Master Degree in Specialized Economic Analysis

WELFARE EFFECTS OF PRICE DISCRIMINATION: THE IMPACT OF BIG DATA

Authors:
Samira Branco & Amélie Brossard-Ruffey

Director: Anna Merino

June 2017
ABSTRACT IN ENGLISH:

The emerging practice of price discrimination based on Big Data will enable firms, especially online retailers to increase their profitability while consumers fear to be the losers of the game. A study of Netflix services demonstrated that a surprisingly restricted number of explanatory variables allow for efficient tailored-prices. We explain that with this technology sellers will be able to approximate consumers’ reservation utility and engage in what we call an almost perfect price discrimination. If it is still superior to buy the good, overall welfare effects depend on the competitive landscape and characteristics of the mass of consumers. Positive effects for consumers are possible but subject to specific assumptions. The most challenging one for antitrust analysis is the access of data and the interaction between retailing firms and data brokers. Part of our work applies the theoretical discussion to the insurance sector.

ABSTRACT IN CATALAN:

La pràctica emergent de discriminació de preus basada en Big Data permetrà les companyies, especialment de venda online, d’incrementar la seva rentabilitat mentre els consumidors temen sortir-hi perdent. Un estudi de Netflix demostrà que un nombre sorprenentment restringit de variables explicatives permetia generar uns preus customitzats i eficients. Nosaltres expliquem que, amb aquesta tecnologia, els venedors seràn capaços d’abordar les restriccions dels consumidors i establir el que nosaltres anomenem discriminació de preus quasi-perfecte. Si encara és més important comprar el producte, els efectes generals del benestar depèndran en el panorama de la competència i en les característiques de la massa de consumidors. Hi pot haver efectes positius per als consumidors, però estaràn subjectes a suposicions concretes. La que presenta un major repte per a l’anàlisi anti-monopoli és l’accés a les dades i a la interacció entre companyies al detall i “brokers” de dades. Part del nostre treball aplica la discussió teòrica al sector d’assegurances.
“Welfare effects of price discrimination: the impact of Big Data”

Samira Branco
Amélie Brossard-Ruffey

Master in Economic Analysis specialized in Competition and Regulated Markets
2016/2017
Abstract

The emerging practice of price discrimination based on Big Data will enable firms, especially online retailers, to increase their profitability while consumers fear to be the losers of the game. A study of Netflix services demonstrated that a surprisingly restricted number of explanatory variables allow for efficient tailored-prices. We explain that with this technology sellers will be able to approximate consumers’ reservation utility and engage in what we call an almost perfect price discrimination. If it is still superior to buy the good, overall welfare effects depend on the competitive landscape and characteristics of the mass of consumers. Positive effects for consumers are possible but subject to specific assumptions. The most challenging one for antitrust analysis is the access of data and the interaction between retailing firms and data brokers. Part of our work applies the theoretical discussion to the insurance sector.
Table of Content

1. Introduction .................................................................................................................................. p 4
2. The New way of price discriminating based on Big Data ......................................................... p 5
   3.1. Market power ....................................................................................................................... p 8
   3.2. Access to Data ...................................................................................................................... p 8
   3.3. Impossibility of Arbitrage .................................................................................................. p 9
   3.4. Price Opacity ..................................................................................................................... p 11
4. Welfare in the context of Perfect Price discrimination .......................................................... p 12
   4.1. Almost Perfect Price discrimination, Competition and Ambiguity on Total Surplus p 12
   4.2. Monopoly ........................................................................................................................... p 13
   4.3. Oligopoly ............................................................................................................................ p 13
       4.3.1. (A)symmetry in assessment : The case of “best-response symmetry” ......................... p 14
       4.3.2. Impossible to disentangle factors of symmetry and asymmetry ................................ p 15
       4.3.3. Implication for mergers ............................................................................................. p 17
5. Fairness and privacy : non-economic factors that affect consumers surplus ................................ ................................................................................................................................. p 18
   5.1. Social consensus around uniform price .......................................................................... p 18
   5.2. Keep up with the Joneses .................................................................................................. p 18
   5.3. Ethic .................................................................................................................................... p 19
   5.4. Consumer Ignorance ......................................................................................................... p 19
   5.5. Privacy and Consumer harm ........................................................................................... p 19
       5.5.1. Is privacy so important ? .......................................................................................... p 20
6. Insurance .................................................................................................................................... p 21
7. Conclusion ................................................................................................................................... p 28
Bibliography ...................................................................................................................................... p 30
1. Introduction

On Tuesday March 28th, US Congress suspended the privacy of data in order to free innovation and business. Data represent an extremely valuable asset for companies, in this case for Internet Service Providers (ISP). Leveraging the deregulation spirit toward the tech sector lingering over Washington, ISP gained control over their consumers’ data and are legally allowed to exploit or sell them for juicy practices such as online advertising or, more innovatively, price discrimination.

On the other side of the Atlantic Ocean, in May 2017, the French Data Privacy Regulator and internet watchdog admonished Facebook and inflicted a €150,000 fine for massively combining personal data for ad targeting without legal basis and clear consent from internet users¹.

As shown by these two examples, there are many tensions regarding big data: it will enable firms to increase their profitability while consumers fear to be the losers of the game.

This thesis will address the effects on Welfare and on competition of price discrimination allowed by the use of Big Data.

