled by firms' obfuscation.

Firms in this model decide their obfuscation level of information. Here, we define obfuscation as a strategy that comprehend all actions that prevent a part of consumers (the naïve ones) from recognizing the best offer. Given this setting, firms have two decisions to make in two different stages. In the first stage, firms decide simultaneously their level of obfuscation. The more a firm obfuscates, the higher is the share of naïve consumers in the market, and consequently the lower is the share of sophisticated. In the second stage, firms compete in prices knowing the proportion of sophisticated and naïve consumers present in the market.

The more prominent firm will always choose the maximum level of obfuscation because it has larger incentive to obfuscate for two reasons. First, by obfuscating more, the presence of naïve consumers' increases, and this is good for the prominent firm because naïve consumers purchase with a higher probability from that firm. So, by obfuscating more, the prominent firm secure itself a large share of consumers. Second, obfuscation limits competition and consequently prices and profit are higher. Both these effects benefit the prominent firm which, therefore, has an incentive to adopt obfuscation strategies. On the other hand, the less prominent firm has a lower incentive to engage in obfuscation because the two effects may have different directions. In fact, on the negative side, if the less prominent firm decides to engage in obfuscation, it loses consumers because the naïve consumers purchase with higher probability from the prominent firm. This negative side is predominant if the asymmetry in prominence among firms is large. However, on the positive side, by engaging in obfuscation, the less prominent firm can benefit from the weaker competition given by the fact that the number of naïve consumers is large. Therefore, when the less prominent firm decides its level of obfuscation, it has to balance these two effects. Clearly, it will have more incentive to obfuscate if the asymmetry in prominence is small and the first effect (the negative one) is also small.

Consumer protection policies can be of two types: policies on the consumer side and policies on the firm side. For example, a policy on the consumer side could be an educational program aimed to increase consumers' cognition of the market. In this way, consumers are less confused by complex price structures. For what concern the firm side policies, an example could be a policy that forces firms to reveal all possible fees or set an obfuscation upper limit. Clearly, the more stringent a policy is, the less consumers will be susceptible to firms' obfuscation. In the extreme case in which a policy is completely effective, firms' obfuscation becomes irrelevant, there would be only sophisticated consumers and the market outcome would become the standard Bertrand competition one. Gu and Wenzel (2014) argue that such policies might not be as effective as we expect or, in some situations, they could not be effective at all.

The policies' intended effects of limiting obfuscation is accomplished with regard to the prominent firm. However, for what concern the less prominent firm, the introduction of such policies has an unintended effect. In fact, the less prominent firm tend to increase its level of obfuscation when a policy is introduced. This happens because, since the prominent firm has reduced its level of obfuscation, competition in the market has become fiercer with respect to what preferred by the less prominent firm. As a consequence, the less prominent firm will increase its level of obfuscation when policies are introduced. In asymmetric contests caused by firm heterogeneity, differently from symmetric ones, policies intended to limit obfuscation effects may be ineffective. In fact, the proportion of naïve consumers may not decrease after the introduction of a consumer protection policy. This happens because the effect of the introduction of the protection policy is offsets by the increase in the obfuscation level of firm 2. Therefore, introducing a consumer protection policy in an asymmetric market might not increase the proportion of sophisticated consumers. The intuition under this concept is that, for any given obfuscation level the introduction of a consumer protection policy (or a stricter policy) decreases the share of naïve consumers. However, if this share goes below the level desired by firm 2 (competition is increased too much), it decides to increase its obfuscation level. On the contrary, firm 1 does not change its level of obfuscation after the introduction of a policy because it was already the maximal one.

For any relevant level of consumer protection policy, the more a firm raises its level of obfuscation, the more naïve consumers are present in the market since comparing prices becomes harder. Given that, to compare prices, consumers need to understand both offers, if both firms raise their level of obfuscation, the share of naïve consumers increases strictly. This conclusion holds for both consumers' side and firms side policies.

When consumers are not able to compare prices, they try to resort to factors such as past experiences, firm reputation, etc. Intuitively, firms differ along these characteristics. We refer to the asymmetry in the prominence level between firms to reflect this observation. In fact, we assume that firm 1 is more prominent than firm 2, and hence it attracts a larger share of naïve consumers. We further assume that marginal cost of production for both firms are constant and normalized to zero. Moreover, obfuscation is assumed to be costless so that we can focus on the strategic effects between firms.

At the beginning of the game, both firms know the level of consumer protection policy. The game is a two stage game. In the first stage firms simultaneously and independently choose their obfuscation level. In stage 2, after they get to know their competitor's obfuscation level, and consequently their share of naïve consumers, they compete in prices.

