ΟΙΚΟΝΟΜΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ

ΣΧΟΛΗ ΟΙΚΟΝΟΜΙΚΩΝ ΕΠΙΣΤΗΜΩΝ

ΤΜΗΜΑ ΟΙΚΟΝΟΜΙΚΗΣ ΕΠΙΣΤΗΜΗΣ

PRICE DISPERSION AND COMPETITION

ΛΑΜΠΡΟΥ ΑΘΑΝΑΣΙΟΣ

Διατριβή υποβληθείσα προς μερική εκπλήρωση
των απαραιτήτων προϋποθέσεων
για την απόκτηση του
Μεταπτυχιακού Διπλώματος Ειδίκευσης

Αθήνα
[Ιανουάριος 2016]

Εγκρίνουμε τη διατριβή του ΛΑΜΠΡΟΥ ΑΘΑΝΑΣΙΟΥ

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[29/01/2016]

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Abstract

The law of one price is almost always empirically rejected and researchers observe price dispersion mostly due to price discrimination. We discuss the different degrees of price discrimination and different models in a monopoly or oligopoly setting. We find that price discrimination increases prices but it is not always harmful towards social welfare compared to uniform pricing. Price dispersion is ubiquitous in online and traditional markets and we investigate the sources behind it. Two leading sources of price dispersion are consumer heterogeneity and consumer search costs and we also find a positive correlation between them and price dispersion. Price dispersion can also arise from consumer confusion over price comparison and inertia. We believe that the most important source of price dispersion is market competition and we conclude by discussing how market concentration/market competition affects price dispersion. We discuss the two opposing theories in the rather limited literature and the rich empirical evidence which does not yield a straightforward relationship. We believe that the relationship between market structure and price dispersion is matter of empirical analysis.

1. INTRODUCTION

The law of one price dictates that the price of homogeneous goods sold at different locations will be the same and is primarily based on arbitrage opportunities. Another economic model that predicts price uniformity is the Bertrand model where a two firm competition under certain assumptions can lead prices to marginal cost. This economic paradox can be solved by relaxing some of the assumptions. Empirical evidence like Asplund and Friberg (2001) & Graddy (1995) find price dispersion in their markets of study and reject LOP due to exchange currency fluctuations and price discrimination respectively.

When market power exists and resale can be prevented, firms are able to price discriminate and charge different prices for the same good to the same consumer or different consumers in order to increase their profits by capturing some or their entire surplus. Following Tirole (1988) we distinguish three degrees of price discrimination. In the first degree (or perfect price discrimination) firms know the consumer's reservation price/preferences and charge their willingness to pay. It can be achieved by a two part tariff as shown by Tirole (1988) but it is an extremely uncommon practice and mostly used as a reference point for welfare studies. Second degree price discrimination occurs when firms have incomplete information about consumers and use various schemes to let consumers "self-select" (e.g. first-class, business and economy tickets). Such schemes include coupons, versioning, quantity discounts and bundling of products. Charging a different group of consumers with observable characteristics a different price is third degree price discrimination which is the most common type (e.g. senior citizen discounts).

We discuss various models of price discrimination (Stole 2007; Tirole 1988; Varian 1992) in a monopoly & oligopoly setting and compare the impact of price discrimination to that of uniform pricing on welfare. Unlike initial intuition, price discrimination is not always harmful and does not in every case reduce social surplus. Cabral (2000) argues that in some cases price discrimination can be a Pareto improvement. Varian (1992) shows that in third degree price discrimination firms use the inverse elasticity rule where a higher price is charged to the least price sensitive group/market. Optimal pricing and the variance of prices depend on market elasticity

and/ or cross-price elasticities. This translates to consumer preferences and consumer heterogeneities which impact price dispersion. Price dispersion occurs when different prices for the same good exist in a given market and is a similar term to price discrimination. Price dispersion is ubiquitous in markets and in order to understand it economic researchers have investigated and identified a number of potential sources.

The first aim of our dissertation is to distinguish the sources behind price dispersion and analyze their positive or negative effect. Our dissertation is predominantly based on Zhao (2006) where she recognizes the three most important sources: consumer heterogeneity, consumer search costs & market competition and empirically analyzes those using data in the U.S grocery market. Firms are able to price discriminate due to consumer heterogeneity (preferences, price elasticities) as theory predicts. Theoretical models and empirical studies show that price dispersion exists due to consumer differences in the level of information (Salop and Stiglitz 1977; Varian 1980), differences in willingness to pay (Diamond 1987; Shepard 1991) and that price dispersion increases as the coefficients of variation in consumer demographics increase (Zhao 2006)

In order to acquire information, consumers have to search which is costly (time, money, lost opportunities etc.). Stigler (1961) in his seminal article on the economics of information was the first to introduce the term consumer search and initiated a study on the subject. He finds that price dispersion is primarily caused by consumers' lack of information due to search costs. Dahlby and West (1986) arrive at the same conclusion for the automobile insurance market in Alberta. Interestingly though Diamond (1971) in his model shows that the introduction of even a small positive search cost drives prices to uniformity (monopoly price) and not price dispersion. By relaxing some of the assumption of Diamond (1971) and assuming different consumer search costs (Braverman 1980; Rob 1985; Salop and Stiglitz 1982; Stahl 1989), firm heterogeneity in production costs (Reinganum 1979),a mixture of those two(Carlson and McAfee 1983) and non-sequential search (Braverman 1980; Burdett and Judd 1983) models are able to generate equilibrium price dispersion. Empirical evidence suggest than an increase in search costs leads to higher price dispersion (Marvel 1976 ; Zhao 2006 ;Chandra and Tappata 2011) however Pennerstorfer et al. (2015) generate an inverse U-relationship between information and price dispersion in the Austrian retail gasoline market. In a leading study on the subject, Sorensen (2000) finds that more frequently purchased drug prescriptions have less price dispersion because expected consumer

benefits of search are greater than one time purchases. The internet has the potential to reduce search costs and make markets more "friction-free", Ghose and Yao (2011) empirically confirm that by finding lower price dispersion online than in a conventional market and Brown and Goolsbee (2002) even show that internet usage lowers price in offline markets as well. However other studies (Bailey 1998; Baye et al. 2004,2006a; Baye and Morgan 2004;Brynjolfsson and Smith 2000;Clemens et al. 2002; Ellison and Ellison 2009) find that price dispersion online is existent and significant, in some cases even higher than that of traditional markets.

Search costs deter consumers from searching thus not letting them to find the lowest price available and allow firms to set various prices for the same good. In addition to not searching enough Grubb recognizes another two potential sources of price dispersion: confusion over price comparison and inertia. Consumers sometimes are willing to pay a premium for imaginary quality differences (Bronnenberg forthcoming), fail to choose the best price because firms use obfuscating practices (Ellison and Ellison 2009) or complicated pricing schemes (Spiegler 2006) to confuse them. They also exhibit inertia by not switching away from past options or past options becoming their default ones, Handel (2013) provides a study on health plan choices for employees in a U.S. firm and proves consumer inertia.

In chapter 2 we discuss that price discrimination indicates some market power and research has shown that competition among firms affects price discrimination and price dispersion subsequently. We aim to shed light to the rather limited existing theory and empirical literature of market competition as a source of price dispersion. Traditional economic theory predicts that as the number of competitors in a market increases, seller's market power decreases and firms are less able to price discriminate thus lowering price dispersion. However theoretical models of Borenstein (1985), Holmes (1989) and Gale (1993) show that price discrimination may increase as the market becomes more competitive. Literature recognizes two opposing forces of market competition on price dispersion: the monopoly effect and brand effect. The airline industry is a prime example of a price dispersed market because airlines use advanced second degree price discrimination and this industry is the source of most empirical evidence (Borenstein 1989;Borenstein and Rose 1994;Clemons et al. 2002;Dai et al. 2014; Dana 1999; Gaggero and Piga 2011; Gerardi and Shapiro 2009; Hayes and Ross 1998; Du et al. 2014; Lijesen and van den Voort 2011; Stavins 2001) . In their seminal article Borenstein and Rose (1994) examine airline ticket prices of eleven major U.S.

airlines and find that price dispersion increased on routes with more competition which is consistent with models of monopolistic competitive price discrimination like Borenstein (1985) and Holmes (1989). It is considered a leading study on the subject and gave new impetus to economists to research the effects of market structure on price dispersion. Gerardi and Shapiro (2009) use the same tools to measure price dispersion and market concentration as Borenstein and Rose (1994) however they find a positive effect of market concentration on fare dispersion which supports traditional economic theory. Along with Gerardi and Shapiro, Gaggero and Piga(2011), Baye et al. (2004) and Barron et al. (2004) show that increased competition leads to lower price dispersion. Similarly to Borenstein and Rose (1994) the majority of empirical studies though leans towards a negative relationship between price dispersion and competition. Moreover some others do not find a straightforward answer and yield mixed results (Clerides and Michis 2006; Dai et al. 2014; Hayes and Ross 1998; Lewis 2008)

We conclude that since there is no predominant model dictating the relationship between market competition and price dispersion, the effect of competition on price dispersion becomes an empirical question.

2. THE LAW OF ONE PRICE AND A MORE REALISTIC APPROACH

An identical product must sell at the same price at all locations when the law of one price holds. However, empirically this is rarely the case: instead we observe a range of prices for even the same product in a market. In this chapter, we will research the law of one price, its empirical literature, why, when and how firms deviate from it.

2.1 THE LAW OF ONE PRICE

The law of one price states that in a competitive market without trade barriers and transportation costs, the price of homogeneous products sold at different locations will be the same. In this law we find three critical assumptions that allow us to make such a strong statement about prices. First of all, we are describing a market that is perfectly competitive. The second assumption is the homogeneity of the products meaning that products must be sufficiently similar in order for consumers not to show any strong preferences on one over the other. Thirdly, there must be no trade barriers so that there is free movement of goods and trade can be facilitated by those participating in the market.

The logic behind the law of one price is simple and primarily based on arbitrage opportunities. If a consumer is able to purchase a good at a lower price in a different market, he will unquestionably do so. Then the arbitrageur will sell the good where prices are higher, making a riskless profit. Arbitrage profits will continue until prices converge across markets.

There is another way of describing the law of one price which is similar. If consumers are always trying to purchase the good from the low price seller, then only the low price seller will sell the good. All other sellers will have to contest and match that price to stay in the market. This leads to the good being sold at the lowest price and all others at that same price which translates to uniformity or the law of one price. Arbitrage in a frictionless economy will instantaneously converge prices.

A model that can explain the intuition behind the law of one price almost perfectly is a famous paradox in economic theory called **The Bertrand Paradox**. It is considered a paradox because a two-firm competition can lead to a perfectly competitive outcome. This is not a behavior compatible with oligopoly where we observe significant market power, price discrimination and often collusion.

First consider a duopoly market where an identical product is produced and offered. Firms compete in prices, which they pick simultaneously, in order to maximize their profits. They have the same constant marginal cost c . Competition in prices means

that consumer will always buy from the cheapest source. We make the assumption that when firms set a common price they split the demand, each getting half the "market". A crucial assumption is that each firm can always supply the demand it faces (no capacity constraints)

What is the best strategy of each firm? What is the Nash equilibrium of this one-shot game?

The answer to both those questions is that firms will set a uniform price $p_1 = p_2 = p$ equal to the marginal cost. The pair of prices $(p_1^*, p_2^*) = (c, c)$ is the single[1] Bertrand-Nash equilibrium of this game.

In this model the competition is so intense that with the participation of a relatively low amount of firms we reach a uniform price equal to the marginal cost. Economists were troubled by this paradox introduced by Bertrand in 1883 and they found that the solution is to relax some of the assumptions. The "paradox" does not apply when we include:

Product differentiation

Consumers in this model find that products are perfect substitutes but firms often offer differentiated products in order to relax the competition between them which drives prices down. If consumers perceive differences between goods then by undercutting the competition firms do not obtain the entire demand and do not increase their profits substantially. Competition does not have the same power to drive prices down to marginal cost since consumers will possibly not choose the lower price.

Capacity Constraints

The second major assumption in this model is that a firm is able to satisfy the full demand of the market when undercutting its rival. However this is not a realistic assumption all the time, so what happens to the equilibrium if we introduce capacity constraints? This is also referred to as Edgeworth solution. Bertrand paradox does not hold under low capacity compared to market demand, equilibrium prices will be greater than marginal cost.

[1] Please note that $(\mathrm{p}_1, \mathrm{p}_2) = (\mathrm{c} + \varepsilon, \mathrm{c} + \varepsilon)$ is not an equilibrium because ε is an infinite set of numbers where there is always a smaller number to choose from

Dynamic Competition

In general firms have a longer lifespan than a year and compete in markets for many decades in some cases, so assuming this is a one-shot game is not economic reality. In a multi period game where the pricing competition is repeated over a finite large number of periods, an equilibrium set of prices higher than marginal cost can be achieved. When T→∞ using trigger strategies and in the fear of facing a price war (punishment) firms will collude and charge the monopoly price P^m, if patient (relatively high discount factor). They will not undercut the rival firm because the total long-run gains will be greater than the short-run "cheating" profits[2]. Folk Theorem suggests that any profit between 0 and Π^m is a feasible equilibrium payoff for the firms participating in this infinitely repeated Bertrand game.

Cost differences

In a similar model if $c_1 \neq c_2 \; and \; c_1 < c_2$ then the equilibrium set of prices is $(p_1^*, p_2^*) = (c_2, c_2)$. Firm with the lower marginal cost has a competitive advantage over its competition and will set a price equal to the largest marginal cost.

Integer pricing

Since prices can take discrete values then now ε is not an infinite set of numbers and the smallest integer to choose from is the cent. Now $(\mathrm{p}_1^*, \mathrm{p}_2^*) = (\mathrm{c} + \varepsilon, \mathrm{c} + \varepsilon)$ is an equilibrium, where $\varepsilon = 1 \; cent$. There is no profitable deviation, if they undercut the rival firm by reducing their price to c since they will capture all the market but have zero profit. They prefer to split the market and make a small positive economic profit.

Jumping back to the discussion about the law of one price, economists working in the field of information economics believe that the internet has the potential to create more efficient /frictionless markets but this has not fully occurred yet. Stock, bond and commodity markets are some of the few markets that the law seems to hold quite well.

[2] If a Firm deviates and undercuts the colluding monopoly price then the other firm will enforce a punishment by charging $p = c$, which translates to zero profits after cheating for both firms.

Arbitrage plays an important part in the law of one price but in practice it is quite difficult to nearly impossible to be imposed for quite a few reasons:

- *Resale's legal impediments*

Law in many countries prevents consumers from engaging in resale. An appropriate example comes to mind, before flying on a commercial airline consumers must present personal identification documents to airport officials that match the name on their boarding pass. This means that a consumer cannot sell the ticket to a third party for personal use therefore resale between consumers is legally banned.

- *High transportation costs*

A consumer facing the decision to buy a good from a different location has to keep in mind that he has to pay for the good to be brought to him or to travel at the other location to purchase the good. This involves transportation costs. High transportation costs mean that it will be difficult for the consumers (arbitrageurs) to buy in low-price areas and then resell to high-price areas because transportation costs shrink profits significantly. So arbitrage might not be even profitable in addition with the cost of time. When high transportation costs exist the economic forces which work to drive prices to the same level are weaker because arbitrage becomes less practical.

