Essays on the Loyalty Penalty: impacts on consumers and policy responses.

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Abstract

This thesis investigates the loyalty penalty, its impact on consumers, and potential policy responses across four chapters. It also contributes to ongoing debates between policymakers and businesses regarding the loyalty penalty.

In the introductory chapter, I provide an overview of the regulatory and academic literature and the general concepts used in this thesis to investigate the loyalty penalty.

The second chapter presents a theoretical model to explain the loyalty penalty. I use a classic framework that distinguishes between shoppers and non-shoppers, extending it to two periods. In each period, two firms compete on price. In the first period, firms set a base price, which remains constant across both periods, and in the second period, they set a renewal price. A consumer who ends up paying the renewal price in the second period is subject to the loyalty penalty. The difference between the renewal and base prices demonstrates how the loyalty penalty can arise from low consumer engagement, leading to its persistence in equilibrium.

In the third chapter, I analyse a duopoly with three types of consumers. Using a framework which distinguishes between savvy shoppers, average consumers, and vulnerable consumers, I assess the effects of the loyalty penalty on these groups, particularly vulnerable consumers, and explore how firms adjust their pricing decisions based on the presence of various consumer types in the market.

Additionally, this chapter contributes to the discussion among policymakers on understanding and defining consumer vulnerability.

The final chapter examines the policy responses implemented by regulators, including Ofcom, Ofgem, and the FCA, to mitigate the loyalty penalty through the lens of the models developed in Chapter 2 and Chapter 3. These policies include banning the loyalty penalty, imposing price caps, introducing social tariffs, and promoting educational initiatives. The chapter evaluates these policies and concludes that some policy responses can have unintended consequences. It argues that acts designed to protect consumers often undermine market competitiveness, highlighting the need for careful policy design.

Acknowledgements

"At some point, everything's gonna go south and you're going to say, this is it. This is how I end. Now, you can either accept that, or you can get to work. That's all it is. You just begin. You do the math. You solve one problem and you solve the next one and then the next. And if you solve enough problems, you get to come home."

– Mark Watney, *The Martian* (dir. Ridley Scott, 2015)

Returning to academia after 15 years in industry was a bold move, but it had been a longstanding dream, and I am happy to have come this far in my journey. Therefore, I would like to begin by thanking the people who made it possible. Firstly, my supervisors: Professor Alex Dickson, Dr. David Comerford, and Dr. Marco Fongoni. I am grateful to Alex for his guidance throughout my PhD journey and for his help in securing funding to study the loyalty penalty. I have learned a lot from him about Industrial Organisation, Game Theory, and theoretical writing. Special thanks go to Dr. David Comerford for his direct guidance, which helped make this thesis as concise and coherent as possible. I also thank Dr. Marco Fongoni for his insightful feedback and advice on theoretical writing - the recommended papers by Thomson and Cochrane were particularly helpful, and I only wish I had found them sooner.

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Finis vitae, sed non amoris.

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Chapter 1

Introduction

This thesis examines the loyalty penalty across four chapters. This phenomenon emerged in digital economy business models, particularly subscription services where automatic renewals cause existing customers to pay more than new subscribers. The main catalyst for this research was a report submitted by Citizens Advice to the Competition and Markets Authority (CMA), which highlighted numerous instances of users suffering from loyalty penalties (Citizens Advice, 2018*a*). Additionally, a report by E.CA Economics, commissioned by the CMA, outlined the lack of explicit academic research on this phenomenon (E.CA Economics, 2020). A subsequent review of the literature confirmed this gap. Therefore, this thesis aims to fill this gap in knowledge and contribute to ongoing debates between policymakers and businesses on the loyalty penalty by offering a simple yet tractable framework for understanding the loyalty penalty and assessing various policy interventions.

Using concepts from Industrial Organisation, the thesis models the loyalty penalty through a game-theoretic lens, considering rational actors to assess the implications for policy and regulation.

Chapter 1 introduces the concept of the loyalty penalty and provides an overview of the academic literature relevant to this phenomenon. It identifies the existing gap in the literature and sets the stage for the thesis, familiarising readers with key concepts that will be developed in later chapters.

In this chapter, I define the loyalty penalty as *the disadvantage incurred by maintaining a rollover contract or subscription over an extended period, in contrast to the benefits available to new customers for the same product or service.*

From this definition it follows that in a homogeneous goods market, both existing and new customers do not necessarily have to belong to the same firm to experience the loyalty penalty. This means that if a long-standing customer pays more than a new customer within the same firm, it can be described as an 'intra-firm' loyalty penalty, where the firm favours new customers with better deals over old ones. Conversely, even if firms are unable to differentiate based on customer tenure, a customer who remains 'loyal' by not seeking alternative providers offering lower prices for the same product experiences an 'inter-firm' loyalty penalty. The penalty arises from the customers decision to remain with their current provider instead of switching, resulting in missed savings opportunities from competitors.

I argue that the loyalty penalty can arise due to lack of consumer engagement. I use the broader term engagement and, therefore, engagement costs, which include the process of shopping around, searching and comparing prices, or re-verifying offers with current suppliers.

I also introduce the concept of different consumer types, particularly vulnerable consumers, whom I define as *individuals at greater risk, such as those with limited understanding of finances, technology, or market characteristics, or those who lack the means or awareness to regularly switch service providers or products.*

Assessing consumer vulnerability is often done in comparison to the concept of the 'average consumer', a standard frequently used in the academic literature and regulatory guidelines. This concept has both advantages and drawbacks. The average consumer is generally defined as *one who is reasonably well-informed, observant, and circumspect, taking into account social, cultural, and linguistic factors.* Although some criticise this standard as setting an overly high bar for assessing vulnerability, it remains a valuable tool for policymakers, and thus, for this thesis as well.

Chapter 2 is titled *"The role of engagement costs in the loyalty penalty"*. In this chapter, I analyse the nature of the loyalty penalty by constructing an explicit model of the loyalty penalty using established ideas from Industrial Organisation about interaction of firms with rational consumers. By examining the processes of consumer interaction within the market and firms' price setting through the framework of game theory, I demonstrate that the loyalty penalty can arise due to insufficient consumer engagement. I adopt the classic framework from the literature on search, which distinguishes between 'shoppers' and 'non-shoppers' in a duopoly market extended over two periods. I present a novel finding that, in contrast to the well-known mixed-strategy solution, firms adopt pure strategies in a two-period extension, a necessary feature for analysing subscription products. These strategies allow firms to exploit customers with a low propensity to engage by increasing the initial price in the second period. I demonstrate that the loyalty penalty in equilibrium can arise as the difference between the renewal price and the base price.

Chapter 3 is titled *"Vulnerability and the loyalty penalty"*. In this chapter, I address the concept of consumer vulnerability. I modify the framework established in the second chapter to analyse the impact of the loyalty penalty on the most vulnerable consumers, exploring how these penalties disproportionately affect them. I extend the model by introducing three types of consumers: 'average consumers' (Type L) with low engagement costs, 'vulnerable consumers' (Type H) with high engagement costs, and 'savvy shoppers' (Type 0) with no engagement costs.

I demonstrate that the presence of vulnerable consumers does not affect the pricing equilibrium until their proportion reaches a certain threshold (Case (a)), or when the number of average consumers drops below this threshold. At that point, firms tend to 'give up' on average consumers and shift focus to exploiting vulnerable consumers (Case (b)). This shows that firms can strategically choose which consumer type to target. The threshold price in Case (b) depends on the reservation price of vulnerable consumers, rather than that of average consumers as in Case (a). The reservation prices, which reflect differences in engagement costs between average and vulnerable consumers, affect the threshold value for average consumers, expressed as a ratio of these prices. This threshold value can also be derived from the model's parameters.

Another important finding is that, unlike the classic model where no engagement in search occurs in equilibrium, I show that average consumers pay engagement costs to avoid the loyalty penalty (Case (b)), and these costs reduce the consumer surplus of average consumers. In this scenario, the surplus of all consumer types declines: savvy shoppers experience a drop due to rising base prices; average consumers, who start behaving like savvy shoppers, see their surplus diminish as they face both engagement costs and higher prices; and vulnerable consumers are hit the hardest, suffering the largest reduction in surplus.

Chapter 4 is titled *"Policy implications: balancing consumer protection with firms competitive incentives"*. In this chapter, I contribute to ongoing discussions of experts, regulators, and policymakers on potential mitigations for the loyalty penalty. Using the models developed in previous chapters, I analyse current policies implemented by regulators such as Ofcom, Ofgem, and the FCA. First, I evaluate the ban on the loyalty penalty, which was implemented by the FCA in 2022. This policy prohibits charging existing customers a higher price than that offered to new customers; however, it does not ban price differences between periods. In such cases, firms may mix their pricing strategies across different periods, leading to higher average prices.

Second, I analyse the use of price caps. While capping prices does not eliminate the loyalty penalty, it helps shield vulnerable consumers from excessive charges and maintain affordability. This approach strikes a balance between firms' pricing strategies and the financial well-being of consumers, thereby protecting them from excessive loyalty penalties and promoting both market stability and competitiveness.

Third, I examine proposed voluntary tariffs, where firms are expected to offer the cheapest available price to their vulnerable customers. A recent survey by Uswitch.com reveals that only one per cent of eligible customers use social tariffs[1]. By applying the established model, I demonstrate that this low uptake may be due to a lack of engagement, and that firms face an incentive to increase engagement costs by creating tedious eligibility processes. I discuss that a more effective policy could be one that enhances engagement, for instance, through data-sharing initiatives or by automatically switching the most vulnerable consumers to the cheapest available tariffs on the market via special services where firms compete for this customer segment.

Fourth, I review educational initiatives and, using the developed model of the loyalty penalty, demonstrate that a one-size-fits-all approach in education may have unintended consequences, potentially increasing the loyalty penalty for certain groups of consumers.

The key insight from the fourth chapter is that regulators must carefully design and implement policies that balance consumer protection initiatives without undermining firms' competitive incentives.

1.1 Understanding the loyalty penalty

1.1.1 The context of the loyalty penalty

The loyalty penalty is a relatively new phenomenon emerging from the rising popularity of subscription sales models and automatic rollover contracts. Historically, such models were favoured primarily by service providers, such as cable TV or cleaning services. Today, many firms across a wide range of industries adopt subscriptions and rollovers. While this is applicable to essential markets, there are a multitude of other subscription business models that have been established, from drinks to haircuts. For example, any layman can easily find a comprehen-

[1] Uswitch (2024) *Social Tariff Deals.* Available at: https://www.uswitch.com/broadband/guides/broadband-deals-for-low-income-families/(Accessed: May 14, 2025).

sive list of available UK subscriptions spanning various products, including food, flowers, clothing, beverages, gadgets, and more.[2]

While subscriptions and rollover contracts aim to enhance and simplify shopping experiences, they have unintentionally given rise to novel types of price discrimination practices. Notably, the loyalty penalty arises, which in this thesis I define as:

Definition 1. *The loyalty penalty is the disadvantage endured as a result of maintaining a rollover contract or subscription over an extended period, compared to the benefits received by new subscribers or customers for the same product or service.*

From the definition, it follows that in a homogeneous goods market, old and new customers do not necessarily have to belong to the same firm to experience the loyalty penalty. In other words, if an existing customer pays more than a new customer within the same firm, it can be described as an 'intra-firm' loyalty penalty, where the firm discriminates against its loyal customers by offering better deals to new entrants. On the other hand, if a customer remains 'loyal' to a firm by not exploring alternative providers that offer cheaper prices for the same good, this situation can be seen as an 'inter-firm' loyalty penalty. In this case, the penalty arises from the customer's decision to stay with their current provider instead of switching, leading to missed opportunities for savings from competitors.

Unsurprisingly, this sales model has caught the attention of regulators, competition authorities, and academics. The significance of this phenomenon raises several questions for policymakers and academics across various fields. Although this thesis focuses on the positive aspects of the loyalty penalty, it is important to understand the issue from both positive and normative perspectives to provide a comprehensive understanding of its implications and ethical considerations. The latter include considerations of fairness and ethics of such discriminatory prac-

[2]Department for Business and Trade (2023) *Subscriptions: types offered by business and numbers held by consumers.* Available at: https://www.gov.uk/government/publications/subscriptions-types-offered-by-business-and-numbers-held-by-consumers (Accessed: May 14, 2025).

tices, their effect on welfare, and what type of regulation would be most appropriate - prohibitive or controlling?

From a positive standpoint, the first question to address is whether the loyalty penalty genuinely exists. Empirical data suggest that many companies do, in fact, charge their long-standing customers higher prices than their newer counterparts. These higher prices often come into play after the expiration of promotions initially offered to attract new customers.

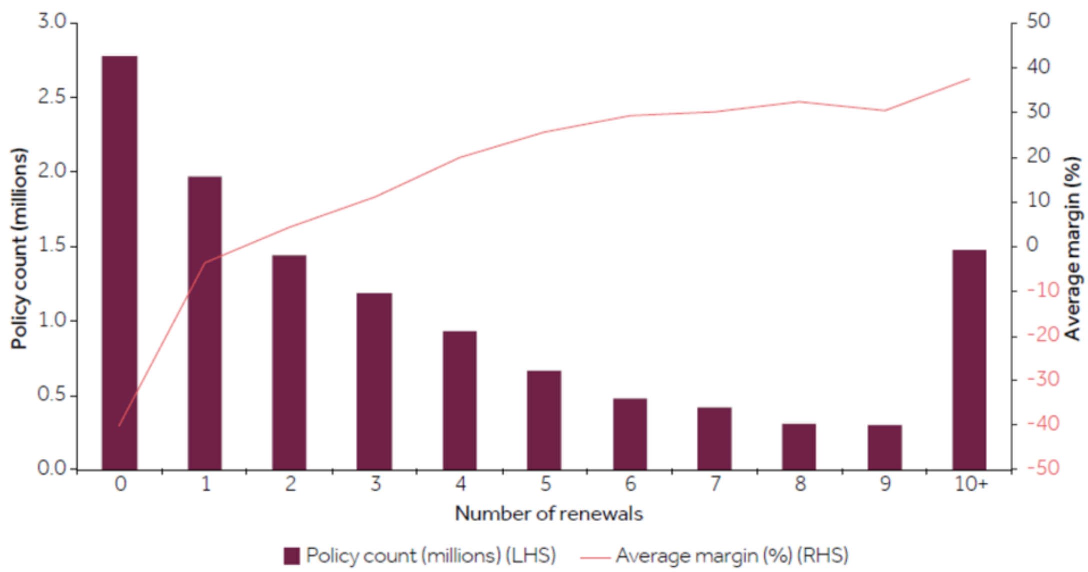


Figure 1.1: Policy count and average margins by number of renewals in home insurance. Source: FCA (2018*a*).

For instance, Figure 1.1 illustrates the loyalty penalty pattern in the home insurance market. It shows how long people stay with their insurance company and how much profit the company makes from them. This information comes from a study by the Financial Conduct Authority (FCA), which looked at companies that make up about 40 per cent of the UK's home insurance market. The study found that, in fact, 31 per cent have renewed their insurance with the same company five times or more and that the longer consumers stay with their insurance company, the more money firms tend to make from them. Moreover, the average margin for new customers is negative which signifies intense competition for new customers (FCA, 2018*a*).

While the loyalty penalty is pervasive, its prevalence varies across industries. Sectors where customers might be tied to contracts (telecommunications, insurance, utilities, mortgages) - where the hassle of changing providers is significant - tend to exhibit this phenomenon more prominently (CMA, 2019).

For instance, the Citizens Advice Bureau submitted a super-complaint to the Competition and Markets Authority, arguing that the loyalty penalty has a particularly damaging effect in so-called ***'essential markets'***. In this thesis I define them as:

Definition 2. *Essential markets are subject to specific state regulations where consumers have limited alternatives and a need for regular consumption.*

According to the Citizens Advice Bureau, the five main essential markets are broadband, energy, insurance, banking (including mortgages), and mobile services (see Figure 1.2). It is argued that a participant in all essential markets could potentially lose up to £987 per annum as a result of the loyalty penalty (Citizens Advice, 2018*a*, p. 10).

From a business perspective, the concept of a loyalty penalty can be examined from multiple angles. Firstly, offering promotional prices to new customers can be seen as a necessary cost of acquisition. Subsequently, companies may rely on the disengagement of long-standing customers, expecting that they will not search for better deals and switch due to the hassle, or a lack of information or awareness.

From the consumer's point of view, the loyalty penalty might have a dual effect - it can benefit active consumers who engage with the market by searching for and switching service or good providers, while being detrimental[3] to those

[3]One might argue that the loyalty penalty is not necessarily detrimental, as some consumers, i.e. such as wealthier individuals, may prefer to pay higher renewal prices for the convenience of staying rather than engaging.

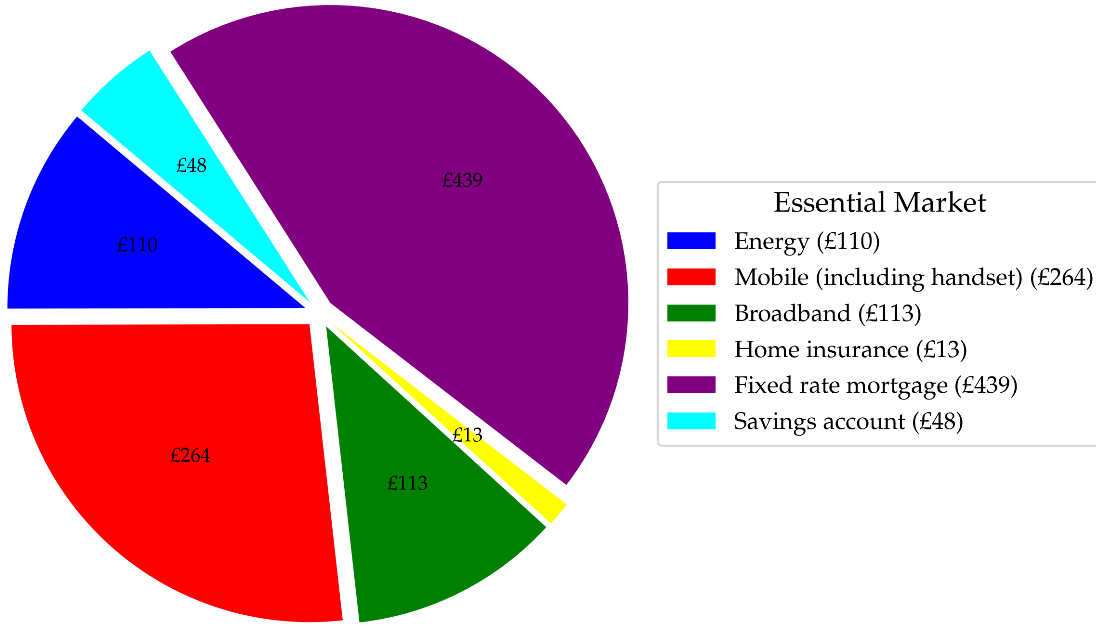


Figure 1.2: The loyalty penalty in essential markets. Source: Citizens Advice (2018*a*).

who do not engage[4]. This suggests that from a positive standpoint, intervention may not always be warranted - active consumers seemingly benefit - so there is a trade-off to consider. However, policymakers also take a normative standpoint on this issue. Therefore, understanding how different types of consumers interact and what externalities they impose on each other requires further study, and this thesis addresses that.

While the positive analysis provides a factual understanding of the loyalty penalty, the normative perspective considers ethics, fairness, and value judgments. At a fundamental level, the loyalty penalty seems counterintuitive. Loyalty, in most ethical frameworks, is a virtue that should be rewarded, not penalised.

[4]From the consumer's point of view, the loyalty penalty does not necessarily mean an unexpected price hike. It can also occur when a promotional deal expires and the consumer is rolled over to a standard contract.

Charging long-standing customers more, especially covertly, can be perceived as exploitative. Given these ethical concerns, should regulatory bodies intervene? If the market fails to self-correct and the loyalty penalty persists, there is a compelling argument for regulatory oversight. Such intervention could ensure transparency, fairness, and protection for consumers, especially in industries with limited competition.

Beyond regulatory intervention, there is a broader question about corporate ethics. Companies, some argue, have a moral and social responsibility to treat their customers fairly. This responsibility extends beyond mere compliance with the law. Avoiding practices like the loyalty penalty might be seen not just as good business sense but as an ethical imperative.

Given the importance of ethical considerations, particularly for consumers with vulnerable characteristics, I will address these issues in the welfare analysis presented in the fourth chapter, which focuses on policy implications.

While much of the discussion centres on companies and regulators, consumers also have a role. In a market economy, consumers can exercise their agency by being informed, regularly reviewing contracts, and switching providers when faced with a loyalty penalty.

The loyalty penalty, when examined through the dual lenses of positive and normative analysis, presents a complex picture. While the positive analysis helps to quantify and understand the phenomenon, the normative perspective pushes researchers and policy makers to grapple with deeper ethical questions. In this thesis the primary focus is on a positive analysis, starting with an investigation into consumer engagement with firms. However, it also provides a useful tool for competition authorities if they decide to engage in actions to reduce the loyalty penalty. The model can be used to assess the potential consequences of such actions and inform decision-making.

1.1.2 The loyalty penalty in the academic literature

To date the most comprehensive report on the loyalty penalty was commissioned by the CMA from E.CA Economics, where notable IO economists such as Professor Paul Heidhues, Professor Johannes Johnen, and Dr. Michael Rauber produced a comprehensive review of the relevant literature. They argue that a good model of the loyalty penalty should consider homogeneous products, repeated interactions of all agents over time, firms' ability to price discriminate between old and new customers when possible, and consumer heterogeneity. Since such models are "surprisingly rare" (E.CA Economics, 2020, p.2), I therefore intend to fill this gap in this thesis.

The models which could be used to study the loyalty penalty come from various literature strands - 'classic' and behavioural (E.CA Economics, 2020). In this thesis I focus on 'classic' models in closely intertwined strands of literature on search costs, switching costs and a behaviour-based price discrimination.

While in the literature the concepts of searching, switching, and a behavioural based price discrimination are interconnected, understanding their differences is important:

Search costs, representing consumers' direct and/or opportunity costs to obtain product information, encompass mental, physical, emotional, and time efforts required to evaluate a product or service's utility expressed in monetary terms. Crucially, these costs are incurred before a purchase and do not always lead to one, highlighting that information comes at a cost (Stigler, 1961).

Switching costs refer to hurdles encountered when changing a product or service after purchase. These costs may include physical, mental, emotional, and time efforts, along with technical and learning constraints. The central insight here is that such costs are incurred only post-purchase and don't enhance pre-purchasing information (Farrell and Klemperer, 2007; Wilson, 2012). Wilson (2012) outlines five major distinctions between these costs[5].

[5] Wilson (2012) built a unified model of search and switching costs and found that search costs

Behaviour-based price discrimination occurs when firms use past consumer behaviour, particularly purchase history, to infer brand preferences and set prices accordingly. The key motivation is to charge higher prices to consumers who value a firms brand more, as their past purchases signal strong brand loyalty. Once consumers reveal their preferences by buying early, firms respond by increasing prices for these 'loyal' customers (Fudenberg and Villas-Boas, 2006).

Farrell and Klemperer (2007) in the seminal survey on switching costs argue that "search costs and switching costs have much in common, and models of the effects of switching costs can also apply to search costs" (Farrell and Klemperer, 2007, p.1978), and that it is often very difficult to empirically differentiate between the two. In the context of essential markets, regulators have made significant efforts to reduce switching costs. For instance, to switch mobile providers, customers only need to request a PAC number via SMS and provide it to the new company, which prevents double payments during the switch. Switching bank accounts is covered by the Current Account Switch Guarantee, and changing energy providers is supported by the Energy Switch Guarantee.

Fudenberg and Villas-Boas (2006) provide an excellent survey on behaviour-based price discrimination models. Usually, this literature assumes that consumers have fixed brand preferences, but switching or search costs are not considered; consumers are forward-looking, fully understanding and anticipating future prices; firms price discriminate based on past purchases, offering different prices to past customers and rival customers. Firms set different prices for past and rival customers, typically in a duopoly where each firm competes for the others former buyers, gaining market power over switchers. Pricing is simple, with a single price per product and no complex contract features, i.e. the Fudenberg and

had a greater impact on market power than switching costs. He suggests five main distinctions between two types of costs, arguing that search costs cannot be incurred by fully informed consumers (1), the consumer has a different amount of information before deciding to incur search costs and switching costs (2), incurring search costs does not necessarily lead to switching a firm (3), this implies that search cost can be incurred several times before switching action (4), and search costs can be incurred pre- and post-purchase (5).

Tirole (2000) model where firms engage in intertemporal price discrimination by using consumers' past purchase behaviour to set future prices. In a two-period duopoly, firms initially compete for consumers, who have exogenous brand preferences and do not search in the first period. In the second period, firms exploit their past customers' brand attachment by charging them higher prices, while offering lower prices to attract the rivals previous customers.