The first part will provide a brief explanation of the theory of price discrimination, and show what can change with the intensive use of Big Data. On the second part, some conditions that allow for price discrimination will be presented. Once exposed the key concepts, the third part will assess the repercussions on welfare, considering different market structures and levels of data access and analysis tools. Some possible merger effects will also be addressed on the third part as well as other features such as fairness considerations and preferences for privacy. Those are related to the use of Big Data and can affect consumer’s welfare but are not captured by the pure economic models. In the last part, all those concepts will be illustrated in the assessment of the Insurance industry.

¹ Robinson, R. “Facebook fined €150k by French regulator over privacy breach.” Financial Times, May 16, 2017. https://www.ft.com/content/36fff550-1e4e-3bc7-b602-ab1d48876e36
2. The New way of price discriminating based on Big Data

The collection of Big Data opens the door for firms and especially online retailers to price discriminate almost perfectly.

Price discrimination is defined by the fact of charging a different price for the same product to different buyers based on their willingness to pay.

The old price discrimination and the new price discrimination:

Traditionally, economic theory defines three degrees of price discrimination, initially based on Pigou (1932)\(^2\). A first degree, also called perfect price discrimination, involves the charge of a singular price equal to each consumer willingness to pay, extracting its entire surplus. On the second degree, prices change with the quantity bought. On the third degree, the monopolist classifies consumers within groups and each group pay a different price, for instance groups can be business travellers and tourists, students and non-students, male or female.

The variety and quantity of information released while navigating today on the Internet (from geolocation, financial situation, app and browsers history to communication content) and tomorrow thanks to the Internet of Things constitutes the digital shadow of each individual. It could be used by sellers to approximate accurately the reservation utility of their customers or at least the extent of their preference for rival goods. Regarding the quantity of information used, Ben Shiller\(^3\) compares in an hypothetical situation, the performance of demographic data versus web browsing history to predict willingness to pay of Netflix consumers and obtain that the later would mean an increase of profitability by 12,2% outperforming the former (+0,8% of profitability). It is surprising how few explanatory variables (5 000 potential website visits) allow for efficient tailored-prices, knowing that much more information about consumers is now seizable to perform real life price discriminations. Thus, Big Data opens the door for a new kind of price discrimination.

---


How well can the seller know you? Ezrachi and Stucke⁴ write that fed with data, algorithms may be able to approximate reservation utility of consumers either because data have been collected from you or either because previous similar consumers have already been observed in the same situation. Individuals are categorized within groups. The size of the groups becomes smaller as the algorithms gain in complexity and acuteness (third degree price differentiation) or even, depending on the algorithm used, to perfect price differentiation.

For the OFT⁵, personalised pricing means sophisticated third-degree price discrimination. We prefer to describe personalised price/discriminated price/individualized price as an Almost Perfect Price Discrimination, so that buying is marginally superior in terms of consumer surplus than not buying.

As far as the implementation of this kind of price discrimination is concerned, first, researches have shown that the volume of data produced is already very high, but a big part of it is useless (as repeated information, for instance). Nevertheless, the conclusion is that “less than 5% of the potentially useful data is actually analysed to generate information, build knowledge, and thus inform decision making and action”⁶, which indicates that there is potential for a huge increase in data processing. The margin error of price discrimination will be reduced as quantity of data tends toward infinity. How accurately can the reservation utility be modelled? It is possible to forecast how the increasing use of data will impact the accuracy of the reservation utility models, as new algorithms allow an assessment at the individual level. A report on differential price and big data from the White House Office of Economic Advisers showed that in 2015 one of the online and offline price practices was exploring the demand curve. Experiments have always been used to test the demand, but with ecommerce and big data, experiments can be run on a quicker, cheaper and broader way. Prices can be randomly changed,

---

⁵ Office of Fair Trading. The economics of online personalised pricing. May 2013.
or time changed, and it is possible to track the behaviour of each consumer in face of these changes. Although consumers might not know their own pain point, experiments can get a very accurate view of their revealed utility, by collecting and assessing their behaviour. A reasonable guess is that sophisticated use of Big Data has a potential to create a path towards (almost) perfect price discrimination.

The first register of consumers’ awareness about the possibility of price differentiation on online purchases was in 2000, when a customer accused Amazon after noticing that deleting the cookies on his browser, DVDs were offered to him at a lower price. Amazon denied that the difference in prices were the result of price discrimination, they rather would be due to random tests on prices instead.  

As underpinned by the Council of Economic Advisers White House paper, if targeted advertisement is common practice, personalized pricing is a fast-evolving but still restrictedly-adopted technology. The recent EU e-commerce sector inquiry report mentions that: “Dynamic/personalised pricing, in the sense of setting prices based on tracking the online behaviour of individual customers, is reported as rare. (...) 87 % of the retailers participating in the sector inquiry declare that they do not apply that type of pricing. No pattern in terms of size or profile can be established among the few retailers explicitly declaring that they use or have used dynamic/personalised pricing”. The fact of price discrimination practice not being currently spread may be the sign that the conditions of its wide implementation are not met yet. Offering clients a personalized or customized price based on their information is conditional on several criteria: crucially access to data, absence of arbitrage and price opacity.

---


3.1. Market power

If the market works in perfect competition, there is no space to price discriminate, as consumers may always find a competitor who offers the product at the same price. Thus, the ability to price discriminate requires some degree of market power that allows price above marginal cost. We will address the analysis under monopoly and oligopoly framework.