- *Personalized services and products*

Sometimes resale is physically impossible or impractical due to personalized products/services. Tailored clothing has to be resold to people with the same measurements which narrows the potential resale market. An extremely difficult product to resale are prescription eyeglasses or contact lenses which require people with the same vision disorders to buy them. Identifying and tracking down a consumer with identical characteristics who is being charged more is extremely difficult and a time consuming procedure. A solution to this problem might be the internet and more specifically electronic marketplaces like e-bay, amazon etc.

- *Imperfect information*

Consumers must be fully informed about prices in order to find a lower price to purchase the good and then resell it at a higher-price market for arbitrage to work however information imperfections regularly occur. In addition there might be some uncertainty about the quality of the good in the resale market.

Empirical literature rejects the law of one price even in almost perfectly competitive markets. Graddy (1995) collected data in the Fulton fish Market in New York City which exhibits most of the features of a perfectly competitive market. There are no physical entry barriers and approximately 35 dealers in total but not all dealers carry all types of fish even though they are able to. They are free to charge a "take it or leave it" price over a particular quantity to different costumers. There is no bargaining unless there is a very large order.

She finds significant levels of price dispersion in the whiting fish trade, Asian buyers who purchase 62% of the total quantity sold payed less per pound than white buyers. In addition her results show considerable intraday price dispersion. The evidence of price discrimination, based on race even though all sellers are white, violates the law of one price.

Another interesting article about violations in the law of one price was introduced by Asplund and Friberg (2001).They collected an impressive dataset from three Scandinavian duty-free outlets in ferry operations between Sweden and Finland. Identical products had price tags in two currencies at the same time and location. This gives consumers the chance to purchase the products at the currency of their liking and as one might expect the lower price currency. Birka lines adjusted the nominal price once per year due to costs on issuing new price catalogs. The sporadic adjustment of nominal prices as currency exchange rates fluctuate daily creates arbitrage opportunities. However, there is no mention of consumers performing arbitrage on the ferry ride. The existence of some arbitrage costs, such as currency exchange cost, allows difference in prices across markets because they render consumers unable to arbitrage. Asplund and Friberg (2001) find that currency fluctuations where the same good is listed in two currencies at the same location are the reason that LOP does not hold.

2.2 IMPERFECT COMPETITION AND PRICE DISCRIMINATION

Uniform pricing may be a good generalization for most retail markets but on the other hand we witness a tremendous amount of cases in which the same good is sold at different prices to different consumers (e.g. museum tickets are cheaper for senior citizens, children train fares are cheaper than adult fares). Have you ever noticed many places where you can get a discount by showing a student ID?

The reason behind those student discounts is not altruism. This is the sellers' attempt to capture a bigger fraction of the consumer surplus than by pricing uniformly.

It is extremely difficult to come up with a full definition of price discrimination but we can roughly say that price discrimination occurs when the seller offers two units of the same good at different prices either to the same consumer or to different consumers. A different range of prices can be observed across similar products even in competitive markets if products' marginal costs are different but price discrimination is something entirely different. It means that firms use their market power to charge higher prices for the same product to the consumers with the willingness to pay for it. For firms to price discriminate it is essential to have market power and prevent resale & arbitrage.

A firm in a perfectly competitive environment is a price taker meaning it charges the equilibrium market price and earns zero economic profits. Without market power, a firm can’t choose its price at all, much less choose to charge different prices to different consumers or use more advanced pricing strategies. In order to take advantage of this pricing strategy the firm must be able prevent arbitrage. As we described arbitrage earlier, the firm will be worse off and loses its ability to price discriminate. The prevention of resale is not normally a severe problem for firms to handle and most difficulties related with price discrimination are how to sort out the consumers.

Following Tirole (1988) it is customary to distinguish three types of price discrimination:

- *First degree price discrimination* where the seller knows the consumers' reservation prices and charges each consumer exactly his willingness to pay, in this case the firm extracts all the consumer surplus. It is also known as perfect price discrimination. This type of price discrimination is highly unlikely in practice due to arbitrage or incomplete information about consumer preferences.

- *Second degree price discrimination* occurs when total lack of information about the characteristics/preferences of each consumer drives the seller to use self-selecting devices (offering price-quantity packages so that consumer would "self-select" into appropriate categories) and extract some consumer surplus.

- *Third degree price discrimination* occurs when the seller can observe a signal about the consumers' preferences/characteristics (e.g. age, occupation, education) and can utilize it to price discriminate.

Tirole points out a significant difference between second and third degree price discrimination. Third degree uses a direct signal about demand, whereas second degree price discrimination selects indirectly among consumers through their choice between different packages. We will now discuss the different types of price discrimination and their behavior in a monopoly-oligopoly (imperfect competition) setting since these practices are often highly controversial in terms of its impact on both consumers and social welfare.

- **PERFECT/FIRST DEGREE PRICE DISCRIMINATION**

The firm has complete information about every customer which means that it can identify each individual buyer's demand curve and can charge each buyer a different price equal to the buyer's willingness to pay. In this case the firm extracts all the consumer surplus, usually with a two-part tariff (with the same price, $P = P^c = MC$, for everybody but with different tariffs for different individuals).

Following Tirole (1988) we will discuss two cases of perfect price discrimination in a monopoly setting. The simplest case of perfect price discrimination occurs when a

single consumer (or a group of identical consumers) has unit demand and a reservation price V for the good. Then the monopolist extracts the whole consumer surplus by charging $P = V$. We have to note that consumers are highly unlikely to reveal their valuation for the good meaning their willingness to pay a high price. When consumers have unit demands and the producer only knows the distribution of valuations over the population but not every individual's valuation then the monopolist cannot price discriminate and charges the monopoly price.

Now let's consider a more complex case where we have n consumers each with identical downward sloping demand $Q = D(P)/n$ for the monopolist's product. The individual's demand and the aggregate demand $Q = D(P)$ is known by the monopolist. The monopolist by implementing a suitable pricing schedule (just charging the monopoly price P^m yields profits $\Pi^m = P^m D(P^m) - C(D(P^m))$) can extract all the consumer surplus and increase his profits.

This suitable affine pricing schedule is a two part tariff $T(Q) = A + PQ$.

If the monopolist adopts the competitive pricing schedule where $P = P^c$ the competitive price so then the net consumer surplus is

$$S^c = \int_0^{Q^c} [P(Q) - P^c] dQ$$

Where $P(Q) = D^{-1}(Q)$ is the inverse demand function.

The two part tariff is complete by charging the consumers a fixed premium for the right to buy at the competitive price P^c. The consumer will not avoid buying the product if they get charged equal or less than S^c/n for the "right to buy" , so this fixed premium may go as high as S^c/n .

$$T(Q) = \begin{cases} P^c Q + \dfrac{S^c}{n} & if \quad Q > 0 \\ 0 & if \quad Q = 0 \end{cases}$$

Monopolist yields a profit equal to $\Pi = S^c + P^c Q^c - C(Q^c)$ which is the shaded area in Figure 2.1.

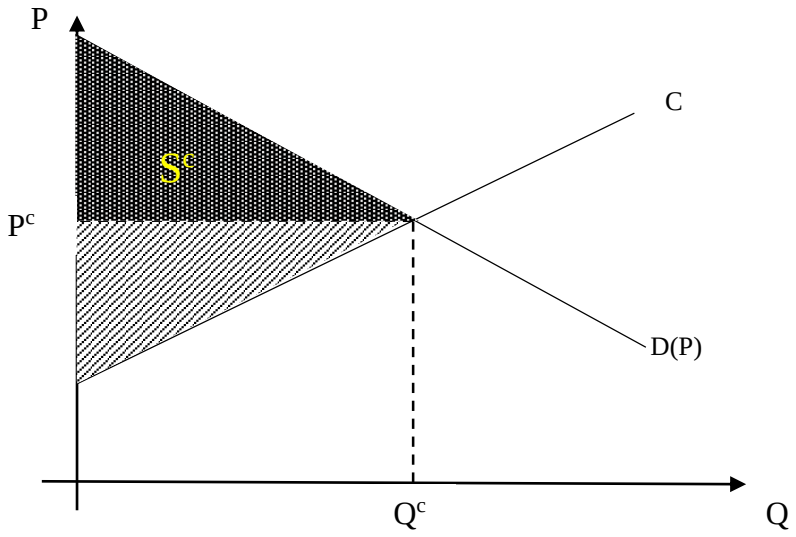

Figure 2.1

We observe that the monopolist obtains the entire social surplus since consumers have their entire surplus subtracted from them by this fixed premium A. As we know the consumer and firm's profit are the total social surplus, profit maximization is synonymous with maximizing social welfare in this setting.

Varian (1992) develops a simpler model which yields similar results to Tirole's model of first degree price discrimination. Let's suppose that a monopolist offers a single agent (we assume one agent in order to simplify the distinction process between consumers) a price and an output combination (r^*, x^*) that provides him the maximum profits. This price r^* is a take it or leave it price in the sence that if the consumer does not pay r^* then he consumes zero units of the good. In order to consume the good consumer must pay r^*.

Economic logic dictates that the consumer must have a non-negative surplus $V = U(x) - r \geq 0$ in order to consume the good otherwise he would be discouraged

from buying any units of output. This is depicted in the following monopolist's profit maximization problem constraint.

$$\max_{\{r,x\}} \quad r - cx \qquad \text{such that} \qquad U(x) \geq r$$

Monopolist pursues the maximum given profit so he wants r to be as high as possible and thus the constraint is satisfied as an equality. We substitute the new equality constraint $U(x) = r$ inside the objective function and the maximization problem becomes

$$\Rightarrow \qquad \max_{x} \quad U(x) - cx$$

By differentiating we derive the first order condition which determines the optimal level of output x^*

$$U'(x^*) = c \qquad\qquad (2.2.1)$$

Substituting this optimal level of production x^* into the constraint we find the "take it or leave it" price

$$r^* = U(x^*)$$

Three useful notes can be derived from the solution of this uncomplicated model:

- ✓ In equation 2.2.1 the marginal willingness to pay is equal to the marginal cost and that indicates a Pareto efficient level of output. The consumer is indifferent to consuming the product since the monopolist captures all his surplus.
- ✓ The level of output produced by the monopolist would be the same as in a competitive market where price equals marginal cost and supply is equal to demand. However in this scenario firm gets zero profits and consumers enjoys utility equal to $U(x^*) - cx^*$.
- ✓ If the firm charged the consumer a different price, the marginal willingness to pay for each unit, then the same outcome would occur.

Stole (2007) studies the economic intuition of this simple pricing strategy in an oligopolistic environment. Suppose there are n firms, each selling a differentiated

substitute product and each firm i has the power to price discriminate in the first degree and capture the entire consumer surplus under its residual demand curve $P_i = D_i(\ Q_i\ , Q_{-i})$ where $Q_{-i} = (Q_1, Q_2, \ldots\ldots, Q_{i-1}, Q_{i+1}, \ldots\ldots, Q_n)$ is the vector of quantities the rival firms sell when they price discriminate.

The firm i's profit function with the ability to price discriminate is

$$\Pi_i(Q_i, Q_{-i}) = \int_0^{Q_{-i}} D_i(y, Q_{-i})\, dy - C_i(Q_i)$$

$C_i(Q_i)$ is the firm i's cost function (increasing & convex) of producing Q_i units of output.

There exists a pure-strategy Nash Equilibrium in quantities $(Q_1^*, \ldots\ldots, Q_n^*)$ such that each firm's output, Q_i^* ,is a best response to the output vector of its rivals quantities ,Q_{-i}^*, which translates to $\Pi_i(Q_i^*, Q_{-i}^*) \geq \Pi_i(Q_i, Q_{-i}^*)$ for every i and Q_i.

The equilibrium allocations are determined by marginal cost pricing based on each firm's residual demand curves $D_i(Q_i^*, Q_{-i}^*) = C_i'(Q_i)$. This means that the price of each consumer's marginal purchase equals the marginal cost, so for a fixed number of firms the social surplus is maximized.

The social surplus includes the consumer surplus which will be zero under the residual demand curves but it does not mean that consumers do not gain any surplus at all. The effect of price discrimination on total consumer surplus requires a careful look on the demand of the consumer. If the goods are close substitutes (makes the residual demand curves extremely elastic) and marginal costs are constant then consumers may have some considerable surplus in an oligopolistic setting. Price discrimination can lower social welfare compared to uniform pricing when the industry configuration is endogenous in contrast with our simple model where the number of firms and product characteristics are fixed.

This practice is extremely rare and it is used as a reference point for economists on welfare effect during their study of other pricing strategies used by firms.

- **SECOND DEGREE PRICE DISCRIMINATION**

A firm can earn some extra consumer surplus by using a pricing strategy called second degree price discrimination .Unlike first degree, following this practice the firm is not able to extract the entire consumer surplus. In this pricing strategy the firm knows that it faces different individuals with different demand functions but it cannot tell who is who, so it offers a menu of different packages or options designed in such a way that consumers sort themselves out (self-select) by choosing different packages. Second degree price discrimination is also known as nonlinear pricing.

Following Tirole (1988) we will discuss a simple model of nonlinear pricing where a firm produces a single good and consumers obtains a surplus/net utility:

$$v = \begin{cases} \theta U(q) - T \; if \; they \; pay \; T \; and \; consume \; q \\ 0 \qquad\qquad if \; they \; do \; not \; purchase \end{cases}$$

Where θ is a taste parameter which in this model we assume it takes only two values(θ_H, θ_L) . $U(q)$ is the utility function where $U(0) = 0$,$U'(q) > 0$ and $U''(q) < O$ meaning increasing utility in q but decreasing marginal utility of consumption. T is the price the consumer pays for the chosen bundle, the marginal cost of producing the good is constant and equal to c.

There are two groups of consumers. Consumers with a taste parameter θ_L(low-demand consumers) in proportion μ and consumers with a taster parameter θ_H (high-demand) and proportion $1 - \mu$. We assume that $c < \theta_L < \theta_H$ and that all consumers have the same utility function $U(q)$.

In order to exercise the second degree price discrimination and consumers to self- select the monopolist has to start by offering two bundles: (q_L, T_L) which is directed to low demand consumers and (q_H, T_H) which is directed to the high-demand consumers.

The monopolist has a profit equal to

$$\Pi^m = \mu(T_L - cq_L) + (1 - \mu)(T_H - cq_H)$$

The 1st constraint that the monopolist faces is the one that requires consumers will be willing to purchase, also known as individual rationality constraint (IRC):

$\theta_L U(q_L) - T_L \geq 0$ *(2.2.2)*

This means that low-demand consumers must have a positive net surplus. If this condition is satisfied, high-demand consumers are also willing to purchase because if they chose the bundle (q_L, T_L) they would have a net surplus of $\theta_H U(q_L) - T_L > 0$ $(\theta_H > \theta_L)$.

The 2nd constraint requires that consumers do not exercise personal arbitrage meaning that high-demand consumers should be deterred from consuming the low-demand consumer's bundle. This is also known as incentive compatibility constraint (ICC):

$$\theta_H U(q_H) - T_H >= \theta_H U(q_L) - T_L \qquad (2.2.3)$$

We have a profit maximizing monopolist who benefits from high prices and wants to extract the most consumer surplus possible so these constraints are satisfied as equalities.