In this thesis, I use the broader term ***'engagement'*** and, therefore, ***'engagement costs'***, which include the process of shopping around, searching and comparing prices, or re-verifying offers with current suppliers. This also can be thought as *'shopping costs'* as used by Rhodes (2014).

Empirical evidence shows that price remains the primary concern in consumer purchasing decisions, and the process of finding a better price influences firms' pricing strategies (Janssen and Moraga-González, 2004; Ofgem, 2019; Giulietti et al., 2014). Therefore, it justifies the focus on the initial stage of market engagement: consumer search.[6]

E.CA Economics (2020) also points out that the classic search literature tends to focus on firms that set prices only once, often overlooking the importance of dynamic pricing, which is fundamental for understanding the loyalty penalty. In this thesis, I address this gap by developing a model which uses ideas from the search literature and incorporates dynamic interactions over two periods.

I leave behavioural reasons outside the scope of this thesis, intending to explore this rich area in future research. Behavioural factors that might contribute to the loyalty penalty include present bias giving rise to procrastination, inattention, and misperceptions. Excellent research on these concepts has been presented in papers by Heidhues and Köszegi (2018), Ellison (2005), and Gabaix and Laibson (2006). Although these papers are not directly focused on the loyalty penalty,

[6] Abstracting from switching costs and brand preferences, as in behaviour-based price discrimination models, I intend to set up a framework that replicates the behaviour of consumers from their first engagement with the market, where products are homogeneous, switching costs are negligible, consumers are myopic, and firms cannot identify consumer types in the first period.

they provide critical insights into the behavioural mechanisms that underpin consumer inaction in such contexts. For instance, the survey on Behavioural Industrial Organisation by Heidhues and Köszegi (2018) examine how firms exploit consumer biases, such as present bias, by designing pricing strategies that take advantage of consumer inattention to future costs. This is particularly relevant in markets with complex pricing, where loyalty penalties may arise. The paper by Gabaix and Laibson (2006) which extends Ellison (2005)'s model, investigates the concept of 'shrouded attributes' and 'add-on pricing', demonstrating how firms can use consumer misperceptions and inattention to hide true costs, leading to higher prices for loyal customers who fail to engage.[7] These patterns can lead consumers to make suboptimal decisions (E.CA Economics, 2020).[8]

There is now a large body of literature on search costs, and several excellent surveys exist, including Baye et al. (2006) and a more recent one by Anderson and Renault (2018). Therefore, the literature review focuses on the class of models that specifically can be suitable to analyse essential markets.

The literature on search costs dates back to 1961 when George Stigler published his seminal work 'The Economics of Information' (Stigler, 1961). He concluded that information frictions prevent the law of one price from holding, leading to market price dispersion even for homogeneous products. Instead of a single price, each firm sets its own price, resulting in price dispersion. This finding can be extrapolated to the loyalty penalty. For instance, we can infer from this that a loyalty penalty might exist: if firms charge different prices, a consumer of one firm may be paying a higher price than is available elsewhere in the market. However, due to search costs, they do not find the lower price, giving rise to a so-called inter-firm loyalty penalty.

[7] An excellent recent survey by Rhodes (2023) on add-on pricing, drip pricing, and false advertising available at: https://papers.ssrn.com/sol3/papers.cfm?abstract id=4430453 (Accessed: May 14, 2025).

[8] Nevertheless, some academics and professionals in antitrust regulation often highlight the pitfalls of the behavioural approach for policy implications. For instance, see Wright and Stone (2012).

This research area has significantly developed since Stigler's original contribution, with contributions from numerous scholars who laid the base models for further researchers. Among the most notable results are the Diamond Paradox (Diamond, 1971), the model of sales with simultaneous search by Varian (1980), 'match' and price framework by Wolinsky (1986), a model with sequential search by Stahl (1989) which became a *workhorse* for many others[9], a model with consideration sets by Armstrong (2005), a model with collusion by Petrikaite (2015), a model with ordered search by Arbatskaya (2007), non-reservation price search by Janssen et al. (2017), stable price dispersion with pure strategy by Myatt and Ronayne (2019), and many others that have emerged over the past 60 years!

Theoretical search models can be categorised based on different characteristics. For example, in models with homogeneous products, consumers evaluate the benefit from searching against their willingness to pay or a certain optimal threshold price (Stigler, 1961; Diamond, 1971; Varian, 1980; Stahl, 1989). In models with heterogeneous products, consumers consider their utility, composed of a time-invariant 'match' which describes their tastes, and firms' prices (Wolinsky, 1986; Armstrong et al., 2009; Rhodes and Parakhonyak, 2020). Given the nature of products in essential markets, models with homogeneous products are more apt for researching the loyalty penalty.

Baye et al. (2006) provide an extensive survey of models with homogeneous products, categorising them based on the search protocol - 'search-theoretic' models and 'clearinghouse' models. The search protocol refers to the predetermined set of rules or procedures that an individual (typically a consumer or firm) follows when seeking information about potential trading partners, products, or prices before making a decision. The search protocol outlines how, when, and where the individual will search, as well as the criteria for stopping the search and making a decision (see Figure 1.3).

In microeconomic models, search protocols are often used to study markets

[9] "Stahl (1989) has provided an enduring work horse model of pricing under consumer search that generates price dispersion." (Anderson and Renault, 2018, p. 178)

with imperfect information, where individuals must expend effort and resources to gather information before making decisions. By modelling different search protocols, economists can analyse how search behaviour affects market outcomes and how policies or interventions might improve market efficiency.

The search-theoretic protocol implies that a consumer incurs a search cost every time they sample a price quote, while the clearinghouse model suggests that consumers use an 'information clearinghouse' to compare all available prices.

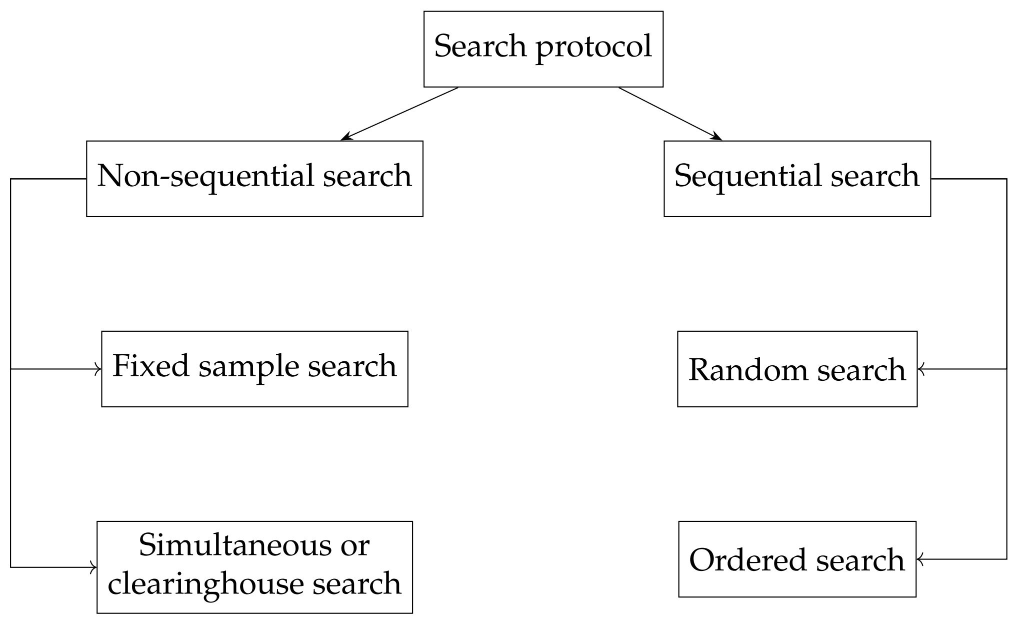


Figure 1.3: Search protocols. Source: Based on Morgan and Manning (1985); Baye et al. (2006).

Although some researchers argue that sequential search models are a better fit - as even when using a 'clearinghouse,' consumers often need to verify observed prices, which are subject to change without notice (Stahl, 1989) - others argue that there is no one-size-fits-all protocol and that the optimal search depends on consumers' goals and resources (Morgan and Manning, 1985; Baye et al., 2006).

Most of the studies mentioned analyse the influence of search costs on firms' pricing strategies statically, assuming firms are not able to recognise the type of their customers and therefore offer them different prices. This led to a recent surge in interest in price discrimination based on consumers' search abilities (Armstrong and Vickers, 2022; Mauring, 2025; Atayev, 2021; Groh, 2021). Yet, most emerging models permitting this assumption do not analyse its effect across different periods, leaving a significant gap for future research, which this thesis aims to fill.

Nevertheless, there are few results that address repeated interactions resembling the loyalty penalty. An excellent example was presented by Andrew Rhodes at the Consumer Search Digital Seminar[10]. In his as yet unpublished work with Alexei Parakhonyak, they propose an elegant model where consumers search for products to learn prices and match values (similar to Wolinsky (1986)), with a lower return search cost compared to the initial search. Over time, as consumers return to firms where they found a better match, firms face more 'loyal' and less price-sensitive demand, gradually increasing prices (Rhodes and Parakhonyak, 2020). In their model, brand preferences explain price walking. In contrast, I consider homogeneous goods and demonstrate that the loyalty penalty can arise even when the consumer is indifferent to the brand.

In existing static search models with homogeneous products, price dispersion typically arises due to differences in consumers' propensity to search and firms' strategic pricing. Consumers vary in their search costs to obtain prices from different firms, leading some to stop searching and accept higher prices to avoid further search expenses. Firms, aware of this behaviour, strategically set their prices, aiming to attract consumers with varying propensities to search. Such strategic decisions usually generate price dispersion in a symmetric equilibrium as a result of mixed strategies, or in an asymmetric equilibrium as a result of pure strategies like in the recent paper by Myatt and Ronayne (2019).

The Burdett and Judd (1983) model further illustrates that price dispersion

[10]Consumer Search Digital Seminar Series (2020) Available at: https://sites.google.com/view/consumersearchseminar/consumer-search (Accessed: May 14, 2025).

can exist even when all consumers face identical search costs.[11] Their analysis demonstrates that in nonsequential search scenarios, where consumers decide in advance how many prices to observe, dispersed price equilibria arise due to firms' strategic pricing. Additionally, in the case of noisy sequential search, where consumers pay to observe at least one price but may see more with some probability, price dispersion is maintained as consumers weigh the costs of continued search against observed prices.[12]

The Burdett and Coles (1997) model extends these insights by considering so-called *'noisy'* search behaviour, where the consumer after incurring a search cost samples either one or two firms and observes the price (or prices) currently offered there with a certain probability. It shows that multiple equilibria can exist, with varying levels of price dispersion depending on consumers' search efforts. Importantly, this model demonstrates that pure strategy equilibria, where all firms set the same price, can occur when search costs are low. Moreover, it highlights that the monopoly price is unlikely to be an equilibrium outcome when consumers can search strategically, further enriching our understanding of price dynamics in search markets.

Nevertheless, while most static models with homogeneous products generate price dispersion due to mixed strategies, Farrell and Klemperer (2007) argue that more real-world features often yield either asymmetric pure-strategy equilibria or symmetric pure-strategy Bayesian-Nash equilibria.

For instance, Myatt and Ronayne (2019) in their recent paper coined the term *'stable price dispersion'*. In their setting with homogeneous products and two periods, they predict an asymmetric equilibrium where firms set a unique profile

[11] Previous papers usually considered some form of ex-ante heterogeneity, such as in production costs, consumer tastes, or rationality - such as different propensities to search independent of consumers' valuations.

[12] However, there are exceptions where symmetric pure strategy equilibria can occur. Specifically, if consumers face zero search costs or have perfect information about all prices, firms are forced to set prices at marginal cost to remain competitive. In such scenarios, firms do not need to randomise their prices, leading to a symmetric pure strategy equilibrium where all firms charge the same price, as in classic Bertrand competition.

of distinct prices played with pure strategies. Nevertheless, their model does not capture the loyalty penalty, as firms set their prices and maintain them in both periods.

Most of the models mentioned above are static, considering firms that set prices only once. They overlook the impact of pricing over time, which is fundamental to understanding the loyalty penalty, and therefore fail to explain this phenomenon.

If these models were extended to account for repeated interactions where firms use mixed strategies, the relationship between expected prices and the loyalty penalty would become unclear. In such cases, prices in subsequent periods could fluctuate, being either higher or lower than initial prices. However, limited attempts to model dynamic competition, where consumers search and switch over multiple periods, indicate that prices tend to increase over time, as demonstrated by the model proposed by Rhodes and Parakhonyak (2020).

Additionally, static models focus on each firm setting a price from a distribution in one period, meaning the loyalty penalty can only be examined in the context of competition between firms, or, as I defined above, the 'interfirm' loyalty penalty. This leaves a gap in understanding how to capture the 'intrafirm' loyalty penalty in a simple model to inform policy interventions.

Finally, it is worth mentioning a recent paper by Yang et al. (2022), which addresses fairness regulation of prices in competitive markets. They explicitly use the term 'loyalty penalty' to describe firms' strategies. However, their approach does not explain the underlying nature of the loyalty penalty, as it is treated exogenously. Their research builds on the theoretical framework of Singh and Vives (1984), modelling a duopoly in two symmetric markets where the loyalty penalty is considered an exogenous 'discriminatory pricing strategy.' They focus on a duopoly with a homogeneous product or service, where each firm sets two distinct prices: a higher price to exploit its loyal customers, and a lower one to lure customers from the competitor. Given policy constraints such as price gaps and caps, they analyse the interplay between market competition and 'price fairness' regulation. However, by treating the loyalty penalty as an exogenous factor, they fail to address the root causes and potential unintended consequences of such pricing strategies and policy implications. Therefore, I find this approach unsuitable for answering the research questions posed in this thesis.

In the next section, I continue introducing the main concepts used in this thesis, particularly different consumer types and consumer vulnerability, which is the focus of the third chapter.

1.2 The concept of consumer vulnerability

This section introduces the concept of consumer vulnerability by reviewing relevant academic literature and regulatory documents and guidance. It outlines the key characteristics of different consumer types and their engagement patterns. This analysis forms the foundation for the model's assumptions in Chapter 3 and contributes to ongoing regulatory efforts to establish a unified definition of consumer vulnerability.

While this thesis does not model engagement costs endogenously - leaving this complexity as a potential avenue for future research - it incorporates empirical insights into consumer behaviour and engagement costs. Such an approach emphasises a broader conceptual understanding, ensuring the model's relevance and achieving a balance between theoretical rigour and practical market applicability.

1.2.1 Understanding vulnerability: insights into consumer types

The report prepared by CMA (2019) points out that the loyalty penalty can be particularly harmful to vulnerable individuals who may struggle to actively participate in a market, thereby posing a high risk of encountering a poor deal. For the purpose of this thesis I define vulnerable customers as follows:

Definition 3. *Vulnerable individuals include consumers at risk, such as those with limited understanding of finances, technology, and market features, or those who lack the means or awareness to regularly switch service providers or products.*

The literature on consumer vulnerability is extensive, but there is no universally accepted definition of consumer vulnerability to date. Various researchers have contested the definitions proposed by their predecessors, each suggesting a 'better' alternative. Andreasen (1975) refers to characteristics that are out of control; Baker et al. (2005) describes it as a 'state of powerlessness'; Commuri and Ekici (2008) consider it a combination of systemic and transient components; Garrett and Toumanoff (2010) suggest distinguishing between disadvantaged and vulnerable consumers; Hill and Sharma (2020) link it to consumers' access to resources; Riedel et al. (2021) view it as a unique and subjective experience of powerlessness; and Raciti et al. (2022) see it as a subjective perception of susceptibility. A similar variety is observed in regulatory reports (CMA, 2019; OECD, 2016, 2023; Ofgem, 2019; Ofcom, 2022). Despite these differences, there is a consensus that consumer vulnerability is a complex and multidimensional phenomenon. The identification of vulnerable consumers generally follows two main approaches: (1) ***Class-based vulnerability***, categorising consumers based on demographic and socio-economic factors, and (2) ***State-based vulnerability***, focusing on the consumer's current circumstances or states, such as health, financial status, or life events.

Class-based approach focuses on individual consumer characteristics that may lead to vulnerability. Key factors include low income, unemployment, education level, language barriers, and minority status. For example, consumers with limited financial literacy may find it challenging to understand and utilise online banking or investment platforms. In a similar vein, language barriers might hinder consumers from comprehensively grasping the terms and conditions on digital platforms, potentially leading to reluctance to engage further (Baker et al., 2005).

A major benefit of this approach is its ability to offer clarity and legal certainty in policymaking regarding vulnerable individuals (Baker et al., 2005), aiding in the development of proactive policies (Commuri and Ekici, 2008). However, its limitation lies in the challenge of distinguishing between various degrees of consumer vulnerability (Cole, 2016).

State-based approach suggests that vulnerability can affect any consumer, regardless of their intrinsic attributes, as a result of a combination of individual traits, personal circumstances, and market dynamics (Baker et al., 2005). In this view, vulnerability is seen as a transient condition. For instance, consumers may become vulnerable due to temporary life events like bereavement, illness, or other personal crises (Baker et al., 2005). In other words, it means that anyone can be considered a vulnerable consumer at some point in their life. Although this approach is intuitively correct and appealing, its major criticism is that it is quite difficult to use for policymaking.

For instance, the European Commission's 2018 consumer survey revealed that 43% of EU citizens considered themselves vulnerable consumers, an increase from 35% in 2016. A significant portion, one-third of respondents, felt vulnerable due to the complexity of offers, terms, and conditions. The 2019 Consumer Conditions Scoreboard further concluded that vulnerability is primarily associated with challenging financial situations (OECD, 2016).

Additionally, a behavioural experiment commissioned by the European Commission yielded more intriguing results. This experiment identified five dimensions of vulnerability (see Table 1.1) and examined them across various essential markets - energy, finance, online services, and a cross-cutting examination encompassing electricity deals (energy sector), broadband packages (online sector), and savings accounts (finance sector). The findings were striking: in the energy sector, 85% of participants were unable to choose the best deal; in the online sector, the figure stood at 53%, and in the cross-cutting experiment, it was 66%.

Furthermore, 57% of consumers in the finance sector and 52% in the energy sector never compared deals. Notably, 23% of participants were vulnerable in at least one dimension, with personal characteristics, financial, and employment circumstances having the highest incidence rates. The study also highlighted specific challenges, such as 23% of survey respondents facing difficulties in comparing deals online due to market-related factors, and 22% avoiding switching due to bundling issues (OECD, 2016).

The assessment of consumer vulnerability is often conducted in comparison to the concept of the ***'average consumer'***, a benchmark used in both academic literature and regulatory documents/guidance. [13] This concept has its advantages and disadvantages. The average consumer is typically defined as:

Definition 4. *The average consumer is "one who is reasonably well-informed, observant, and circumspect, taking into account social, cultural, and linguistic factors" (OECD, 2016, p.138).*

Despite criticism that this concept might set the bar too high for assessing vulnerability, it remains a useful tool for policymakers, hence for this thesis as well.

[13]For example, in the Digital Markets, Competition and Consumers Act 2024, the average consumer standard is relevant for assessing unfair commercial practices, misleading advertising, and exploitative pricing strategies. The Act, which strengthens the UK's competition and consumer protection framework, considers how an average consumer would interpret business conduct, particularly in digital markets where behavioural biases and data-driven personalisation affect decision-making. See more at: Digital Markets, Competition and Consumers Act (2024) Available at: https://bills.parliament.uk/bills/3453/publications (Accessed: May 14, 2025).

Dimension	Indicators	Questions/Variables
1. Heightened risk of negative outcomes or impacts on well-being	1. Unassertive when experienced a problem	Did not take action when experienced a problem when buying or using goods or services in last 12 months
	2. Overpaid for services	Paid more for services in last 12 months due to being unable to use a certain payment method
2. Having characteristics that limit ability to maximize well-being	3. Perception of own vulnerability due to personal characteristics	Feels vulnerable because of health problems, financial circumstances, employment situation, age, belonging to a minority group, personal issues, other reasons
3. Having difficulty in obtaining or assimilating information	4. Does not feel informed	How informed feels about prices etc. when buying goods and services
	5. Gets information from few sources	Where gets information to compare deals
	6. Does not compare deals due to information-related factors	Whether compares deals, How difficult finds it to compare deals, Why finds it difficult to compare deals, Why never compares deals
	7. Has not recently switched due to being unsure about where to get information	Whether has switched in last 5 years, Why has never switched
4. Inability or failure to buy, choose or access suitable products	8. Does not compare deals due to a) personal, b) market-related and c) access-related factors	Whether compares deals, How difficult finds it to compare deals, Why finds it difficult to compare deals, Why never compares deals
	9. Has not recently switched due to a) personal factors, b) market-related factors, c) access-related factors, d) termination costs and e) bundling of offers	Whether has switched in last 5 years, Why has never switched, Has not switched in last 12 months due to termination costs or bundling
	10. Declined a loan	Whether has tried but failed to obtain a loan in the last 5 years
	11. Excluded from e-commerce	Did not make a purchase online in last 12 months due to difficulty of process or not having payment card
5. Higher susceptibility to marketing practices	12. Perception of own vulnerability due to marketing practices	Feels vulnerable because offers, terms or conditions are too complex

Table 1.1: Mapping concepts of vulnerability from the literature to survey-based indicators. Source: (OECD, 2016, p.61)

In the context of the third chapter, which deals with three types of consumers, the 'average consumer' benchmark serves a significant purpose. It represents a type of consumer who incurs positive engagement costs, more than savvy-shoppers but less than vulnerable consumers. This distinction provides a valuable framework for applying the theoretical model to real-world scenarios. It also facilitates the identification of specific groups that may require additional protections or interventions, thereby guiding policymakers in creating more targeted and effective regulations.

1.2.2 Engagement cost heterogeneity in the context of existing academic literature

I capture different types of consumers by introducing heterogeneity in engagement costs. Therefore, in addition to the previous literature, I briefly review related papers, which can be applied to the study of the loyalty penalty.

In the most prominent models, search cost heterogeneity is applied exogenously. For instance, Varian (1980) distinguished consumers by their search costs, suggesting that consumers exhibit heterogeneous search costs, with some facing zero search costs ('informed' consumers) and others facing prohibitively high search costs ('uninformed' consumers). The uninformed consumers do not engage in search activities due to their high search costs. Stahl (1989) employed a similar approach but presented a model where consumers engage in sequential search, in contrast to the clearinghouse model in Varian's work. In his paper, he refers to 'informed' consumers as 'shoppers' and to 'uninformed' consumers as 'non-shoppers'.[14] This approach allowed the breaking of the Diamond paradox[15], and the models usually have a solution in mixed strategies. Consequently, this

[14]Although in Stahl's model, in contrast to Varian's, the search choice of non-shoppers is endogenous, firms behave in a way that prevents these consumers from searching in equilibrium.

[15]Peter Diamond (1971) showed that even with minimal search costs, firms in a perfectly competitive market may set monopoly-level prices. The paradox arises because consumers, facing a small cost to search for better prices, may choose not to search at all. As a result, firms have no incentive to lower prices, and all firms charge the same high price, eliminating price competition.

approach was widely used (Janssen et al., 2011; Janssen and Parakhonyak, 2014; Baye et al., 2006).

This dichotomy in consumer types serves as a valuable starting point for assessing the market with the loyalty penalty. However, consumers who do not search in these models are not necessarily vulnerable. In the real world, consumers typically possess varying abilities to assess information. Therefore, I look at the literature that explicitly incorporates search cost heterogeneity.

For instance, Rob (1985) considered a variety of search costs and found that such variability can lead to a diverse range of price outcomes. His model illustrates how the introduction of variable search costs can create different types of market equilibria in pricing, offering a more nuanced perspective on price competition in markets with imperfectly informed consumers. Depending on the heterogeneity of search costs, various equilibria can arise, including single, multiple, and continuous price distributions. This work highlighted the complexities of consumer and seller behaviour in such markets and provided a methodological framework for computing equilibrium price distributions.

Another approach to introducing an element of heterogeneity in search costs among consumers is to consider variations in the order in which consumers search for firms. This heterogeneity stems from the different sequences in which they search for firms, rather than from the individual characteristics of consumers (Stahl, 1996).[16]

To illustrate this concept, consider the following example, demonstrating how the consumer search order, as proposed by Stahl (1996), introduces heterogeneity in search costs even when the cost per search action remains constant:

Imagine an online market with three sellers - A, B, and C - offering identical goods but at varying prices: A at £20, B at £15, and C at £10. There are two consumers in this market, X and Y. For simplicity, assume the search cost for each action is £2, representing the effort, time, and resources expended during the

[16] In 1996, Stahl revised his seminal model (1989) to include search heterogeneity.

search.