3.2. Access to data

A necessary condition to almost perfect price discrimination is the ability to predict the willingness to pay of different consumers, and use it to offer different prices. Tracking consumers’ online behaviour provides many inputs to this assessment. Processing tools allow for a quick and cheap analysis of the data collected, in order to offer a specific consumer the highest possible price that suits him. Thus, access to data could be considered as a strategic input to almost perfect price discrimination.

Regarding the way data brokers have been collecting and processing information recently, a study carried on by the US Federal Trade Commission, depicts that:

“First, some data brokers collect publicly available web-based data through web crawlers, which are programs that capture content across the Internet and transmit it back to the data broker’s servers. The data brokers use a software to determine which websites to crawl, how often, and what data points to collect from each website.”

This study also found out that the main sources used to collect data are: government sources; other publicly available sources (like social media, blogs and internet in general); and commercial sources (that includes websites, data provided by their own clients, consumer's’ web browsing activities from online advertising networks, for instance). Besides, there are many

---

other players collecting information about consumers, especially online, like Internet Service Providers, online search engines like Google and social media like Facebook.

Although data is made available for free by consumers, the activity of collecting, storing and treating data creates a lot of value for firms. Up to now, the most important use of aggregated data seems to be not related to price differentiation, as this practice is not yet widespread, but to targeted advertising. However, if a firm wants to practice price discrimination, the access to big data, whether it is bought from a data broker or collected by itself, and the development of a pricing algorithm, arise as a cost, to be balanced against the benefits of subsequent increase in profitability.

Moreover, the access to data can be associated with economies of scale and scope which benefit the biggest players and creates incentive for vertical integration. Also, it is reasonable to think about it as a sunk cost in some industries.

Due to these characteristics, the concentration of ownership or access to data poses a problem on competition, as the strategic use of this input can lead to foreclosure effects, for instance leveraging the position of the firm in another market.

Considering the relevance of access to data, data brokers can be considered a strategic player when evaluating the possible competitive effects of the use of Big Data on price discrimination. Data brokers are selling the input used to enable price discrimination, and the willingness to pay for this input is related to how much firms expect to increase their profits discriminating in prices. This ability will vary accordingly to the competitor's strategy and capacity to price discriminate. Hence, data brokers have incentives to provide the data in the way it creates more value to their customers.

### 3.3. Impossibility of Arbitrage

10 The three types of products offered by nine Data Brokers in the United States in 2012 (marketing, risk mitigation and people search) generated approximately $426 million annual revenue.
Some individuals called “arbitrageurs” could dedicate themselves to exploit the price differences between consumers resulting from price discrimination. Typical arbitrageurs would be perceived by the pricing algorithm as low-valuation consumers and offered low prices. Because it is a profitable activity, arbitrageurs would resell the goods to high-valuation consumers. Repeated undercutting strategies would lead at the end of the day to the collapse of the price discrimination scheme. A similar logic applies traditionally to perfect competition with homogeneous products where it is extremely difficult to prevent arbitrage for the same reasons.

A deeper analysis is presented by Jean Tirole\textsuperscript{13} who identifies two conditions for the arbitration to hold: non transferability of the commodity and non transferability of preferences.

Transferability of the commodity refers to the transaction costs between one arbitrageur and a high-valuation consumer in case of reselling. It is possible that arbitrageurs have to incur some costs in order to be offered the lowest price possible online. To signal an extremely low valuation, they should be able to understand the discriminatory criteria of the algorithm and to trick it (for instance polluting their web history). Time and efforts necessary to erase information can be considered as a cost of arbitration. One can guess that pricing algorithms will grow in complexity with time, and may be able to detect and retaliate against arbitration intentions. However, Internet as a matching platform between sellers and buyers (like Ebay) dramatically increased the facility of transferability of commodities with respect to past decades and should continue to do so.

Transferability of the demand refers to the utility a consumer derives from a given good held by someone else and willing to exchange it. The good has to match the preferences of the consumers, so arbitrageurs better not arbitrage with too customized product, harder to sell. Homogenous and non-perishable goods are easily transferable while too personalized one and perishable are not. Air tickets are a hard to transfer because travel route are specific to individual needs or tastes and the travel date works as an expiry date. Product differentiation is an efficient hurdle to arbitrage.

As shown by the below chart\textsuperscript{14}, the two first categories of product most purchased online are difficult to arbitrage as far as the transferability of demand is concerned.

![Share of internet users who have ever purchased products online as of November 2016, by category](image)

### 3.4. Price opacity

Price opacity is characterized by the fact that consumers are not able to observe prices that are quoted to others consumers, this characterises price opacity. It arises especially on online commerce, and when pricing involves some complex features. This is an important characteristic of insurance premiums, which will be analyzed in the last part.

Under an oligopoly market structure, opaque prices can make price differentiation more likely to be harmful to consumers.\textsuperscript{15}


\textsuperscript{15} Office of Fair Trading. The economics of online personalised pricing. May 2013.
4. Welfare in the context of Perfect Price discrimination

4.1. Almost Perfect Price discrimination, Competition and Ambiguity on Total Surplus

Antitrust analysis usually takes place within unique price equilibrium. Individualized prices open a whole new world from this perspective. This part attempts to describe the competitive mechanisms at work when firms discriminate consumers, in order to know what are the overall welfare effects and how the competition authority should deal with it.

Many points need discussion: Is a discriminating monopoly more harmful than a classic one? Is entry more difficult in the context of ‘almost perfect’ price discrimination? Can competition be increased or reduced? Are firms systematically better off? Does it have any impact on the assessment of mergers? What does competition looks like when firms have unequal access to the input ‘data’ or unequal ability to analyze it?