(2.2.2) becomes $T_L = \theta_L U(q_L)$ *(2.2.2')*

(2.2.3) becomes $T_H = \theta_H U(q_H) - \theta_H U(q_L) + T_L$

$$= \theta_H U(q_H) - \theta_H U(q_L) + \theta_L U(q_L)$$

$$= \theta_H U(q_H) - (\theta_H - \theta_L)\, U(q_L) \qquad (2.2.3')$$

The price(T_L) charged to low-demand consumers extracts their entire surplus but price T_H leaves some net surplus for high demand consumers since they can always purchase the "low" bundle (q_L, T_L) and enjoy a net surplus of $\theta_H U(q_L) - T_L = (\theta_H - \theta_L)\, U(q_L)$

Substituting *(2.2.2')* & *(2.2.3')* into the profit function we get

$$\Pi^m = \mu[\theta_L U(q_L) - cq_L] + (1-\mu)[\,\theta_H U(q_H) - (\theta_H - \theta_L)\, U(q_L) - cq_H]$$

The monopolist maximizes profit $\max_{\{q_L, q_H\}} \Pi^m$ with no constraints now

First order conditions are as follows:

$$\frac{\partial \Pi m}{\partial q_H} = 0 \;\Rightarrow\; \theta_H U'(q_H) = c \quad (2.2.4)$$

$$\frac{\partial \Pi m}{\partial q_L} = 0 \;\Rightarrow\; \theta_L U'(q_L) = c/[1 - \frac{(1-\mu)}{\mu}\frac{(\theta H - \theta L)}{\theta L}] \qquad (2.2.5)$$

We observe from equation *(2.2.4)* that high-demand consumers purchase the socially optimal quantity because the marginal cost is equal to the marginal utility of consumption for the good. However low-demand consumers choose to purchase a sub-optimal quantity since $\theta_L U'(q_L) > c$.

The economic intuition behind this is that the monopolist on the one hand wants to extract the high-demand consumer's large surplus but on the other hand faces personal arbitrage which was explained above. The monopolist knows that high-demand consumers suffer less from a reduction in consumption than the low-demand ones and so he lowers the quantity offered to the low-demand consumers to deter h-d consumers from selecting the low-demand bundle. Since low-demand consumers are not attracted to personal arbitrage, there is no need to make changes to the high-demand consumption (no distortion at the top).

Varian (1992) offers a graphical explanation of the price discrimination problem with self-selection (hereby for term coherence we will use the term "personal arbitrage" as first put by Tirole). Let's assume two consumers as described above, their respective demand curves are clearly distinguished at the figures below, and for simplicity the marginal cost is zero.

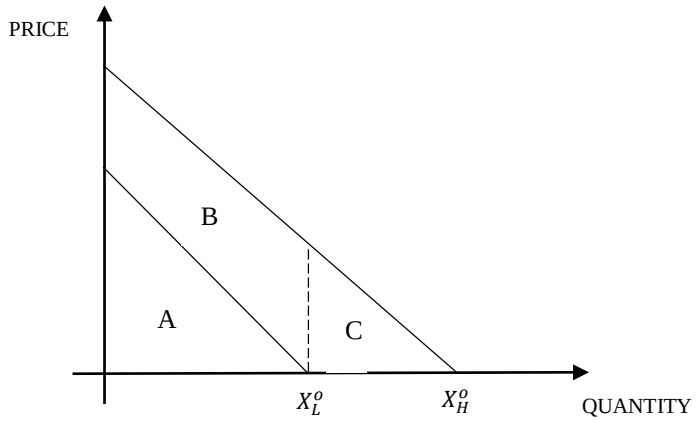

Figure 2.2

When there is no personal arbitrage problem, price discrimination is described by Figure 2.2.

Firm offers output X_L^o to the low demand consumer at a price equal to A meaning the consumer's surplus, i.e. the area under the demand curve, and quantity X_H^o to the high demand consumer who pays A+B+C to consume the foresaid quantity.

On the contrary this case cannot be sustained since the high-demand consumer can perform personal arbitrage and purchase the low-demand consumer's bundle by doing so has net surplus equal to the area B. In order for the high demand consumer to select his own bundle, the firm offers quantity X_H^o at a price equal to A+C.

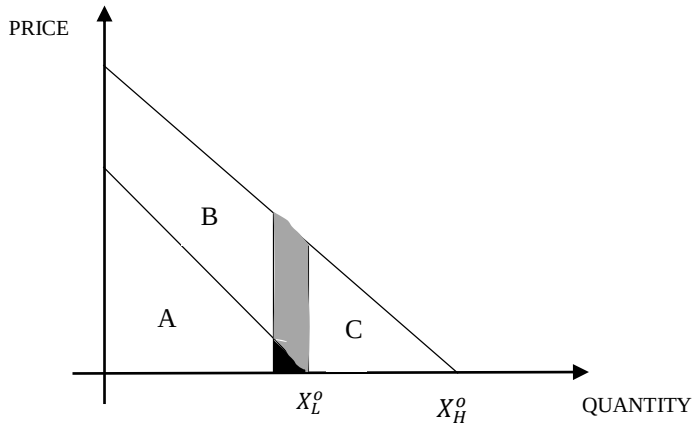

Figure 2.3

This policy isn't optimal since the firm "loses" a considerable amount of surplus. If the firm offers the low-demand consumer a smaller quantity bundle, it loses the profits pointed out by the black area in *Figure 2.3* but gains profits equal to the grey trapezoid area. Profits increase since high demand consumers have a positive (non-zero) willingness to pay at the new quantity offered and the low-demand consumers have zero willingness to pay at X_L^o, hence no effect on profits. Reducing the bundle of the low-demand consumer until a certain point will keep increasing profits.

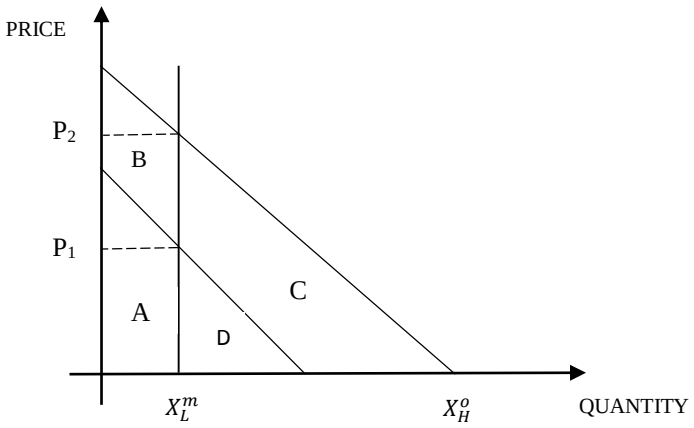

Figure 2.4

Firm maximizes profits by choosing the level of output offered, consequently the consumption, and in the final solution low-demand consumer purchases X_L^m at a price P_1 which means that the aggregate amount paid is the rectangle A =($P_1 \cdot X_L^m$).

High-demand consumer consumes X_H^o and pays $+C + D$. In agreement with our results from the Tirole's nonlinear pricing model the high-demand consumer purchases the socially correct amount and still has a positive surplus in the amount of B in addition to that the other type of consumer consumes X_L^m enjoying zero surplus.

In economics alongside the classification of price discrimination in three degrees we have the distinction between indirect and direct price discrimination. Charging different prices for different consumers based on their identity is direct price discrimination. This practice is very uncommon due to lack of information on consumer preferences and arbitrage. When a firm gives its customers a variety of pricing choices and permits them to choose between those is called indirect price discrimination. Second degree price discrimination falls into the latter category. Offering a menu of options/ quantity- price bundles and enticing consumers to buy a bigger pack than buying a single item is purely a mechanism for the firm to allow consumers to self-select into different groups according to their demand. We will now briefly discuss four other pricing strategies that fall into the same category as second degree price discrimination.

I. Quantity Discounts

Everyone has paid a visit to their local supermarket and has noticed that a 330ml can of famous soda costs 0.60€ but a "six pack" costs around 3.41€, roughly 0.57€ per can. This is a small scale example of quantity discounts that involves customers paying a lower per unit price when buying large amounts of an item. The intuition behind it is that sellers face economies of scale, enjoying a lower average cost when pushing larger amounts of quantity and large volumes accompanied with a discount seem attractive to price sensitive consumers. The renowned buy one get one for free sale is essentially a 50% quality discount because you buy a unit at half the price.

II. Coupons

Coupon hunting or couponing as people refer to it requires a considerable amount of time and effort because consumers have to search through newspaper sections, search for the right websites and comb through e-mails for discounts on the products they are interested in purchasing. Coupons are strategically placed far away from the item they give a discount to, so that not everyone has easy access, and "target" people with a low cost of time who are willing to go through the time consuming process. The reason behind that is the existence of high correlation between cost of time and price elasticity of demand, people with low cost of time tend to have a more elastic demand. Even though coupons are available for everyone mainly price sensitive people are willing to use them and that is what firms are after to increase their profits.

III. Versioning

When practicing versioning, or also known as quality discrimination, firms offer a variety of versions of essentially the same core product and consumers choose the version of the product more suitable to their preferences. Examples are very traditional and include business, first class and economy airplane tickets, hardcover and soft-cover books, red, blue and black label Johnnie Walker brand of scotch whiskey etc..

Airlines mostly use this technique and aim to charge a higher price to not very price sensitive business-first class travelers who seek more comfort, better and quicker

service, more legroom and privacy unlike economy passengers that are willing to purchase the cheaper version with numerous restrictions because they just prefer to save money. Another extreme form of versioning and price discrimination is when firms offer two versions of a good one of which has reduced functionality and can be described as a damaged good. For example, IBM offered a low cost version of its regular Laser Printer with the name Laser Printer E which printed half the pages in a minute and was sold at half the price as the regular printer. Laser Printer E was equipped with the same components as its more expensive predecessor however IBM imbedded in it a chip that slowed down the printing process. Someone might claim that the cost differences can account for the differences in prices when firms discriminate in quality. It is accurate that business class tickets have a higher marginal cost than economy tickets. On the other hand, that is deceitful when discussing the case of damaged goods where technology is implemented to reduce the quality or functionality of the service/ good provided and we would expect a higher marginal cost. Therefore price discriminatory purposes lie behind this practice.

Cabral (2000) argues that in some cases price discrimination can be a Pareto improvement[3] for all the parties involved. First of all, firms use price discrimination in order to acquire a bigger piece of the consumer surplus otherwise they would not get involved in those practices. Secondly, low quality consumers purchase a low quality or damaged good at a lower price instead of not purchasing anything at all so they are better off. Last but not least, high quality consumers take advantage of the incentive compatibility constraint (personal arbitrage) firms have to obey and enjoy a relatively lower price for their high-quality good.

IV. Bundling

Product bundling is putting together two or more products in a single package and selling them at a reduced priced (reduced compared to selling them separately).

[3] Pareto improvement is any change in the economy which leaves anyone as well off and at least an individual better off.

Some can easily access the Walmart website and observe that this particular electronics store sells a Sony PlayStation 4 bundle which includes the console, an extra wireless controller and a yearly membership to the PlayStation network for $433.95 which saves the consumer $55 in costs. Seems like a win-win situation for both consumers and sellers but we must not forget that bundling is a price discrimination strategy used by firms with market power to increase their profits. The seller has a higher profit margin when selling all the components together than selling each individual item. Typically complementary goods are being "pushed" together in bundles but sometimes costumers prefer buying products together e.g. cars with tires on, left and right shoe because one good raises the marginal utility of the other. Sometimes firms choose to offer the bundle and the products separately to the consumers which is called mixed bundling but when only the bundle is offered, pure bundling occurs.

- **THIRD DEGREE PRICE DISCRIMINATION**

Charging different groups of consumers a different price (constant for all units of output for each group) is engaging in third degree price discrimination. Perfect price discrimination requires complete information about the consumer's preferences which is extremely demanding and an unlikely scenario. On a more realistic note, firms identify groups of consumers based on observable characteristics like location, age, sex, ethnic group and set prices accordingly, this is the most common type of price discrimination. There is a plethora of examples but the most common are students getting a 25% discount at movie theaters and senior citizens receiving discounts on train tickets. Ordinarily these groups of consumers have different demand features than others. Firms take advantage of these easily identifiable characteristics to increase their profits by capturing some of the consumer surplus (since they cannot perfectly price discriminate).

In this subchapter we will debate on three different models of an oligopoly firm and a monopolist (two cases) applying third degree price discrimination.

First of all we start with the basic textbook case of a third degree price discriminating monopolist who faces two markets that can be easily distinguished and

divided e.g. student (discounted) and normal cinema customers. Following Varian (1992) let us assume that the profit maximization problem of a monopolist offering quantities (x_1, x_2) of a good with marginal cost c to two different groups of consumers or "markets" is

$$\max_{\{x_1,x_2\}} p_1(x_1)x_1 + p_2(x_2)x_2 - cx_1 - cx_2$$

Where $p_i(x_i)$ is the inverse demand function for group i

As always in order to solve this problem we have to differentiate with respect to x_1 and x_2 to find our two first order conditions which are:

- With respect to x_1 : $p_1(x_1) + p_1'(x_1)x_1 = c$
- With respect to x_2 : $p_2(x_2) + p_2'(x_2)x_2 = c$

It is implied that $\frac{dp_i}{dx_i} = p_i'(x_i)$

We know that the elasticity of demand in market i is $\varepsilon_i = \frac{dx_i}{dp_i}\frac{p_i}{x_i}$

So using the formula for the elasticity to rearrange these two condition we get

$$p_1(x_1)\left[1 - \frac{1}{|\varepsilon_1|}\right] = c \qquad \frac{p_1(x_1) - c}{p_1(x_1)} = \frac{1}{|\varepsilon_1|}$$

Or equivalently

$$p_2(x_2)\left[1 - \frac{1}{|\varepsilon_2|}\right] = c \qquad \frac{p_2(x_2) - c}{p_2(x_2)} = \frac{1}{|\varepsilon_2|}$$

Dividing those two equations we derive the formula that explains the pricing strategy of the firm:

$$\frac{p_1(x_1)}{p_2(x_2)} = \frac{\left[1 - \frac{1}{|\varepsilon_2|}\right]}{\left[1 - \frac{1}{|\varepsilon_1|}\right]}$$

This formula implies that $p_1(x_1) < p_2(x_2)\ if\ and\ only\ if\ |\varepsilon_1| > |\varepsilon_2|$ .The firm will charge a higher price to the least price sensitive (more inelastic demand) group or "market". This is referred to as optimal pricing. Now it is easy to follow why students receive a discount on train or cinema tickets and other goods. This happens mainly due to the low to zero income of students which makes them very price sensitive so firms offer them a discounted price to entice them to purchase .This way the firm may be able to increase sales and revenue. Likewise optimal pricing explains why we observe major price differences for the same good between different countries when there are no transportation costs or import taxes involved.