Consumer X begins their search with A, then B, and finally C. Initially, X finds the product at A for £20. Deciding to continue searching, X incurs a £2 search cost and discovers the product at B for £15. Continuing further and incurring an additional £2, X finds the product at C for £10 and decides to purchase. In total, X incurs £4 in search costs and pays £10 for the product.

Conversely, consumer Y starts her search with C, finding the product immediately for £10 and ceases further search, thus incurring no additional search costs. Both consumers purchase the product for £10, but the effective price, including search costs, differs: £14 for X and £10 for Y. This discrepancy is due to their different search sequences, leading to varied search costs.

Additionally, as in Stahl (1989), consumers receive a 'free sample' from a randomly chosen firm, providing price knowledge without incurring search costs. After this, they decide whether to incur further search costs for additional pricing information. Given the search costs, consumers may opt not to search beyond the free sample, particularly if the expected gain from finding a lower price is outweighed by the search cost. This implies that often, consumers might not search beyond their free sample.

Another interesting approach was proposed by Ellison and Wolitzky (2012). They build on Stahl (1989)'s consumer search model, introducing two key refinements. First, consumers do not know the exact time required to search for firm prices but are aware of the distribution of search times. Firms, in contrast to Stahl's framework, can influence the search time. Consumers either search costlessly or incur a cost for each unit of search time. The authors develop two models.

In the first model a convex disutility function for search is introduced, where firms select both prices and search times. The results show that firms randomise prices, bounded above by the monopoly price. Deliberately increasing search time (or as they call it 'obfuscation') leads to higher prices and search costs, negatively impacting consumers. When obfuscation is costly, firms balance search times such that even high-priced firms ensure purchases by costly searchers. High-priced firms choose more obfuscation, while low-priced firms may not obfuscate at all.

In the second model they assume a linear search disutility and introduce uncertainty about the exogenous part of search time. Both consumers and firms are uncertain about this component, complicating search decisions. Firms choose the minimum obfuscation level for each price, resulting in price distributions bounded below the monopoly price. However, excess obfuscation arises, harming both buyers and sellers, as firms raise obfuscation to ensure that costly searchers do not search twice.

Chen and Zhang (2012) extend Stahl (1989), considering two types of non-shoppers: local, who always buy from the local shop, and global non-shoppers, who might or might not shop around. They argue that when the number of local consumers becomes large enough, or when the difference in search costs between local and global consumers is substantial, firms might deviate from Stahl's equilibrium. Instead, they would prefer to mix over a *'clustered distribution'* where high and low prices are separated by a zero-density gap.

To incorporate the consumer's vulnerability, in contrast to the aforementioned models, I explicitly assume that there are two types of positive engagement costs - high and low. Translating this to the previous numerical illustration, let's assume that instead of always incurring £2 for each action, consumer X might incur £10, and consumer Y might incur £2. In this case, the consumer X might never search, because the cost outweighs the benefit to engage. Another distinctive feature is that I analyse in two periods.

The empirical literature offers further insights into the types of search costs. For instance, search costs can be modelled as a function of observable characteristics. This approach is often adopted in empirical models due to data availability. De Los Santos et al. (2012), for example, used consumer browsing data from an online retailer to estimate search costs based on observable characteristics, such as the consumer's purchase history. Hong and Shum (2006) estimated search costs for online book buyers using the number of websites visited as an observable measure of search intensity.

The state-dependent search costs or learning approach captures the concept that the cost of searching might change as consumers gather more information. Sorensen (2000) introduced a model in which search costs increase as consumers gather more information, leading to decreasing returns to search. This model, applied to the prescription drug market, showed how consumer search behaviour can impact market outcomes. Koulayev (2014) examined how learning reduces search costs over time, finding that search costs decrease as consumers become more experienced in searching for products online. Honka (2014) also examined consumer learning in the context of the online auto insurance industry, finding evidence that consumers' search costs decrease as they gain experience.

Additionally, the search cost as unobserved heterogeneity approach is often used when search costs cannot be directly observed. For example, Moraga-Gonzalez and Wildenbeest (2008) estimated search costs as an unobserved variable in a model of consumer search and price competition, revealing significant heterogeneity in search costs across consumers, which affected both consumer behaviour and market outcomes.

Recognising the intrinsic complexity and transience of consumer vulnerability, there remains a need for a viable theoretical base. This necessitates certain simplifications, such as those proposed further in the third chapter, categorising consumer types based on the magnitude of their engagement costs into three categories: ***savvy-shopper***, ***average***, and ***vulnerable***.

To conclude this section, after reviewing regulatory documentation/guidance and relevant academic literature, it is important to acknowledge that the absence of a universal definition for 'vulnerability' and 'average consumers', or a standardised approach to addressing consumer vulnerability, does not undermine the proposed theoretical framework. Instead, it offers policymakers a simple, reliable, and accessible tool for evaluating policies aimed at addressing the effect of the loyalty penalty on different types of consumers.

Chapter 2

The role of engagement costs in the loyalty penalty

The loyalty penalty refers to the disadvantage incurred as a consequence of being on a rollover contract or subscription for an extended period of time, compared to the benefits enjoyed by new subscribers or customers receiving the same product or service. In this chapter, I present a simplified two-period model of the loyalty penalty: firms initially set consistent base prices, and are then incentivised to increase these prices in the subsequent period.

In the model the loyalty penalty originates from the consumer's lack of engagement within the market, which can be attributed to the cost of engagement. In each period, consumers must interact with the market by researching and validating information about prices.

The initial engagement involves a sequential search process, during which consumers consider the benefits derived from their search. However, in the second period, they are unable to renegotiate the initial prices with their current provider. This chapter's findings show a departure from traditional static sequential search models with 'informed' and 'uninformed' consumers that feature equilibrium in mixed strategies. Instead, it demonstrates a symmetric pure-strategy equilibrium, where there exists a threshold price that serves as a base price. As a result, firms can charge higher renewal prices to their loyal customers in the second period.

2.1 Introduction

Consider the following scenarios: you've been a loyal customer of a telecommunications company for the past decade. You've never missed a payment and have even recommended their services to friends. Similarly, you've been a long-term policyholder with an insurance company. You've consistently paid your premiums on time, have never been in an accident, and even accepted annual price increases from your insurer without considering a change.

Conventional wisdom suggests that your loyalty should be rewarded, perhaps with discounted rates or premium services. Yet, one day you discover a disconcerting reality: new subscribers are paying significantly less for the same telecom package you've been purchasing for years, or new policyholders with the same characteristics are receiving the same insurance coverage at a much lower premium.

In both scenarios, instead of being rewarded, you find yourself penalised for your loyalty. This situation, paradoxical from the consumer's point of view, is known as the ***'loyalty penalty'***.[1]

The idea behind subscription and rollover contracts is to facilitate the consumer experience and reflect the nature of products in essential markets, ensuring that consumers do not incur substantial losses if they lose access to such services at the point of contract renewal. For instance, driving without insurance in the UK can lead to an unlimited fine[2]. Another attribute stemming from periodic purchases is the necessity of regular consumer engagement with the market.

In this chapter, I present a basic microeconomic model that encapsulates critical aspects of consumer-firm relationships across essential markets, characterised by subscription and rollover products. The objective is to address this relatively

[1] The loyalty penalty can manifest in different ways, i.e. price jumps, price walking, legacy pricing.

[2] Police.uk (2024) *Driving without insurance.* Available at: https://www.police.uk/advice/advice-and-information/rs/road-safety/driving-without-insurance/ (Accessed: May 14, 2025).

new phenomenon by filling the gap in existing models that could explicitly explain the 'intrafirm' loyalty penalty, particularly in the context of subscriptions and rollovers.

The central argument of the chapter is that the loyalty penalty arises due to costs associated with engagement, leading to a lack of consumer engagement in markets. For instance, Citizens Advice, analysing the broadband market, reports that only 39 per cent of customers are willing to spend additional time shopping around, and 28 per cent lack the capacity to do so. Furthermore, once customers enter a contract, engagement drops further, with 71 per cent failing to re-engage with the market and 55 per cent never attempting to renegotiate the contract (Citizens Advice, 2017).

An E.CA Economics report commissioned by the CMA identifies several economic factors contributing to this phenomenon, which I consider as engagement: searching and switching (E.CA Economics, 2020). They propose that a theoretical understanding of the loyalty penalty should encompass several key elements: a market of homogeneous products, repeated interactions of all agents over time, firms' ability to price discriminate between old and new customers when possible, and consumer heterogeneity due to ability to engage. Although extensive literature exists on each of these factors, comprehensive models combining all the aforementioned features "are, surprisingly, rare" (E.CA Economics, 2020, p. 2). The current literature arguably does not fully capture the facets of actual consumer behaviour crucial to understanding the full impact of loyalty penalties (E.CA Economics, 2020, p. 4,6). By constructing a model that combines these features, I can examine the sources and consequences of loyalty penalty behaviour and understand the impact of policy interventions. The aim is to fill this gap, providing scholars and practitioners with a simple microeconomic model based on Industrial Organisation principles to rigorously consider the consequences of the loyalty penalty and how to address it if deemed a problem.

The chapter generates insights into the loyalty penalty using a game-theoretic approach with microeconomic tools. The foundational point is a duopoly model with identical firms and two types of consumers, who live and operate over two periods. The firms supply an identical product (or service) in each period at marginal costs normalised to zero and compete on price. In the first period firms set a base price for new customers which remains in both periods, and in the second period firms set renewal price for existing customers.

In the first period all consumers are new to firms, therefore, they simultaneously set the base price in first period, which becomes common knowledge and exists in both periods. Then they have to choose by how much to raise the price (if at all) in the second period for existing customers (renewal price).

The consumers have identical positive valuation for the product (service) and must engage in the market to learn the prices to buy at most a single unit in each period. A fraction of consumers have zero engagement costs ('shoppers') and, therefore, know all prices, the remaining consumers have positive engagement cost ('non-shoppers'). Similar to the most of the literature, I assume that engagement cost is less than consumer's valuation.

The initial engagement with the market begins with the search process; therefore, this chapter closely relates to the search literature that focuses on static models with homogeneous products[3]. In line with the existing literature, I assume that the first engagement is costless, which guarantees trade. When a consumer joins a firm, they pay the base price, which firms set in the first period. If a consumer stays with the firm into the second period, the base price is no longer available, and the consumer must pay the renewal price. If they switch providers, they have access to the other firm's base price. In other words, in the second period consumers that are new to a firm pay the base price; consumers that purchase in two consecutive periods pay the renewal price. Non-shoppers must pay an engagement cost to (re)discover the base price, while shoppers are fully informed. The

[3]Considering the aim to build a simple, tractable dynamic model of the loyalty penalty, the chapter focuses on a model with homogeneous products for two reasons: the nature of the products in essential markets, and empirical evidence showing that price concerns remain the biggest deterrent to supplier switching (Ofgem, 2019), with only about 5 per cent variation in prices explained by firm heterogeneity (Giulietti et al., 2014).

model also assumes that if new consumers are indifferent, they distribute evenly between the two firms. However, if a consumer is already with a firm, they will stick with that firm if they are indifferent.

The equilibrium concept - a Subgame Perfect Nash Equilibrium (SPNE) - requires that renewal prices are optimal given base prices (equilibrium in the subgame), and that firms' base prices are consistent with a Nash Equilibrium (NE) given these equilibrium continuation prices.

One of the first elements the model aims to capture is the role of initial pricing strategies employed by firms. Specifically, base prices can be seen as promotional rates or introductory offers that may be increased in the subsequent period. Therefore, the model examines whether such prices can act as a precursor to future price hikes. This is crucial because these initial pricing strategies might serve as bait to attract new customers, only to increase the prices once the customers are 'locked in.' By modelling this aspect, I shed light on the strategic pricing decisions made by firms and how they set the stage for the loyalty penalty to occur.

I interpret the loyalty penalty as the difference in prices paid by the customer who decided to stay with the current firm in the second period (hence the term *'loyal'*) compared to the customer who changes firm. The model also provides another insight into firms' pricing: the base price is always positive and, with the presence of both types of consumers, never reaches the competitive level (marginal costs). The base price can be expressed through the primitives of the model, as a function of engagement costs, the proportion of shoppers in the market, and consumers' valuation. This, in turn, allows for an analysis of comparative statics and shows how equilibrium prices change depending on the model's primitives.

The second important aspect is consumer behaviour, with a particular focus on consumer engagement captured through search. In many markets, especially those with subscription models, consumers often do not engage, meaning they continue with their existing subscription even when better options may be available. This behaviour can be due to various factors, such as the hassle of finding providers or simply a lack of awareness of alternative options. Engagement costs, both monetary and non-monetary, further exacerbate it. The model quantifies this element to understand how it also contributes to the firms' pricing and persistence of the loyalty penalty over time.

The model illustrates how the loyalty penalty can arise as an equilibrium outcome. It identifies a threshold price and highlights its role in influencing firms' pricing strategies. If one firm sets this threshold as its base price, a competitor may undercut it in the first period to capture all shoppers. In the second period, the undercutting firm faces a strategic choice: maintain its customer base by setting the renewal price such that no shoppers are willing to switch, or raise the price to maximise profits from non-shoppers, even at the risk of losing active shoppers. Firms exploit non-shoppers by raising renewal prices, and the presence of these disengaged consumers allows firms to set base prices above marginal costs. However, as more consumers engage with the market (i.e., shop around), both base and renewal prices tend to decline, especially when consumers' engagement costs are low.

The subgame perfect Nash equilibrium identified in the model provides a clear understanding of these dynamics, offering insights into how firms balance the need to attract new customers with the opportunity to retain and profit from existing ones, all while accounting for the cost of consumer engagement.

This model is closely related to classic search models (Stahl, 1989; Janssen et al., 2005; Varian, 1980; Burdett and Judd, 1983) but is modified to allow dynamic interaction with 'sticky' base prices. Unlike in the static model, where similar settings result in firms playing mixed strategies, such modifications lead to a symmetric pure strategy equilibrium. Nevertheless, the model successfully captures the loyalty penalty phenomenon due to costly engagement.

As a result, the model could be used to explore the broader market implications of the loyalty penalty, especially from a regulatory standpoint. The model could be used to consider scenarios where regulatory bodies might step in to protect consumers without damaging the competitive incentives of firms. For example, it could examine the impact of mandating prohibition of the loyalty penalty or limiting the extent to which prices can be hiked for existing customers. By doing so, the model will provide valuable insights into the potential effectiveness of various regulatory strategies aimed at mitigating the loyalty penalty.

By capturing these critical aspects, the model aims to offer a simple yet comprehensive analytical framework for studying the loyalty penalty. It will not only contribute to academic discourse but also provide policymakers with theoretical foundations for crafting more effective regulation.

In the subsequent Section 2.2, I formally present the model and the equilibrium analysis. Section 2.3 provides comparative statics, and I conclude in Section 2.4.

2.2 The Model

In this section I present the model of the loyalty penalty. I begin by providing context for the model through a brief review of the general static model. Then I suggest modifications which allow to capture the loyalty penalty.

2.2.1 Setting the stage: a brief recap of a static general model

This chapter is influenced by the search model from the seminal work of Dale Stahl (1989) and its unit demand version by Janssen et al. (2005). The focus on unit demand is determined by the nature of the products and services in essential markets. This approach also provides an opportunity to find an explicit expression for the reservation price (which in Stahl's model is given implicitly).

The static model 'a-la Stahl' became a popular workhorse amongst search theoretic economists (Anderson and Renault, 2018). This type of model usually considers a market with $n \geq 2$ identical symmetric firms, all of which produce an identical product at marginal cost normalised to zero, and cannot price discriminate between their customers. Each consumer has an identical value $v > 0$, and the monopoly price is defined as $\hat{p} = v$.

Consumer populations differ in their approach to finding the best prices: a proportion λ are 'shoppers' who enjoy the search process and do not incur any cost in obtaining relevant information. The remaining $1 - \lambda$ are 'non-shoppers' who face an engagement cost $e > 0$, except for the first sample, which is free. Non-shoppers utilise a sequential engagement strategy comparing the benefit from each additional sample to the cost of engagement. They follow a predefined rule, known in the literature as *'the reservation price rule'*, to sample firms.[4] They have a perfect recall[5] and compare the prices to a 'cutoff price' (the reservation price $\bar{p}$) and then decide whether to make a purchase or continue their engagement in search. Meanwhile, firms according to their conjectures of consumers' engagement behaviours and competitors' strategies, simultaneously decide on their prices.

Peter Diamond (1971) showed that when consumers sequentially search for the prices of a homogeneous good, and price-setting firms produce at identical costs, while all consumers face a positive search cost ($\lambda = 0$), firms can charge the monopoly price. This is known as 'The Diamond Paradox'. The key mechanism is that consumers expect all firms to charge the same price, which removes their incentive to search for better deals after visiting the first firm. As a result, firms have no incentive to undercut each other and instead set the monopoly price, knowing consumers won't search further.

[4] There are also alternative rules of search. For instance, Janssen et al. (2017) analyse equilibrium where consumers rationally choose engagement strategies that are not characterised by a reservation price. They argue that Reservation Price Equilibria (RPE) fail to accurately measure market power in consumer search markets because consumers often lack key information, like firms' costs, and learn as they search. RPE face theoretical issues, including non-existence and reliance on specific out-of-equilibrium beliefs. The authors propose alternative equilibria where consumers use rational search strategies not defined by a reservation price and found that non-RPE always exist, are independent of out-of-equilibrium beliefs, involve active consumer search, and align with recent empirical evidence.

[5] Consumers can revisit previously searched firms without incurring any cost.

In contrast, when all consumers are fully informed ($\lambda = 1$), the incentives to undercut drive the price down to marginal costs, resulting in a race to the bottom and a Bertrand (1883) equilibrium.

Stahl (1989) offered an elegant solution for explaining the transition from Diamond to Bertrand competition. In his model, consumers are split into two groups: those who incur a cost when searching for prices (non-shoppers) and those who enjoy searching and do so at no cost (shoppers), always finding the best deals. Firms must lower prices to attract the shoppers, who are sensitive to price differences. This creates a dilemma for firms: either fully exploit the non-shoppers by charging them the highest price they are willing to pay (the reservation price) or lower prices slightly to attract more shoppers.

This situation triggers an undercutting game among firms, pushing prices down to a competitive level (Bertrand price). However, this does not result in a pure strategy Nash equilibrium because any firm could deviate by increasing its price, focusing on non-shoppers who don't compare prices due to engagement costs.

A pure strategy symmetric Nash equilibrium (SNE) does not exist in this game because there is always a profitable unilateral deviation from any candidate symmetric pure strategy. However, Nash's theorem guarantees the existence of at least one equilibrium, which shifts focus to the investigation of mixed strategies. In a symmetric mixed strategy Nash equilibrium, firms randomise their pricing, selecting prices from an interval based on a distribution function. In this equilibrium, consumers are expected to stop engagement and make a purchase when they encounter a price at or below the endogenous reservation price. This price is determined by the optimal engagement rule, balancing the benefit of further engagement against the engagement cost.

This concept was initially introduced by Stigler (1961), whose work sparked further developments in the field. Kohn and Shavell (1974) introduced the optimal search rule, which involves a process of continuing to engage in search until the expected marginal benefit equals its marginal cost. Building upon these principles, many economists (Stahl, 1989; Janssen et al., 2005; Dana, 1994; Petrikaite, 2015; Giulietti et al., 2014; Atayev, 2021; Groh, 2021) incorporated the optimal engagement rule into their models.

Formally, such a rule in a static model can be described as follows. Consider a buyer who has observed a given price r, which is lower than her valuation v. If she decides to purchase at this price, her consumer surplus will be $v - r$. However, she anticipates that a better price, denoted as $p^E < r$, might exist. To find this lower price, she would need to incur an engagement cost, e. If she proceeds with further search, her expected consumer surplus from obtaining the expected price p^E is $v - p^E - e$. Therefore, the buyer will continue searching only if the expected benefit of further engagement outweighs the benefit of purchasing at price r. This condition can be written as:

$$v - p^E - e \geq v - r \tag{2.1}$$

Now, let $F(p)$ represent the cumulative distribution function of prices in the symmetric Nash equilibrium (NE), with a known density $f(p)$, and assume that all players know this distribution. Let $\underline{p}$ denote the lower bound of the price range. Given the observed price r, the expected price is the average price below r, which can be expressed as:

$$p^E = \int_{\underline{p}}^{r} p \, dF(p) \tag{2.2}$$

Buying at r should provide at least the same benefit as continuing the search for a lower expected price. This condition is:

$$\begin{aligned} v - r &= v - \int_{\underline{p}}^{r} p \, dF(p) - e \\ r &= \int_{\underline{p}}^{r} p \, dF(p) + e \end{aligned} \tag{2.3}$$

The reservation price, denoted $\bar{p}$, is defined as the price r that satisfies Eq. 2.3. Hence, Eq. 2.3 can be re-written as follows:

$$\bar{p} = \int_{\underline{p}}^{\bar{p}} p \, dF(p) + e \tag{2.4}$$

Firms are assumed to set prices that discourage further search and therefore avoid setting prices above $\bar{p}$, making $\bar{p}$ the upper limit of the distribution $F(p)$.

Then, the expected benefit from marginal search $(\bar{p} - p)$ should be at least equal to the cost of marginal engagement in search:

$$\int_{\underline{p}}^{\bar{p}} (\bar{p} - p) \, dF(p) = e \tag{2.5}$$

Integrating Eq.2.5 by parts yields:

$$\int_{\underline{p}}^{\bar{p}} F(p) \, dp = e \tag{2.6}$$

In summary, all participants consider a mixed strategy in equilibrium and are aware of a price distribution $F(p)$ with bounds $[\underline{p}, \bar{p}]$, where $\bar{p}$ is referred to as the reservation price. Consumers are expected to stop searching and make a purchase when they encounter a price equal to or lower than the reservation price. The reservation price is defined by the sequential engagement rule, balancing the benefit of further search against the engagement cost. Firms, knowing this, price below the reservation price to prevent further search. As a result, the upper bound of the price distribution, $\bar{p}$, is endogenous, determined by the interaction between consumers' search behaviour and firms' pricing strategies.

On the other side assume two firms[6] are playing mixed strategies by simulta-

[6]Given that the dynamic model of the loyalty penalty will be constructed for duopoly, it is logical to demonstrate the solution of the static model for two firms ($n = 2$)

neously drawing prices from the same distribution $F(p)$. With probability $1-F(p)$ a firm offers the lowest price and earns a profit $p(\lambda + \frac{1-\lambda}{2})$: it serves its non-shoppers and entire fraction of shoppers. With probability $F(p)$ a firm offers the highest price and earns a profit $p\frac{1-\lambda}{2}$ by serving only its non-shoppers. Thus, the expected profit is:

$$\begin{aligned} \mathbb{E}[\pi] &= p\left(\lambda + \frac{1-\lambda}{2}\right)[1-F(p)] + p\frac{1-\lambda}{2}F(p) \\ &= p\left(\lambda[1-F(p)] + \frac{1-\lambda}{2}\right) \end{aligned} \tag{2.7}$$

To satisfy the indifference condition required of mixed strategies in equilibrium, the expected profit must be the same for any price in the distribution. Thus, for a price $\bar{p}$, the expected profit is $\mathbb{E}[\pi] = \bar{p}\frac{1-\lambda}{2}$, which represents the firm's expected profit across all prices in the mixed strategy. This ensures that no firm has an incentive to pick one price over another, as the expected profit is constant for all prices in the distribution. The equilibrium condition can be written as:

$$p\left(\lambda[1-F(p)] + \frac{1-\lambda}{2}\right) = \bar{p}\frac{1-\lambda}{2} \tag{2.8}$$

In a mixed-strategy Nash equilibrium, this indifference condition ensures that firms randomise over the range of possible prices according to the distribution $F(p)$.

The shape of distribution $F(p)$ can be found by rearranging the equation above:

$$F(p) = 1 - \frac{(\bar{p}-p)(1-\lambda)}{2p\lambda} \tag{2.9}$$

The density function $f(p)$ is obtained by taking the derivative of the cumulative distribution function $F(p)$ with respect to p:

$$f(p) = \frac{\bar{p}(1-\lambda)}{2\lambda p^2} \tag{2.10}$$

To obtain the expression for the lower limit of the distribution set $F(p) = 0$ in Eq. 2.9 and solve for p giving:

$$\underline{p} = \bar{p}\frac{(1-\lambda)}{(1+\lambda)} \tag{2.11}$$

This provides all the necessary components to derive the endogenous reservation price, defined by the relationship between the benefit of marginal engagement and the engagement cost. To do so, re-write the left-hand side of Eq.2.5 as $\bar{p} - \int_{\bar{p}\frac{(1-\lambda)}{(1+\lambda)}}^{\bar{p}} pf(p)dp$ and substitute the expression for $f(p)$. After evaluating the integral and solving for $\bar{p}$, obtain the following expression for the optimal reservation price:

$$\bar{p} = \frac{e}{1 + \frac{(1-\lambda)}{2\lambda}\ln\left(\frac{1-\lambda}{1+\lambda}\right)} \tag{2.12}$$

Additionally, the comparative static analysis shows that as λ approaches zero, both the minimum price charged by firms and the reservation price for consumers increase, eventually converging to the monopoly price. This is because firms face less competitive pressure to reduce prices, as there are fewer shoppers engaging in search. The reservation price for non-shoppers rises since they are less likely to search, and thus more willing to accept higher prices. As the reservation price reaches the consumer valuation v, non-shoppers are more likely to stop searching and make a purchase, thereby reducing the firms' incentive to undercut one another. At this point, the market outcome resembles that of a monopoly, where firms can charge higher prices without fear of losing customers to competitors.