Economic review identifies four key effects on welfare of price discrimination.

The Appropriation Effect is the capture of consumer surplus by the firm thanks to the ability of charging the price close to its willingness to pay. In a monopoly with perfect first degree price discrimination, all consumer’s surplus would be stripped by the firm. This effect makes consumers worse off, and firms better off.

On the other hand, another force at play is that almost perfect price discrimination may expand the output, as the firm can offer lower prices to a group with lower willingness to pay, without changing the prices offered to consumers with high willingness to pay. In other words, deadweight loss is annihilated; efficiency of the market is restored. This is the Output Expansion effect of almost perfect price discrimination against uniform prices, which results in both firms and consumers being better off.

Under Oligopoly, the Intensified Competition Effect can arise, because price

---

We are not dealing with the Commitment Effect as it takes place within a dynamic framework.
discrimination increases the market “reach” of each firm by allowing it to compete for customers located near its competitors without unilaterally cannibalising its own local market. This effect will be shown using the Hotelling model framework, under which assumptions consumers end up better off and firms worse off.

Hence, the market structure and the respective strength of these three effects will define the final effect on consumer’s welfare.

4.2. Monoply

It is necessary for the monopolist to identify low valuation consumers for the Output Expansion Effect to materialize. Otherwise only high valuation consumers will be charged their reservation utility and quantity produced will be the same. Armstrong (2006) also notes that if the distribution of consumers is asymmetric in the sense that the weak market (density of low valuation consumers) is larger than the strong market, a non discriminating firm would fix a low price. A discriminating firm would in this situation only marginally increase output, while reaping the entire consumer surplus.

4.3. Oligopoly

The Intensified Competition Effect will be explained thanks to the intuitions conveyed by the Hotelling model. Then, it is important to underline the several conditions necessary for it to hold. They include the asymmetry in terms of location (consumers distant from one firm have to be close to the other one) and the symmetry in terms of data and the way to process it.

One reference model for the antitrust assessment describes the prices offered by the firms to each consumer as an auction contest which determining parameters are the consumer

---

17 Can also be called “business-stealing effect” or “customer poaching effect”.
location (in terms of distance, brand preferences, tastes, loyalty) in line with the logic of a Hotelling model, and marginal costs. Firms would like to raise the prices for their closest consumers (those who prefer their product) but they may be wooed by distant firms that propose them low prices to compensate the dis-taste for their product. The firm would reply offering its close customers a price slightly under the marginal cost of its distant rival plus the individualized travel costs a distant customer would have had to incur to buy this rival product, minus the distance costs to its own product.

\[
p_{\text{close}} + t_{\text{close}} < p_{\text{distant}} + t_{\text{distant}}
\]
\[
p_{\text{close}} < p_{\text{distant}} + t_{\text{distant}} - t_{\text{close}}
\]

This personalized price is driven down compared to the local monopoly price in force absent price discrimination. Then, contrary to a uniform price pattern, there is a competitive pressure for all firms, leading to an overall reduction of profit.

But why do firms engage in price discrimination if it is not strategic for them? According to Thisse and Vives\textsuperscript{19}, firms are stuck in a prisoner’s dilemma with a unique equilibrium outcome. They do make more profit with uniform prices but price discrimination is a dominant strategy. They cannot avoid the low profit equilibrium unless there is further coordination (for instance generated by a databroker).

Firms are worse off and some consumers benefit more than others. Consumers that are largely indifferent between the two goods are not receptive to the differentiation strategies of the sellers and are modelled as equidistant to both firms: \(t_{\text{distant}}\) and \(t_{\text{close}}\) cancel out and remain only the components typical of a Bertrand competition.

4.3.1. (A)symmetry in assessment: The case of “best-response symmetry”

However, if both firms identify the same group of consumers as being strong (best-response symmetry), the intensified competition effect will not occur, given that firms will not try to steal

consumers from their rivals but rather to expand the market (Expansion Effect). As a result the prices in market 1 (the strong market) increase to $\gamma$ and decrease to $\alpha$ in market 2 (the weak market).

![Diagram of Duopoly Reaction Functions]

The uniform equilibrium could be anywhere in the quadrangle $\alpha\beta\gamma\delta$, depending on the relative weights the firms place on the markets.

### 4.3.2. Impossible to disentangle factors of symmetry and asymmetry

Firms may identify best response symmetry or asymmetry strategies based on the same revealed consumers’ characteristics, depending on each particular situation. For instance, the OFT elucidated that “web browsing history could potentially be used to identify which consumers are sophisticated and likely to search for lower prices, which is best-response symmetric. Alternatively, it could be used to gauge brand preferences, which are best-response asymmetric.”

Thus, to conclude on which is the prevailing effect of price discrimination, one has to
take several factors into account (competitive outlook of the market, strength of the firm), including also the pattern distribution of customers and the best-response symmetry or asymmetry.

When there is **asymmetry on the access to data**, or in the technology that analyse it, the results in terms of welfare might be very different. In practice it means that one firm might be able to practice price discrimination for some consumers, but the market will also exhibit uniform prices set by the firm without data or set for those non identifiable consumers. The way both firms interact will depend on whether all consumers have access to uniform prices, whether the goods are homogeneous or differentiated, how different are the analysis technologies or if consumers can choose to hide their private information, avoiding being “tracked” by firms.