A more complicated case is when the price set in one of those two markets has an effect on the other group's demand e.g. a bar having a Ladies Night on Friday night and setting lower prices will probably influence tomorrow night's demand to some extent. So when the price influences the demand of the other good the monopolist's profit maximization becomes

$$\max_{x_1,x_2}\ p_1(x_1,x_2)\,x_1 + p_2(x_1,x_2)x_2 - cx_1 - cx_2$$

First order conditions similarly to the previous problem yield

- With respect to x_1 : $p_1 + \frac{\partial p_1}{\partial x_1}x_1 + \frac{\partial p_2}{\partial x_1}x_2 = c$
- With respect to x_2 : $p_2 + \frac{\partial p_2}{\partial x_2}x_2 + \frac{\partial p_1}{\partial x_2}x_1 = c$

We now insert the formula for elasticity

$$p_1\left[1 - \frac{1}{|\varepsilon_1|}\right] + \frac{\partial p_2}{\partial x_1}x_2 = c$$

$$p_2\left[1 - \frac{1}{|\varepsilon_2|}\right] + \frac{\partial p_1}{\partial x_2}x_1 = c$$

Varian (1992) assumes symmetry in cross-price effects $\frac{\partial p_1}{\partial x_2} = \frac{\partial p_2}{\partial x_1}$ (quasi-linear utility function), that the goods are substitutes $\frac{\partial p_2}{\partial x_1} > 0$ and that $x_1 > x_2$. So combining those two equations and the assumptions, it can be easily shown that

$$p_1\left[1 - \frac{1}{|\varepsilon_1|}\right] - p_2\left[1 - \frac{1}{|\varepsilon_2|}\right] > 0$$

Now we have the final inequality

$$\frac{p_1}{p_2} > \frac{\left[1 - \frac{1}{|\varepsilon_2|}\right]}{\left[1 - \frac{1}{|\varepsilon_1|}\right]}$$

Similarly with the simplest case we discuss before, in a more general setting we have that the market with the more inelastic demand $|\varepsilon_1| < |\varepsilon_2|$ will have the biggest price $p_1 > p_2$

$\Pi^m \leq \Pi^{3pd}$ monopolist's profits in third degree price discrimination are at least as high as in setting one price for both markets. We can easily derive that consumers in high elasticity markets enjoy a lower price under the price discriminating monopolist. In contrast, low elasticity consumers are impacted the most and would favor a uniform price.

The important question to answer is: What about social welfare? How can we be sure that the losses of low elasticity consumers are less significant than the gains of the seller and high elasticity consumers?

Varian discusses different cases and shows that under the assumption of linear demand curves and when both markets are served by the monopolist, welfare decreases under price discrimination. On the other hand, given that one of the two markets is relatively small if the monopolist could not price discriminate then he would not choose to serve the small market. Only serving the large market would be optimal for him. Price discrimination in this scenario opens up a market which was not served under regular monopoly and welfare increases. This tends to create a Pareto improvement

where all groups benefit. Generally if we cannot observe a severe increase in output, performing price discrimination would probably be harmful for welfare. Tirole's welfare analysis agrees with Varian. For this practice to be socially beneficial, i.e. to increase social welfare, total output must rise by a large amount. Welfare results of third degree price discrimination are unclear and require a careful examination of each case separately.

A monopolist practicing third degree price discrimination is a characteristic part of economic theory and it generates a very simple solution, the inverse elasticity rule. The monopolist applies this rule to each market separately and finds the optimal pricing, the market with the lower elasticity receives a higher price.

$\frac{p_i - c}{p_i} = \frac{1}{\varepsilon_i^m}$ where ε_i^m is the market elasticity of demand for each market. But how does this translate when oligopolists compete simultaneously in multiple markets? Do they apply a similar rule?

To answer our questions we will examine a model introduced by Stole (2007). There are two firms $j = (\alpha, b)$ who offer products in both markets $i = 1,2$ and they face a constant marginal production cost c per unit. Before we continue our analysis it is important to introduce the terms strong and weak market. Stole(2007) defines that " market i is weak (and the other is strong) for firm j if, for any uniform price(s) set by the other firm(s), the optimal price in market i, is lower than the optimal price in the other market ". When the weak and strong markets happen to be the same for both firms then we call that market satisfies best-response symmetry.

We assume that market 1 is the weak market so that makes market 2 the strong one. Firm j's own-price firm elasticity of demand in market i is the sum of the market elasticity $\varepsilon_i^m(p)$ and the cross-price elasticity $\varepsilon_i^c(p)$ under some assumptions[4]

[4] Symmetric demand functions $q_i(p) \equiv q_i^{\alpha}(p,p) \equiv q_i^{b}(p,p)$ and symmetry in prices $p = p_i^{\alpha} = p_i^{b}$.

$$\varepsilon_i^f(p) = -\frac{p}{q_i(p)} q_i'(p) + \frac{p}{q_i(p)} \frac{\partial q_i^{\alpha}(p,p)}{\partial p_i^b} = \varepsilon_i^m(p) + \varepsilon_i^c(p)$$

The duopoly firms will now charge prices in each market following an inverse-elasticity rule just like the monopolist but with a major difference:

$$\frac{p_i - c}{p_i} = \frac{1}{\varepsilon_i^m(p) + \varepsilon_i^c(p)}$$

The goods offered in both markets are substitutes so the cross-price elasticity is strictly positive i.e. $\varepsilon_i^c(p) > 0$.

Comparing the monopolist's and duopolists' pricing rules quite a few results can be extracted. First of all, competition (since now we have two firms instead of just a monopolist) will lower prices in both markets and therefore we anticipate an increase in welfare under third-degree price discrimination. Secondly, the most interesting result is that the effect of competition in the price differentials or, as we shall call it, price dispersion across markets is unclear and depends on cross-price elasticities. For price dispersion to exist the consumers in market 1 have to find the products to be close substitutes (i.e. $\varepsilon_1^c(p_1) \to \infty$) therefore firms to set prices close to marginal cost (perfectly competitive)and in market 2 consumers must show a strong preference to just one good (i.e. $\varepsilon_2^c(p_2) \to 0$) thus forcing the firms to choose a price near the monopoly price. On the other hand, price dispersion is insignificant if in both markets the products are considered to be closed substitutes since prices will be driven to marginal cost due to severe competition.

Last of all, welfare analysis again shows ambiguous results. Whether the effect of price discrimination on welfare is positive or negative, compared to uniform pricing, relies on relative prices and output. Competition might lead to a higher price in the more elastic market therefore a higher relative price under the price discrimination monopolist.

Is price discrimination legal?

Price discrimination features more frequently in antitrust analysis the last few years. In Europe it is prohibited by Article 82(c) (former Article 86) of the EC Treaty which states:

"*Any abuse by one or more undertakings of a dominant position within the common market or in a substantial part of it shall be prohibited as incompatible with the common market in so far as it may affect trade between Member States. Such abuse may, in particular, consist in:*

[…] (c) applying dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage; […]"

An important thing to notice is that Article 82 requires that the party engaging in price discrimination must have some form of market power to be lawful. Price discrimination indicates market power but this is not always the case in some markets. Using price discrimination as a clue for the presence of market power in an antitrust trial requires careful examination.

In the U.S the main concern is the protection of competition against discriminatory pricing so the Robinson-Patman Act of 1936 was passed which reads as follows:

"It shall be unlawful for any person engaged in commerce [……] to discriminate in price between different purchasers of commodities of like grade and quality [……] and where the effect of such discrimination may be substantially to lessen competition or tend to create a monopoly in any line of commerce, or to injure, destroy, or prevent competition with any person who either grants or knowingly receives the benefit of such discrimination, or with customers of either of them"

Unlike Article 82, this act does not include the abuse of dominant position and just focuses on the net effects on competition. We have to note that we observe different prices due to cost variations in dealing with different consumers or due to bidding wars between firms driving them to offer a lower price for a specific client. In these cases Robinson-Patman Act permits price discrimination but other cases must be analyzed

under the rule of reason. Price discrimination cases pose an enigma for antitrust officials who have to investigate each case separately, understand each uniqueness in order to rule a wisely deliberated verdict.

To summarize this chapter, we discussed that the law of one price hardly ever holds and firms under imperfect competition, where market power exists, exercise price discrimination. The focal point is that we observe a range of prices for the same good and the optimal pricing depends on market elasticity and/ or cross-price elasticities. The cross-price elasticities measure the consumer's sensitivity of choosing the competing firm's good when prices change. This translates to consumer preferences and consumer heterogeneities which impact the variance of those prices across stores or the phenomenon economists call price dispersion. Price dispersion itself is price discrimination that is important to understand.

3. LEADING FACTORS OF PRICE DISPERSION

Price dispersion occurs when different sellers offer different prices for the same good in a given market. It is also defined as the variation in prices of homogenous goods sold by competing firms in a market. Price discrimination is a similar term however the latter involves a single seller offering different prices to different groups of consumers. For example on a recent trip to the Monastiraki flea market fairly identical products like same-sized stamped souvenir shirts made from the same material were priced between 5€ and 10€. Also fridge magnets had a price range of 1€ to 2.5€. Quite a surprising price range for products that are sold in stores located right next to each other. Research has shown that many homogenous products in traditional and online markets are characterized by significant price dispersion.

Baye et al (2006a) examines the persistence of price dispersion in a well-established online retail market using a Varian (1980) type model. In order to best fit the conditions of this model, they gathered observations spanning over an 18 month

period for 36 consumer electronics products offered at price comparison site Shopper.com. They find that a large fraction of price dispersion remains unexplained even after controlling for firm heterogeneities in costs, branding, reputation, trust, product availability and shipping costs. Their results indicate that price dispersion is significant and persists across products and across time which supports the empirical relevance of equilibrium models of persistent price dispersion like Varian (1980).

In order to understand price dispersion economists have investigated and identified a number of potential sources of price dispersion. Five most important sources include:

- Consumer heterogeneity
- Consumer Search costs
- Confusion over price comparison
- Inertia
- Market Competition

Zhao (2006) studies three of those fives sources in her paper and checks for consistency with the existing theories of price dispersion. She finds that price dispersion is positively related with consumer heterogeneity, consumer search costs and market competition.

Consumer heterogeneity usually arises from differences in demographics (e.g. age, gender, level of education), willingness to pay for product characteristics, type of consumers or level of information (informed/uniformed).Information about product prices and characteristics is acquired by searching which is associated with search costs. Stigler (1961) in his seminal article on the economics of information was the first to discuss the effects of consumer search on price dispersion. He argued that a decrease in search costs should reduce price dispersion. After Stigler's work, numerous researchers followed and evaluated the effects of search costs on price dispersion. Internet has the potential to reduce search costs and help consumers make a better choice.

Nonetheless we have to point out that searching does not guarantee that consumers will choose the best option. Grubb (2015) provides theory and evidence that consumers fail to choose the best price and we observe a range of prices because consumers do not search enough, become confused when comparing prices and exhibit inertia by not switching away. He also discusses possible regulatory interventions to help consumers make a better choice.

Competition is commonly indicated by market structure factors such as market concentration and market share. Economic theory predicts that price discrimination and price dispersion decreases with competition but models by Borenstein (1985), Holmes (1989) and Gale (1993) show the opposite. We then turn to the rich empirical literature where Borenstein and Rose (1994) offer a unique study that lead the path in the rather limited research of the effects of competition (number of competitors in the market and market concentration) on price dispersion. Other leading studies on the subject (Gerardi and Shapiro 2009) show that price dispersion decreases with competition.

Product differentiation is considered to be a source of price dispersion however our theoretical and empirical literature analysis does not extend to differentiated product markets. In this chapter we will discuss the five leading sources of price dispersion mentioned above.

3.1 CONSUMER HETEROGENEITY

Consumer heterogeneity is one of the two key ingredients of price discrimination alongside market power. Firms are able to exercise the different degrees of price discrimination based on consumer's differences in price elasticities, preferences and willingness to pay for quality or different versions of products. Borenstein and Rose (1994) state that price discrimination is likely to increase with the variance of attributes in the population that reflects buyer's elasticities or cross elasticities among brands.

One aspect of consumer heterogeneity is the differences in the level of product information that individual consumers have available when making purchase decisions. Price dispersion arising from consumer differences in the level of information about prices has been analyzed by economic researchers which take a different route than Diamond (Salop and Stiglitz 1977; Varian 1980).They are what Baye et al.(2004a) describes as "clearinghouse" models.

Salop and Stiglitz (1977) provide a model and a theoretical analysis of the equilibrium of an economy in which agents differ in their ability and willingness to make economic decisions. Consider a market where an identical commodity is sold at the different stores but there are two kinds of consumers. The "informed" consumers who know the entire distribution of offered prices and the "uninformed" consumers who know nothing about the price distribution. Informed consumers always shop at the lowest price store while uninformed ones shop at random. Only uninformed consumers shop at high price stores and the fraction of them is high enough to keep those stores in business. In this economy imperfectly informed consumers can only become informed at a cost. For example, informed buy a newspaper with sale prices on it but uniformed do not.

Their assumptions lead to a monopolistically competitive equilibrium and generally price dispersion (price range between the perfectly competitive and monopoly price).They find that price dispersion depends on the magnitude of information costs between the two consumer groups and scale economies.

Based on the model of Salop and Stiglitz (1977) and allowing for the possibility of randomized pricing strategies by stores, Varian (1980) was the first to explain the rationale of price dispersion by means of sale. In his model of sales, he provides an explanation of why stores find it in their interest to randomize prices in an effort to price discriminate between informed and uniformed consumers. Thus, consumer heterogeneity based the consumer's level of pricing information is a cause of price dispersion. He also shows that heterogeneity in search costs is another cause for temporal price dispersion (over time for a specific product).

A seller's motivation for price discrimination is likely to increase with the variation of attributes in the population that reflect buyers' search costs, price elasticities, or preferences (Diamond 1987; Shepard 1991).

Diamond (1987) explores a model where there are two classes of consumers and no explicit search costs .Consumers differ only in their willingness to pay to purchase one unit of the consumer good in the market. His analysis focuses on the two-price equilibrium where the lower price equals the lower willingness to pay, while the higher price is the reservation price of the type with higher willingness to pay. Diamond (1987) finds that price dispersion can exist in consumer markets due to consumer heterogeneity related to differences in consumers' willingness to pay.

A very important study on the relationship between consumer heterogeneity and price dispersion was introduced by Shepard (1991) in the retail gasoline market. She evaluated price dispersion and price discrimination in the context of two groups of gasoline retailers (multi-product and single product stations) as well consumer heterogeneity. She gathered microdata consisting of retail prices and characteristics of all 1,527 stations in a four-county area near Boston. She developed two tests, the first test discriminated between price structures associated with price discrimination and with cost driven, competitive differentials. This test showed that the price differential at multiproduct stations does not appear to be cost driven. In addition, the results of the second test indicate that nor peak load pricing is a believable explanation for the observed price structure.

Shepard (1991) showed that price dispersion can occur in multi-firm product markets due to price discrimination when consumer heterogeneity exists. Consumer heterogeneity in this case is related to differences in consumers' willingness to pay for quality.

Zhao (2006) offers general evidence on different sources of price dispersion in the context of the grocery market. One of those sources is consumer heterogeneity which in Zhao's study is measured by the coefficient of variation of the education level of female shoppers and the coefficient of variation of household income. She uses female demographics because it is believed that female family members play a bigger role in household grocery shopping and education level in particular affects the efficiency of information gathering or time organization. Zhao (2006) finds a positive correlation between price dispersion and consumer heterogeneity. As the coefficients of variation in consumer demographics increase, stores tend to price discriminate more resulting to greater price dispersion.

As we discussed in Chapter 2, airline firms price discriminate between business and vacation travelers (business & economy class tickets).There appears to be considerable consumer heterogeneity between these two groups of consumers since business travelers are more time and quality sensitive. Borenstein and Rose (1994) & Clemons et al. (2002) studied the effects of differences in business passengers versus vacation passengers on price dispersion. Both studies found that consumer heterogeneity plays an important role in price dispersion.

We will next discuss the literature of costly consumer search and the effect of search costs on price dispersion. Consumer heterogeneity in some cases is related to consumer search costs however those two theories about the sources of price dispersion are not overlapping.

3.2 SEARCHING AND CONSUMER SEARCH COSTS

Consumers maximize their surplus/utility and in order to do so they search over a distribution of prices to acquire their product of choice. The law of one price and the Bertrand model of competition assume that consumers are always able to buy from the source with the lowest price and that prices converge to uniformity. However, literature indicates that price dispersion can insist in markets where there is imperfect information and consumers incur search costs to get information. For instance, Baye et al (2006b) showed that price dispersion can arise as an equilibrium phenomenon in a homogeneous goods market with symmetric firms if consumers are not fully informed about prices. Beginning with Stigler (1961), the literature has acknowledged the role of imperfect information in generating equilibrium price dispersion.