In summary, the static model demonstrates that a symmetric Nash Equilibrium in pure strategies is unattainable when $0 < \lambda < 1$, due to firms' incentive to undercut and the resulting price dispersion through the use of mixed strategies.

However, as $\lambda \to 0$, the model converges to a pure strategy equilibrium where firms charge the monopoly price, as competitive pressure diminishes. In contrast, at $\lambda = 1$, a pure strategy Nash equilibrium exists where firms charge the marginal cost, as all consumers are informed and competitive pressure is maximised.

In other words, the dilemma – to lower prices to attract shoppers or to maintain higher prices to exploit non-shoppers – effectively rules out the stability of a symmetric pure strategy NE, leading to a market characterised by mixed strategy equilibrium which gives rise to price dispersion. While price dispersion is consistent with an inter-firm loyalty penalty, this static model does not allow us to get any traction in understanding any intra-firm loyalty penalty as its very nature means it is simply not set up to do so.

2.2.2 Setup to capture the loyalty penalty

Consider a two-period game involving a unit mass of consumers, each of whom wants to purchase a single unit of a product (service) in each period for which they have an ex-ante identical valuation $v > 0$. Symmetric firms i and j produce homogeneous goods or services. In essential markets, this could refer to monthly, annual, or biennial subscriptions for services, or insurance policies. The assumption of homogeneous products firstly stems from the nature of the products in the essential markets (for instance, a price per kW hour of the electricity), also it allows me to isolate and analyse the impact of price competition and the loyalty penalty without the added complexity of product differences. By focusing on identical goods or services, I can directly study how firms compete on price alone and how consumer engagement affects pricing strategies. This simplifies the analysis and provides a clearer understanding of how pricing dynamics operate in essential markets.

Both firms manufacture at a marginal cost normalised to zero and compete in price. They simultaneously set a base price $p_1^{i,j} \in [0, v]$ in the first period, which becomes common knowledge among firms and remains in both periods.[7] In the second period, firms set a renewal price $p_2^{i,j} \in (0, v]$ such that $p_2^{i,j} \geq p_1$ and must decide how much to raise the price (if at all).

Turning attention to the consumer side, in both periods their primary concern is the price p, and they are assumed to purchase no more than one unit of the product in each period if the price doesn't exceed their valuation. The consumers must engage with the market if they want to find the better deal, and such an engagement can be costly $e \geq 0$. However, all consumers have free access to information about one price (the first sample is free). This feature of the model, where consumers have free access to information about one price (the first sample is free), is a common assumption in models of consumer search and is often justified by the ubiquitous presence of advertising in the marketplace. Indeed, in many markets, firms use various forms of advertising to disclose prices to consumers, effectively providing a 'free sample' of price information (Baye et al., 2006; De Los Santos et al., 2012).

Consumers can be one of two types: 'shoppers' – a fraction of consumers $\lambda \in [0, 1]$ can engage with the market without incurring any costs, easily finding the best deals and switching suppliers when necessary, so they effectively know all information about prices. The remaining fraction $1 - \lambda$ are 'non-shoppers', they initially split equally between firms and observe the first sample for free, then incur an engagement cost $e > 0$.

For instance, after observing one price in each period, consumers decide whether to engage in further search for information on other prices, following an optimal engagement rule. In the first period, firms cannot identify the type of consumer and offer the base price, as all consumers are considered 'new' to the firm. In the second period, the base price is no longer available to existing con-

[7]'Sticky' base prices or introductory offers are widely observed in markets. For instance, mobile and broadband providers offer deals with fixed introductory prices. Usually, firms do not frequently change these offers to maintain their reputation and due to administrative costs. This assumption is especially viable in a duopoly framework.

sumers. Instead, the firm from which they purchased in the first period notifies them of the renewal price p_2,[8] while continuing to offer the base price to 'new' consumers. At this point, consumers must decide whether to accept the renewal price or engage in further search for a better option. They are assumed to have perfect recall within the period but lack recall across periods,[9] and as such would have to pay the engagement cost to (re)discover the base price of the other firm.

This model disallows re-negotiations between firms and existing consumers in the second period. This assumption accurately mirrors many real-world markets, particularly for standard consumer goods, where price negotiation is either not feasible or seldom occurs. Consumers are presented with a choice where they can either accept the new price or engage and potentially switch firms. Since they are unaware of the base prices of other firms, they are required to engage to ascertain this information. By abstaining from negotiation in our model, I maintain its tractability and focus, concentrating on the core dynamics of price competition and loyalty penalties.[10]

At the point of indifference, the model assumes that consumers prefer to stay with their current firm.

The parameters of the model v, e, λ, and the rationality of the actors, are assumed to be common knowledge. This assumption simplifies the analysis and keeps the focus on the mechanisms of price-setting and consumer engagement.

I am looking for a profile of prices, consisting of a base price chosen in the first

[8]This notification can be considered as a free sample in the second period.

[9]This assumption reflects the dynamic nature of market information and memory constraints, as supported by psychological studies (Ebbinghaus, 1885; Sorensen, 2000).

[10]The lack of negotiation in the model mimics many real-world markets where price negotiation is either not feasible or rare, especially in the context of standard consumer goods. In such markets, prices are typically set by the seller, and the buyer must decide whether to accept the price or search elsewhere.

Relaxing this assumption could be a valid extension to the model; however, it is beyond the scope of this chapter. The inclusion of negotiation could add a significant layer of complexity to the model, potentially making it less tractable and diverting attention from its core focus, which is to investigate the dynamics of price competition and loyalty penalties. Hence, the absence of negotiation helps keep the model simple and focused.

period, which remains in place for both periods, and a renewal price chosen in the second period. The equilibrium concept - a Subgame Perfect Nash Equilibrium (SPNE) - requires that renewal prices are optimal given base prices (equilibrium in the subgame), and that firms' base prices are consistent with a Nash Equilibrium (NE) given these equilibrium continuation prices.

The simplifications I employ are deliberate and purposeful. While it is acknowledged that real markets often feature information asymmetry, variations in product quality, branding, or consumer sentiment, and a spectrum of engagement costs, nevertheless the selected assumptions enable a streamlined understanding of the interactions in the model while maintaining its analytical tractability. Despite its stylisation, the model serves as a useful tool to gain insights into the key mechanisms of price competition and the loyalty penalty.

2.2.3 Consumers' strategy

Empirical studies have shown that search behaviour can vary (De Los Santos et al., 2012; Honka, 2014). For instance, the sequential search assumption offers key insights into the trade-offs consumers face when gathering information, particularly in contexts where consumers have limited cognitive resources (Hauser and Wernerfelt, 1990). Furthermore, it's supported by empirical studies in specific contexts, i.e. the market for prescription drugs (Sorensen, 2000).

In sequential search models with homogeneous goods, consumers adopt an optimal search rule, typically governed by a reservation price. This reservation price is endogenously adjusted based on the distribution of prices and the varying search costs among consumers, which can differ significantly between shoppers and those facing positive costs. Unlike sequential search, clearinghouse models assume that consumers have immediate access to all available prices at certain cost. This is often justified by the prevalence of online platforms that aggregate price information. In such models, the decision to engage is usually predetermined; consumers who find the price acceptable will make a purchase without further search Varian (1980); Baye and Morgan (2001).

In the context of a duopoly, the distinction between sequential and clearinghouse search disappears (Janssen et al., 2011). Once consumers decide to engage, they become aware of all prices. Therefore, consumer engagement in this model can be seen as an optimal sequential search or an optimal decision to use a clearinghouse.

Based on these considerations, consumer engagement in this chapter rests on the following assumptions and simplifications:

1. Consumers form conjectures about an equilibrium base price p^E which remains in both periods based on firms' strategies, and use the same reservation price in each period.
2. Consumers do not account for/have beliefs about future price increases and there is no discounting.
3. Consumers do not update their beliefs about the price offered by the other firm based on whether her current firm raises her price or not.[11]
4. A fraction of consumers, denoted by λ, always shops around without incurring any cost.
5. The remaining fraction, denoted by $1-\lambda$, uses its free sample, and then engages only if the observed price exceeds their reservation price, represented by $p^E + e$, where e represents an engagement cost.

Based on these assumptions, the latter fraction of consumers would prefer to engage in the market by either visiting another firm or checking the clearinghouse only if the observed price exceeds $p^E + e$. In such an event they sample all available options, and if they cannot find a price that matches their conjectures, they purchase from the cheapest available firm as long as the price doesn't surpass

[11] By points 2 and 3, I refer to the assumption of passive beliefs, where consumers do not update their expectations based on observed prices. This assumption is common in the search literature, including Burdett and Judd (1983) and Wolinsky (1986), which model consumer search behaviour while assuming firms take prices as given without strategic belief updating.

their valuation.

Therefore, the reservation price in this model can be formally defined as $\bar{p} \in \min\{p^E + e, v\}$ and the optimal engagement rule can be defined as:

Definition 5. *Under the assumption that consumers are myopic, the optimal engagement rule on the equilibrium path in both periods is defined as follows: consumers make engagement decisions based on a reservation price determined by their equilibrium expectations of current-period prices and engagement costs. The reservation price is expressed as: $\bar{p} = \min\{p^E + e, v\}$. The decisions are:*

(i) 'Engage' if the observed price exceeds the reservation price;

(ii) 'Accept the price' if the observed price is at or below the reservation price;

(iii) 'Exit' the market if all prices exceed valuation.

The engagement rule effectively captures the consumer's decision-making process, considering the benefits and costs of engagement, and the impact of engagement costs on consumer behaviour and market dynamics.

2.2.4 Firms' strategy

The key to understanding the dynamics of this model lies in recognising the interdependencies between the two periods within the game, which depend on both the rival's best response (continuation strategies) and the consumer engagement rule. More specifically, the decisions made in the second period are contingent upon the outcomes of the first period (See Figure 2.1). By employing backward induction, I solve the game by determining the optimal actions in the second period, then using this information to guide decisions in the first period. This process ensures that each player's strategy is optimised based on future outcomes.

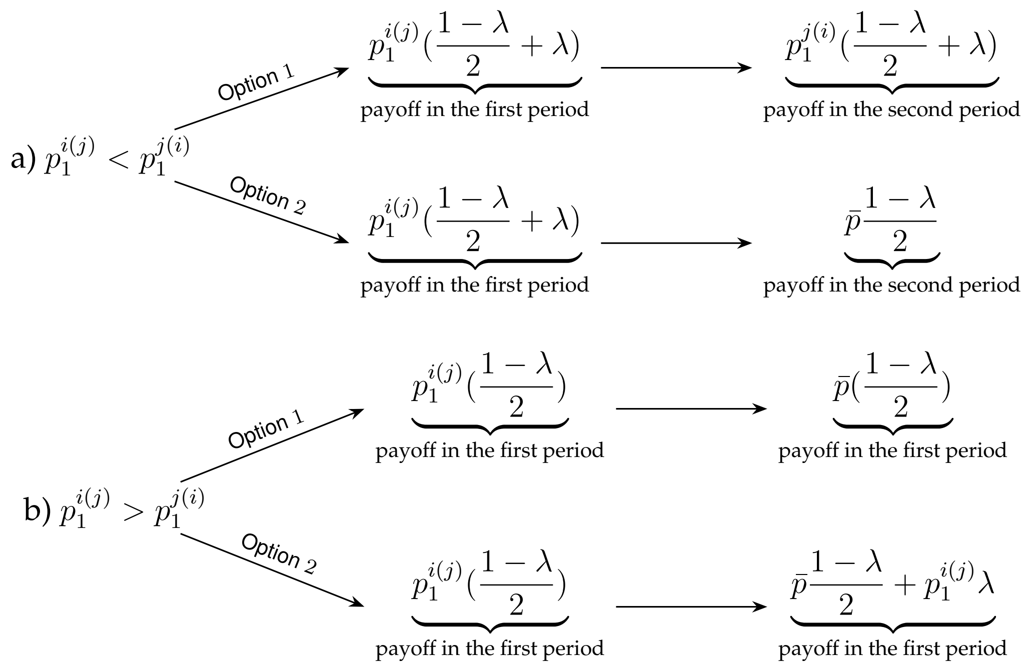


Figure 2.1: Continuation strategies for firms with lower (a) and higher (b) base prices. In Part (a), Option 1, the undercutting firm sets the renewal price to match the rival's base price. In Option 2, the undercutting firm decides to 'give up' on shoppers and sets the renewal price at the reservation price level. In Part (b), in both options, a firm that has been undercut in the first period, anticipating that the undercutting firm could retain shoppers, optimally chooses to set the renewal price at the reservation level, as any price below that yields a lower payoff in the second period. However, if the undercutting firm decides to 'give up' on shoppers, the firm that was undercut acquires all shoppers, who buy at its base price in the second period.

Firstly, given consumers' behaviour, when firms set identical base prices, the optimal continuation strategy for them is to set the renewal price at the reservation level, as any price below the reservation level yields lower payoffs. If one firm sets the base price lower than its rival, it has two potential continuation strategies when setting the renewal price: either match the rival's base price to retain all the shoppers acquired in the first period or set it at the reservation level, thereby giving up on the shoppers. The firm with the higher base price optimally chooses to set the price at the reservation level. However, if the rival decides to give up on the shoppers, it will acquire them in the subsequent period, as they will switch to buying at its base price. Considering these interdependencies, Proposition 2.2.1 presents the first result:

Proposition 2.2.1. *Consider a two-period game where two types of consumers are present ($\lambda \in (0,1)$), and two firms (i and j) play pure strategies, setting a base price ($p_1 \in [0, \bar{p}]$) and a renewal price ($p_2 \in (0, \bar{p}]$), such that $p_1 < p_2$. There exists a threshold price $\tilde{p}$ such that if Firm $i(j)$ selects the base price $p_1 = \tilde{p}$ in the first period and the renewal price $p_2 = \bar{p}$ in the second period, then Firm $j(i)$, when deciding to undercut $\tilde{p}$ to attract all shoppers in the first period, becomes indifferent in the second period between:*

(i) setting the renewal price to retain the shoppers ($p_2 = \tilde{p}$), or

(ii) significantly raising the renewal price to maximise profits from non-shoppers, even if this results in losing the shoppers ($p_2 = \bar{p}$).

Such a price satisfies:

$$\tilde{p} \equiv \bar{p}\frac{1-\lambda}{1+\lambda}$$

Proof. The proof requires the examination of the possible continuation strategies within this game. First of all, suppose that in the first period, both firms set the prices such that $p_1^i = p_1^j \leq \bar{p}$. This means that, by symmetry, they attract an equal share of both types of consumers. Then, suppose that firms want to increase the price in the second period. Given the behaviour of non-shoppers, firms set the second period prices in a way such that non-shoppers will not want to engage:

$p_2^{i,j} = \bar{p} = p_1^{i,j} + e$ and obtain total payoff:

$$\pi^{i,j} = \underbrace{p_1^{i,j}\frac{1}{2}}_{\text{payoff in the first period}} + \underbrace{\bar{p}\frac{1-\lambda}{2} + p_1^{i,j}\frac{\lambda}{2}}_{\text{payoff in the second period}} \tag{2.13}$$

Note, that given that there is no re-negotiation in the second period, shoppers observe the base price of a rival and switch. However, non-shoppers accept the renewal price because it doesn't surpass their reservation price. Firms have no incentive to increase the price by less than $\bar{p}$ in the second period because it will not attract any shoppers.

Now suppose, that one firm deviates in the first period and sets the base price, such that $p_1^{i(j)} < p_1^{j(i)}$. Such a firm obtains the entire demand from shoppers and the demand from its non-shoppers in the first period. In the second period, the firm with the lower price can either match the first-period price of the rival and retain the shoppers (See Option 1 at Figure 2.1); or it can increase the price up to the reservation level and lose the shoppers (See Option 2 at Figure 2.1). In such an event, the shoppers switch to the rival.

By considering an undercutting scenario, firms can identify a threshold price relative to their rival's price. This involves comparing payoffs from two continuation strategies under the threat of undercutting. If the rival sets this threshold as its base price, the undercutting firm becomes indifferent between two options for the next stage: setting the renewal price equal to the rival's base price to retain all shoppers, or raising the renewal price to the reservation price, even if it loses all shoppers. The threshold price is such that:

$$\overbrace{\underbrace{p_1^{i(j)}(\frac{1-\lambda}{2}+\lambda)}_{\text{First period}}+\underbrace{p_1^{j(i)}(\frac{1-\lambda}{2}+\lambda)}_{\text{Second period}}}^{\text{The lower price firm's payoff from Option 1}} = \overbrace{\underbrace{p_1^{i(j)}(\frac{1-\lambda}{2}+\lambda)}_{\text{First period}}+\underbrace{\bar{p}(\frac{1-\lambda}{2})}_{\text{Second period}}}^{\text{The lower price firm's payoff from Option 2}}$$

$$p_1^{j(i)}(\frac{1-\lambda}{2}+\lambda) = \bar{p}(\frac{1-\lambda}{2})$$

$$p_1^{j(i)} = \bar{p}\frac{1-\lambda}{1+\lambda} \tag{2.14}$$

□

The nuances of this strategy become clearer upon detailed examination. The concept of undercutting is prevalent across industries ranging from telecom and broadband to energy utilities, insurance, and financial services. It demonstrates firms' inherent drive to expand their consumer base. Fundamentally, by undercutting firms want to captivate a broader audience, resulting in a boost in service penetration. Such aggressive expansion often emerges as a pivotal key performance indicator (KPI) for top management. Commonly referenced KPIs in this context are customer acquisition and customer retention.

However, if a firm sets its price strategically, it can anticipate two key outcomes before revealing its prices: either gaining market share through lower pricing or increasing revenue from existing customers with higher prices. This foresight is critical in shaping the firm's next moves. By carefully analysing the benefits of its pricing decisions, the firm can determine a threshold price relative to its competitors anticipated price. This threshold then informs its pricing strategy for the next stage.

Firms employing undercutting face a dilemma: should they expand their base by offering lower prices or maximise revenue from existing customers by raising the prices for them? However, the prices should not be so high as to encourage engaging and thereby lose non-shoppers. This model examines this balancing act. Given the constraints of the second period, firms must determine both their willingness to engage in undercutting and the intensity of such efforts. In setting their prices, firms aim for a balance - one that not only undercuts competitors but also anticipates future pricing boundaries. These constraints typically concern whether to match a competitor's projected price or adhere to a previously established reservation price. The following corollary addresses the optimal continuation strategy of an undercutting firm:

Corollary 2.2.2. *The optimal continuation strategies by an undercutting firm are as follows:*

Case 1: From symmetric prices, if those are below the threshold price $\tilde{p}$ and one firm undercuts, then its renewal price is the reservation price.

Case 2: From symmetric prices, if those are above the threshold price $\tilde{p}$ and one form undercuts, then its renewal price is the rival's base price.

At the point of indifference, I break the tie by assuming that the firm sets its renewal price at the reservation level.

Proof. **Case 1:** Suppose that firms set their base prices at $p_1^i = p_1^j < \tilde{p}$. Now, suppose that Firm i undercuts by setting $p < p_1^j < \tilde{p}$. In the second period, such a firm can set its price to retain the shoppers, which means it should match the rival's base price, or it can give up on shoppers and set the renewal price at the reservation level. To find the optimal strategy, I need to compare the payoffs from these strategies. Denote the payoff from the 'matching' strategy as π_{match} and the payoff from the 'reservation' strategy as π_{res}, and assume for the sake of contradiction that $\pi_{\text{match}} > \pi_{\text{res}}$. Then:

$$\begin{aligned}\overbrace{\underbrace{p(\frac{1-\lambda}{2}+\lambda)}_{\text{First period}}+\underbrace{p_1^j(\frac{1-\lambda}{2}+\lambda)}_{\text{Second period}}}^{\pi_{\text{match}}} &> \overbrace{\underbrace{p(\frac{1-\lambda}{2}+\lambda)}_{\text{First period}}+\underbrace{\bar{p}(\frac{1-\lambda}{2})}_{\text{Second period}}}^{\pi_{\text{res}}} \\ p_1^j\frac{1+\lambda}{2} &> \bar{p}\frac{1-\lambda}{2} \\ p_1^j &> \bar{p}\frac{1-\lambda}{1+\lambda}\end{aligned} \tag{2.15}$$

However, $p_1^j < \bar{p}\frac{1-\lambda}{1+\lambda}$ by assumption, thus proving the first part of corollary by contradiction.

Case 2: Now assume that firms set their base prices at $p_1^i = p_1^j > \tilde{p} \leq \bar{p}$. If Firm i undercuts by setting $p < p_1^j$, then in the second period it can set the renewal price either matching the rival's base price or setting at the reservation level. Denoting the payoffs as π_{match} and π_{res}, and assuming for the sake of contradiction that $\pi_{\text{match}} < \pi_{\text{res}}$ obtain:

$$\begin{aligned}\overbrace{\underbrace{p(\frac{1-\lambda}{2}+\lambda)}_{\text{First period}}+\underbrace{p_1^j(\frac{1-\lambda}{2}+\lambda)}_{\text{Second period}}}^{\pi_{\text{match}}} &< \overbrace{\underbrace{p(\frac{1-\lambda}{2}+\lambda)}_{\text{First period}}+\underbrace{\bar{p}(\frac{1-\lambda}{2})}_{\text{Second period}}}^{\pi_{\text{res}}} \\ p_1^j\frac{1+\lambda}{2} &< \bar{p}\frac{1-\lambda}{2} \\ p_1^j &< \bar{p}\frac{1-\lambda}{1+\lambda}\end{aligned} \tag{2.16}$$

Which contradicts the initial assumption that $p_1^j > \bar{p}\frac{1-\lambda}{1+\lambda}$, thus proving the corollary by contradiction. □

Intuitively, the threshold price can also be seen as the point at which firms might shift focus away from aggressive price competition, opting instead to target non-shoppers who are willing to pay the reservation price. At this point, firms can perform just as well, or even better, by stopping further undercutting, as continued price cuts offer diminishing payoffs compared to focusing on non-shoppers. In static models, the lower bound of the price distribution, which emerges endogenously, also serves as the point where further undercutting yields diminishing payoffs; however, firms neither price below this lower bound nor exactly at it, as profitable deviations always exist. In contrast, the threshold price in my model is a fixed point that acts as bait, allowing firms to shift to exploiting non-shoppers in the subsequent period, leading to a pure strategy outcome. Nevertheless, the opportunity to attract shoppers remains, so firms may still choose to undercut if the rivals base price is above the threshold.

The presence of such a threshold price implies that, if a firm anticipates the rival's price to be greater than $\tilde{p}$, it will undercut in the first period and optimally match the rival's price in the second period. Conversely, if the firm expects the rival's price to be below $\tilde{p}$, the firm may lose the incentive to undercut, as it can achieve a better outcome by raising its price to the reservation level in the second period. In this case, the benefit of gaining shoppers in the first period through price-cutting becomes insignificant, reducing the importance of initial competition through undercutting.

To maintain consistent notation throughout the chapter, denote $\underline{p}$ as the minimal possible price (which I assume is zero), and $\bar{p}$ as the reservation price. As the threshold price $\tilde{p}$ could introduce a fixed point on the price range and might negate the potential for a mixed strategy, prompting the solution in pure strategy, it's crucial to investigate all feasible pricing strategies that firms might adopt.

2.2.5 Symmetric equilibrium

Traditional static models suggest there are no symmetric pure strategy equilibria within the interval $[\underline{p}, \bar{p}]$ for $\lambda \in (0, 1)$. This model, however, introduces a threshold price, $\tilde{p}$, which affects firms' price-setting incentives. I consider the profile of prices with base price $\tilde{p}$ and renewal price $\bar{p}$ as a potential equilibrium candidate for $\lambda \in (0, 1)$.

Proposition 2.2.3. *In the two-period pricing game with two firms and two types of consumers ($\lambda \in (0, 1)$), there exists a profile of prices that generates a symmetric subgame perfect Nash equilibrium in which firms choose pure strategies in each subgame as follows:*

1. *In the first period, each firm sets a base price $p_1^{i(j)} = \tilde{p}$ which remains in both periods;*
2. *In the second period, each firm sets a renewal price $p_2^{i(j)} = \bar{p}$.*

In this equilibrium, no firm has an incentive to deviate from this strategy profile given the strategies of the other firm and consumer's engagement rule.