On average, firm 2 charges a lower price with respect to firm 1. This happens because firm 1 has a higher opportunity cost of competing for sophisticated consumers relative to firm 2. In fact, firm 1 loses more revenue from each unit of price reduction due to its higher share of naïve consumers. This implies that sophisticated consumers prefer to purchase the product from firm 2. Given that sophisticated consumers prefer to buy from firm 2 because it offers a lower price, firm 2 benefits from the presence of sophisticated consumers in the market. An increase in the proportion of naïve consumers leads to weaker competition because there are fewer sophisticated consumers to compete for. Furthermore, this results in higher prices charged by both firms.

Firms' profits are affected by an increase in naïve consumers in three ways. First, as we said, the presence of more naïve consumers in the market leads to lower competition and hence to higher prices and profits. Second, the demand for sophisticated consumers' decreases. Third, the demand for naïve consumers increases. Note that the first and third effects are positive, while the second is negative. The prominent firm faces a strictly positive overall effect because it has never had incentives in competing for sophisticated consumers. In fact, for firm 1, the positive effects always compensate for the negative effects due to the larger share of naïve consumers. On the other hand, for the less prominent firm, the overall effect is not clear. The less prominent firm, when choosing whether to increase its level of obfuscation, has to balance the increase in the demand for naïve consumers and the softened price competition with the decreased demand for sophisticated consumers. This means that firms differ in their incentives to adopt obfuscation strategies.

The more prominent firm (firm 1) has an incentive to set the highest level of obfuscation possible because its expected profit increases as the share of naïve consumers increases, and this is made possible by increasing obfuscation. If there is an increase of asymmetry between the prominence level of firms, obfuscation and consequently the proportion of naïve consumers are reduced. In fact, when the market is more symmetric, firm 2 attract less naïve consumers. This implies that firm 2 prefers the presence of a lower share of naïve consumers in the market so that it can benefit more from the presence of sophisticated consumers. This results in less obfuscation from firm 2 when the market is more asymmetric.

Conclusion

Contrary to the standard economic theory, real world consumers often adopt heuristics when they make choices. Heuristics are defined as not optimal but practical and easy methods to reach a choice. The heuristic that we consider in this work is the categorization of prices. This is mainly due to consumers' cognitive limitations in achieving optimal results. In fact, consumers might face too many information or too complex tasks. For these reasons, we enter in the field of bounded rationality of consumers. Memory and cognitive limitations influence consumers' choices, because they could have difficulties in gathering, processing and storing information in memory. Moreover, when comparing products, consumers might not be able to evaluate attributes because they are limited in recall beliefs from their memory. Cognitive limitations influence mainly the choice of the alternative because consumers may not fully understand prices and qualities, or they may not be able to make comparisons among firms' products.

In this work, we showed that, when memory is involved in consumer's decisions, some specific inputs needs to be retrieved at the choice time. The input recall requires a lot of effort and usually consumers do not retrieve the exact input, so the choice process becomes harder to manage. Moreover, it has been explained how differences in memory abilities among consumers benefit firms in terms of profits if they understand how to take advantage of this situation. When there are consumers with memory limitations, firms may be able to price discriminate by using complex price policies. In order to do that, a firm may alternate between regular and sales prices in a manner such that only more competent agents can recognize the pattern, hence purchase the good only when it is on sale. On the contrary, consumers with low-cognitive abilities, are not able to understand this pattern of prices, hence they are forced to purchase randomly, paying a time-average price. By doing that, the firm reaches a higher level of profit.

By reviewing some theoretical models, it has been shown that, when there is heterogeneity among consumers (in terms of cognitive abilities), firms are able to take advantage of consumers' bounded rationality to earn higher profits by simply adopt a complex price scheme. This happens because cognitive limited consumers are not able to understand the real price scheme and have to resort on heuristics. The difference between the monopolistic and oligopolistic case is that, when the market is formed by more than one firm, they can still benefit from consumers' bounded rationality using complex price policies still but they will never jointly reach the monopolist's profit. This happens because competition prevents firms to take

complete advantage of consumers' bounded rationality and make joint profit equal to the monopolist's case.

Another important result is that, also firms who did not adopt a complex price policy benefit from the opaque situation created by firms that use a complex price scheme. This happens because consumers are not able to distinguish between firms who adopt a complex price policy and those who adopt a simple price policy.

We also noted that, when consumers do not have perfect memory, it is not possible for them to perfectly recall information about prices. So, in order to face this constraint given by memory imperfections, consumers try to group prices into categories according to their perceived similarities. Through these categories, consumers can make imperfect but practical approximation of reality. It has been found that, when price categorization due to memory limitations is present, usually there is also price dispersion.