If information was costless then consumers would not stop searching until they found the lowest price and all firms would have to comply the lowest price or exit the market. However it is costly (time, lost opportunities, money, etc.) for consumers to search and gather information. Rob (1985) states that when a buyer's perceived search costs exceed the anticipated price reduction, the buyer will stop searching for lower prices. Many consumers will thus consciously buy at prices which are not the lowest obtainable.

As consumers incur search costs to obtain price information, some of them engage in price searching and other purchase products randomly. Costly searching is what allows firms to set higher prices than others in equilibrium, even when all firms sell a homogeneous good and have the same production costs.

Information is power as Stigler (1961) suggests. He introduced the term "consumer search" and initiated a study on the subject. His seminal article in the Journal of Political Economy was a step forward in understanding price dispersion and

especially the effect of information on the variance of prices we observe. He stated that price dispersion is ubiquitous even in homogeneous products. He cites an example where a seemingly identical automobile was sold by different car dealerships locally and its price range was from $2,350 to $2,515. His main conclusion is that price dispersion is caused by consumer's lack of information due to search costs and an absence of absolute homogeneity (particularly differences in the level of customer service and stock variety) in commodities.

In addition he argued that even though most economists treat advertising with hostility, advertising can be beneficial and is a key in reducing consumer search costs .By reducing search costs, he believed that the price dispersion would be reduced greatly.

Interestingly Diamond (1971)'s theoretical model showed that the introduction of even a small search cost will not lead to price dispersion but monopoly pricing. In his model the only equilibrium is for all firms to set the monopoly price regardless of the number of firms and the level of search costs. This is referred to in literature as the Diamond paradox.

Diamond (1971) assumed that there are identical buyer in the market who want to buy a single unit of a commodity from a large number of sellers. The buyers know the distribution of prices however each buyer only knows one price quote from one seller and can learn another one at a fixed cost. Buyers must decide whether to learn a new price quote or not. The intuition behind the Diamond paradox is pretty straightforward: no buyer with one price quote would want to search for a second, unless the new quote is expected to be lower by at least the amount of the search cost. Suppose a firm has set a price below monopoly price and lower than everyone else. Firm has an incentive to raise its price by an amount less than the cost of searching at another firm and buyers would still decide to buy there since the benefit would not be greater than the cost. This incentive to raise prices means that all firms will charge the monopoly price in equilibrium. Buyers expect that all firms charge the same price in equilibrium and hence have no reason to search.

Equilibrium dispersion models

Rothschild (1973) recognized that there were some serious difficulties with the existing models of price dispersion. By the time he wrote his article in the Journal of

Political Economy no one had produced a model where price dispersion was a result of equilibrium behavior. As Rothschild (1973) has stressed, imperfect consumer information alone is not a sufficient condition for price dispersion. The challenging part is to show that sellers charge a range of prices as a rational response to consumers' search behavior and vice-versa.

Since Diamond's (1971) path-breaking work on the integration of individual search with market equilibrium, numerous economists (Braverman, 1980; Burdett and Judd 1983;Carlson and McAfee 1983; Reinganum 1979; Rob 1985;Salop and Stiglitz 1977,1982;Samuelson and Zhang 1992; Stahl 1989; Varian 1980) succeeded in building models of rational search that derive equilibrium price dispersion as a consequence of positive search costs in any market and escape the Diamond Paradox. The paradox is avoided by relaxing some of Diamond's (1971) assumptions of sequential search, homogeneous search costs or firm homogeneity.

Price dispersion can be obtained in an abundance of search models when consumers have different search costs (Braverman 1980; Rob 1985; Salop and Stiglitz 1982; Stahl 1989). Reinganum (1979) on the other hand generates price dispersion from differences in production costs among firms. In addition various combinations of these assumptions are known to result in an equilibrium with a distribution of prices. Buyers non-sequential search strategies are also being used (Braverman 1980; Burdett and Judd 1983)

Braverman (1980) analyzes the nature of equilibrium and its welfare properties. He showed that only two prices can be sustained in the dispersed price equilibrium: the competitive price at the minimum of the average cost curve and the monopolistically competitive one.

Rob (1985) presents a systematic investigation of the price dispersion phenomenon which is due to the fact that consumers must pay something to secure a price quotation and proves that price dispersion is a stable market outcome. He notes that this informational imperfection gives sellers a limited monopoly power to the extent that buyers shift to other sellers only in response to a significant rise in prices. In addition, buyers with high search costs search less extensively and buy, on average, at higher prices.

Stahl (1989) in his model assumes consumers with heterogeneity in search costs. More specifically N competing firms sell a homogeneous good to two types of

consumers: shoppers who are informed about all prices because they don't incur search costs and non-shoppers who search sequentially with a positive search cost c. His paper provides a bridge between the Bertrand (perfectly competitive) and Diamond (monopolistically competitive) outcomes. He shows that as the proportions of shoppers goes to 1 and as search costs declines to zero the Nash Equilibrium converges to the Bertrand NE. Remarkably though Stahl (1989) predicts that equilibrium prices are dispersed and converge to the monopoly price (rather than marginal cost) as the number of competing firms increases.

Reinganum (1979) shows that price dispersion exists in the "simplest" model by making two assumptions that other models lack: differing marginal costs among firms and elastic consumer demand curves. In the equilibrium of Reinganum (1979) low cost sellers charge their monopoly price but high cost sellers charge less than their monopoly price in order to make some sales.

Carlson and McAfee (1983) develop a model which includes both those two assumptions above. More specifically they assume that firm's cost functions differ and that there is a distribution of consumer search costs. They test how changes in key parameters affect the mean and the variance of prices and derive testable implications. They show that a decrease in the density of the distribution of consumer search costs leads to increased price dispersion. Also that there is a negative relationship between the variance of prices and the slope of the marginal cost functions. Burdett and Judd (1983) find dispersed price equilibria even if all buyers have the same cost to becoming informed in models of either non-sequential search or noisy sequential search. They indicate that price dispersion may exist independent of the heterogeneities used by other authors and that equilibrium price dispersion may be a durable long-run phenomenon, not emerging from short run differences in firm's cost functions.

However there are models which do not follow the classic search model theory where higher search costs lead to higher price dispersion. For instance, Samuelson and Zhang (1992) in their search model use Rothschild (1973)'s assumption about the heterogeneity in firm marginal costs and that consumers have different evaluations for products of different firms in order to examine the effect of search costs on prices and price dispersion. They identify two opposing forces at work: the marginal demand and total demand effect. Marginal demand effect dictates that, for example, if search costs increase the incentive of consumers to seek an alternative decreases. This in a sense ties

the consumers to the firm and increases its market power therefore gives the firm an incentive to increase its price. However an increase in search costs will cause fewer consumers to sample a firm, thus reducing its total demand and decreasing the number of consumers the firm can extract surplus from. This yields an incentive to reduce prices. Surprisingly unlike initial intuition, Samuelson and Zhang (19992)'s results indicate that the latter effect dominates and an increase in search costs leads to a decrease in price dispersion and prices.

A major conclusion of equilibrium models of price dispersion is that both social and consumer welfare is typically decreasing in search costs. Also that a reduction in search costs for some consumers can benefit others because those who will search more will put a downward pressure on prices for everyone.

Empirical evidence on imperfect information and price dispersion

Consumers incur search costs in order to gather information and price search until the perceived search costs exceed the anticipated price reduction. Due to costly search, consumers search too little and fail to choose the best price. This is what allows firms to set higher prices than other of a homogeneous good. We will discuss the large empirical literature that links price dispersion with consumer search behavior in many industries. Literature covers a variety of issues including the effect of higher search costs, the relationship between dispersion and purchase frequency, the difference between online and offline price dispersion, and the dynamics of online price dispersion.

Marvel (1976) was one of the first to provide empirical evidence to support the proposition that information affect price dispersion .His empirical results are based on price data(maxima and minima of samples of gasoline pump prices) made available by the U.S. Bureau of Labor Statistics, ranging from 1964 through the middle of 1971. He checked for price dispersion across stations in a single market and for price variability over time in the retail gasoline market even though observations on the size of consumer information were tricky to find at the time. Income was used as a proxy for search cost and an education (correlated with income) variable was included in the regression to reduce effects of the income variable. Marvel pointed out that the significance level of some coefficients, particularly the proxies for search cost, were low but the signs are in

every case in accordance with expectations. His empirical analysis showed that an increase in units purchased or a decrease in search costs leads to a decrease in price dispersion.

Dahlby and West (1986) use data on automobile insurance premiums in Alberta which were collected over a 7 year period (1974-81) to test whether price dispersion is based on costly consumer search. Their tests for equilibrium price dispersion are based on the model by Carlson and McAfee (1983) because it is the most empirically manageable model of price dispersion. They found that price dispersion existed in all driver classes for all territories and years. However their most striking finding is that premiums are least dispersed in driver classes in which search is most likely to occur. They conclude that even though quality variations and differential screening of firms to drivers (low risk-high risk) are contributing factors, the main reason for price dispersion in the market for automobile insurance in Alberta is costly consumer search.

The empirical importance of price dispersion that arises from imperfect information is examined by Sorensen (2000) in the retail market for prescription drugs. He studies price data for 20 pharmacies across two cities in upstate New York in 1998.These cities were picked purposely because they are geographically isolated and the pharmacies can be reasonably regarded as the whole set of options for the local shoppers. He finds that pharmacy heterogeneities cannot explain more than one-third of the observed price variation. Most of the price dispersion can be attributed to imperfect information, search costs and consumer incentives to price-shop. Consumers are more price-sensitive and extra willing to price-shop when prescriptions must be purchased more frequently (e.g. treatment for chronic conditions).He shows that price dispersion is significantly higher, more specifically 34%, for one-time prescriptions than for monthly-purchased prescriptions. His results are consistent with typical search models where the cost of search is weighted against the potential reduction in price.
In the same manner as Stigler (1961), Sorensen proposes advertisement of prices as a measure to lower prices and price dispersion when dispersion is related to consumer search. More specifically he notes that programs that centralize information or improve access to it would be beneficial to consumers.

The second source of price dispersion that Zhao (2006) tests for in his paper is consumer search costs. Since search costs are not directly observable, she uses measures such as the frequency of visiting stores, purchase frequency of product and purchase frequency of a certain brand. Zhao (2006) finds that there is positive correlation between price dispersion and higher consumer search costs. The rationale is that as search costs increase, firms are able to charge different prices which leads to an increase in price dispersion across stores for the same product.

Chandra and Tappata (2011) present a model and use a panel data consisting of daily gasoline prices to examine equilibrium price dispersion in the U.S. retail gasoline industry. As search model theory suggests search costs, lower consumer incentives to price-hunt and in accordance with the theory they find that fuel types that are associated with higher search costs exhibit higher equilibrium levels of price dispersion. For example, premium gasoline has 47 percent more price dispersion than regular gasoline. They add that price dispersion decreases as the level of prices rises because consumer might not gain more from searching during that period. Chandra and Tappata (2011) also propose that a centralized source informing consumer about gas prices or website listing of prices by internet users will lessen the effect of imperfect information and reduce price dispersion and prices in the market.

Pennerstorfer et al. (2015) theoretically and empirically examine the relationship between information and price dispersion. They construct a model closely related to Stahl(1989)'s model where N firms sell a homogeneous product and there is a share μ of informed consumers who observe all prices ("shoppers") .The most interesting part of this study is how they measure information. They rely on the share of long distance commuters as the measure of proportion of "shoppers" in the market because they freely sample prices along their daily commute. Also they use quarterly data on diesel prices at the gas station level from October 1999 to March 2005 to measure price dispersion.

Pennerstorfer et al. (2015) find that there is an inverted U-shaped relationship between price dispersion and information. This means that as the share of informed consumers increases, price dispersion first increases and then starts decreasing once the share of informed consumers exceeds a critical level μ*. They estimate that this critical level μ* lies between 70% and 76%. Starting at μ=0 ,everyone is uninformed and firms charge the monopoly price however as the share of informed consumers increases some firms

have an incentive to reduce the price to capture the "shoppers" so price dispersion increases. As the share of informed consumers exceeds this level, the majority of the firms lowers their prices (more specifically stations at the upper bound of the price distribution) to become more appealing to the informed portion of the market, which reduces price dispersion. In addition they posit that an increase in the share of informed consumers has a positive effect on market price (lower).

Internet markets and price dispersion

The rise of electronic commerce and Internet marketplaces as alternatives to traditional retail markets at the end of the 20th century gave new motivation for empirical studies on pricing behavior. Consumer can now online comparison shop online, much more effortlessly than in actual markets. Bailey (1998) believed that electronic markets would be more efficient and friction-free than traditional markets because they would reduce consumer transaction and search costs by helping the matching process of buyers and sellers. Thus reducing prices and price dispersion and make markets more competitive.

Baye et al. 2004 quotes a paragraph from The Economist, November 20, 1999, p. 112.

"The explosive growth of the Internet promises a new age of perfectly competitive markets. With perfect information about prices and products at their fingertips, consumers can quickly and easily find the best deals. In this brave new world, retailers' profit margins will be competed away, as they are all forced to price at cost."

Brown and Goolsbee (2002) examine the market for term life insurances from 1992 to 1997 and present evidence on the impact of Internet competition on prices and price dispersion in the offline market. This is surprising as most studies analyze price dispersion in online markets versus offline markets. Based on Stahl (1989), they use variation in the share of consumers searching on the Internet as their measure of consumer information. They find that the growth of internet comparison sites has made the life insurance market more competitive and can explain a large portion of the price declines during that period. A key finding of their study is that at first internet usage has resulted in a rise of price dispersion but a decrease later on as internet usage continued to grow.

Ghose and Yao (2011) use a unique data set of 3.7 million transaction price records happening online in 2000 to estimate and compare the extent of price dispersion in both an online market and a traditional market. They find that price dispersion in their electronic market is extremely low and close to zero. In addition they show that price dispersion online is significantly lower than in the conventional market. Their results support the theoretical prediction that search cost in electronic markets is lower than that in traditional markets and thus as search theory predicts we observe lower price dispersion.

However the effects of the Internet on commerce vary as other empirical evidence (Bailey 1998; Baye et al. 2004,2006a; Baye and Morgan 2004;Brynjolfsson and Smith 2000;Clemens et al. 2002; Ellison and Ellison 2009) show significant levels of price dispersion on the Internet, which is in contrast to theoretical predictions. For example, Baye et al. (2004) analyzed detailed information on prices of 1000 items collected from a price comparison site and found that price dispersion is significant and persistent. Some studies have found that offline dispersion is lower than online dispersion.

Bailey (1998) tested the hypothesis that Internet commerce is more frictionless than actual physical markets by obtaining a dataset of more than 30.000 observations collected from February 1997 to January 1998. His work on books, CDs and software showed that prices and price dispersion online was actually higher online than in retail stores. Bailey (1998) believes that high search costs, immaturity of Internet commerce, lack of trust on Internet retailers and price discrimination are possible explanations for the higher price dispersion in online markets.