Proof. The proof requires to show that there is no profitable unilateral deviation from this strategy. For that consider two possible types of deviations: undercutting and increasing.

First, assume that a firm decides to undercut $\tilde{p}$ by ϵ, where ϵ is a small positive number. Recall that $\tilde{p} = \bar{p}\frac{1-\lambda}{1+\lambda}$ represents the threshold price. According to Case 1 of Corollary 2.2.2, an undercutting firm in the second period raises the price to the reservation price. Consequently, the payoff for the undercutting firm is:

$$\begin{aligned}\pi_D &= \underbrace{(\tilde{p} - \epsilon)\left(\frac{1+\lambda}{2}\right)}_{\text{First period}} + \underbrace{\bar{p}\frac{1-\lambda}{2}}_{\text{Second period}} \\ &= \bar{p}(1-\lambda) - \epsilon\left(\frac{1+\lambda}{2}\right)\end{aligned} \tag{2.17}$$

For this to be a profitable deviation, it must exceed the payoff:

$$\begin{aligned}\pi_E &= \underbrace{\tilde{p}\left(\frac{1}{2}\right)}_{\text{First period}} + \underbrace{\bar{p}\left(\frac{1-\lambda}{2}\right) + \tilde{p}\left(\frac{\lambda}{2}\right)}_{\text{Second period}} \\ &= \bar{p}(1-\lambda)\end{aligned} \tag{2.18}$$

Comparing (2.17) and (2.18), undercutting results in a lower payoff by a term of $\epsilon\left(\frac{1+\lambda}{2}\right)$, making it unprofitable:

$$\bar{p}(1-\lambda)-\epsilon\left(\frac{1+\lambda}{2}\right)<\bar{p}(1-\lambda)$$

Now, consider a unilateral deviation to increase the base price. A deviating firm would lose all shoppers in the first period but retain demand from non-shoppers, which is given by $(\tilde{p}+\epsilon)\frac{1-\lambda}{2}$. In the second period, the rival, having captured all shoppers in the first period, according to Case 2 of Corollary 2.2.2, finds optimal to match its renewal price to the deviating firm's base price to preserve its hold on the shoppers. This means that the deviating firm would only obtain demand from non-shoppers, yielding a payoff of $\bar{p}\frac{1-\lambda}{2}$.

Thus, the deviating firm will not gain any demand from shoppers in either period, and at best, it can set the base price at the reservation level. This results in a payoff equivalent to sticking to the original price profile:

$$\begin{aligned}\pi_D &= \underbrace{\bar{p}\left(\frac{1-\lambda}{2}\right)}_{\text{First period}}+\underbrace{\bar{p}\left(\frac{1-\lambda}{2}\right)}_{\text{Second period}} \\ &= \bar{p}(1-\lambda)\end{aligned} \tag{2.19}$$

Since neither undercutting nor increasing deviation yields a higher payoff, I conclude that $(\tilde{p},\bar{p})$ constitutes a symmetric subgame perfect Nash equilibrium. □

Proposition 2.2.3 and its proof demonstrates the existence of a symmetric pure strategy Nash Equilibrium in this game. However, before declare the problem solved it is necessary to verify that there is no other symmetric pure strategy Nash equilibrium.

2.2.6 Other symmetric equilibrium candidates

The analysis proceeds considering other equilibrium candidates. Firstly, I consider $\lambda \in (0,1)$ and examine the price in the intervals $[\underline{p}, \tilde{p})$ and $(\tilde{p}, \bar{p}]$.

Lemma 2.2.4. *Consider $\lambda \in (0,1)$ and let any price in the interval $(\underline{p}, \tilde{p})$ be denoted as $\tilde{p}^-$ and any price in the interval $(\tilde{p}, \bar{p})$ be denoted by $\tilde{p}^+$.*

Case 1 The profile of prices where the base price $p_1^{i(j)} = \tilde{p}^-$ and the renewal price $p_2^{i(j)} = \bar{p}$ is not a symmetric SPNE.

Case 2 The profile of prices where the base price $p_1^{i(j)} = \tilde{p}^+$ and the renewal price $p_2^{i(j)} = \bar{p}$ is not a symmetric SPNE.

Proof. To prove this lemma it requires to demonstrate a profitable unilateral deviation for each case.

Case 1: The profile of prices $(\tilde{p}^-, \bar{p})$ played by both firms yields the following payoff:

$$\begin{aligned}\pi^{i(j)} &= \underbrace{\tilde{p}^- \left(\frac{1}{2}\right)}_{\text{First period}} + \underbrace{\bar{p}\left(\frac{1-\lambda}{2}\right) + \tilde{p}^- \frac{\lambda}{2}}_{\text{Second period}} \\ &= \tilde{p}^- \left(\frac{1+\lambda}{2}\right) + \bar{p}\left(\frac{1-\lambda}{2}\right)\end{aligned} \tag{2.20}$$

Re-write $\tilde{p}^- = \bar{p}\frac{1-\lambda}{1+\lambda} - k$, where k is an arbitrary positive number such that $k \leq \bar{p}\frac{1-\lambda}{1+\lambda}$. Then re-write the payoff as follows:

$$\begin{aligned}\pi^{i(j)} &= \bar{p}\frac{1-\lambda}{1+\lambda}\frac{1+\lambda}{2} - k\frac{1+\lambda}{2} + \bar{p}\frac{1-\lambda}{2} \\ &= \bar{p}\frac{1-\lambda}{2} - k\frac{1+\lambda}{2} + \bar{p}\frac{1-\lambda}{2}\end{aligned} \tag{2.21}$$

A deviating firm can always set the base price at $\bar{p}$ and obtain a greater payoff:

$$\pi_D = \bar{p}\frac{1-\lambda}{2} + \bar{p}\frac{1-\lambda}{2} \tag{2.22}$$

Therefore, this profile of prices is not a symmetric SPNE.

Case 2: The profile of prices $(\tilde{p}^+, \bar{p}]$ yields the following payoff:

$$\begin{aligned} \pi^{i(j)} = & \underbrace{\tilde{p}^+\left(\frac{1}{2}\right)}_{\text{profit in the first period}} + \underbrace{\bar{p}\left(\frac{1-\lambda}{2}\right) + \tilde{p}^+\frac{\lambda}{2}}_{\text{payoff in the second period}} \\ & = \tilde{p}^+\left(\frac{1+\lambda}{2}\right) + \bar{p}\left(\frac{1-\lambda}{2}\right) \end{aligned} \tag{2.23}$$

By undercutting the deviating firm can attract all shoppers and retain them in the subsequent period, and obtain the payoff:

$$\begin{aligned} \pi_D &= (\tilde{p}^+ - \epsilon)\left(\frac{1-\lambda}{2} + \lambda\right) + \tilde{p}^+\left(\frac{1-\lambda}{2} + \lambda\right) \\ &= (\tilde{p}^+ - \epsilon)\left(\frac{1+\lambda}{2}\right) + \tilde{p}^+\left(\frac{1+\lambda}{2}\right) \end{aligned} \tag{2.24}$$

The term $\tilde{p}^+\left(\frac{1+\lambda}{2}\right)$ in both equations can be omitted from the comparison. So, the terms left to compare are:

$$(\tilde{p}^+ - \epsilon)\left(\frac{1+\lambda}{2}\right) \text{ and } \bar{p}\left(\frac{1-\lambda}{2}\right)$$

Multiply remaining terms by $\frac{2}{1+\lambda}$:

$$\tilde{p}^+ - \epsilon \text{ and } \bar{p}\frac{1-\lambda}{1+\lambda}$$

Recall that $\tilde{p} \equiv \bar{p}\frac{(1-\lambda)}{(1+\lambda)}$. Then the terms can be re-written as:

$$\tilde{p}^{+} - \epsilon \text{ and } \tilde{p}$$

$\tilde{p}^{+} > \tilde{p}$ by assumption. So there exists ϵ such that this is satisfied, and the deviation yields greater payoff. That means the deviation is profitable thus no pure strategy symmetric Nash equilibria exist for these specific price ranges. □

To complete the analysis, I examine extreme cases when $\lambda = 1$ and $\lambda = 0$.

Lemma 2.2.5. *For $\lambda = 1$, the profile of prices where $p_1^{i,j} = p_2^{i,j} = \underline{p} = 0$ is a symmetric SPNE.*

Proof. The engagement rule implies that when $\lambda = 1$ all consumers are informed and shop around without any cost. They have full access to information in each subgame and can always find the lowest price. As a result, firms engage in intense competition, pushing prices down to marginal cost. Given that there is no negotiation, firms still have no incentive to raise prices, as it won't be able to attract shoppers in the second period because the competitor will match the renewal price to prevent engaging and switching, retaining those shoppers. It is straightforward to verify that for $\lambda = 1$, the threshold price is indeed zero: $\tilde{p} = \bar{p}\frac{1-\lambda}{1+\lambda}$. Therefore, as it was demonstrated in Corollary 2.2.2 the firm with the lower base price in the interval $(\tilde{p}, \bar{p})$ optimally sets the renewal price by matching the rival's base price, making any deviation of the rival unprofitable. Therefore, the initial profile of prices where $p_1^{i,j} = p_2^{i,j} = \underline{p} = 0$ is a symmetric SPNE. □

This result aligns with the traditional arguments of static models. In Stahl's model, setting the price at the minimum level is not a pure strategy Nash equilibrium for a positive proportion of shoppers. However, as $\lambda \to 1$ the equilibrium converges to a Bertrand-type outcome.

Now examine the next candidate equilibrium with the following lemma:

Lemma 2.2.6. *For $\lambda = 0$, the profile of prices where $p_1^{i(j)} = p_2^{i(j)} = \bar{p}$ is a symmetric SPNE.*

Proof. The profile of prices $p_1^{i(j)} = p_2^{i(j)} = \bar{p}$ yields a payoff:

$$\begin{aligned} \pi^{i(j)} &= \bar{p}\left(\frac{1}{2}\right) + \bar{p}\left(\frac{1}{2}\right) \\ &= \bar{p} \end{aligned} \tag{2.25}$$

Let one firm deviate slightly by undercutting the base price such that $p_1 = \bar{p} - \epsilon$, where ϵ is an infinitesimally small positive number.

$$\begin{aligned} \pi_D &= (\bar{p} - \epsilon)\left(\frac{1}{2}\right) + \bar{p}\left(\frac{1}{2}\right) \\ &= \bar{p} - \epsilon\left(\frac{1}{2}\right) \end{aligned} \tag{2.26}$$

Since $\bar{p} > \bar{p} - \epsilon\left(\frac{1}{2}\right)$, where $p_1^{i(j)} = p_2^{i(j)} = \bar{p}$ is a symmetric SPNE. □

Based on the consumer engagement rule, the absence of shoppers in each subgame produces outcomes similar to those in Diamond (1971), where even minimal engagement costs allow firms to exercise monopoly power and charge the highest possible price. Firms can fully exploit their non-shoppers by setting the price at the reservation level. No firm has an incentive to undercut, as it will not attract any additional customers.

In the context of traditional static models, the symmetric equilibrium at $\bar{p}$ only emerges when there are no shoppers in the market ($\lambda = 0$), in such a case even infinitesimal engagement costs lead to the Diamond Paradox. The same applies to this model.

2.2.7 Uniqueness of the symmetric equilibrium and the loyalty penalty

Finally, the main result of the chapter can be formally summarised in the following proposition:

Proposition 2.2.7. *In the two-period game where two types of consumers are present ($\lambda \in (0,1)$), there exists a unique symmetric equilibrium where firms use a pure strategy (p_1, p_2) such that $p_2 > p_1$, indicating the presence of the loyalty penalty. These prices satisfy $p_1 = \tilde{p}$ and $p_2 = \bar{p}$. The loyalty penalty, however, does not exist when all consumers in the market are of the same type.*

Proof. The uniqueness of the equilibrium for $\lambda \in (0,1)$ follows directly from Proposition 2.2.3 and Lemma 2.2.4. During the analysis, it was established that a unique pure strategy symmetric Nash Equilibrium exists when firms set their base prices at $p_1 = \tilde{p}$ and are able to increase them in the second period up to the reservation level $p_2 = \bar{p} = \min\{p_1 + e, v\}$. That means that firms optimally choose the pure strategy $(p_1 = \tilde{p}, p_2 = \bar{p})$, where $p_2 > p_1$. Such a difference between prices in the periods represents the loyalty penalty.

It also follows from Lemmas 2.2.5 and 2.2.6 that the presence of both types of consumers is a necessary condition for the loyalty penalty. □

Given that $p_1 = \tilde{p} = \bar{p}\frac{1-\lambda}{1+\lambda}$ and the reservation price $\bar{p} = \min\{\tilde{p} + e, v\}$, the reservation price can be expressed as a function of the engagement cost and the type of consumers. Considering if v is high enough such that $\bar{p} = \tilde{p} + e < v$:

$$\bar{p} = e\frac{1+\lambda}{2\lambda} \tag{2.27}$$

From this the first period price can be expressed as a function of engagement cost and consumer type:

$$\begin{aligned} e\frac{1+\lambda}{2\lambda} &= \tilde{p}+e \\ \tilde{p} &= e\frac{1-\lambda}{2\lambda} \end{aligned} \tag{2.28}$$

Therefore, when $\tilde{p}+e<v$ the first period price takes the form: $e\left(\frac{1-\lambda}{2\lambda}\right)$. And when $\tilde{p}+e \geq v$, it takes the form: $v\frac{1-\lambda}{1+\lambda}$.

Both forms of the base price depend on a common primitive λ, which represents the amount of shoppers in the market. Therefore, it is possible to identify the threshold value of shoppers, denoted $\tilde{\lambda}$, at which the base price is changing its form:

$$\begin{aligned} e\frac{(1-\lambda)}{2\lambda} &= v\frac{1-\lambda}{1+\lambda} \\ \tilde{\lambda} &= \frac{e}{2v-e} \end{aligned} \tag{2.29}$$

Therefore, the price $\tilde{p}=e\frac{1-\lambda}{2\lambda}$, when $\lambda > \frac{e}{2v-e}$ and $\tilde{p}=v\frac{1-\lambda}{1+\lambda}$ when $\lambda \leq \frac{e}{2v-e}$.

By definition, the loyalty penalty refers to the price difference between the first and second periods. Thus, the value of the loyalty penalty can be determined by subtracting $\tilde{p}$ from $\bar{p}$ and take two forms, when $\lambda \in (\tilde{\lambda}, 1)$:

$$\begin{aligned} LP &= \tilde{p}+e-\tilde{p} \\ LP &= e \end{aligned} \tag{2.30}$$

Alternatively, when $\lambda \in (0, \tilde{\lambda}]$:

$$\begin{aligned} LP &= v-\tilde{p} \\ LP &= v\frac{2\lambda}{1+\lambda} \end{aligned} \tag{2.31}$$

The model of the loyalty penalty based on modified static model of search predicts the presence of the loyalty penalty as an equilibrium outcome.

In this model, the dynamic nature of the interaction means that firms have the opportunity to set the price in the first period and increase it in the second period for customers who do not engage. This resembles the practice which is also known in the literature as 'investing then harvesting' or 'bargains then ripoffs.' The base price is set above marginal costs, and the existence of the threshold price leads firms to adopt a pure strategy, thereby generating a unique subgame perfect Nash equilibrium, in contrast to static models.

In the next section I will provide with some comparative statics. The aim is to examine how different parameters impact the equilibrium that has been identified, offering further insights into the model's behaviour.

2.3 Comparative statics

The first comparative static result in this model concerns the types of consumers, categorised as either shoppers or non-shoppers. The distinction between these two groups is essential for understanding the nature of equilibrium. Shoppers are assumed to be more price-sensitive and willing to switch between different firms, while non-shoppers are less price-sensitive and tend to stay with their current firm. The aim of the comparative statics analysis is to explore how variations in the proportion of these consumer types affect the established equilibrium - namely, the optimal base price in the first period and the renewal price in the second period, and consequently the size of the loyalty penalty. This analysis provides insights into how consumer behaviour impacts firms' pricing strategies and market outcomes.

Proposition 2.3.1. *In a duopoly setting, the equilibrium prices decrease in the proportion of shoppers.*

Proof. For $\lambda > \tilde{\lambda}$, taking the partial derivative with respect to λ for the base price $p_1 = \tilde{p} = e\frac{1-\lambda}{2\lambda}$ yields:

$$\frac{\partial \tilde{p}}{\partial \lambda} = -\frac{e}{2\lambda^2} < 0 \tag{2.32}$$

And straightforward for p_2 given that $p_2 = \bar{p} = p_1 + e$.

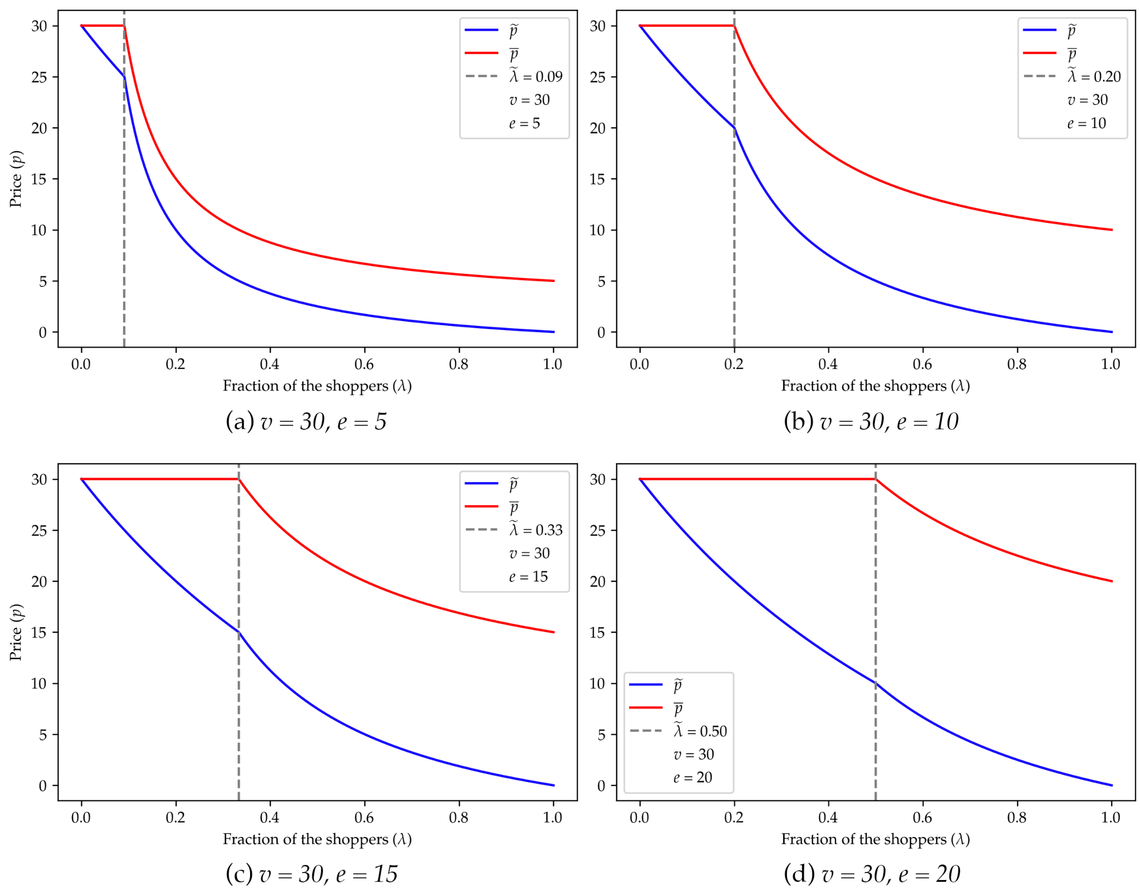
For $\lambda \leq \tilde{\lambda}$, taking the partial derivative with respect to λ for the base price $p_1 = \tilde{p} = v\frac{1-\lambda}{1+\lambda}$ yields:

$$\frac{\partial \tilde{p}}{\partial \lambda} = -\frac{2v}{(1+\lambda)^2} < 0 \tag{2.33}$$

And straightforward for p_2 given that $p_2 = \bar{p} = v$.

The equilibrium base price transitions smoothly from Diamond-type to Bertrand-type outcomes as the fraction of consumers with zero engagement costs ranges from 0 to 1. A rise in the fraction of shoppers corresponds to a reduction in the NE pricing level. The renewal price is increasing until it reaches consumers' valuation v. □

Figure 2.2 illustrates the relationship between the prices and the fraction of consumers, as well as the transition from 'Bertrand to Diamond' for a fixed value $v = 30$ and various values of e (panels (a)-(d)). The blue line represents the base price $\tilde{p}$, while the red line represents the renewal price $\bar{p}$. The dashed line represents the threshold value of shoppers when the base price $\tilde{p}$ change its form, transitioning from $\tilde{p} = e\frac{1-\lambda}{2\lambda}$ to $\tilde{p} = v\frac{1-\lambda}{1+\lambda}$.



(a) $v = 30$, $e = 5$

(b) $v = 30$, $e = 10$

(c) $v = 30$, $e = 15$

(d) $v = 30$, $e = 20$

Figure 2.2: The interdependence of the equilibrium prices and the fraction of shoppers for different engagement costs.

The second comparative static result in this model concerns the effect of engagement cost on prices. The analysis of engagement cost as a parameter will involve a two-fold approach. First, the study will quantify how changes in engagement cost levels influence the base price and the renewal price. This will be followed by an assessment of how these changes propagate through the market, affecting variables such as pricing strategies, consumer choices, and ultimately, welfare. The goal is to provide an understanding of the role that engagement cost plays in shaping both the equilibrium and the broader market landscape.

Proposition 2.3.2. *In a duopoly setting, the base price on the interval* $(\tilde{\lambda}, 1]$ *increases with engagement costs and is independent of engagement cost on the interval* $[0, \tilde{\lambda}]$*. The renewal price increases with engagement cost and/or is capped by the consumer valuation* v*.*

Proof. Recall that the base price takes two forms depends on the values of λ, e, and v. Specifically, the price $\tilde{p} = e\frac{1-\lambda}{2\lambda}$ when $\lambda > \tilde{\lambda}$, and $\tilde{p} = v\frac{1-\lambda}{1+\lambda}$ when $\lambda \leq \tilde{\lambda}$.

Therefore, for $\lambda > \tilde{\lambda}$, taking the partial derivative with respect to e for the base price:

$$\frac{\partial \tilde{p}}{\partial e} = \frac{1-\lambda}{2\lambda} > 0 \tag{2.34}$$

and for $\lambda \leq \tilde{\lambda}$:

$$\frac{\partial \tilde{p}}{\partial e} = 0 \tag{2.35}$$

Similarly, considering that $\bar{p} = \min\{e\frac{1+\lambda}{2\lambda}, v\}$, taking the partial derivative with respect to e for the renewal price when $\lambda > \tilde{\lambda}$:

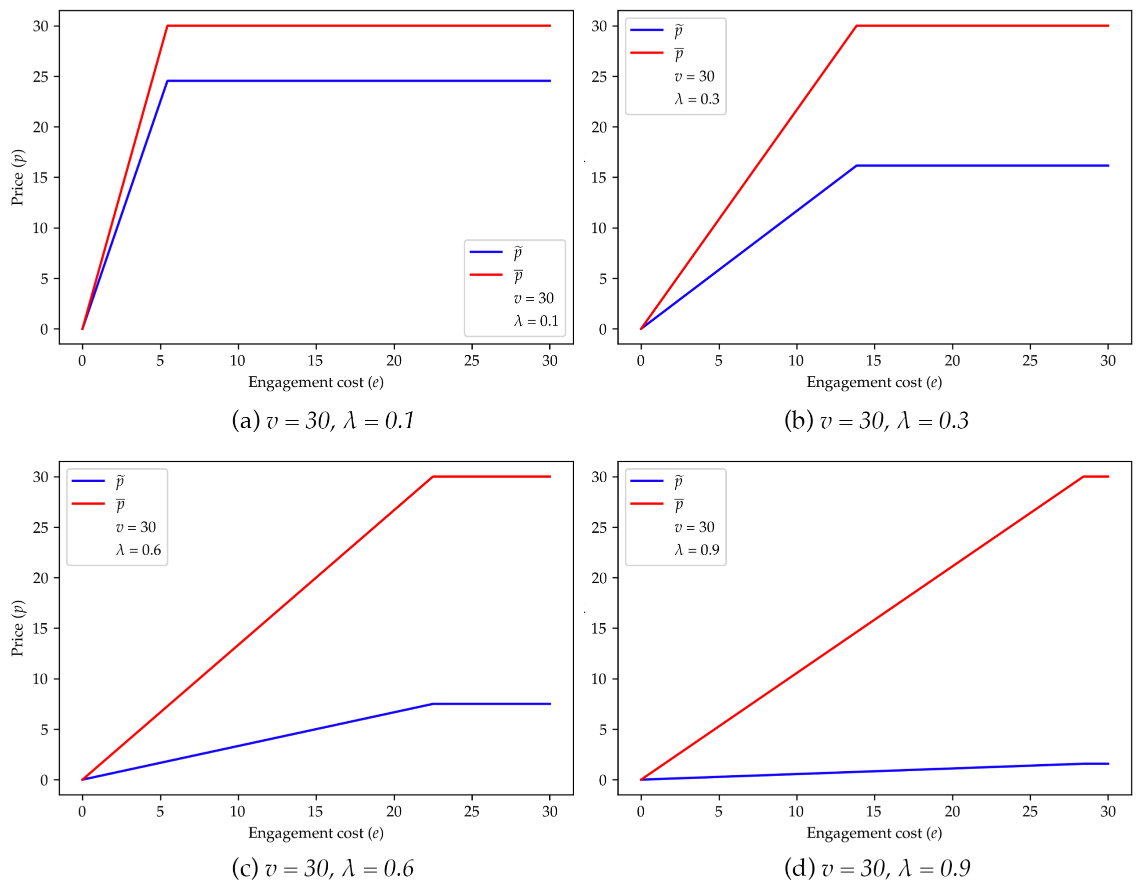
$$\frac{\partial \bar{p}}{\partial e} = \frac{1+\lambda}{2\lambda} > 0 \tag{2.36}$$

and when $\lambda \leq \tilde{\lambda}$:

$$\frac{\partial \bar{p}}{\partial e} = 0 \tag{2.37}$$

$\square$

Figure 2.3 illustrates the relationship between the level of prices and the level of engagement costs, showing how prices increase with increasing engagement costs (panels (a) - (d)).