The model analysed shows that consumers' bounded rationality moves firms' equilibrium outcome away from the Bertrand competitive outcome and let firms earn positive profits. Given that consumers can recall only categories, firms are incentivized to charge prices at the top of the category but, competition, leads firms to price only in the lowest category. Moreover, as the number of categories increases (consumers put more effort in memory resources), firms' prices and profit decrease. This means that, improvements in consumers' memory capacities leads to an improvement in the equilibrium prices that are always closer to the marginal costs faced by the firms.

It is important to note that categorization becomes more precise as long as we get closer to the lower end of price range. Intuitively, consumers put more effort in encoding lower prices than higher prices and this results in firms charging lower prices.

We also need to distinguish two types of categorization: symmetric and asymmetric. In the first case, consumers classify prices of both firms into categories and, when comparing prices, they can recall just the categories so they compare the labels of categories. For what concern the asymmetric case, consumers compare the recall category of the price of one firm to the exact value of the price of the other firm. Results are the same for both categorization types but, in the asymmetric case, profit are lower with respect to the symmetric one. In fact, in the asymmetric categorization model, consumers have more information about prices. Asymmetric categorization leads to a fiercer competition between firms, hence, to a reduction of their profits.

Furthermore, an increase in consumers' memory could lead to an increase of prices if there are also loyal consumers in the market. In fact, as n becomes bigger, consumers have more

memory and this leads them to be more sensitive to price differences between firms. When there are also loyal consumers, consumers who buy from one firm independently of the price, as the number of categories increases, consumers make less mistakes and purchase the product from the firm the actually charges the lowest price and this reduces firms' profits from the limited memory consumers group. To face this problem, firms end up charging higher prices, on average, so that they are able to extract a larger part of surplus from the loyal consumers. This means that, the more there are memory improvements of limited memory consumers, the more the average market price charged by firms is higher; and it is the highest when informed consumers have perfect recall. It is interesting how, even if consumers' cognition capacities increase, there is also an increase in prices. This is clearly due to the existence in the market of uninformed/loyal consumers that purchase whichever price the firm they are loyal to charges.

We need to emphasize that, in any case, the expected price paid by limited memory consumers decreases as n increases because firms' profit does not vary depending on n, but uniformed/loyal consumers, on average, end up paying higher prices as n increases because firms need to compensate the loss from limited memory consumers. This happens because, limited memory consumers pay the minimum price charged by the firms while, the loyal ones, pay the expected price charged by firms which it is greater as n gets bigger. This conclusion is different from the symmetric categorization model in which, both limited memory consumers and uninformed/loyal consumers pay the same price that decreases as n increases. In the symmetric categorization, the improvement of memory generates a positive externality to uninformed/loyal consumers; while in the asymmetric categorization generates negative externality.

Firms try to take advantage from consumers' cognitive limitations by using obfuscation, a practice that consists in making prices more complex and less transparent so that it is more difficult for consumers to make price comparisons. It is intuitive how consumers face search costs when they have to choose among different products that for example could be the cost of visiting various stores, or the cost of the time spent doing shopping. We showed that obfuscation, seen as an action that raises the amount of time consumers need to learn firm's price, results to be always profitable for firms. This occurs for two reasons: first, because obfuscation raises the cost consumers have to face if they decide to search further; and second, because an increase in obfuscation would make consumers think that their expected search cost for future search is too high. This allows firms to soften competition, charge higher prices and consequently earn higher profits. As one may think, obfuscation damages consumers. This is because with obfuscation consumers have to face higher search costs that they would not have

otherwise, and because they incur in higher prices. Furthermore, all firms benefit from obfuscation, also those who adopted transparent policies and did not use obfuscation strategies. This is because, if there is a high level of obfuscation in the market, consumers tend to search less and make less comparisons, hence also transparent firms benefit from it. We saw that, also when there is heterogeneity in firms' level of market dominance, firms are incentivized to adopt obfuscation strategies and consumer protection policies might be ineffective.

Firms can understand part of consumers behaviour through market surveys and try to use this information to adopt some of the strategies mentioned in this paper. For example, firms could deduce how consumers construct price categories and set prices following the category scheme. It is clear that, differently from the models, in reality it is more difficult to understand consumers' memory and thinking, so it would be impossible to fully understand consumers' categorization.

This is why, most firms prefer to use obfuscation strategies to exploit consumers' bounded rationality. In fact, we can find obfuscation strategies in many real-world phenomena. Obfuscation, seen as a technique that raises consumers' search costs, can be done by increasing the time consumers need to know the final price of a product.