In a similar study to Bailey (1998), Brynjolfsson and Smith (2000) compare actual prices charged by Internet and conventional retailers of books and CDs to check the efficiency of e-commerce. Books and compact discs were specifically chosen because the physical products themselves are homogeneous and gathered data for over 8,500 individual price observations from February 1998 to May 1999.The find that Internet retailers charge, approximately 16%, lower prices than traditional retailers for both books and CDs even after including tax, shipping and handling, and mileage charges. Which highlights that Internet provides a more efficient channel for these specific products. However, their key finding is that price dispersion still exists throughout internet markets on the range of 30% and is higher than in conventional

outlets. If prices are weighted by proxies for market share they find the opposite, higher price dispersion in traditional channels, which reflects dominance among certain heavily branded retailers (e.g. Amazon). Brynjolfsson and Smith (2000) argue that Internet price dispersion is largely due to retailer heterogeneity in branding, awareness and trust.

Bailey (1998) & Brynjolfsson and Smith (2000) both find that in Internet outlets there are significantly more frequent price adjustments and in smaller increments than in conventional outlets which reflects lower menu costs.

In the airline ticket market, Clemons et al. (2002) posit that the consumer search costs have been lowered because independent travel agents and more recently online travel agents (OTAs) have entered the market. However they still observe price dispersion in the range of 18% even after controlling for differences in quality. This price dispersion may result from price discrimination due to OTA's website design which segments consumers.

A form of skepticism about studies that show high online price dispersion is that it might be largely illusionary on the basis that posted prices are being used and these might not have been the actual prices the transactions happened. This might lead to an overestimation of price dispersion (Ghose and Yao 2011).

Baye et al. (2004) recognized the problem and in order to address the issue in their empirical study, they concentrated on the difference between the lowest and second lowest price rather than the difference of highest and lowest price to measure price dispersion. The comparison site they collected data from was charging a fee to post a price so it is irrational for firms to post a price in which a transaction would not occur. On the other hand, Brown and Goolsbee (2002) & Ghose and Yao (2011) chose to use transaction prices in their analysis.

In this chapter we found that search costs lower consumer search and are a major reason of why we observe dispersed prices in homogeneous product markets. In the next chapter we will cover additional reasons to why consumers might fail to select the lowest price and why they act passively to switching away when prices change

3.3 CONFUSION OVER PRICE COMPARISON AND INERTIA

When consumers want to purchase a product they have to go through three stages. First of all they must search for prices and information is power as Stigler (1961) first posited. After that, they have to choose the lowest price from the consideration set their research came up with and finally switch to other products when prices change. Grubb (2015) argues that consumers face obstacles through all those stages and they do not always choose the best price because they appear to search too little, become confused upon price comparison and show excessive inertia through not enough switching away from past choices or default options. Two additional reasons (except search costs) that may lead consumers to fail to choose the lowest price seller of a homogeneous product are:

- Confusion over product quality
- Confusion over complex price structure

Confusion over quality

Stigler (1961) argued that advertising by firms helps decrease search costs and thus reduces price dispersion in a market. Conversely advertising is not only meant to inform but to assist in price discrimination. Firms want their product to be distinguished from rival firms' product and they attempt to influence consumer confusion about quality through persuasive advertising. Consumers might not perceive that products are homogeneous and attribute imaginary differences to products.

In a study on the subject, Bronnenberg et al (forthcoming) seek to answer how the tendency to buy national brands varies with consumer information and expertise in physically homogeneous products categories. They cite an example where a 100-tablet package of 325mg Bayer Aspirin costs $6.29 and the same package of CVS store-brand aspirin costs $1.99 at cvs.com in 2013. Even though the two brands share the same

dosage, directions and active ingredient, evidence suggests that consumers are willing to pay three times more to buy Bayer.

More specifically in their remedy case study, they compare the purchasing behavior of informed consumers/experts (nurses, pharmacists, physicians) with average consumers. Remarkably, even after controlling for household income and other demographics, the average consumer devotes 74% of headache remedy purchases to store brands while pharmacists buy store brands 91% of the time. In a second case study of pantry staples (salt, sugar, and baking soda), they find that chefs buy brand name products 23% of the time, as compared to 40% for the average consumer. Bronnenberg et al (forthcoming) conclude that a sizeable portion of the brand premium in many health and food categories is due to misinformation about the quality difference.

If consumers misperceive homogeneous goods to be differentiated, there is no reason to expect that increasing the number of competitors will lower prices towards costs (Grubb 2015).

Confusion over price comparison

Additionally consumers may have trouble choosing the best price when prices are complex therefore firms try to exacerbate consumer confusion about prices through obfuscation. A typical practice of wireless firms is to offer dominated options (better services at a lower price).They present it in such a way that the dominance of a package/service is not transparent and it is highly likely that consumers choose the dominated option. This happens because comparing two packages usually requires comparing a vector of multiple pricing parameters.

Ellison and Ellison (2009) discuss various obfuscating practices by small firms selling computer parts through Pricewatch.com. Some are as simple as making product descriptions complicated and creating multiple versions of products. A more complicated practice is an add-on pricing scheme where poor quality goods are listed at low prices and websites are designed to convince costumers to upgrade to higher quality via add-ons. Furthermore, in Pricewatch.com firms practiced drip pricing by withholding “shipping and handling” fees until check out. In some instances shipping fees even accounted for 98 percent of the total price. Pricewatch.com battled price obfuscation by introducing a fixed amount fee for shipping and added a column warning

consumers about not reported fees. Ellison and Ellison (2009) argue that consumers should read the fine print and that obfuscation is an action that raises search costs and/or the fraction of consumers who incur search costs.

Economists developed models of equilibrium pricing where firms choose only prices and consumers observe them with noise. To add to that there are other models where firms not only choose prices but choose the price frame making it more difficult for consumers to compare. Grubb (2015) cites an example where "$5 per 8 oz." is the same price as "$10 per pound", but the two different units of measurement could correspond to different frames. This mix of prices and price frames results to consumer confusion and positive profits.

The first family of models assumes that consumers are more likely to misrank two prices when those prices are close together but the probability of making a mistake will reduce as those prices differ more.

The second family of models assumes that consumer confusion about price rankings is endogenous to both firms and consumers. Firms choose to obfuscate prices through complexity and consumers choose how much they will search to comprehend the pricing structure.

Spiegler (2006) develops a model of one consumer and N firms. He suggests that firms employ strategies with complex, multidimensional price vectors and consumers find it difficult to understand and evaluate this structure. Consumers usually try to simplify the whole problem in order to save time and energy by using "short-cuts". They sample a small number of price dimensions and choose the best-priced firm along this small sample. In this case, firms have an incentive to introduce variance in their distributions, meaning to price low on some dimensions to attract customers but to price high on others to extract surplus. Spiegler (2006) interprets such variance in pricing across dimensions as a form of obfuscation. He shows that by increasing the number of competitors in the market, firms will respond with strengthening their obfuscating tactics rather than with competitive pricing. In conclusion, he notes that increased competition may even cause consumer or social welfare to deteriorate.

Grubb(2015) provides evidence on the importance of price confusion from a case study of Mexico's privatized social security market. In 1997 all workers in Mexico

contributed a percentage of their income and had to choose among 17 firms who offered a homogeneous but differently priced retirement fund management plan (AFORE).The price of which had two components: an annual fee on balances and a flow fee on income. Even though 17 firms competed in the market, the result was high prices and high margins. The reason is that demand was price insensitive. Ranking AFORE prices is a challenging and a complex procedure for consumers to handle so they were unable to rank the prices from low to high.

In 2005 the market regulator, in order to help consumers, introduced a fee index that summarized the two price components into a single number. However it did not take into account individual's financial situation so the measure did not produce correct results for everyone. Consumers responded to the index, even when switching to an AFORE with a lower index actually meant paying higher fees. This shows that part of the price insensitivity reflects a lack of understanding prices. The introduction of the index reduced the fees paid marginally but raised dramatically the average fee paid by low-income individuals.

Grubb points out that the fee index is a contributing factor along with consumer inertia, to the failure of reducing average fees closer to cost.

Inertia

In the third stage of choice, consumers sometimes seem to be significantly passive and decide to maintain the same option even if prices and product attributes have changed which would make them pick something else if asked to pick for the first time. In other cases, inertia is exhibited by previous choice becoming a default option for future purchases.

The dominating opinion is that inertia raises prices however this is not generally true as some studies show. The key to understanding inertia and constructing policies to fight it, is detecting the sources behind it. Two primary sources of inertia are search and switching costs. Grubb (2015) notes that search costs are a more prevalent source than switching costs. He also distinguished some potential behavioral sources of inertia.

Consumers might perceive lower returns to search or inflate their search costs and will search less or not at all. When consumers are confused with price comparison,

they will probably remain inactive, keep their default option and will not switch away. The greater the complexity of choice, the less the motivation to act and make a choice. Switching costs may be psychological because consumers exhibit attachment to previous choices or particular brands. In addition, lack of action by consumers in all three stages of choice can be caused by inattention, prospective memory[5] and procrastination.

Handel (2013) studies the health plan choices for employees in a large US based firm and checks for the presence of inertia. His data set contains a major change in consumer's choice set meaning that at year t_o the firm altered the health plan offerings and demanded employees to actively choose from the new menu. He uses two descriptive tests and finds that employees' insignificant adjustment to large (price) changes was due to inertia. In the first test in order to reflect the price changes in t_1, he compared the behavior (choices) between the cohort of employees who joined the firm in t_o and the cohort that joined the firm in the following year t_1. Interestingly, 21% of t_0 new enrollees choose PPO_{250} at t_0 and 20% of this cohort choose PPO_{250} at t_1. On the other hand, new enrollees at t_1 choose PPO_{250} only 11% of the time. Even though all employees are virtually identical on all other demographic dimensions, the choices in these cohorts are not the same at year t_1. Very few t_o employees switched plans despite the price increase. This lack of switching reflects inertia. The second test showed that after the large price changes in year t_1, the option PPO_{250} became strictly dominated for certain employees however only 11% of them switched to an un-dominated plan due to considerable persistence in plan choice which was caused by inertia.

Grubb (2015) argues that Handel (2013) cannot identify different sources of inertia and his inertia is solely an outcome of an excessive switching cost per family. He notes that inertia might have emanated from employees being unaware of the price changes, avoiding switching due to confusing price comparisons and procrastinating or forgetting about enrollment deadlines.

[5] Prospective memory is a form of memory that involves remembering to perform a planned action or intention at some future point in time

Handel (2013) also examined a range of different policies to decrease inertia in his specific case, such as: targeted information provision, premium change alerts and simplified insurance plan benefit descriptions.

Policy interventions

In addition, Grubb (2015) suggests three possible policy interventions in order to improve market conditions and help consumers choose the best price. Firstly, market designers should try to simplify the choice environment in order to reduce the price complexity which leads to poor choices. A scalar price is simpler to compare than a vector however firms can shift to other forms of obfuscation. Empirical evidence (Ellison and Ellison, 2009) show that market designers face a grizzly task against firms' obfuscation efforts. In their study even though the internet retailer took measures against price obfuscation practices, evidence suggested obfuscation was ever present. In Baye et al. (2006a)'s study, the data was collected from the price comparison site, Shopper.com where firms have to pay Shopper.com a fixed monthly fee plus an additional fee per qualified lead[6]. The cost structure of Shopper.com provides deterrents for obfuscating pricing strategies because posting a low price for an unavailable product hoping that it will attract consumer traffic to one's site comes with a considerable cost.

Secondly, a regulator or a third party can provide or facilitate expert advice to increase market transparency like the fee index in Mexico's social security market or price comparison sites. However an expert although benevolent can give imperfect advice (e.g. limited information). Also an expert might not benevolently provide the best advice due to conflicts of interest (e.g. higher price translates to higher commissions).

Thirdly, a policy maker can choose the lowest price among homogeneous goods in behalf of the consumers. If not the policy maker can select a sensible default option for consumers but still allow them some freedom to opt out of that choice and pick something else.

[6] A click through by a consumer from the Shopper.com site to the merchant's site

3.4 MARKET STRUCTURE/MARKET COMPETITION

So far we have discussed four out of the five possible sources of price dispersion. Consumer heterogeneity is the basis of price discrimination and is positively related to price dispersion. Literature suggests that imperfect information due to consumer search costs are a major driver of price dispersion because consumers do not search enough and don't choose the best price which allows firms to set higher prices than others. Therefore higher search costs indicate price dispersion. But what about the relationship between competition, prices and price dispersion?

It is very uncommon to observe perfectly competitive markets. The majority of markets are oligopolistic where a few, large firms sell products and buyers have imperfect information especially about prices. In economics the limited number of firms allows the influence of determining market prices (firms are not price takers). Competition is very important in determining market prices and firms in market environments where market power exists are able to exercise price discrimination.

A commonly-held opinion is that increased competition among sellers generally has the effect of lowering prices and almost every economic model and empirical literature agree with this opinion. However Rosenthal (1980) and Stiglitz (1987) have created models where an increase in the number of sellers leads to a higher price.

Rosenthal (1980) uses a model similar to that of Varian (1980) and arrives at the result that a more competitive market can result in an increase in the average price. Stiglitz (1987) posited that with a larger number of competitors we may have higher prices, with the result depending on the assumptions regarding search costs. The reason behind the idea is that under the assumption of search models that searchers know the distribution of prices but not the location of specific prices, an increase in the number of competitors makes it more costly for searchers to find a low-cost seller.

Research has studied the effects of some important aspects of competition, as market concentration and the number of competitors in a market, on price dispersion. Most models of price dispersion predict that as the number of market participants increases, sellers' market power decreases and firms are less able to price discriminate. However Borenstein (1985) and Holmes (1989) created models indicating that price

discrimination may increase as market moves from monopoly to imperfect competition. In these price discrimination models if consumers are segmented based on their cross elasticity of demand among brands this will produce greater price dispersion if the market is more competitive. This is referred to as competitive type discrimination. When consumers are sorted based on their industry elasticity of demand they call it monopoly-type discrimination. Monopoly-type discrimination typically will generate greater price dispersion if the market is closer to monopoly. As we shall examine later,literature recognizes two opposing forces of market competition on price dispersion : the monopoly and the brand effect.

There are empirical evidence suggesting that price dispersion is an outcome of competition. For example, Baye et al. (2004) use price listings from an internet website where suppliers of a good advertise their product on a leading price comparison site. Their results show that price dispersion is an equilibrium phenomenon by using a clearinghouse framework and find systematic differences in the level of price dispersion depending on the number of firms.

The airline ticket industry (Borenstein and Rose 1994; Dai et al 2014; Dana 1999 Gaggero and Piga 2011; Gale 1993; Gerardi and Shapiro 2009; Hayes and Ross 1998; Stavins 2001) is a prime example of an industry where dispersed prices exist even though the market seems conducive to competition because online ticket comparison services and online ticket sellers existing together with the traditional selling channels. Other markets that economists empirically study for competition induced price dispersion include the retail gasoline market (Barron et al 2004; Lewis 2008; Png and Reitman 1994) and the grocery market (Walsh and Whelan 1999; Zhao 2006).

Every one of these empirical studies was largely influenced by the seminal work of Borenstein and Rose (1994) which was published in the Journal of Political Economy. They study airline ticket prices of eleven major U.S. airlines. In contrast with the notion that with increased market competition price dispersion decreases, they find that that price dispersion increased on routes with more competition. Their finding is consistent with models of monopolistic competitive price discrimination (Borenstein 1985; Holmes 1989). However some studies contradict the results of Borenstein and Rose (1994) or find ambiguous results as we shall examine in this chapter.

Theory on market competition's influence on price dispersion has been limited but the empirical literature on the subject is quite rich. We wish to shed more light to the existing theory and empirical literature.