(a) $v = 30, \lambda = 0.1$

(b) $v = 30, \lambda = 0.3$

(c) $v = 30, \lambda = 0.6$

(d) $v = 30, \lambda = 0.9$

Figure 2.3: The loyalty penalty prices and engagement costs.

The next comparative static result in this model concerns the loyalty penalty and how it depends on the level of engagement cost and types of consumers.

Proposition 2.3.3. *In a duopoly setting, the loyalty penalty increases with engagement costs and is capped by consumer valuation v. Moreover, the loyalty penalty increases with the fraction of shoppers on the interval $[0, \tilde{\lambda}]$ and is independent of the fraction of shoppers on the interval $(\tilde{\lambda}, 1]$.*

Proof. Recall that the loyalty penalty can take two forms: $LP = e$ when $\lambda > \tilde{\lambda}$ and $LP = v\frac{2\lambda}{1+\lambda}$ when $\lambda \leq \tilde{\lambda}$. For the first expression, it is straightforward that the loyalty penalty increases with engagement costs and is independent of the fraction of shoppers. However, the loyalty penalty is capped by consumer valuation. Therefore, taking the partial derivative of the second expression with respect to λ yields:

$$\begin{aligned}\frac{\partial LP}{\partial \lambda} &= v\frac{2}{1+\lambda} - v\frac{2\lambda}{(1+\lambda)^2} \\ &= 2v\frac{1}{(1+\lambda)^2} \\ &> 0\end{aligned} \tag{2.38}$$

□

This comparative static illustrates the interesting interdependence between the two types of consumers. Even though shoppers never pay the loyalty penalty, they create a positive externality for non-shoppers by driving down the base price, which can also lower the reservation price for non-shoppers when $\lambda > \tilde{\lambda}$. As a result, non-shoppers are still able to achieve some surplus, since firms cannot set the renewal price equal to the consumer's valuation without triggering additional search by non-shoppers. However, when the proportion of shoppers decreases, firms can increase the base price. This leads to higher renewal prices in the second period, causing non-shoppers to lose all their surplus in that period. The absence of shoppers would allow firms to set prices at the consumer valuation in both periods. In such a case, there is no loyalty penalty in the market, but there are also no competitive incentives for firms, allowing them to set maximum price.

Table 2.1 provides a summary of the comparative statics obtained through this analysis. The arrow direction shows how the model variables change (increase or decrease) when differentiated with respect to the model's parameter.

Table 2.1: Summary of Comparative Statics

	Comparative Statics					
Parameter	$\tilde{p} = e\frac{1-\lambda}{2\lambda}$	$\tilde{p} = v\frac{1-\lambda}{1+\lambda}$	$\bar{p} = e\frac{1+\lambda}{2\lambda}$	$\bar{p} = v$	$LP = e$	$LP = v\frac{2\lambda}{1+\lambda}$
e	$\uparrow$	–	$\uparrow$	–	$\uparrow$	–
λ	$\downarrow$	$\downarrow$	$\downarrow$	–	–	$\uparrow$

2.4 Conclusion

In this chapter, I examined the loyalty penalty in essential markets – a puzzling phenomenon where customers' loyalty results in a cost rather than a reward. The model presented explains how the loyalty penalty emerges as an equilibrium outcome, where firms raise renewal prices for consumers who disengage from the market. While non-shoppers enable firms to set base prices above marginal costs, a growing proportion of active shoppers drives both base and renewal prices down when engagement costs are sufficiently low.

The subgame perfect Nash equilibrium price derived in the model sheds light on the strategic behaviour of firms in competitive settings. This equilibrium captures the balance firms strike between attracting new customers and retaining existing ones, while taking into account consumers' engagement costs.

Through a microeconomic lens, this chapter contributes to the literature on consumer-firm interactions, particularly in subscription and rollover contexts. It lays the groundwork for future research by modelling the loyalty penalty, incorporating insights from search theory alongside factors like homogeneous products, repeated interactions, and firms ability to price discriminate between new and existing customers.

Moreover, this chapter paves the way for more complex models that account for diverse consumer types, which could offer further insights into the loyalty penalty and inform more refined policy interventions. Future research could also explore dynamic models involving heterogeneous products and multi-period interactions between consumers and firms, providing a deeper understanding of the loyalty penalty and supporting more targeted policy responses.

In the following chapters, I will continue investigating how the loyalty penalty affects various consumer groups, particularly vulnerable ones, and analyse the associated policy implications.

Chapter 3

Vulnerability and the loyalty penalty

The presence of different consumer types leads to varying magnitudes of the loyalty penalty, influenced by the dominant consumer type in the market. Firms strategically adjust pricing across periods to exploit certain consumer groups. This model explains the loyalty penalty's mechanism and its differential impact on various types of consumers. A significant presence of vulnerable consumers prompts firms to exploit them more, raising base prices and imposing negative externalities on all consumers. The chapter highlights the link between the loyalty penalty's magnitude and firms' efforts to attract and retain a certain type of consumers. Therefore, policy measures must carefully balance protecting vulnerable consumers and maintaining competitive market incentives to avoid reducing firms' incentives to offer discounts and deals.

3.1 Introduction

Despite the Competition and Markets Authority's assertion on the loyalty penalty that customers should not always be 'on-guard' when paying for essential services, finding the best deal remains daunting, "even for an adviser with seven years of experience" (Citizens Advice, 2018*a*, p.15), to say nothing of vulnerable customers (Citizens Advice, 2017; CMA, 2019). Reports by the CMA and the Citizen Advice Bureau are filled with real-life examples reminiscent of Dickensian tales, illustrating the grim realities faced by those trapped in the loyalty penalty. These include an elderly widow, scrimping to survive yet overpaying for energy; a caregiver for a sick father, burdened by excessive insurance charges; a migrant woman unable to afford a price hike of her insurance; an anxious diabetic unfairly overcharged for energy; and other stories that are chilling in their portrayal of hardship and systemic failure (CMA, 2019).

Vulnerable customers are disproportionately affected by the financial impact of the loyalty penalty (Citizens Advice, 2018*a*). For these individuals, the loyalty penalty can lead to significant financial strain, as they may end up paying more for the same services compared to more engaged consumers.[1] Therefore, this chapter seeks to explicitly include the vulnerable customers as a separate consumer group and develops an understanding of the implications of the loyalty penalty - both on them and on the rest of the market. While the analysis is grounded in the positivist paradigm, it forms the groundwork for the subsequent examination of suitable policy responses.

The primary research questions addressed in this chapter are: How do firms decide their pricing strategies in the presence of consumers with positive heterogeneous engagement costs, particularly vulnerable consumers? What are the implications of these pricing strategies on market equilibrium and the welfare of different consumer groups?

To answer these questions, I develop a theoretical model that incorporates two types of positive engagement costs among consumers over two distinct periods. The term *'heterogeneous engagement costs'* refers to the varying degrees of effort, time, and resources consumers must invest in searching for, comparing, and potentially switching between different products or services. Figure 3.1 illustrates that almost half of the population in essential markets in the UK never searches for a better deal, highlighting the prevalence of high engagement costs among consumers.

[1] In the United Kingdom, vulnerable consumers pay up to 30% more for essential services due to the loyalty penalty, a disparity that exacerbates financial inequality (Citizens Advice, 2018*a*)

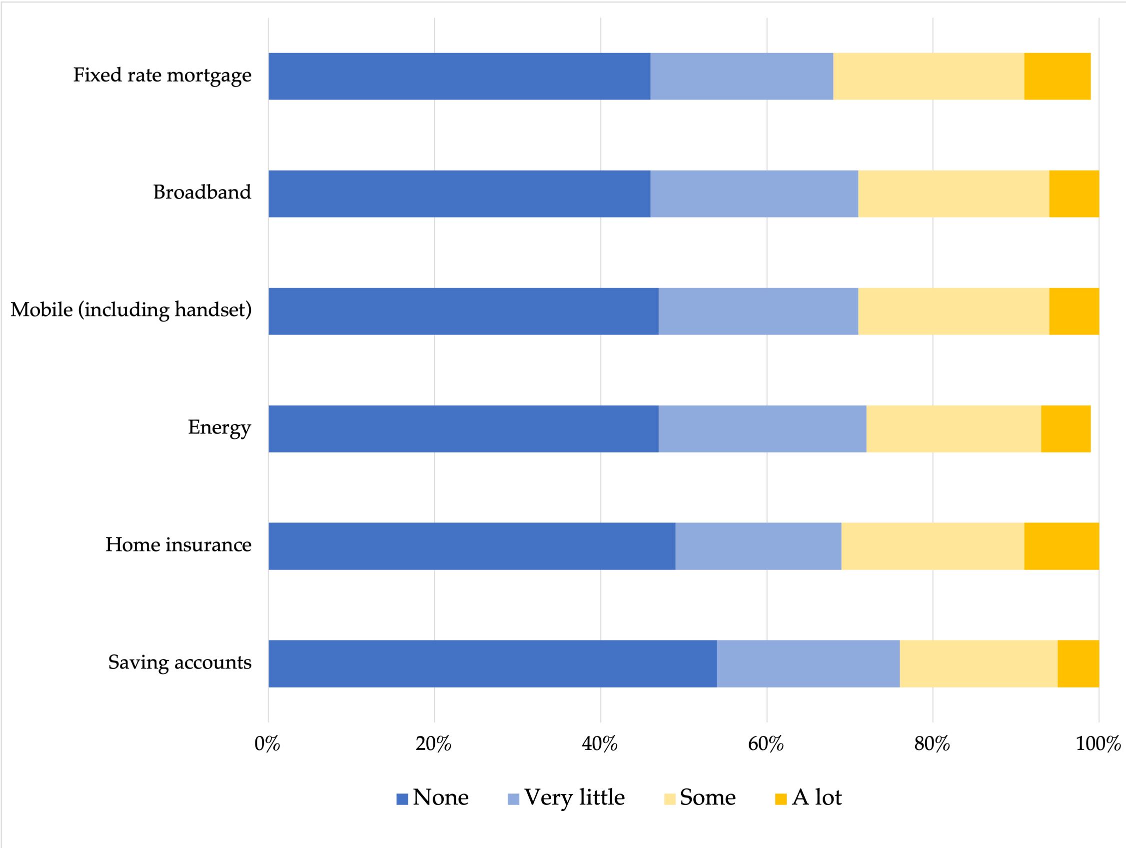


Figure 3.1: The consumers' engagement in essential markets in the UK. Source: Citizens Advice (2018*a*).

In this chapter's model, consumers are categorised into three groups based on their engagement costs: savvy-shoppers with negligible engagement costs, average consumers with relatively low engagement costs, and vulnerable consumers facing high engagement costs. By modelling the costs over two periods with explicitly different positive engagement costs, I examine how and when firms can exploit those customers most reluctant to engage.[2]

[2]I defined the concepts of ***'vulnerable consumers'*** and ***'average consumers'*** in the first chapter. These concepts are prevalent in the academic literature and various official reports (OECD, 2016, 2023). Despite some criticisms of these definitions, I adopt this simplification in the model to illustrate the contrast between vulnerable consumers, average consumers, and savvy-shoppers.

The main insight of this model is that the nature of the market equilibrium depends critically on firms' strategic decisions regarding which consumer type they prefer to target. Firms face a strategic trade-off influenced by the diversity of consumer types. When firms focus on attracting savvy-shoppers and average consumers, they may offer lower initial prices to gain market share, accepting lower profits from vulnerable consumers who are less likely to engage due to high engagement costs. Conversely, targeting vulnerable consumers allows firms to set higher renewal prices, capitalising on the disengagement of these consumers. This strategic choice affects the magnitude of the loyalty penalty and has significant implications for market dynamics and consumer welfare.

This approach contributes to the literature on heterogeneous search and switching costs, extending models by Stahl (1996) and Rob (1985) by explicitly modelling firms strategic pricing considering different positive engagement costs over two periods with three consumer types. Unlike previous models that often assume a simple dichotomy of 'shoppers' and 'non-shoppers,' this model allows for a nuanced examination of how varying engagement costs among different consumer groups influence firms' pricing strategies and market outcomes.

The model serves as a tool for examining the market-wide implications of the loyalty penalty, offering insights into how different consumer groups are affected by firms' strategic pricing. It provides a theoretical framework for understanding the delicate balance firms must strike when setting prices for new and existing customers, especially when considering vulnerable consumers who are less likely to engage within the market.

These findings have important implications for policymakers concerned with consumer protection and regulatory responses to the loyalty penalty. By understanding the strategic interplay between firms and consumers with varying engagement costs, regulators can design more effective interventions to mitigate the adverse effects on vulnerable consumers and promote fairer market practices.

The remainder of the chapter is structured as follows: Sections 3.2 and 3.3

present the model and its theoretical analysis, while Section 3.4 provides numerical examples to enhance understanding and foster discussion of the results. Section 3.5 concludes.

3.2 The Model

3.2.1 Model setup

Consider a duopoly market with firms i and j, offering homogeneous goods or services, which they produce at zero marginal costs over two distinct time periods, Period 1 and Period 2. The consumer base is categorised into three distinct types based on their engagement costs. There is a unit mass of consumers. A proportion λ are savvy shoppers (or Type 0), who incur no engagement costs. The remaining fraction, $1-\lambda$, are split in two types - a fraction $\alpha \in [0,1]$ are Type L and have low engagement costs e_L, the fraction of Type L in the entire population is $\alpha(1-\lambda)$; and a fraction $1-\alpha$ are Type H and have high engagement costs $e_H > e_L$, the fraction of Type H in the entire population is $(1-\alpha)(1-\lambda)$. From the perspective of policy analysis, Type L consumers can be seen as *'average'* consumers, while Type H consumers may represent those who are *'vulnerable'*. All types of consumers have identical valuation for a product or service at v, such that $v \geq e_H > e_L$.[3]

As in the previous chapter, consumer behaviour is characterised by a sequential sampling of price quotes from the firms, perfect recall within a period, but no recall between periods: consumers must re-engage to verify prices. Their purchase decisions are influenced by a balance between observed prices and their specific engagement costs. In the case of indifference it is assumed that consumers prefer to stay with their current provider.

From the firms' perspective, their behaviour is shaped by their understanding

[3]The types of consumers can be conceptualized in terms of (Stahl, 1989, 1996; Janssen et al., 2005) papers 'shoppers' (Type 0) with zero engagement costs and 'non-shoppers' with low (Type L) and high (Type H) engagement costs, respectively.

of the consumer types in the market and strategic pricing decisions. In period 1, they set a base price p_1 which, in the second period, is only available to new customers[4], followed by a renewal price p_2 for their 'old' customers in period 2. The firms' pricing strategy takes into account the rival firm's pricing and the consumer types. Re-negotiation with a current firm is not allowed.

I look for a set of prices (a profile of prices that includes a base price and a renewal price) that constitutes a symmetric Subgame Perfect Nash Equilibrium (SPNE) by using backward induction to optimally determine the base price chosen by firms in the first period and the renewal price chosen in the second period.

3.2.2 Consumers types and their behaviour

Consumers form their conjectures about an equilibrium price p^E based on firms strategies. A fraction of Type 0 consumers (λ) shops around cost-free, while fractions Type L ($\alpha(1-\lambda)$) and Type H ($(1-\alpha)(1-\lambda)$) initially receive one sample for free which is randomly determined and then engage using the reservation price rule, which is described below.

Definition 6. *The optimal engagement rule on the equilibrium path in both periods is myopic. Each consumer type makes engagement decisions based on their reservation price, which is determined by their equilibrium expectations of current period prices and their engagement costs. These satisfy:*

(i) For Type L ('average' consumer): $\bar{p}_L = \min\{p^E + e_L, v\}$;

(ii) For Type H ('vulnerable' consumer): $\bar{p}_H = \min\{p^E + e_H, v\}$;

And the decisions are:

(i) 'Engage' if the observed price exceeds the reservation price;

(ii) 'Accept the price' if the observed price is at or below the reservation price;

(iii) 'Exit' the market if all prices exceed valuation.

[4]The base price remains constant across periods.

Definition 6 formalises consumer engagement which follows from the consumer behaviour analysis.[5]

To capture an extreme case of vulnerability, assume that Type H has very high engagement costs such that they never engage and in equilibrium they always buy at the price at or below $\bar{p} = v$. There is no demand above v. Also I assume that the consumer does not have a perfect recall between periods, therefore use this strategy in each period.

Intuitively, the model could be understood as follows. Type 0 or the 'savvy-shoppers', known for their agility in the market without bearing any engagement costs, potentially play a pivotal role in influencing pricing strategies of firms (recall the Diamond (1971) result when there no shoppers in the market). One of the key aspects of this investigation is to ascertain if their active market participation effectively mitigates the loyalty penalty, not only for themselves but also indirectly influencing the market dynamics for other consumer groups.

Type L or average consumers have some engagement cost. They are less active than savvy-shoppers but not as passive as the vulnerable consumers due to lower engagement costs. The model seeks to explore whether their level of engagement is sufficient to influence market prices.

Type H or vulnerable consumers with higher engagement costs could potentially be the most affected by the loyalty penalty. The model aims to unravel how

[5] The analysis resembles that presented in Chapter 2: Suppose a consumer observes the price p^* on an interval from 0 to v. If the consumer buys at p^* she gains the utility: $u = v - p^*$. Also, suppose there is a price $p^E < p^*$, and if the consumer engages and finds this price, she gains the utility: $u = v - p^E$. But finding that price can cost e then considering this cost she gains the utility $u = v - p^E - e$. Therefore, the consumer actions can be described as follows:

- Buy at an observed price if: $v - p^* > v - p^E - e$;
- Continue engagement if: $v - p^* < v - p^E - e$;
- Indifferent if: $v - p^* = v - p^E - e$

Then define $\bar{p}$ as a cutoff price, when consumer ceases her engagement, then such a price must satisfy: $\bar{p} = p^E + e$. And in an event, when the sum of price and engagement exceed a consumer valuation, the consumer uses v as her reservation price, therefore: $\bar{p} = \min\{p^E + e, v\}$. Then I can define the reservation prices for both types of consumers as it is in Definition 6.

their limited market activity could potentially lead to exploitative pricing strategies by firms. This part of the analysis is important in understanding the extent to which the loyalty penalty impacts different segments of the market, particularly those who are most at risk.

A significant component of this study is understanding how firms might alter their pricing in response to the varying levels of consumer engagement. Are firms likely to exploit the loyalty of less active consumers, especially the vulnerable ones? This exploration is vital in comprehending the full scope of market dynamics and the potential need for regulatory measures.

This approach not only contributes to academic discourse but also has practical implications for regulators and/or competition authorities, informing policy decisions aimed at protecting vulnerable consumers and ensuring a fair market for all.

3.2.3 Firms' pricing strategies

Given consumers' optimal engagement rule, firms set the base price in the first period. In the second period, in contrast to the previous model – where firms faced the dilemma of setting a renewal price to retain shoppers or to fully exploit non-shoppers while discouraging further engagement – the presence of vulnerable consumers with a higher reservation price now forces firms to decide whether to 'keep' average consumers, who may rejoin the engagement pool or give up on them, and this decision depends on which type of consumers yields a greater payoff. Figure 3.2 below illustrates the price range when there are two reservation prices, $\bar{p}_L$ and $\bar{p}_H$, on the right-hand side, and the minimal possible price (the Bertrand price), $\underline{p}$, on the left-hand side, with consumers anticipating a base price p^E in equilibrium.

Assuming that there is no demand above $\bar{p}_H = v$ (the Diamond price) a customer of any type encountering a price higher than $\bar{p}_H$ will continue to pay the engagement cost to sample prices and if she does not find a lower price, she opts

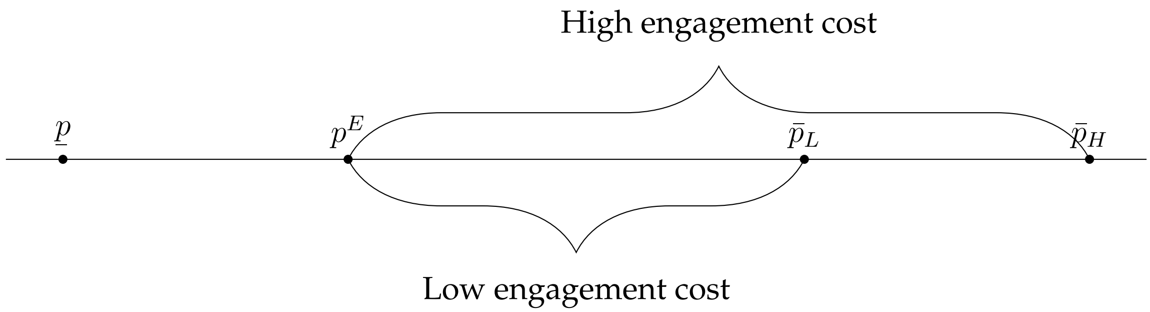


Figure 3.2: Price range

not to purchase. Type 0 customers search all firms and consistently find the cheapest deal. Type L customers accept any price at or below $\bar{p}_L$, but will engage in search if the price exceeds this threshold as the benefit of finding a better price outweighs the engagement cost. If both firms offer a price greater than $\bar{p}_L$, then Type L customers act like savvy-shoppers, they sample both firms and buy from the cheapest as long as the offer does not exceed $\bar{p}_H$. Type H customers end their engagement and purchase at a price at or below $\bar{p}_H$ as I assume that their engagement costs are that high, that they never engage. All customers prefer to quit the market if they cannot find a price at or below their valuation.

Additionally, similar to the model with a single type of consumer that bears engagement costs, undercutting may be profitable in the first period. Therefore, I also examine the optimal continuation strategies in a hypothetical undercutting game, aiming to identify which renewal pricing strategy firms will find optimal – either matching the rival's base price or setting it at the reservation price level.

From this thought experiment, I identified a threshold parameter $\tilde{\alpha}$ that divides the game into two cases, each associated with a distinct price profile consisting of a base price and a renewal price: Case (a) is $\alpha \geq \tilde{\alpha}$ and I consider the price profile $(\tilde{p}_L, \bar{p}_L)$; Case (b) is $\alpha < \tilde{\alpha}$ and I consider the price profile $(\tilde{p}_H, \bar{p}_H)$.