The best results to consumers are achieved when both firms with equal access to data and technology decide to price discriminate. It leads, as explained above, to more competition. This is the symmetric result, on which consumers would have no reason to try to hide their data. But, if data is bought from a data broker, this one has incentives to sell it in a way that maximizes the value of the data. Data set price is maximized when there is less competition on the downstream market. Hence, models that consider data brokers as the upstream player on the market, providing inputs to price differentiation, conclude, even under different frameworks, that the Data Broker adopts a strategic behaviour, which will maximize its profits by reducing competition in the downstream market. The intuition is straightforward: downstream firms will have no willingness to pay for data that does not provide them the ability to increase their profits. Thus, as selling equal data for all of downstream firms promotes competition, this strategy would make the use of data unprofitable, leading their willingness to pay to zero. For this reason, models that allow for asymmetric access or use of data predict a reduction on consumer’s welfare and an increase in profits. The intensified competition effect never arises. Furthermore, these results create incentives for consumers to engage effort and resources in concealing the data, which is a social waste.

It is possible to mention two studies that analysed this effect under two different
frameworks. Montes (2015)\textsuperscript{20} describes a model of differentiated products and perfectly asymmetric profiling technologies. The pure strategy equilibrium is that the information will be sold to one exclusive buyer, because it is when the data shows the higher potential to increase the difference between the buyer firm profits. On the other hand, Belleflamme (2017)\textsuperscript{21}, using a model with homogeneous products and different degrees of asymmetry in profiling technologies, found mixed strategies leading to equilibrium where Data Brokers have incentives to sell the data to all competitors, but offering a different quality to each one. Those studies show the academic advance on the study of price differentiation with Big Data, but they seem not to be part of the current framework of agencies and governmental authorities.

The concluding importance of these results is that different access to data and/or different assessment technologies is a reasonable assumption for the real world competition even without the strategic behavior of the Data Broker. Hence, as long as this asymmetry holds, consumers have a low likelihood of being better off with the use of Big Data on price discrimination.

4.3.3. Implication for mergers

The price effects of a merger of more distant competitors (we are back to a Hotelling type of analysis) are bigger under price discrimination than under uniform pricing. The ability to price discriminate intensifies pre-merger competition between distant competitors more than it intensifies competition between nearby competitors. This valuable competition between relatively distant firms that price discriminate is lost when they merge. However, the price effect of a merger of close competitors is smaller under price discrimination than under uniform pricing because price discrimination does substantially intensify the competition between the merging firms and the distant competitor, competition that is relatively weak with uniform pricing. Therefore, under price discrimination, competition authorities should, unlike to uniform price schemes, be more careful in approving distant

competitors mergers than close competitors mergers.

5. **Fairness and privacy : non-economic factors that affect consumers surplus**

If consumers are too infuriated by the practice, they will stop consuming, destroying welfare because firms face subsequently a lower demand.

5.1. **Social consensus around uniform price**

Consumers may reject it because their cognitive appraisal of prices and price formation is shaped by practice and rotten in history. Before the 19th century, prices were indeed individualized as a result of a bargain between sellers and buyers. The price system later evolved, triggered by moral considerations\(^{22}\) and a shift in the costs and benefits associated to bargain, toward a uniform price system, which is the current social consensus. Uniform price, the nowadays tacitly agreed and expected practice, is to be questioned by the price differentiation implemented thanks to Big Data. As uniform price is the consumer benchmark, being price discriminated without being explicitly notified may be experienced as a breach of trust. To make matter worse, tailored-prices of the 21th century are likely to be a take-it-or-leave-it offer made by an omniscient algorithm to helpless consumers.

5.2. **Keep up with the Joneses**

As mentioned, tailored-prices were, before the 19th century, the results of a bargain between two parties equally involved and likely to influence the outcome. The participation and

\(^{22}\) From the 17\(^{th}\) century the Quakers, an American religious movement, advocated that the personal prices were unfair. All buyer should be treated equally notwithstanding their apparent characteristics. George Fox, the founder of the Religious Society of Friends (Quaker), wrote in his Journal in 1653 that “if [people] sent any child to [quaker merchants] shops for any thing, they were as well uses as if they had come themselves”. In other word, notwithstanding the ingenuity of a child, he should pay the same price as his bargain-skilled and authoritative mother would have because “God shows no favouritism” (Acts 10:34). It is on those ethical grounds of a Moral System of Exchange that the American merchants advertised their new fixed price policies. In addition, with the increasing volume of transaction it became costly to spend time bargaining. Posted price were adopted because they were relatively cheaper. (https://www.theatlantic.com/business/archive/2017/02/turow-aisles-future-of-shopping/517413/)
interaction part reduces the consumer feeling of injustice because he is involved; as was shown by Richards, Liaukonyte, and Streletskaia in their implication experiment. The same paper\textsuperscript{23} mentions that fairness is a matter of perception biased toward a self-interested inequity aversion. On the other hand, some criteria of discrimination are well accepted such as discounts for older people or young.

5.3. Ethic

Tailored-prices raise a lot of concerns and fears regarding the winners and losers-to-be of this practice. It is indeed likely to disfavour those consumers with fewer market options or inelastic demand but no hasty generalization can yet be drawn on the extent to which it will affect the Poor or the Rich.

5.4. Consumer Ignorance

Many piece of literature relative to Big Data and Price Discrimination wave flags arguing that consumers are not widely aware of the existence of the practice and of the use made with their data. We consider that the practice of price customization not being fully implemented yet this problem will tend to shrink with time.