4. PRICE DISPERSION AND MARKET COMPETITION

4.1 THEORETICAL ANALYSIS

In chapter 2.2 we argued that a necessary condition for price discrimination is market power. Classic economic theory argues that market power increases the firm's ability to sustain markups, and thus increases the firm's ability to implement price discrimination strategies. Intuition might suggest that in markets more densely populated with buyers, the resulting higher number of sellers would be associated with a "more competitive" market, characterized by lower prices and less price dispersion (Baye et al 2004). For instance, Dahlby and West (1986) find that the variance in real automobile insurance premiums decreases with the number of firms in the market.

The most straightforward way to examine the impact of competition on price dispersion from the classical textbook perspective is a Cournot model of third-degree price discrimination introduced by Stole (2007). In this model there are $j = 1, \dots, n$ firms with a constant marginal cost of production c but he assumes that the firms are active in $i = 1, \dots, m$ markets. As in every Cournot model, firms compete in output where each firm j simultaneously chooses the output for each of the i markets $\{q_1^j, \dots \dots \dots, q_m^j\}$

Q_i is the aggregate demand of each market and $p_i = D_i(Q_i)$ the demand curve of the market. For every market i, equilibrium quantities $\{q_1^*, \dots \dots \dots, q_m^*\}$ must satisfy

$$MC = D_i(nq_i^*) + D_i'(nq_i^*)q_i^* = p_i\left(1 - \frac{1}{n\varepsilon_i^m}\right)$$

Where ε_i^m is the market elasticity of segment.

Many observations can be derived from this framework but the one we are interested in is about the relationship between competition (the number of firms) and price dispersion. If each market segment has a constant demand elasticity, relative prices across market segments are constant in n and as a result an increase in the number of firms results to a decrease of absolute price dispersion. Interestingly, as in Chapter 2 the welfare effects are ambiguous. Price discrimination has positive effect when some markets are served under this regime but where not under uniform pricing. On the other hand it reduces welfare when total output remains unaffected.

Economic theory therefore predicts that more concentrated markets should be characterized by more price discrimination and subsequently more price dispersion. However, a number of theoretical studies have shown that this may not be the case. Borenstein (1985) and Holmes (1989) show that the existence of brand loyalty in imperfectly competitive markets could create a negative relationship between concentration and price dispersion.

More specifically Borenstein (1985) and Holmes(1989) predict that price dispersion among sellers should decrease with increased competition if industry elasticities are the more prevalent basis of segregation(monopoly-type discrimination) and price dispersion should increase when competition increases if heterogeneity in cross elasticity is the more common source of price discrimination(competitive-type).

Economic researchers empirically study price dispersion in the airline industry due to the nature of airfare structure in order to better understand the drivers of price dispersion. A major study on the effect of market competition on price dispersion was provided by Borenstein and Rose (1994) who analyze price dispersion of airline tickets charged to different passengers on the same route. Their most striking and important finding is the significant positive effect of competition on price dispersion. They find that dispersion increases on routes with more competition or lower flight density.

A theoretical model of airline price discrimination to study the relationship between market structure and price dispersion is developed by Gale (1993). He assumes

there are two flights operating on a particular route, one in the morning and one in the afternoon, which are offered by a single airline or by two independent airlines. He subsequently compares the equilibrium results of a non-cooperative duopoly and a monopoly and shows that there is more price discrimination in the non-cooperative duopoly. The increased dispersion in the non-cooperative duopoly is due to competition between the two airlines for consumers who are more time sensitive. His results are consistent with the empirical analysis of Borenstein (1989) in the US airline market which points out that price dispersion drops as concentration rises in the market. He also provides a welfare analysis and shows that welfare could be lower under duopoly because of the inefficient allocation of output.

In the literature we distinguish two opposing effects of competition on price dispersion: the monopoly effect and the brand effect.

The monopoly effect has to do with the impact of market competition on a firm's ability to maintain a markup over marginal cost. It predicts that an increase in competition lowers the markup on the price inelastic consumers (business passengers) closer to the level of prices charged to price elastic consumers (leisure passengers). This erodes the firm's ability to price discriminate thus leading to lower price dispersion.

Opposite to that, the brand effect relies on the fact that heterogeneous consumers who differ in their degree of brand loyalty exist in multi-product markets. Price inelastic consumers usually have more brand loyalty, and get charged more, than price elastic consumers who are more price sensitive. Brand effect suggests that increased competition will reduce the (lower) prices of leisure passengers while leaving the (higher) prices of business travelers unchanged. Thus resulting in higher price dispersion as well as more price discrimination.

In addition, Dai et al (2014) also identify two opposing forces of competition on price dispersion: the direct price effect and the indirect quality effect.

The direct price effect refers to the change in prices holding qualities fixed and the indirect quality effect looks at the impact of quality change on prices. As competition intensifies the direct effect increases price dispersion because the low-quality product price will fall by a greater percentage, due to competition, than the high-quality product. However competition will drive firms to differentiate themselves on quality and enhance the quality of the low-end product, the high-quality product has a fixed quality

at the efficient level (no distortion at the top).Higher quality means a higher price for the low-quality product which results in lower price dispersion. They find that the direct effect dominates on price levels (prices fall as competition intensifies) but not on price dispersion.

As you can see theoretical models do no provide a direct answer on the sign of the effect of market structure on price dispersion. Stole(2007) proves than the increase in the number of firms leads to an increase in price dispersion but Borenstein (1985), Holmes (1989), and Gale (1993) show that price discrimination may increase as the market becomes more competitive. Gerardi and Shapiro (2009) believe that since there is no predominant theoretical model dictating the relationship between market structure and price dispersion, it then becomes a matter of empirical analysis.

In order to empirically test the relationship between market structure and price dispersion, researchers create econometric models and regress a set of variables. In these regressions the dependent variable is price dispersion which is measured mostly with the Gini coefficient or transformed versions of it and rarely the variance of prices (Marvel 1976; Carlson and McAfee 1983). They regress price dispersion on market structure variables such as market concentration, number of firms while controlling for include cost, population, product and other market characteristics.

Market competition is inversely related to market concentration meaning that less concentrated markets exhibit more intense competition. Market concentration is typically measured by the Hirschman Herfindahl Index (also referred to as the Herfindahl index in some studies) which is defined as the sum of squared market shares of all firms. It takes into account both the number of firms and their market share inequality. For instance, Gerardi and Shapiro (2009) in their study find that the average HHI of airline routes is between 0.72 and 0.78 and that the average number of competitors per route has decreased between 1993 and 2006 from 3.0 to 2.6 which indicates a very concentrated market. Market concentration is one of the independent variables applied by Borenstein and Rose (1994),Hayes and Ross(1998) and Zhao to evaluate the effect on price dispersion. Hayes and Ross(1998) calculated the HHI based on the number on passengers served by airlines within the terminal, Borenstein and

Rose(1994) calculated it based on then number of passengers of specific flights on a given city-pair route. Zhao (2006) used the sales of brands of specific product categories to measure the HHI index. Every one of these studies found that price dispersion has a negative correlation with concentration or in simpler words that in more concentrated markets, price dispersion tends to be reduced.
Other studies like Lewis (2008) and Carlson and McAfee (1983) just use the number of competitors as a measure of competition in a market and study the effect it has on prices and price dispersion.

Lijesen and Van der Voort (2011) argue that the HHI does not correctly reflect the impact of competition on price dispersion and use a decomposed version of it in their study in order to distinguish between the effect of the number of competitors and the effect of market share inequality on price dispersion. Clerides and Michis(2006) cannot construct the precise Herfindahl index due to the complexity of their data and proceed by calculating two different versions of the HHI.

In order to measure price dispersion, economic researchers use the variance of price or more commonly the Gini coefficient which ranges from 0 to 1. This coefficient reflects inequality across the entire range of prices and its exact formula varies from study to study. In the study of Gaggero and Piga(2011) the average Gini is approximately 0.35,in Gerardi and Shapiro(2009) 0.22 and in Borenstein and Rose(1994) 0.18. The expected absolute difference in prices as a proportion of the mean price for two customers drawn at random from a population can be given if we multiply the Gini coefficient by two. This means that expected difference in fares between two random passengers on a given flight is on average 36 percent of the airline's average ticket fare in Borenstein and Rose (1994).

Hayes and Ross (1998) & Gaggero and Piga (2011) use three different measures of inequality: the Gini coefficient, the Atkinson index and the Entropy claiming that the joint evaluation will boost the robustness and reliability of their results. For the reason that each index places different weight to a different part of the price distribution with the Atkinson index being more sensitive to the upper end, the Gini coefficient giving more weight to the central part and the Entropy index placing more weight on the lower part of the distribution.

4.2 EMPIRICAL EVIDENCE ON THE RELATIONSHIP BETWEEN PRICE DISPERSION AND MARKET COMPETITION

Airlines use complex advanced second degree price discrimination in order to have travelers self-select themselves to the most appropriate price. Airline pricing has drawn the attention of economic researchers because of the importance of price discrimination in airline fare structures, the availability and abundance of data. Price dispersion in this market arises because airlines engage in price discrimination strategies, which consist in dividing passengers according to their price elasticity and charging them a different fare. Price discrimination indicates some degree of market power and research has shown that competition among firms affects price dispersion.

Gerardi and Shapiro (2009) & Gaggero and Piga (2011) use the same tools to measure price dispersion and market concentration as Borenstein and Rose (1994) but opposite to them, they find a positive effect of market concentration on fare dispersion. They identify two conflicting forces of competition on price dispersion and the final sign of the relationship depends on which force dominates.

Evidence in support of classic economic theory

We will now discuss the empirical literature that offers support to classic economic theory which suggests that price dispersion and market competition are negatively correlated.

Gerardi and Shapiro (2009) show that market concentration has a significant positive effect on price dispersion, in contrast with the findings of Borenstein and Rose (1994). After controlling for time-invariant, route-specific effects they find that an increase in the number of carriers on a route results to decreased price dispersion which led them to believe that the findings of Borenstein and Rose suffer from bias due to an omitted variable (e.g. plane size) and an invalid instrument (distance).
Their results indicate that competition hinders the ability of a carrier to price discriminate and segment markets which indicates a dominance of the monopoly effect. In addition, they find that the impact of competition on price dispersion is greater on

routes with a mixture of business and leisure travelers than on routes with a homogeneous consumer base.

They use a sample of over 80.000 observations on prices from nine major U.S carriers over the period 1993 to 2006 , a decade after Borenstein and Rose(1994)'s study data, which might constitute a reason for the contradicting results. During that time the U.S airline market faced many and rather important changes in competition, demand and cost due to increases in oil price, the recession and terrorist attacks in the early 2000's. This led large carriers to declare bankruptcy and allowed low cost carriers to enter the market reducing the large carriers' market share.

However Gerardi and Shapiro (2009) indicate that besides price discrimination, peak load pricing, demand uncertainty and fare wars are other sources of price dispersion in the airline ticket market.

Empirical studies on the airfare price dispersion mainly focus on the U.S. airline market (Borenstein 1989; Borenstein and Rose 1994; Hayes and Ross 1998; Stavins 2001; Gerardi and Shapiro 2009;Dai et al 2014). However Gaggero and Piga(2011) use data on European markets, more specifically fares posted online for flights operated between the UK and the Republic of Ireland during the period 1st June 2003 and 31st December 2004. They find that market competition has a negative and significant impact on price dispersion which provides strong evidence in favor of the monopoly effect. They show that price dispersion intensifies in more concentrated markets where few firms with a large market share on a route exist. Firms can extract consumer surplus from last-minute passengers by price discriminating without having much concern about competitors' pricing strategies. In their sample the brand effect is weak because of little incentive for consumer loyalty to low cost airlines (no frequent flyer programs) and monopoly effect dominates.

Their analysis lends support to the EU Competition Commission's decision to block the merger of Aer Lingus and Ryanair because it would hinder competition in the Irish airline market by creating a dominant position thus harming certain segments of consumers.

Barron et al. (2004) empirically examine the relationship between the number of competitors, average prices and price dispersion for a frequently purchased, homogeneous good: the regular unleaded gasoline. They collected data about prices

and characteristics of every gasoline station in four different geographical market areas. Their price data was obtained on a single day in 1997 which varies across areas. They find that stations with a greater number of competitors have insignificantly lower average prices (e.g. a 50% increase in the number of competitors leads to an approximate 0.5% decrease in average prices). However even after controlling for brand and station characteristics they find a significant negative relationship between seller density and price dispersion. A higher number of stations within a 1.5 mile radius is associated with both lower average price and lower levels of price dispersion.
Barron et al (2004) conclude that observed patterns of price dispersion are consistent with models of spatial competition rather than models of imperfect information and consumer search (Carlson and McAfee 1983; Varian 1980).

The first empirical study of price dispersion that examines how price dispersion varies with market structure on the Internet is offered by Baye et al (2004). They base their empirical analysis on 4 million daily price listings by different merchants selling the most popular 1,000 products at Shopper.com during the period from August 2, 2000 until March 31, 2001. They find systematic differences in the level of price dispersion and prices depending on the number of firms. Specifically, average prices are greater when few firms post prices and price dispersion declines dramatically from 22% to 3% as the number of firms listing prices increases from 2 to 15 or more.
They find no evidence of any convergence to the law of one price and they believe that the increase of insurance companies listing rates at price comparison sites can explain the price declines in Brown and Goolsbee (2002).

Empirical evidence on the positive relationship between P.D and M.C

Economic intuition dictates that as competition increases, firms are less able to price discriminate and as a result price dispersion decreases and very few empirical studies (Barron et al. 2004; Baye et al. 2004; Gaggero and Piga 2011; Gerardi and Shapiro 2009) support that notion. In contrast to than intuition Borenstein (1985), Holmes (1989) and Gale (1993) show that price discrimination and price dispersion increase as market become more competitive. For example, in Gale's theoretical model there is more price discrimination under duopoly than under monopoly. Empirical

literature started to arise after the seminal article of Borenstein and Rose (1994) in which they analyze pricing of U.S. airlines to evaluate the effect of competition on price dispersion and find a significant positive effect of competition on price dispersion. Empirical studies that verify the findings of Borenstein and Rose (1994) and the dominance of the brand effect show that firms price discount more on the price elastic consumers than on price inelastic when competition increases which leads to an increase in price dispersion.

Earlier than Borenstein and Rose (1994) however an empirical study (Marvel 1976) and a theoretical model (Carlson and McAfee 1983) which focused on consumer search costs and information as a source of price dispersion, also found evidence on the relationship between market structure and price dispersion. Marvel (1976) uses price data on the retail gasoline market from 1964 through the middle of 1971 and the Herfindahl index (various brands' sales market shares) appears as an independent variable in his regression equation. He finds that competition and price dispersion are positively related, more particularly that in more concentrated markets there is less observed price dispersion. Carlson and McAfee (1983) construct an equilibrium model and test how changes in parameters (e.g. the number of firms, density of consumer search costs) affect the average price and price dispersion. They find that, ceteris paribus, an increase in the number of firms will increase the variance of prices.

Borenstein (1989) analyzes the effects of route and airport dominance on the prices that an airline charges and while doing so, he finds indirect evidence of the negative relationship between market concentration and price dispersion. He uses a data set that includes observations on the nine largest U.S airlines during the third quarter of 1987.In one set of regressions he regresses the 20th, 50th and 80th percentile prices for each airline-route combination on market structure variables (HHI constructed from carrier shares in the market) and other independent variables meant to control for cost and quality factors. He shows that increasing route concentration tends to raise the firm's 20th and 50th percentile prices, while lowering the 80th percentile price. In simpler words, decreased competition (higher concentration) appears to raise lower end-fares but lowers high-end fares which results in a decrease of price dispersion. Borenstein (1989)’s empirical findings appear to be in favor of the brand effect we discussed earlier.