This can be done, for example in face to face retail shopping, by trained salespeople to quote consumers the final price only after a certain period of time. Alternatively, firms can increase search costs by choosing the level transparency with which convey information about prices. This might be the situation of the bank field in which a firm may choose the complexity of its fee structure such that consumers spend time reading the full list of fees applicable. The time consumers spend learning a firm's price can also be interpreted as the time needed to learn a product's quality and hence a quality-adjusted price. A common example of firms' adoption of non-transparent price policies is given by low-cost airlines companies. In fact, airline companies usually advertise a low price of the flight but, when consumers want to complete the purchase, they discover extra fees for difference services. Moreover, internet retailers usually divide their products' price into the effective price of the good and the shipping fees.

We just saw that there are many real-world examples of obfuscation strategies; this means that firms are aware of consumers' limitations and know how to take advantage of them.

Despite the real world phenomena, we just described, I think that some of the models analysed in this work are difficult to apply to reality. For example, in a real world situation, I find it difficult that, as stated by Rubinstein (1993), a firm may have different costs for different consumers. Moreover, the cut-off points and the number of categories a consumer can choose, are hard to be understand for firms. It is not easy for firms to predict consumers' reservation

values and categorization structures. Despite these unrealistic features of some models, I also think that firms engage in obfuscation because they find it profitable and they adopt the techniques showed by Ellison and Wolitzky (2012), Garrod (2008) and Gu and Wenzel (2014).

I think that the studies done until now are noteworthy but they are still too theoretical. I think there is need of more empirical studies that confirm these theories. Anyway, firms could learn a lot on how, being less transparent can benefit them.

Bibliography

Alba J. W., Hutchinson J. W. and Lynch Jr. J. G., (1991), "Memory and decision making", in Handbook of consumer behaviour, Eds. Robertson T. S. and Kassarjian H. H., Prentice Hall, Englewood Cliffs, New Jersey, pp. 1-49

Atkinson R. C. and Shiffrin R. M. (1968), "Human memory: a proposed system and its control processes", in The Psychology of Learning and Motivation: Advances in Research and Theory, Vol 2, pp. 89-195

Baris O. F. and Kutlu L., (2017), "Price dispersion and optimal price categories with limited memory consumers", in Managerial and Decision Economics, Vol 39, Issue 1, pp. 97-106

Bettman J. R. (1979), "memory factors in consumer choice: a review", Journal of Marketing, Vol 43, pp. 37-53

Bettman J. R., Luce M. F. and Payne J. W., (1998), "Constructive consumer choice processes", in Journal of Consumer Research, Vol 25, Issue 3, pp. 187–217

Biehal G. and Chakravarti D, (1986), "Consumer's use of memory and external information in choice: macro and micro perspective" in Journal of Consumer Research, Vol 12, No. 4, pp. 382-405

Chen Y., Iyer G. and Pazgal A., (2010), "Limited memory, categorization, and competition" in Marketing Science, Vol 29, No. 4, pp. 650-670

Ellison G. and Wolitzky A., (2012), "A search cost model of obfuscation" in The RAND Journal of Economics, Vol 43, Issue 3, pp. 417-441

Ellison G., (2006), "Bounded rationality in industrial organization", in Advances in Economics and Econometrics: Theory and Applications. Blundell, Newey and Persson, Cambridge University Press, Ninth World Congress.

Gaffeo E., Mittone L. and Tamborini R., (2011), "Introduzione all'economia", Zanichelli editore S.p.A., Bologna

Garrod L., (2008), "Price transparency and consumer naivety in a competitive market" in CCP working Paper 07-10, ESRC Centre for Competition Policy, University of East Anglia, Norwich, United Kingdom

Grubb M. D., (2015), "Failing to choose the best price: theory, evidence, and policy" in Review of Industrial Organization, Vol 47, Issue 3, pp. 303-340

Gu Y. and Wenzel T., (2014), "Strategic obfuscation and consumer protection policy" in The Journal of Industrial Economics, Vol 62, Issue 4

Hopkins E., (2006), “Price Dispersion”, New Palgrave Dictionary of Economics, 2nd Edition, Palgrave Macmillan

Lynch Jr J. G. and Srull T. K., (1982), “Memory and attentional factors in consumer choice: concepts and research methods” in Journal of consumer research, Vol 9, pp. 18-37

McGuire W. J., (1976), “Some internal psychological factors influencing consumer choice”, in Journal of Consumer Research, Vol 2, pp. 302–319