5.5. Privacy and consumer harm

It is a sensitive hypothesis to argue that privacy breach has adverse effects on consumer welfare.

Beforehand have to be identified the intrinsic and strategic values of privacy\textsuperscript{24}. Privacy acquires a strategic value when the non publicity of private information brings advantages to the consumer. In this framework, Big Data means a reduction in asymmetric information at the expenses of the consumer.


Inversely, privacy is intrinsically valued by human beings for its own sake. The taste for intimacy varies across individuals and across time. Not all women prefer to keep pregnancy secret and their preferences of disclosing the happy event may change over the 9 months carrying the child.

It may be difficult to disentangle the inherent and strategic dimensions of privacy. From an economic point of view, a breach of intrinsic privacy is a cost suffered heterogeneously, while a breach of strategic privacy is efficient for society as it reduces asymmetry of information and sometimes is individually advantageous (when consumers obtain better terms of trade).

5.5.1. *Is privacy so important?*

Privacy can be protected through opting-out of online tracking, using technology such as TOR anonymous browser or Duck, Duck, Go! search engine. However, classic tracking technologies are still massively used. Switching implies costs for consumers of changing habits and having to surf with less efficiency given that the best search engines are based on past searches. This behaviour pattern reveals that privacy benefits do not outweigh the switching costs associated with its protection (“rational ignorance”\(^{25}\)). The higher utility derived from tracking services with respect to footprintproof but less efficient services shows that privacy is not valued enough and harm is negligible.

One reason for this is suggested by Benjamin Wittes and Jodie Liu\(^{26}\) who evidenced that people are more privacy concerned with proximate observation by individuals than distant observation by computers or algorithms.

It can also be considered useless trying to fool the Internet Giants, for instance by polluting one’s Web history: “It turns into a game of statistical cat-and-mouse between you and your ISP: Can they figure out how to separate the signal from the noise? ISPs will have a lot more resources (money and smart engineers who will be paid a lot) to try to figure out how to do

---

\(^{25}\) White House report. “*Big Data and Differential Pricing*”, February 2015

that—way more resources than any individual or small open source project will.”

Regarding the cost of fooling sophisticated pricing scheme, Shiller (2014) was arguing that “even if consumers did understand which behaviours result in low prices, they might prefer to ignore them rather than change potentially thousands of behaviours just to receive a lower quoted price for one product.”

The ultimate solution for firms is to charge high prices to discourage manipulation or hiding and also because “consumers who decide to hide are identified as consumers with a high willingness to pay” (Belleflamme).

6. Insurance

Insurance is an interesting industry to exemplify the features that allow for price differentiation and its effects on consumer’s welfare. First, for being an industry that has always used consumer’s data to price its products, the access to big data and new technologies to analyse more granular data sets have a natural impact on pricing. Second, price differentiation can arise on risk-based valuations, when the effect on welfare will be assessed using the moral hazard or adverse selection framework, or on valuations of consumers behaviour, for instance offering higher renewal prices to consumers that are not likely to shop around. In this case, the analysis is similar to any other online retailer price differentiation. Those two kinds of practices can have different effects on welfare. Third, the use of big data to price differentiate have been a concern to insurance regulators, and it is useful to enrich the discussion with economic analysis.

There are many different kinds of insurance, but considering the analysis we want to carry on, our focus is on the retail products, like car insurance or home insurance.

---


Besides the industry characteristics above described, it is possible to notice some characteristics of the product that favour price discrimination: on the first place, from the customer’s perspective, prices are very opaque. There are many risk-based factors that can make prices different for each consumer, for instance the age of the driver for car insurance, or the size and the location of the house for home insurance. Hence consumers cannot easily compare prices and it is not possible for them (and it can be very difficult even for the regulator) to disentangle price discrimination based on costs or not. Finally, it is impossible to arbitrage with insurance. A customer cannot buy insurance, benefiting from an individual low price and then sell it to someone else. Those features enhance the ability of insurance to use non-risk price discrimination.”

Two intrinsic informational problems in the insurance industry can be ameliorated by the use of more granular information: adverse selection and moral hazard. And in both cases, the pooling equilibrium is reduced, and an even more separated equilibrium arises.

Regarding adverse selection, the use of Big Data provides a more individualized segmentation of risks, as it provides a more complete picture of the insured. In a pooling equilibrium, the good types exit the market, as they may consider the price is too high. For instance, as a result of micro-segmentation by the use of granular data, maybe a lower risk segment can be split into two different segments, one that can present even lower risk than the initial one, leading “to a broader spread of premiums between the lower and higher risks.”

Hence, to this lower risk segment, premiums would be reduced, and this could bring new consumers into the market, as now they could face an acceptable price for what they consider is their level of risk. On the other hand, splitting the high risk pool could exclude some high risk consumers from the market, as it could result in much higher prices to this group (of course, if everyone decides to specify and assess risk in the same way). The total effect on consumer welfare will depend on how many consumers are affected by those two effects.

---

Another effect is that the agents can reduce their efforts to signal their types, as much as Big Data creates a more straightforward assessment.

Considering the consequence for the insured party, using the previously mentioned framework, it is reasonable to assume that most of the privacy concerns are related to the strategic value of privacy that may arise for the higher risk individuals. However, using personal health history data to price healthy and life insurance offers involves the intrinsic value of privacy. DNA tests able to identify pre-disposed health risks are becoming more affordable. In some countries, the policyholders have the obligation to disclose this kind of information to the insurers. On one hand, it improves risk assessment, reducing anti-selection. On the other hand, it may create a group of consumers for which no coverage is offered, at the same time that it may hurt their intrinsic privacy. These concerns may be addressed by specific industry regulation or general policy.