Borenstein and Rose (1994) use ticket and price data from the Databank 1A (DB1A) of the Department of Transportations's Origin and Destination Survey for the second quarter of 1986, similarly to Borenstein (1989). Borenstein and Rose (1994) believe that airline fare dispersion arises from cost variations of serving different passengers but also from discriminatory pricing and try to distinguish which is the primary source. In addition they try to measure the effects of market structure on observed price dispersion by using market concentration (HHI) and discrete structure variables (monopoly, duopoly and competitive market).They confirm their theoretical predictions of competitive-type discrimination and reject monopoly-type as the dominant source of airline price dispersion. They find that routes characterized by higher levels of competition exhibit more price dispersion. They attribute this result to airline pricing practices that are based on exploiting heterogeneity in customers' brand preferences. More specifically because business travelers remain loyal to an airline and ignore lower airfare offered by competitors.

In their study they measure market density by the total number of flights on the route and find that higher market density and higher concentration of tourist traffic appears to reduce price dispersion. Their results are again consistent with models of monopolistically competitive price dispersion (Borenstein 1985; Holmes 1989)

Dana(1999) extends Prescott's(1975) model to monopoly and oligopoly market structures in which they use capacity constraints and aggregate demand uncertainty to explain why firms sell their homogeneous output in multiple prices. His model predicts dispersed price equilibria where firms strategically sell at multiple prices instead of randomizing as in Varian (1980). In contrast with traditional economic theory, he shows that price dispersion increases with the number of firms. In order to find that he compares the outcome of monopoly with the outcome of imperfect competition and finds that prices become more dispersed as markets become more competitive. Dana findings are in accordance with Borenstein and Rose (1994) who find a positive relationship between price dispersion and competition. In addition he offers complementary explanations to airline price dispersion besides price discrimination such as price rigidities, costly capacity (perishable nature of goods) and demand uncertainty.

Stavins (2001) examines whether higher market concentration leads to lower price discrimination in the airline market. She uses a cross sectional data sample of tickets of different US carriers for flights operated on the same day and on different domestic routes and interestingly she includes the time of ticket purchase (ranging from 35 to 2 days in advance of departure). Price discrimination is measured with the effect of ticket restrictions on airfare and for that reason in her empirical analysis four types of ticket restrictions are being used: advance-purchase requirements, cancellation penalties, Saturday night stay-over requirements and "other" unspecified restrictions. In order to measure each carrier's market share and construct the HHI index, she uses the number of direct flights on each route. She finds that price discrimination and price dispersion on a particular route decrease with market concentration. Stavins' (2001) main idea is that as more carriers operate in a given market, competition for leisure travelers increases and greater discounts are being given as a result, while fares charged to business travelers remain essentially unchanged.

Du et al. (2014) analyze how exogenous demand interventions affect price dispersion in the Chinese air market through two major events: the introduction of a High Speed Railway (July 1st 2011) and the Wenzhou High Speed train crash (July 23rd 2011). The Beijing-Shanghai itinerary was dominated by airline transportation and the opening of the high speed railway reduced the demand as it was considered a substitute by consumers and it made the airline market more competitive. On the other hand the train accident cushioned the downward demand shock by the introduction of the railway and softened the competition among airlines.

Using ticket and price information data collected from June 20th to August 3rd, 2011 , they find strong evidence to support the notion that the brand effect dominates .They establish a positive relationship between market competition and price dispersion in the airline market along the railway area. Their results indicate that price dispersion increases significantly after the introduction of High Speed Railway as the market becomes more competitive but decreases after the train accident when market competition lessens.

In accordance with the brand effect discussed by Gerardi and Shapiro(2009) and the findings of Stavins (2001),Du et al. (2014) believe that when the competition intensifies, a firm discounts more on the elastic consumers than on the inelastic consumers(more brand loyalty) and therefore price dispersion increases.

Lijesen and Van den Voort (2011) construct a Hotelling type spatial competition model and test their theoretical findings using airline ticket fare data collected on a daily basis for 12 markets originating in Europe. They argue that when the HHI is used to measure market concentration it will not correctly reflect the impact of competition on price dispersion so they propose a decomposed index. They show dispersion is mainly caused by unobserved asymmetry in product differentiation and that is more related to the absence of market share than with the concentration of the market. However their empirical results on price dispersion are consistent with the findings of Dana (1999). They find price dispersion to increase in the number of firms signaling a positive correlation between price dispersion and competition.

Dana (1999) and Stavins (2001) suggest the tariff rule that requires the passing of a night from Saturday to Sunday as a way of segmenting customers into those who travel for business and those who travel for leisure. Stavins finds that ticket restrictions, in the form of Saturday night stay-over and advance-purchase requirements, have a significant and negative effect on prices. Borenstein and Rose (1994) had previously found that the high concentration of leisure traffic is associated with lower levels of price dispersion. Lijesen and Voort (2011) in their study on intra-European air travel, find that the travel on Saturdays and Sundays had a negative impact on price dispersion.

The relationship between competition and price dispersion has also been studied in other industries besides airlines. Png and Reitman (1994) develop a model of service time competition and empirically investigate whether firms differentiate themselves on service time when facing direct competition in the retail gasoline market. They use Shepard (1991)'s station level data from four eastern Massachusetts counties collected over 12 weeks in 1987.Their theoretical analysis stress that we observe dispersed prices because some stations set higher prices and thereby offer shorter queues, whereas others offer lower price and longer queues. In order to test their theoretical predictions they compare the degree of price dispersion at stations that face more direct competition with dispersion at stations facing less competition. Their main finding is that prices are more dispersed in markets with a greater number of competitors, supporting their service-time differentiation hypothesis.

This dissertation is largely based on the study of Zhao (2006) who investigates three potential sources of price dispersion: consumer search costs, consumer heterogeneity and competition. We have already discussed that she found price dispersion to be greater when search costs are higher and consumer heterogeneity is greater. Zhao (2006) data are drawn from a suburban area of Chicago covering a two-year period (June 1991-June 1993) and an interesting fact revealed by the data is that a new store enters the market at week 85. This allows her to create a dummy variable to capture the increase in competition resulting from the entry of a new store and test for the relationship between competition and price dispersion in the market. Alongside the dummy variable, Zhao (2006) uses a lagged version of the Herfindahl Index. She finds that the coefficient of the HHI index is negative and significant which is consistent with Borenstein and Rose (1994) and that the entry of a new store has a positive but not significant effect on price dispersion. As the Herfindahl index increases, competition decreases, which leads to decreases in price dispersion across stores.

Zhao (2006) recognizes that there is a small number of stores in her data and her results might not reflect the truth so she studies price dispersion over time for the same product at the same store. In order to capture the effect of relevant competing stores that are not included in the data. She still finds that price dispersion over time for a product in a store increases as competition across stores increases.

Similarly to Png and Reitman (1994), Zhao (2006) suggests that price dispersion for the same product across stores may increase as store competition increases and stores are more vertically differentiated from each other because of the competition.

Moving to the Irish grocery market now, Walsh and Whelan (1999) try to investigate whether the observed dispersion in the market price of related brands is an outcome of "monopoly type" or "competitive type" pricing of brands over heterogeneous consumer groups. In order to examine the patterns of price dispersion they use the empirical methodology of Borenstein and Rose (1994) and utilize a rich data set of bimonthly data spanning from October 1992 to October 1995. They find evidence of competitive type pricing and estimate that price dispersion over the retail price of related brands will increase with competition when conditioned on brand distribution structures.

Busse and Rysman (2005) examine advertising rates in yellow pages directories because firms use non-linear pricing, making second degree price discrimination clearly evident in the market. Using a data set consisting of almost all Yellow Pages directories in the United States in 1997, they find that competition acts to increase price dispersion in Yellow Pages advertising. The main reason is that price schedules involve size discounts and increased competition between directories leads firms to discount more leading to lower prices but a higher degree of price dispersion (and price discrimination).

Mixed relationship

So far it is clear that competition affects price dispersion but the sign of the effect is not clear and depends on the results of the empirical analysis. Economists cannot yet determine with absolute certainty that competition has either a positive or a negative effect on price dispersion. Interestingly, we wish to end this dissertation by discussing the existence of some empirical studies that do not yield an inverse U or mixed relationship between market concentration/market competition and price dispersion.

Hayes and Ross (1998) point out the extensive dispersion of airfares in the US airline market and try to attribute it to different sources such as price discrimination. Despite the fact that they use three alternative measures to capture all the aspects of price dispersion, they do not find a straightforward connection between market structure and price dispersion. Their results differ from those of Borenstein and Rose (1994) because Hayes and Ross' data of 1332 observations were taken during industry turmoil in the early 1990's instead of the mid 80's when air carriers enjoyed significant market power. They find that price dispersion is mostly due to peak-load pricing and fare wars (desperate carriers in the brink of bankruptcy offering discounted fares). In addition, competition from Southwest Airlines reduced competition.

Dai et al. (2014) examine the correlation between price dispersion and market structure by developing a theoretical model that generates an inverse-U relationship. Their empirical analysis on a rich dataset from the US airline markets in the period

1993-2008 proves the existence of such a relationship. They show that price dispersion increases with competition in concentrated markets and decreases with competition in less concentrated markets. At first, the Gini coefficient they use rises as we go from a monopoly (most concentrated market with HHI index equal to 1) setting to a duopoly market (highest level of price dispersion with the average Gini coefficient equal to 0.238). However it then declines when competition increases and we move from a duopoly to a competitive market (least concentrated market).
They identify two opposing forces of competition on price dispersion: the direct price effect and the indirect quality effect which we talked about earlier. They find that the direct effect dominates on price levels (prices fall as competition intensifies) but not on price dispersion.

The mixed role of competition on price dispersion has been documented in other markets such as the market for retail gasoline (Lewis 2008) and detergents (Clerides and Michis 2006). Clerides and Michis (2006) use price and sales data in six countries to investigate the relationship between price dispersion and competition in the market for detergents. Their analysis yields mixed results as they find a positive relationship for two countries, a negative in three countries and no relationship in another country. They find that price dispersion rises at low values of concentration, drops at intermediate values and then rises again as we approach monopoly. They believe that differences in the level of maturity in each market may play an important role to the variety in results across countries.

Lewis (2008) measures price dispersion among differentiated retail gasoline sellers and tests how sensitive the relationship between dispersion and the local competitive environment is. He uses weekly posted retail prices for 327 stations in the San Diego area and creates two groups of gasoline stations for his empirical study. A high-brand group made up of premium branded stations and a low-brand group consisting of low-priced and independent stations. His empirical results reveal that considerable price variation remains even after controlling for product and station differences and that stations' prices change frequently relative to one another in order to create some consumer information imperfection about the price distribution. He finds a complex relationship between price dispersion and seller density which varies across different types of stations. More specifically, price dispersion is higher for high-brand

stations when there are lot more competing low-brand stations in a local vicinity. However, price dispersion is lower for both high-brand and low-brand stations when there are more competitors of their own type nearby. Lewis (2008) believes that theoretical models of price dispersion would produce more accurate results by incorporating seller differentiation in their analysis.

5. CONCLUSIONS

The law of one price is almost never empirically valid since studies show price dispersion in online and traditional markets. The law of one price is primarily rejected due to price discrimination. In the presence of market power and in the absence of arbitrage, firms are able to price discriminate mostly in the second degree by offering different packages/options for consumers to "self-select" and in the third degree. Firms use price discrimination in order to increase their profits by extracting consumer surplus and economic theory condemns upon it as a social harmful practice.

Unlike initial intuition we find that price discrimination may increase social welfare when total output increases or when a market opens up under price discrimination that was not previously served under uniform pricing. When engaging in third degree price discrimination firms use the inverse elasticity rule which dictates that a higher price will be charged at the more inelastic group or "market" .Optimal pricing depends on market and cross price elasticities which translate to consumer preferences and consumer heterogeneity determining the range of prices.

Firms are able to price discriminate based on consumer heterogeneity (price elasticities, reservation prices) and we find that price discrimination increases as the variation of attributes in consumer demographics increases resulting to greater price dispersion. Price dispersion can also arise due to consumer differences in willingness to pay and differences in the level of information about prices.

Information is costly to gather and so we recognize consumer search costs as the second important source of price dispersion. The majority of search models when assuming positive search costs yields equilibrium price dispersion. Empirical literature

suggests that price dispersion can persist in markets in which there is imperfect information and consumers incur search costs to obtain price information. As consumers incur search costs to get information, some consumers will engage in price searching and others will make purchases in random. Consumers will stop price searching when the perceived search costs exceed the anticipated price reduction thus usually failing to choose the lowest (best) price. This allows firms to charge different and higher prices in equilibrium, therefore we observe price dispersion in markets. We find that a decrease in search costs and an increase in the purchase frequency reduces price dispersion.

Even though the internet is a powerful tool in the hands of consumers and has the potential to reduce search costs making markets more "friction-free", empirical evidence suggest that price dispersion online is significant and persistent. In some cases online markets exhibit more price dispersion than traditional markets however we find that the Internet has succeeded in reducing prices in online and offline markets which saves lots of millions of consumer surplus. A major reason the internet has not yet successful in providing frictionless markets is because firms intensify consumer confusion about prices through obfuscation mechanisms in price comparison sites. We recognized another two reasons of why consumers fail to choose the best price which are confusion over price comparison and search cost induced inertia.

Consumers become confused over quality due to misinformation about quality differences and are sometimes willing to pay a premium in order to buy a brand product. Apart from price obfuscating practices, firms use complex, multidimensional price vectors making it more challenging for consumers to evaluate and compare prices. Search and switching costs cause inertia and consumers exhibit too little switching away from past choices or default options. Simplifying the choice environment, facilitating expert advice or a benevolent policy maker choosing in behalf of the consumer could improve market conditions and help consumer make a better choice.

Lastly but not least we discussed market competition (or by its inverse index market concentration) as a source of price dispersion. The relationship between competition and prices is pretty straightforward and negative however as our research showed the effect on price dispersion is ambiguous. Traditional industrial organization dictates a negative correlation between the number of firms and price dispersion. More specifically an increase in the number of sellers would make it more difficult for the firm to sustain markups thus hindering its ability to price discriminate resulting in less

price dispersion. However newer theoretical models showed that price dispersion among sellers may increase as the market becomes more competitive if brand loyalty exists. We distinguish two opposing effect of competition on price dispersion: the monopoly effect and the brand effect.

The monopoly effect supports the classic theory approach and predicts that an increase in competition acts to reduce the markup associated with goods bought by price-inelastic consumers to a level more in line with the prices charged to price-elastic consumers, resulting in less price dispersion. On the other hand, the brand effect relies on the fact price-inelastic consumers have more brand loyalty and get charged more than the price-elastic who are more price sensitive. An increase in competition would result in lower prices for the price-elastic while leaving prices for the price-inelastic essentially unchanged. Consequently increased competition under the brand effect leads to higher price dispersion.

We then moved to the empirical literature where the majority of studies focuses on the airline industry because airlines use advanced second degree price discrimination in their airfare structure. We found empirical evidence to support the positive relationship between competition and price dispersion, because firms discount more on the price elastic than on the price inelastic when competition increases. Nevertheless a few studies were presented in which the monopoly effect dominated. In addition there were studies to show an inverse U-relationship or unclear results.

We determine that since there is no principal theoretical model, the relationship between market structure and price dispersion becomes an empirical question.

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