This can be formally stated as the following lemma:

Lemma 3.2.1. *There exists a threshold parameter $\tilde{\alpha}$ that divides the game into two cases,* *each associated with a distinct price profile consisting of a base price and a renewal price. This threshold satisfies:*

$$\tilde{\alpha} = 1 - \frac{\bar{p}_L}{\bar{p}_H}. \tag{3.1}$$

The cases are as follows:

(i) ***Case (a):*** *When there are many average and few vulnerable consumers $\alpha \in [\tilde{\alpha}, 1]$, the price profile is $(\tilde{p}_L, \bar{p}_L)$, where the base price satisfies:*

$$\tilde{p}_L = \bar{p}_L \frac{(1-\lambda)}{(1+\lambda)}. \tag{3.2}$$

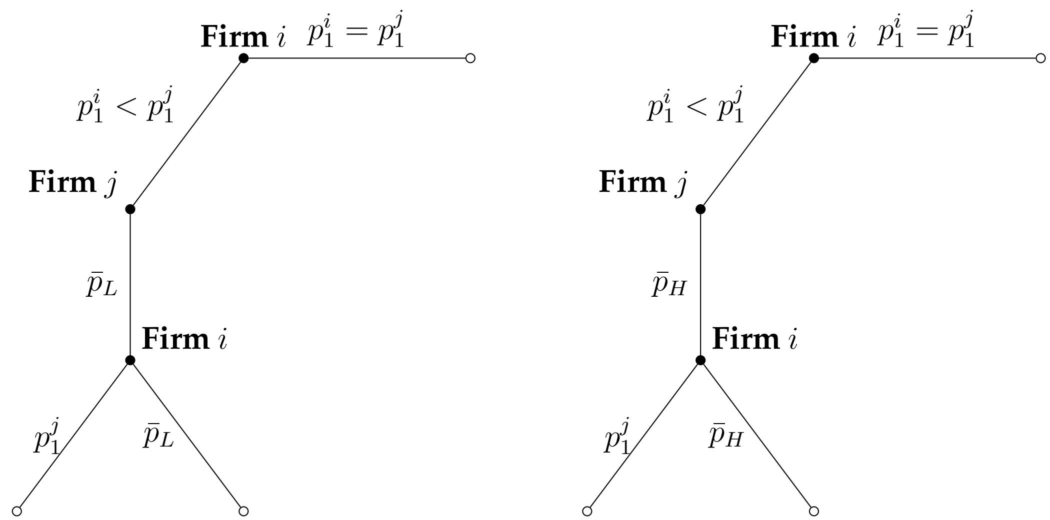
(ii) ***Case (b):*** *When there are few average and many vulnerable consumers $\alpha \in (0, \tilde{\alpha}]$, the price profile is $(\tilde{p}_H, \bar{p}_H)$, where the base price satisfies:*

$$\tilde{p}_H = \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{(1+\lambda)}. \tag{3.3}$$

The detailed logic of this thought experiment and proofs are provided in Appendix A.1.

Firms use $\tilde{\alpha}$ and a threshold price as benchmarks for critical decisions: whether to match a competitor's lower price to retain all customer types, or to increase their price to the reservation level for less price-sensitive consumers, depending on which type of non-shoppers will yield greater profits. In doing so, firms consider not only immediate profits but also long-term customer relationships and market share dynamics.

When setting a base price firms aim to optimise their appeal to Type L and Type H customers while remaining competitive for Type 0 customers. This strategic pricing could lead to a form of equilibrium where firms maximise their profits without alienating any customer segment. Figure 3.3 illustrates two possible scenarios of an undercutting game depending on parameter values.



(a) $\alpha > \tilde{\alpha}$ (b) $\alpha < \tilde{\alpha}$

Figure 3.3: Two possible scenarios of an undercutting game depend on parameters. If Firm i undercuts Firm j, then Firm j sets the renewal price either at $\bar{p}_L$, as in case (a), or at $\bar{p}_H$, as in case (b). Firm i then decides whether to set the renewal price at p_1^j or $\bar{p}_L$ in case (a), or at p_1^j or $\bar{p}_H$ in case (b)

The form of the threshold price ($\tilde{p}_L$ or $\tilde{p}_H$) depends on the parameter α, which alters the nature of the potential equilibrium. When firms aim to retain Type L consumers, this indicates a strategy of competitive pricing to attract a broader market segment that is less sensitive to price changes. In contrast, the formula for Type H consumers suggests a strategy that might be employed in markets where firms can set higher prices by exploiting the most vulnerable.

This complexity highlights the importance for firms to understand their consumer base and to continuously monitor market trends and adjust their strategies accordingly. Thus, the threshold price might serve as a flexible tool in strategic pricing, adaptable to varying market conditions and consumer behaviour patterns.

The intuition here is that when α, which represents the proportion of average customers in the market, falls below a certain value, firms prefer to fully exploit consumers who are less sensitive to price hikes. In such an event, firms will base their pricing strategy on Type H consumers. This, in turn, allows Type L consumers to avoid the loyalty penalty because, in the second period, they re-join the engagement pool as the benefit from engagement outweighs its cost. However, this may affect the overall level of the base price.

There are two things to note. First, when considering the latter profile of prices, the reservation price of Type L consumers can be expressed as $\bar{p}_L = \tilde{p}_H + e_L$. Second, $\tilde{p}_L = \tilde{p}_H$ when $\alpha = \tilde{\alpha}$, so I break the tie by assuming that, at this point, firms set the renewal price at $\bar{p}_H$.

The presence of the threshold price also determines the optimal continuation strategies. These auxiliary results are presented in Corollary 3.2.2, which follows from Lemma 3.2.1, and they are useful for further analysis, as they help in understanding the optimal responses of firms in a two-period game.

Corollary 3.2.2. *In two-period game the optimal continuation strategies are as follows:*

Case (a). When there are many average and few vulnerable consumers $\alpha \in [\tilde{\alpha}, 1]$*:*

(i) A firm with a lower base price in the interval $(0, \tilde{p}_L)$ will set its renewal price at the reservation price level of Type L customers.

(ii) A firm with a lower base price will set its renewal price by matching the rival's base price if it is in the interval $(\tilde{p}_L, \bar{p}_L]$.

Case (b). When there are few average and many vulnerable consumers $\alpha \in (0, \tilde{\alpha}]$:

(i) A firm with a lower base price in the interval $(0, \tilde{p}_H)$ will set its renewal price at the reservation price level of Type H customers.

(ii) A firm with a lower base price will set its renewal price by matching the rival's base price if it is in the interval $(\tilde{p}_H, \bar{p}_H]$.

See proof in Appendix A.1. When firms are indifferent to match or increase the renewal price, I break the tie by assuming that, at this point, firms set the renewal price at the reservation level.

The analysis advances by positing $\tilde{p}_L$ as a price that yields the symmetric Subgame Perfect Nash Equilibrium (SPNE) for $\alpha \in [\tilde{\alpha}, 1)$ and by positing $\tilde{p}_H$ as a price that yields the symmetric Subgame Perfect Nash Equilibrium (SPNE) for $\alpha \in (0, \tilde{\alpha}]$.

3.3 Equilibrium analysis

In this section, I analyse how the presence of vulnerable customers affects the equilibrium. In the previous section, I established that the presence of vulnerable customers divides firms' strategies into two cases: (a) when $\alpha \in [\tilde{\alpha}, 1]$, and (b) when $\alpha \in (0, \tilde{\alpha}]$.

Interestingly, for α values in Case (a), the presence of Type H consumers does not affect the previously established equilibrium. In this analysis, I will show that the results of Case (a) closely follow those presented in Chapter 2. Nevertheless, I sketch the main findings of Case (a) here. This aims to help to form a complete picture before proceeding with Case (b), where I will demonstrate how the equilibrium changes when the presence of vulnerable consumers becomes significant.

The intuition behind Case (a) is that when the proportion of vulnerable consumers is low, firms treat all non-shoppers as average consumers, disregarding the vulnerability of the minority group and not exploiting them. Therefore, the model resembles the one with only two types of consumers, with no engagement occurring in equilibrium.

However, when the proportion of vulnerable consumers reaches a certain threshold (or equivalently, when the proportion of average consumers falls below this threshold), firms alter their strategy, as I will demonstrate in Case (b). In this scenario, average consumers pay the engagement cost in equilibrium.

In the extreme case of $\alpha = 0$, the model with vulnerable consumers reduces to the version presented in Chapter 2, but with reservation prices $\bar{p}_H$ and no engagement in equilibrium.

3.3.1 Case (a): $\alpha \in [\tilde{\alpha}, 1]$

In this section, I outline the main findings for Case (a), with all detailed proofs provided in the Appendix A.2.

Symmetric equilibrium:

Lemma 3.3.1. *Given $\alpha \in [\tilde{\alpha}, 1]$ and $\lambda \in (0, 1)$, the profile of prices when firms set $\tilde{p}_L = \bar{p}_L \frac{1-\lambda}{1+\lambda}$ as a base price, and $\bar{p}_L$ as a renewal price constitutes a symmetric subgame perfect Nash equilibrium in pure strategies.*

Given that $\bar{p}_L \frac{1-\lambda}{1+\lambda} + e_L = \bar{p}_L < v$, the equilibrium base price can be expressed as $\tilde{p}_L = e_L \frac{1-\lambda}{2\lambda}$ and the equilibrium renewal price can be expressed as $\bar{p}_L = e_L \frac{1+\lambda}{2\lambda}$.

Now, it is possible to express $\tilde{\alpha}$ as a function of the model's parameters e_L, λ, and v. With the assumption[6] that $\bar{p}_H = v$ and the expression of the reservation

[6]Recall that I am assuming that vulnerable consumers have extremely high engagement cost e_H such that they are ready to buy at or below v

price of Type L consumers as $\bar{p}_L = e_L \frac{1+\lambda}{2\lambda}$ yields: $\tilde{\alpha} = 1 - \frac{\frac{e_L(1+\lambda)}{2\lambda}}{v}$ which simplifies to $\tilde{\alpha} = 1 - \frac{e_L(1+\lambda)}{2\lambda v}$.

Other equilibrium candidates:

In this section, I examine whether other symmetric equilibria exist within the given price ranges $[\underline{p}, \tilde{p}_L)$ and $(\tilde{p}_L, \bar{p}_L]$. However, to analyse this, I take into account the number of savvy shoppers.

Firstly, in Lemma 3.3.2, I consider an equilibrium where the proportion of savvy shoppers is between 0 and 1. In Lemma 3.3.3, I examine the price range when all consumers are savvy shoppers, and in Lemma 3.3.4, I consider the case where savvy shoppers are absent from the market.

Lemma 3.3.2. *Consider $\lambda \in (0,1)$ and intervals $[\underline{p}, \tilde{p}_L)$ and $(\tilde{p}_L, \bar{p}_L]$.*

Case 1: The profile of prices where the base price $p_1^{i(j)} \in [\underline{p}, \tilde{p}_L)$ and the renewal price $p_2^{i(j)} = \bar{p}_L$ is not a symmetric SPNE.

Case 2: The profile of prices where the base price $p_1^{i(j)} \in (\tilde{p}_L, \bar{p}]$ and the renewal price $p_2^{i(j)} = \bar{p}_L$ is not a symmetric SPNE.

Lemma 3.3.3. *For $\lambda = 1$, the profile of prices where $p_1^{i,j} = p_2^{i,j} = 0$ is a symmetric SPNE.*

All customers are informed, and a Bertrand-type equilibrium prevails.

Lemma 3.3.4. *For $\lambda = 0$, the profile of prices where $p_1^{i,j} = p_2^{i,j} = \bar{p}_L$ is a symmetric SPNE. Additionally $\bar{p}_L \to \bar{p}_H = v$.*

The only possible equilibrium is the Diamond equilibrium. Similar to Diamond (1971) as $\lambda \to 0$, the reservation price approaches monopoly price.

This also resembles the classic finding by Stahl, who argues that in the absence of shoppers "if there are two types of consumers with search costs[7] $c_H > c_L > 0$, the Diamond result would prevail" (Stahl, 1989, p.710), which is consistent with the model in this chapter.

[7] Stahl denotes the search cost as c.

The analysis of Case (a) concludes that the profile of prices, where the base price is $p_1^{i(j)} = \tilde{p}_L$ and the renewal price is $p_2^{i(j)} = \bar{p}_L$, generates a unique symmetric subgame perfect Nash equilibrium in which all three types of consumers are present. No engagement by those with positive engagement costs occurs in this equilibrium, and the loyalty penalty is $LP = \bar{p}_L - \tilde{p}_L$.

3.3.2 Case (b): $\alpha \in (0, \tilde{\alpha}]$

In this section, I outline the main findings for Case (b), with all detailed proofs provided in the Appendix A.3.

Symmetric equilibrium:

After determining optimal continuation strategies, I consider the profile of prices where the base price $p_1^{i(j)} = \tilde{p}_H = \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{1+\lambda}$ and the renewal price $p_2^{i(j)} = \bar{p}_H$ is a symmetric SPNE.

Lemma 3.3.5. *Given $\alpha \in (0, \tilde{\alpha}]$ and $\lambda \in (0, 1)$, the profile of prices when firms set $\tilde{p}_H = \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{(1+\lambda)}$ as a base price, and $\bar{p}_H$ as a renewal price constitutes a symmetric subgame perfect Nash equilibrium in pure strategies.*

Firms prefer to fully exploit consumer vulnerability, as it yields a greater payoff than 'keeping' average consumers. They set the base price in the first period based on the reservation price of vulnerable consumers, which exceeds that of average consumers. The base price applies to all types of consumers in the first period. In the second period, average consumers behave like savvy shoppers. However, unlike savvy shoppers who sample all prices for free, average consumers incur an engagement cost. This result contrasts with classic models with no engagement in equilibrium, where firms typically aim to discourage non-shoppers from further engagement. In this model, engagement actually occurs in equilibrium.

Other equilibrium candidates:

The analysis proceeds by considering other equilibrium candidates. First, I consider prices when $\lambda \in (0,1)$, followed by the extreme cases $\lambda = 1$ and $\lambda = 0$. However, in contrast to the previous case, the presence of average consumers adds additional complexity to the analysis. Although I examine equilibrium candidates in the intervals $[\underline{p}, \tilde{p}_H)$ and $(\tilde{p}_H, \bar{p}_H]$, I must account for the reservation price of average consumers, which bisects the latter interval into $(\tilde{p}_H, \bar{p}_L]$ and $(\bar{p}_L, \bar{p}_H]$. All proofs for this subsection are presented in Appendix A.3.2.

I begin with the interval $[\underline{p}, \tilde{p}_H)$.

Lemma 3.3.6. *Consider $\lambda \in (0,1)$ and let any price in the interval $[\underline{p}, \tilde{p}_H)$ be denoted as p, then the profile of prices with a base price $p_1^{i,j} = p$ and a renewal price $p_2^{i,j} = \bar{p}_H$ in not a symmetric SPNE.*

In this interval, undercutting yields a diminishing payoff. A firm can always deviate by slightly increasing its base price, provided it does not surpass the threshold price. In such a case, the deviating firm loses the savvy shoppers in the first period but gains all of them in the second period, as the rival finds it optimal to set the renewal price at the reservation level.

The following lemma examines equilibrium candidates in the interval $(\tilde{p}_H, \bar{p}_H]$.

Lemma 3.3.7. *Consider $\lambda \in (0,1)$, and let any price in the interval $(\tilde{p}_H, \bar{p}_H)$ be denoted as p, then the profile of prices with a base price $p_1^{i,j} = p$ and a renewal price $p_2^{i,j} = \bar{p}_H$ is not a symmetric SPNE.*

The analysis reveals that when all types of consumers are present in the market, any profile of prices where the base price is chosen from the interval $(\tilde{p}_H, \bar{p}_H]$ and the renewal price is set at $\bar{p}_H$ does not constitute a symmetric SPNE. The intuition behind this result is that while the cutoff price for average consumers creates a boundary for their engagement decisions, firms still have an incentive to deviate unilaterally to fully exploit vulnerable consumers as they yield a higher payoff. This deviation disrupts any potential equilibrium in pure strategy in this price range.

I proceed by considering extreme cases of the parameter λ. Recall that $\lambda = 1$

means that all consumers are savvy-shoppers, and $\lambda = 0$ means that all consumers are either average or vulnerable.

Lemma 3.3.8. *For $\lambda \in \{0, 1\}$, the following price profiles constitute symmetric SPNE:*

(i) When $\lambda = 1$, the profile of prices is $p_1^{i,j} = p_2^{i,j} = 0$.

(ii) When $\lambda = 0$, the profile of prices is $p_1^{i,j} = p_2^{i,j} = \bar{p}_H$.

At extreme values of λ, the equilibria of Case (a) and Case (b) coincide, aligning with previous findings and the literature. In the extreme cases, the Bertrand equilibrium is observed when $\lambda = 1$, and the Diamond equilibrium occurs when $\lambda = 0$. Lemma 3.3.4 also established that as $\lambda \to 0$, $\bar{p}_L \to \bar{p}_H = v$. This result holds in Case (b) and can be additionally verified by analysing the expression $\tilde{\alpha} = 1 - \frac{e_L(1+\lambda)}{2\lambda v}$. It is evident that as λ approaches zero, $\tilde{\alpha}$ decreases and eventually becomes negative. This implies that Case (b) converges to Case (a), as equilibrium prices conditioned on Type L consumers converge to monopoly prices.

Before declaring the main result, let's resolve a situation which observed at $\alpha = \tilde{\alpha}$ by verifying the tie-break rule.

Lemma 3.3.9. *For $\alpha = \tilde{\alpha}$:*

(i) In the second period, firms are indifferent between unilaterally setting the renewal price at $\bar{p}_L$ or $\bar{p}_H$.

(ii) However, when both firms set the renewal price at $\bar{p}_H$, it yields a greater payoff. Thus, the tie breaks by both firms set the renewal price at $\bar{p}_H$.

The main result can be formally stated as the following proposition:

Proposition 3.3.10. *In a two-period game with two firms and three types of consumers, there exist profiles of price that constitute a Subgame Perfect Nash Equilibrium and yield a unique symmetric equilibrium in pure strategies. These profiles of prices are:*

(i) Set the base price at $\tilde{p}_L$ and a renewal price at $\bar{p}_L$ for $\alpha > \tilde{\alpha}$;

(ii) Set the base price at $\tilde{p}_H$ and a renewal price at $\bar{p}_H$ for $\alpha \leq \tilde{\alpha}$.

Proof. Follows from Equilibrium Analysis. □

The next section will provide an interpretation of these results through the prism of loyalty penalty among different types of consumers.

3.4 Interpreting model results in the context of the loyalty penalty

3.4.1 Interpretation and comparative statics

The base price in equilibrium (SPNE) takes one of two forms. When there is a sufficient proportion of average consumers, firms 'ignore' the presence of vulnerable consumers and base their prices on the reservation price of the average consumers. In the second period, firms set the renewal price to discourage further engagement by average consumers. As a result, both types of non-shoppers pay the loyalty penalty:

If $\bar{p}_L < v$:

$$\begin{aligned} LP_{\text{average}} &= \bar{p}_L - \tilde{p}_L \\ &= e_L \end{aligned} \tag{3.4}$$

Or if $\bar{p}_L = v$:

$$\begin{aligned} LP_{\text{average}} &= v - \tilde{p}_L \\ &= v\frac{2\lambda}{1+\lambda} \end{aligned} \tag{3.5}$$

By contrast, when the proportion of vulnerable consumers in the market is large, or conversely the proportion of average consumers is small, firms 'give up' on the average consumers and prefer to set the base price based on the reservation price of vulnerable consumers.

$$\begin{aligned} LP_{\text{vulnerable}} &= \bar{p}_H - \tilde{p}_H \\ &= e_H \end{aligned} \tag{3.6}$$

Or it takes the following form when the engagement costs of Type H are so high that they are willing to buy at their valuation:

$$\begin{aligned} LP_{\text{vulnerable}} &= v - v\frac{(1-\lambda)(1-\alpha)}{1+\lambda} \\ &= v\frac{1+\lambda-(1-\lambda)(1-\alpha)}{1+\lambda} \\ &= v\alpha\frac{1-\lambda}{1+\lambda} \end{aligned} \tag{3.7}$$

It is evident from Eq.3.6 that the loyalty penalty increases with higher engagement costs. However, when firms find it optimal to extract all surplus from vulnerable consumers, the loyalty penalty for this group intensifies as the proportion of average consumers increases. This occurs because the increasing proportion of average consumers, who engage in equilibrium (and pay engagement cost), drives the base price down. Once the proportion of average customers reaches a point where firms opt to retain them, these customers also become subject to the loyalty penalty, alongside the vulnerable consumers. Interestingly, at this point, vulnerable consumers become better off, as they pay the same loyalty penalty as average consumers. This provides a positive externality for vulnerable consumers by reducing their penalty to the level experienced by average consumers:

$$\frac{\partial LP_{\text{vulnerable}}}{\partial \alpha} = v\frac{1-\lambda}{1+\lambda} > 0 \tag{3.8}$$

At first glance, it may appear contradictory, but in fact, there are no contradictions. The loyalty penalty depends on the base price, which takes two forms. When firms exploit Type H consumers, the presence of Type L consumers drives the base price down until it becomes conditional on Type L customers. This might look that with fewer average customers, the loyalty penalty paid by the most vulnerable is less, but in fact this occurs because the base price increases for all consumer types.

The properties of equilibrium prices for Case (a) resemble the results presented in Section 2.3 of this thesis. Therefore, I continue by outlining some properties of the equilibrium prices for Case (b): the base price $\tilde{p}_H$ and the renewal price $\bar{p}_H$. I also present the properties of the threshold value of α, the loyalty penalty, and the surplus acquired by each type of consumer in equilibrium.

The following lemmas present the effect of savvy shoppers (Lemma 3.4.1) and average consumers[8] (Lemma 3.4.2) on the equilibrium prices $\tilde{p}_H = \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{(1+\lambda)}$ and $\bar{p}_H = v$.

Lemma 3.4.1. *In a duopoly setting, the equilibrium base price decreases in the proportion of savvy-shoppers and the renewal price is independent on the proportion of savvy shoppers.*

Proof. Differentiating $\tilde{p}_H$ with respect to λ yields:

$$\frac{\partial \tilde{p}_H}{\partial \lambda} = -2\bar{p}_H \frac{(1-\alpha)}{(1+\lambda)^2} < 0 \tag{3.9}$$

And straightforward for $\bar{p}_H$ given that $\bar{p}_H = v$. □

Lemma 3.4.2. *In a duopoly setting, the equilibrium base price decreases in the proportion of average consumers and the renewal price is independent on the proportion of average consumers.*

[8]Recall that λ represents the proportion of savvy shoppers, α represents the proportion of average consumers, and $(1-\alpha)$ represents the proportion of vulnerable consumers.

Proof. Differentiating $\tilde{p}_H$ with respect to α yields:

$$\frac{\partial \tilde{p}_H}{\partial \alpha} = -\bar{p}_H \frac{(1-\lambda)}{1+\lambda} < 0 \tag{3.10}$$

And straightforward for $\bar{p}_H$ given that $\bar{p}_H = v$. □

The base price decreases as the proportion of savvy-shoppers and average consumers in the market increases; and increases when the proportion of savvy-shoppers and average consumers decreases.

When α falls below the threshold value as the proportion of average consumers decreases, firms find it profitable to give up on them and exploit vulnerable consumers. This raises the base price for all types of consumers in the first period.

The following three lemmas present the effect of model parameters such as low engagement cost e_L, the fraction of savvy shoppers λ, and consumer valuation v on the threshold value of average consumers, $\tilde{\alpha} = 1 - \frac{e_L(1+\lambda)}{2\lambda v}$.

Lemma 3.4.3. *The threshold value $\tilde{\alpha}$ decreases as the engagement costs of average consumers, e_L, increase.*

Proof. Differentiating $\tilde{\alpha}$ with respect to e_L yields:

$$\frac{\partial \tilde{\alpha}}{\partial e_L} = -\frac{(1+\lambda)}{2\lambda v} < 0 \tag{3.11}$$

□

Reducing the engagement costs for the average customer (Type L) raises the threshold proportion of these customers that firms require to base their pricing strategies on them. The intuition is that as average consumers lower their engagement costs, firms may choose to give up on them and instead focus on fully exploiting more vulnerable consumers.

Lemma 3.4.4. *The threshold value $\tilde{\alpha}$ increases as the proportion of savvy-shoppers, λ, increases.*

Proof. Differentiating $\tilde{\alpha}$ with respect to λ yields:

$$\begin{aligned}\frac{\partial \tilde{\alpha}}{\partial \lambda} &= \frac{e_L(2\lambda v) - e_L(1+\lambda)(2v)}{(2\lambda v)^2} \\ &= \frac{e_L}{2\lambda^2 v} > 0\end{aligned} \tag{3.12}$$

□

The intuition is that a growing share of savvy-shoppers increases the required proportion of average consumers for firms to base their pricing strategies on them. Conversely, a decreasing proportion of savvy-shoppers lowers the threshold of Type L customers, meaning that with fewer savvy-shoppers in the market, the firm's incentive to retain average customers grows. As λ decreases, the model transitions to the one described in the second chapter, requiring fewer average consumers to determine the price profile, while ignoring vulnerable consumers. However, as demonstrated in the second chapter's model, prices rise as λ approaches zero, and the model exhibits the Diamond result when $\lambda = 0$.

Lemma 3.4.5. *The threshold value $\tilde{\alpha}$ increases as the consumer value, v, increases.*

Proof. Differentiating $\tilde{\alpha}$ with respect to v yields:

$$\frac{\partial \tilde{\alpha}}{\partial v} = \frac{e_L}{2\lambda v^2} > 0 \tag{3.13}$$

□

Increasing consumer value requires a larger share of average consumers for firms to condition base price on them. With more average consumers, firms are incentivised to adjust first period prices to cater to this group in the second period. However, if their number is too small, firms may shift focus to exploiting vulnerable consumers in the second period, leading to higher prices overall. This shows how market composition directly impacts pricing strategies, as firms tailor their approach based on the presence of different consumer types.