Big data also impacts the endogenous component of risk, the part that is controllable by the individual, as new technologies reduce the cost of monitoring an individual behaviour after the contract is signed, in order to adjust the premium. Telematics devices (information technologies applied to cars) fitted to insured parties cars are designed to measure and transmit to insurers many aspects of a driver behaviour and habits. If it creates an individualized price based on a specific risk assessment, it also allows transparency on the premium, motivating consumers to adopt a safer behaviour in order to benefit from reduction on the risk rates and premium. This creates a positive externality for society: the policyholder has private incentives to drive safely, and by adopting this behaviour increases the safety for all the others drivers. Premiums can also increase for bad drivers due to their behaviour, as the result of the separated equilibrium replacing the pooling one.

As another example, the Internet of Things gives rise to smart/connected homes, providing real time information about damages and risk factors, improving risk assessment and

Example of genetic test available: https://www.youtube.com/watch?v=8rmmLOkCvjo#action=share
safety for policyholders.\textsuperscript{32}

As a result of the reduction of moral hazard problem, new products may also be created by the use of big data and processing. The new companies that have recently explored these innovative possibilities created by the use of intensive technology in the insurance industry have been called insurtech. For instance, the insurtech metromile uses a telematic device to offer a pay-per-mile insurance, focused on those customers that do not use their car very often\textsuperscript{33}. A very interesting example on how the intensive use of data can create new markets is found on health insurance. AllLife is a company that offers life and disability insurance to consumers who face diseases like HIV and Diabetes, and that could have an under provision of insurance services, as long as they agree to follow a strict medical protocol.\textsuperscript{34}

On this analysis, the welfare effect related to improving the risk assessment and being able to include new low risk consumers in the market shows up in a static perspective assessment. It is possible to measure the total effect as long as you know how many consumers were included and how many were excluded. On the other hand, the ability to create new products is related to dynamic efficiency assessment. Although it is difficult to predict the effect of big data on innovation, as a general conclusion we know that the effect of innovation is positive to consumers welfare.

Regarding non-risk price discrimination on insurance, it takes risk-based prices as a starting point, and then other factors not related to risks, such as price elasticity of demand, are taken into consideration in order to calculate the premium.\textsuperscript{35} Insurance offers coverage for a certain period in time and it requires renewals from time to time. A common way of non-risk price discrimination is to charge more on the renewal than to a new client with the same risk,

\begin{footnotesize}
\textsuperscript{33} https://www.metromile.com/
\textsuperscript{34} https://alllife.co.za/
\textsuperscript{35} Sometimes, non risk-based price discrimination is called price optimization in the insurance industry, to differentiate it from the risk based price differentiation. But there is no consensus about the use of price optimization exclusively to non-risk based prices calculations, hence we decided to use a more specific approach.
\end{footnotesize}
considering a lower price elasticity of a loyal customer. On this example, the data needed to price discriminate need not be so complex, but the use of big data allows companies to test consumer’s willingness to pay, and to aggregate much more information on policyholders’ behaviour, such as their probability to shop around, improving their ability to benefit from this practice without increasing the risk of adverse selection. A recent study from the Financial Conduct Authority - UK found out that average home insurance premiums showed a material increase over five years, without any evidence that cost of claims increased with the length of enrolment. They concluded that many consumers do not search for options at the renewal, hence their price elasticity of demand is lower after the first purchase.

Regarding non-risk price discrimination, the assessment of the welfare effect of the use of Big Data on price differentiation is similar to any other industry, although the ability to price differentiate increases as insurance can rely on characteristics that favour this practice (price opacity, impossibility of arbitrage, intensive use of data on prices calculations). One might argue that the reputational risk is higher, and could even undermine the good-faith principle and the acceptance of risk-based price discrimination, but the opacity of prices can provide a convenient veil to this practice, making this hypothesis not very credible.

The use of Big Data to improve risk-based assessment on premiums calculations represents a progress in an activity that has always been carried on by insurance companies. Although there are clear consequences to consumers, the sector regulators are interested in assessing those consequences, but do not oppose to the practice. In fact, European Insurance and Occupational Pensions Authority (EIOPA), in a recent presentation, advocates that the use of big data can create new competitors, enhancing competition and reducing prices, resulting beneficial for consumers.\(^{36}\) On the other hand, non-risk based price differentiation is considered a risk linked to the use of more granular segmentation, for its potential to cause “\textit{discrimination}\(^{36}\)
issues where brand loyalty, inertia or ability to pay more is exploited.”37

A strongest action was taken by the National Association of Insurance Commissioners (NAIC) - US. On November 2015, NAIC released the Price Optimization White Paper with recommendations to the State Regulators to adopt on their laws that “rates shall not be excessive, inadequate, or unfairly discriminatory.”38 And under this requirement, non-cost based rating practices, as “price elasticity of demand, propensity to shop for insurance, retention adjustment at an individual level and a policyholder’s propensity to ask questions or file complaints, should not be allowed, for being inconsistent with it. The prohibition lies exclusively on the concept of fairness, no economic reason is appointed.