Mojtahed V., (2012), “On price recognition and competition with boundedly rational consumers”, in “three essays in microeconomics” PhD Thesis, pp. 26-47

Monroe K. B. and Lee A. Y., (1999), “Remembering versus knowing: issues in buyers’ processing of price information”, in Academy of Marketing Science Journal, Vol 27, No. 2, pp. 207-225

Nedungadi P., Chattopadhyay A. and Muthukrishnan A. V., (2001), in International Journal of Research in Marketing, Vol 18, Issue 3, pp. 191-202

Piccione M. and Rubinstein A., (2003), “Modelling the economic interaction of agents with diverse abilities to recognize equilibrium patterns”, in Journal of the European Economic Association, Vol 1, Issue 1, pp. 212-223

Rubinstein A., (1993), “On price recognition and computational complexity in a monopolistic model”, in Journal of Political Economics, Vol 101, No. 3, pp. 473-484

Shapiro S. and Krishnan H. S. (1999), “Consumer memory for intentions: a prospective memory perspective”, Journal of Experimental Psychology, Vol 5, No. 2, pp. 169-189

Solomon M., Bamossy G., Askegaard S. and Hogg M. K., (2006), “Consumer behaviour, a European Perspective”, Prentice Hall, London

Spiegler R., (2006), “Competition over agents with boundedly rational expectations” in Theoretical Economics, The Econometric Society, New York, Vol 1, Issue 2, pp.207-231

Spiegler R., (2016), “Choice Complexity and market competition” in Annual Review of Economics, Vol 8, pp. 1-2

Tulving E., (1972), “Episodic and semantic memory” in Organization of Memory, Oxford, England: Academic Press, pp. 381-403

Weber E. U., Goldstein W. M. and Barlas S., (1995), “And let us not forget memory: the role of memory processes and techniques in the study of judgment and choice” in Psychology of Learning and Motivation, Vol 32, pp. 33-81

Appendix

Proposition 2.2:

"The consumers reject the offer in the first case if

$$\pi^L[(1-\alpha_i)(v^L - y_1) + (v^L - x_2) + \alpha_i(v^L - x_1)] < 0$$

and therefore

$$\alpha_1 > \frac{2\varepsilon^L + (v^L - v^H)}{(v^L - v^H) - 2\varepsilon^L}$$

In the second case consumers reject the offer if

$$\pi^L(1-\alpha_i)(v^L - y_1) + \pi^H(v^H - z) < 0$$

and therefore

$$\alpha_1 > \frac{\pi^L(v^L - v^H) + \pi^H\varepsilon^H}{\pi^L(v^L - v^H)}$$

A firm should choose α_1 in such a way that later is better for consumers." (Mojtahed, 2012, p. 47)

Proof of Proposition 2.3:

"Each firm can potentially use exactly n + 1 prices conditional on the choice of the partitions by the consumers. Firm 1 will have demand only if its price is the same or lower than firm 2's price. Clearly, both firms charging at the top of the lowest partition (p1=p2=k1) is an equilibrium. A firm that raises prices will lose all consumers, whereas lowering the price will only bring lower revenues from half of the market. The payoff matrix for firm 1 is given by (the payoff for firm 2 can be specified in an analogous way):

$$\Pi_1(p_1 = k_r, p_2 = k_t) = \begin{cases} 0 & \text{if } r > t \\ \frac{k_r}{2} & \text{if } r = t \\ k_r & \text{if } r < t \end{cases}$$

Consumers will optimally choose their cutoffs so that the unique equilibrium will be at lowest partition and that the lowest cut-off will be at the lowest possible value. We start by considering the highest possible prices. For $p_1 = k_{n+1} = 1$, $p_2 = k_{n+1} = 1$ not to be an equilibrium, the cutoffs must satisfy $k_{n+1}/2 < k_n$; similarly, for $p_1 = k_n$, $p_2 = k_n$ not to be an equilibrium, we need $k_n/2 < k_{n-1}$ Similarly, we need $k_{r+1}/2 < k_r$ for r = 1, …, n. Iterated substitution leads to the following condition on k_r (r =1, …, n):

$k_r > \frac{1}{2}^{n+1+r}$

Clearly, the best choices for consumers are $k_r^* = \frac{1}{2}^{n+1+r} + \varepsilon$ for any infinitesimal $\varepsilon > 0$. Both firms price at the top of the lowest partition and split the market generating profits of $\Pi_j^* = \frac{1}{2}(\frac{1}{2})^n + \frac{\varepsilon}{2}$. Furthermore, given the choice of all consumers, no single consumer can benefit from unilaterally changing her cut-off points." (Chen et al., 2010, pp. 664-665)