The Financial Conduct Authority, in our previous example when an increase in premiums of home insurance over five years was identified, demanded the insurance companies to inform the client the price charged in the previous year at the time of a renewal, which is a less interventionist approach to non-risk price differentiation practice that without judging issues of fairness was able to increase competition on the market (the number of consumers that decided to switch or negotiate their policy increased by 11-18%).

Using all those features, one may ask if it is possible to make a competitive forecast of the industry in face of the intensive use of Big Data to risk based and non-risk based price discriminate, in order to focus on regulatory concerns. Despite the optimism from the European Insurance and Occupational Pensions Authority (EIOPA) on how the improvements on risk assessment can enhance competition creating new competitors, this possible beneficial result does not come without some regulatory concern about possible anti competitive behaviors. As shown, the strong potential to use data to price insurance premiums turns it into a very critical input. Thus, the control of data can result in enough market power that can prevent a new entry in the market, or use a dominant position on one insurance branch to leverage or extend a firm's position on another branch. It is reasonable to assume that collecting data and developing

37 Idem 34
38 Nacional Association of Insurance Commissioners - Casualty Actuarial and Statistical (C) Task Force - “Price Optimization White Paper”, 2015
techniques to use it is subject to economies of scale and scope, which results in benefiting the largest and multi-products players. Investing in technologies to gather and process a bigger amount of data, being able to use it as a strategic input, involves some sunk costs, from which pre-emptive deterrence behavior may strategically arise. Summarizing, the concentrated control over two inputs that tend to be more and more important over times, collecting a bigger amount of data and developing excellent techniques of assessing it, can lead to less competitive insurance markets.

A possible solution would be making personal data portable among insurance companies, at the will of the customer, eliminating the possibility of concentration on the control over data. In practice, it demands some regulation defining rights to use data, and how they could be transferred or ownership of data to consumers.

However, in practical terms, portability does not come without cost, as it demands a standardized data format in order to be adopted at a reasonable cost. And regarding the cost to collect and store data, an interesting problem may arise. On the consumers side, the use of big data related to risk price differentiation can be beneficial, with some low risk consumers being included and new products being created. On the other hand, non-risk price differentiation will only be beneficial to consumers under some specific conditions. Those two practices are not easy to disentangle. On the industry side, insurers compare costs and benefits before investing, hence they have incentives to invest on data gathering and storing if this can provide a competitive advantage. If personal data is made portable, this advantage vanishes, which reduces incentives to invest in those new technologies, decreasing the possible advantages of the intensive use of Big Data. How to maintain incentives to increase the beneficial and innovative collection of big data eliminating competitive advantage?

---


40 There is a different between those two approaches, with some preference on rights to use data. For instance, from Australian Government. Productivity Commission. *Data availability and use. Inquiry Report, Overview and Recommendations*, No. 82, March 31, 2017: “Rights to use data will give better outcomes for consumers than ownership: the concept of your data always being your data suggests a more inalienable right than one of ownership (which can be contracted away or sold).”
One option would be to ask consumers to pay a fee to access and transfer their own data. But, considering that (1) neither consumers, nor firms nor regulators are totally aware of the economic value of consumer’s personal data, (2) that this data was provided by consumers to companies for free, (3) that there is not a clear way to inform consumers about the costs of collecting and storing the data, (4) that these costs can be very different for each firm (due to scale/scope economies), (6) that there are positive externalities when the data is used to create new products and (7) that a consumer cannot disentangle positive or negative variation on premium derived from the use of their personal data, it is hard to imagine how a fee like this one could be established and charged under so much uncertainty.

Another possible solution can come from the fact that which gives data more value is the assessment and conclusions one might get from analysing it, and this is how the insurance industry has worked ever since. Hence, only transferring personal data does not eliminates incentives to collect and store data, as long as each firm believes in their analytic tools to make this data more profitable than to their competitors.

In spite of all those practical difficulties on portability of data, this kind of regulation could have the positive effect of increasing the technological race for developing efficient ways to analyse data, decreasing the risk of concentration on this input.

7. Conclusion

As a practice-to-be, Big Data seems likely to produce a shift from third-degree price discrimination based on broad demographic categories towards personalized pricing with conflicting effects depending on the competitive framework. Duopoly markets with price differentiation lead to an intensification of competition, benefiting consumers. But when there is symmetry in Best Responses; or asymmetry on access to data or in processing data technologies, the positive outcome for consumers may not arise. The practice would then benefit sellers and some buyers that would otherwise be priced out of the market, at the expense of other, less-price sensitive consumers. This outcome is efficient from the point of view of the market but disregard the consumer welfare standard and raises fairness and privacy considerations.
Studies have been carried on how data brokers will confer value to their data sets by strategically reducing competition in downstream markets. They will sell their data in a way that allows their clients (the firms) to increase their profits with price differentiation and escape the prisoner’s dilemma low profit equilibrium. Adopted this strategic behavior, the intensified competition effect should not arise.

Allowing ownership of data, or rights of use, might reduce incentives to data collection in the framework that we used in this analysis. But it is important to emphasize the other uses to Data, like advertising or cost based price discrimination, like on the insurance industry for instance.
Bibliography


Allianz SE, “Allianz and Panasonic enter partnership to provide Smart Home solutions”, 2015


DiscoverySA “What’s new in 2016: Know your DNA” 2015.
https://www.youtube.com/watch?v=8rmmLOkCvjo#action=share


Robinson, R. “Facebook fined €150k by French regulator over privacy breach.” Financial Times, May 16, 2017. https://www.ft.com/content/36fff550-1e4e-3be7-b602-ab1d48876e36