Next, for the sake of further analysis, I define the consumer surplus as follows:

Definition 7. *The consumer surplus in equilibrium for each consumer type depends on $\tilde{\alpha}$ and is calculated as the difference between their valuation and the price they pay (and engagement cost if incurred), summed across both periods.*[9]

Type 0 ;

Case (a) $CS_{\text{Type 0}} = 2(v - \tilde{p}_L)$;

Case (b) $CS_{\text{Type 0}} = 2(v - \tilde{p}_H)$;

Type L :

Case (a) $CS_{\text{Type L}} = 2v - \tilde{p}_L - \bar{p}_L$;

Case (b) $CS_{\text{Type L}} = 2(v - \tilde{p}_H) - e_L$;

Type H :

Case (a) $CS_{\text{Type H}} = 2v - \tilde{p}_L - \bar{p}_L$;

Case (b) $CS_{\text{Type H}} = 2v - \tilde{p}_H - \bar{p}_H$;

To better understand the complex dynamics of this two-period model with multiple parameters, I will illustrate it through numerical examples in the next section.

However, to conclude this section, a key takeaway from the model is that firms can strategically choose which type of consumer to retain while discouraging others from further engagement. This shift changes the nature of the threshold price, making it dependent on the reservation price of vulnerable consumers rather than that of average consumers, as influenced by their proportion in the

[9]Recall that in Case (a), firms 'keep' average consumers and 'ignore' vulnerable consumers; in Case (b), firms 'give up' on average consumers and fully exploit vulnerable consumers.

market. The reservation prices are shaped by differences in engagement costs. A threshold value for average consumers exists, expressed as the ratio between the reservation prices, where this proportion becomes significant. Moreover, this threshold value can be derived from the models parameters.

Another key insight from the model is that in Case (b), engagement occurs in equilibrium, and average consumers pay the engagement costs, which impacts their consumer surplus.

3.4.2 Numerical examples

For the first numerical example assume that 30%, or $\lambda = 0.3$ are savvy shoppers. Based on regulators' reports such assumption is viable (Citizens Advice, 2018*a*). Also, assume that average (Type L) consumers have a relatively low engagement cost, $e_L = 5$, compared to vulnerable (Type H) consumers, whose engagement cost is so high that they always buy at or below $v = 30$.

Figure 3.4 and Table 3.1 present the results of the model with three types of consumers. The fraction of savvy shoppers (Type 0) is fixed at $\lambda = 0.3$. The horizontal axis represents the fraction of average consumers (Type L), intersecting the green dashed line that represents the threshold value of α, dividing the model into two cases: Case (a) $\alpha \in [\tilde{\alpha}, 1]$ and Case (b) $\alpha \in (0, \tilde{\alpha}]$.

The solid blue line represents the base price, which changes its form from $\tilde{p}_L$ in Case (a) to $\tilde{p}_H$ in Case (b), and coincide at $\tilde{\alpha}$. The solid red line represents the renewal price, which also shifts at the threshold value of average consumers. In Case (a), it is set at the reservation price of average consumers $\bar{p}_L$. As the proportion of average consumers decreases, firms abandon them and set the renewal price at the reservation price of vulnerable consumers, leading to an increase in the loyalty penalty.

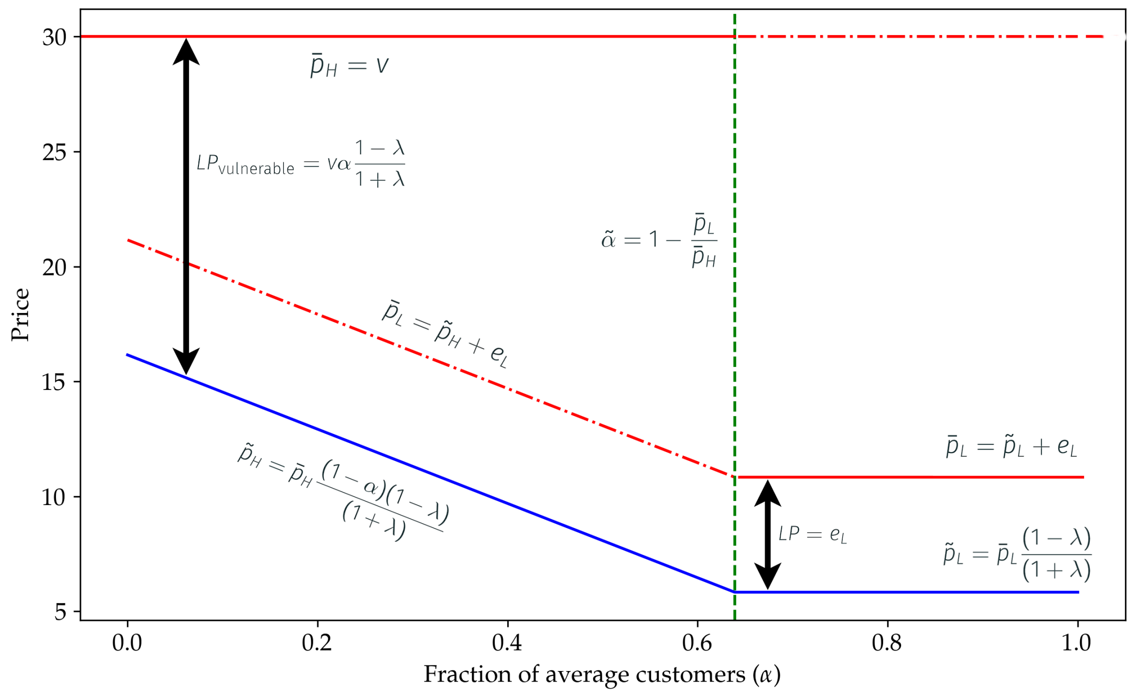


Figure 3.4: Numerical example $\lambda = 0.3$, $v = 30$, and $e_L = 5$. The solid blue line represents the base price, which changes its form when it reaches the dashed green line, representing the threshold value of average consumers. The base price starts to increase as α decreases over the interval $\alpha \in (0, \tilde{\alpha}]$. The solid red line represents the renewal price. In the interval $\alpha \in [\tilde{\alpha}, 1]$, the renewal price corresponds to the reservation price of Type L consumers, with no engagement occurring in equilibrium for Case (a). In the interval $\alpha \in (0, \tilde{\alpha}]$, representing Case (b), the renewal price is set at $\bar{p}_H = v$, Type L consumers buy at the base price in both periods but pay engagement cost.

Table 3.1: Numerical example $\lambda = 0.3$, $v = 30$, and $e_L = 5$.

α	p^E	$\bar{p}_L$	$\bar{p}_H$	LP	CS Type 0	CS Type L	CS Type H
0.00	16.15	21.15	30	13.85	27.70	22.70	13.85
0.10	14.54	19.54	30	15.46	30.92	25.92	15.46
0.20	12.92	17.92	30	17.08	34.16	29.16	17.08
0.30	11.31	16.31	30	18.69	37.38	32.38	18.69
0.40	9.69	14.69	30	20.31	40.62	35.62	20.31
0.50	8.08	13.08	30	21.92	43.84	38.84	21.92
0.60	6.46	11.46	30	23.54	47.08	42.08	23.54
0.64	5.83	10.83	30	24.17	48.34	43.34	24.17
0.70	5.83	10.83	30	5	48.34	43.34	43.34
0.80	5.83	10.83	30	5	48.34	43.34	43.34
0.90	5.83	10.83	30	5	48.34	43.34	43.34
1.00	5.83	10.83	30	5	48.34	43.34	43.34

In equilibrium, average consumers pay the engagement cost because I break the tie at $\tilde{\alpha}$, such that firms set the renewal price at $\bar{p}_H$. In Case (b), the base price increases as the proportion of average consumers decreases. After the initial spike at $\tilde{\alpha}$, the loyalty penalty begins to decline, but this is due to the increasing base price. The consumer surplus of all consumer types decreases in Case (b). Savvy shoppers experience a decline in consumer surplus due to rising base prices, and average consumers, who start to behave like savvy shoppers, obtain reduced consumer surplus as they incur engagement costs to find better prices in addition to rising base prices. Vulnerable consumers fare the worst, with the sharpest decrease in surplus (see Figure 3.5 below).

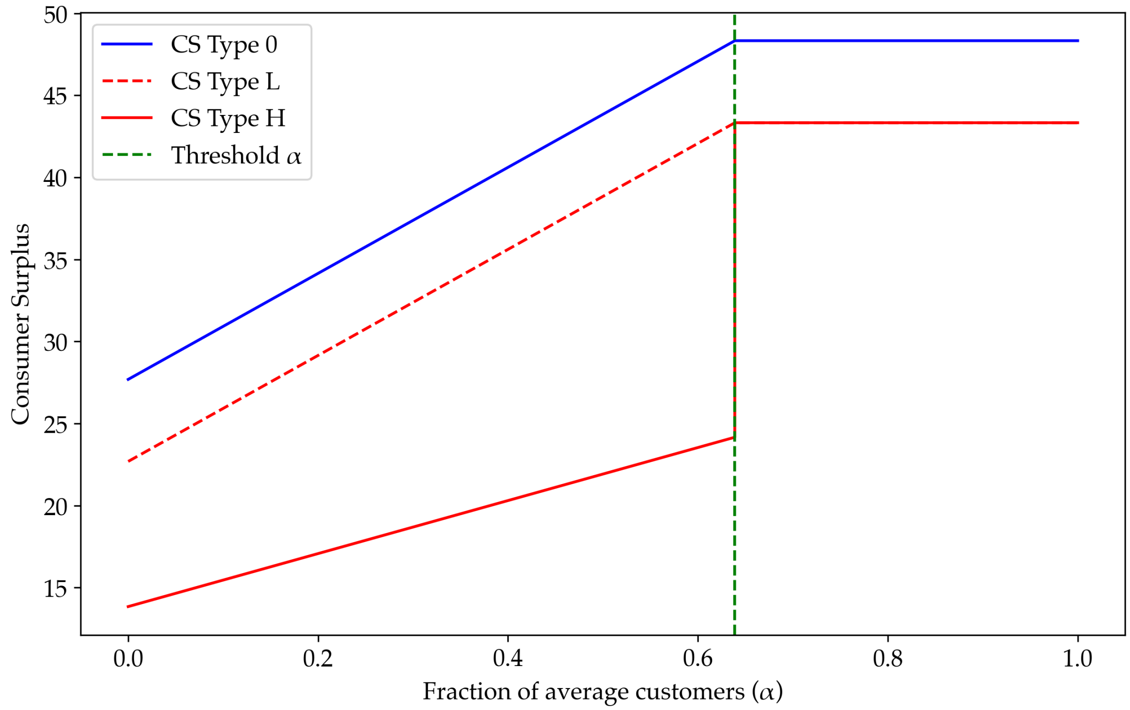


Figure 3.5: Consumer surplus $\lambda = 0.3$, $v = 30$, and $e_L = 5$. The solid blue line represents the consumer surplus of Type 0 consumers. The solid red line represents the consumer surplus of Type H consumers. The dotted red line represents the consumer surplus of Type L consumers.

To illustrate the influence of savvy-shoppers, let's consider two extreme cases.

Firstly, let's assume that 95% of the population are savvy-shoppers ($\lambda = 0.95$) who consistently shop around to find the best deals. This behaviour intensifies firms competitiveness and drives prices down towards the Bertrand equilibrium level. However, the presence of vulnerable consumers presents firms with an opportunity to significantly raise prices in the second period, thereby exploiting the vulnerable customers. In this scenario, the magnitude of the loyalty penalty is substantial. The difference between the prices in the first and second periods becomes disproportionately high, reflecting not just market dynamics but also a strategic exploitation of consumer vulnerabilities. This situation underscores the disproportionate impact that the loyalty penalty can have on less market-savvy or more vulnerable consumers, particularly in markets where savvy-shoppers dominate yet do not entirely mitigate the effects of price exploitation (Figures 3.6 and 3.7, and Table 3.2).

Table 3.2: Numerical example $\lambda = 0.95$, $v = 30$, and $e_L = 5$.

α	p^E	$\bar{p}_L$	$\bar{p}_H$	LP	CS Type 0	CS Type L	CS Type H
0.00	0.77	5.77	30	29.23	58.46	53.46	29.23
0.10	0.69	5.69	30	29.31	58.62	53.62	29.31
0.20	0.62	5.62	30	29.38	58.76	53.76	29.38
0.30	0.54	5.54	30	29.46	58.92	53.92	29.46
0.40	0.46	5.46	30	29.54	59.08	54.08	29.54
0.50	0.38	5.38	30	29.62	59.24	54.24	29.62
0.60	0.31	5.31	30	29.69	59.38	54.38	29.69
0.70	0.23	5.23	30	29.77	59.54	54.54	29.77
0.80	0.15	5.15	30	29.85	59.70	54.70	29.85
0.83	0.13	5.13	30	29.87	59.74	54.74	29.87
0.90	0.13	5.13	30	5	59.74	54.74	54.74
1.00	0.13	5.13	30	5	59.74	54.74	54.74

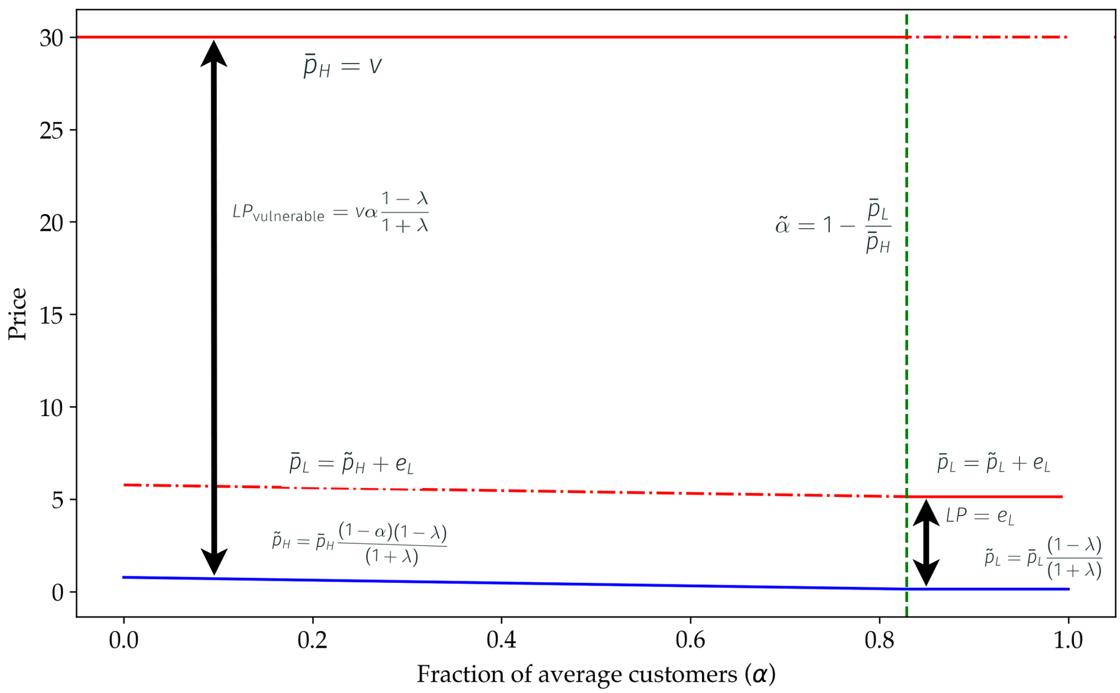


Figure 3.6: Numerical example $\lambda = 0.95$, $v = 30$, and $e_L = 5$.

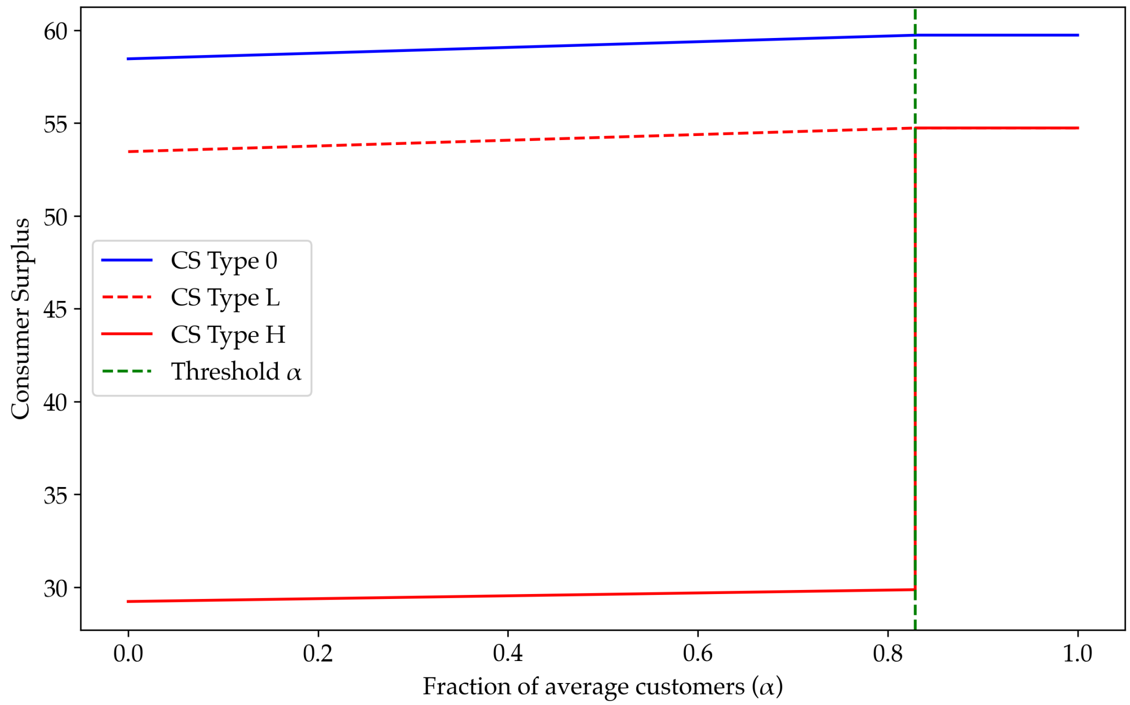


Figure 3.7: Consumer surplus $\lambda = 0.95$, $v = 30$, and $e_L = 5$. The solid blue line represents the consumer surplus of Type 0 consumers. The solid red line represents the consumer surplus of Type H consumers. The dotted red line represents the consumer surplus of Type L consumers.

In the third example, suppose that only 5% of the population are savvy-shoppers who consistently shop around to find the best deals. This lack of actively engaged consumers enables firms to increase prices. Due to the opportunity to substantially raise the base price, both reservation prices of Type L and Type H consumers are converging to the consumer value v. As the threshold value of average consumer decreasing, the firms condition their pricing strategies on them. In this scenario, the loyalty penalty affects both types of non-shoppers. Although the penalty is not excessively high, it still occurs due to the elevated base prices set by the firms. This situation highlights a key aspect of the loyalty penalty: even in a market with relatively high prices and limited competition, non-shoppers are still subjected to this penalty, albeit to a lesser degree than might be expected in a more competitive environment. It illustrates how market dynamics, influenced by the proportion of savvy-shoppers, directly impact the extent and distribution of the loyalty penalty across different consumer types (Figures 3.8 and 3.9, and Table 3.3).

Table 3.3: Numerical example $\lambda = 0.05$, $v = 30$, and $e_L = 5$.

α	p^E	$\bar{p}_L$	$\bar{p}_H$	LP	CS Type 0	CS Type L	CS Type H
0.00	27.14	30	30	2.86	5.72	2.86	2.86
0.10	27.14	30	30	2.86	5.72	2.86	2.86
0.20	27.14	30	30	2.86	5.72	2.86	2.86
0.30	27.14	30	30	2.86	5.72	2.86	2.86
0.40	27.14	30	30	2.86	5.72	2.86	2.86
0.50	27.14	30	30	2.86	5.72	2.86	2.86
0.60	27.14	30	30	2.86	5.72	2.86	2.86
0.70	27.14	30	30	2.86	5.72	2.86	2.86
0.80	27.14	30	30	2.86	5.72	2.86	2.86
0.90	27.14	30	30	2.86	5.72	2.86	2.86
1.00	27.14	30	30	2.86	5.72	2.86	2.86

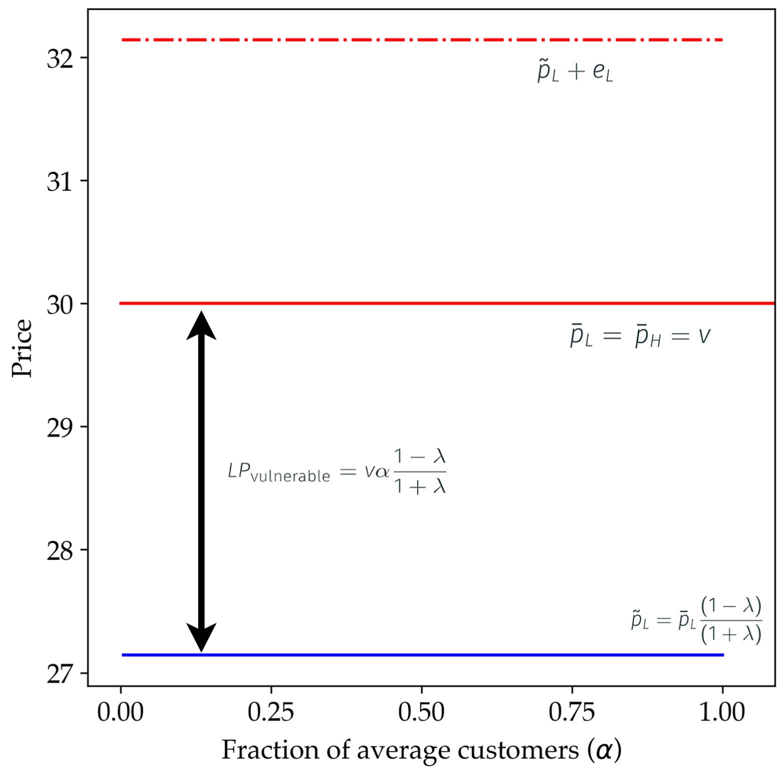


Figure 3.8: Numerical example $\lambda = 0.05$, $v = 30$, and $e_L = 5$.

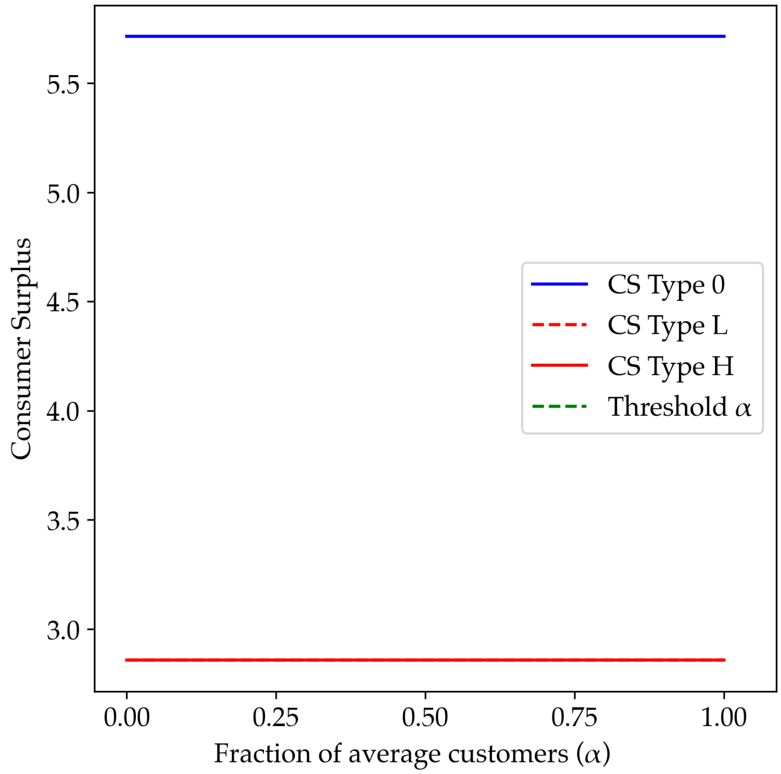


Figure 3.9: Consumer surplus $\lambda = 0.05$, $v = 30$, and $e_L = 5$. The solid blue line represents the consumer surplus of Type 0 consumers. The solid red line represents the consumer surplus of Type H consumers.

3.5 Conclusion

The presence of three types of consumers - savvy shoppers, average consumers, and vulnerable consumers - leads to varying magnitudes of the loyalty penalty in the market. Firms strategically adjust their pricing decisions in both periods based on the consumer type, determining which group to exploit the most. Consumers affect each other through the base price, which is influenced by the proportion of certain consumer types.

The model offers an intuitive explanation for the mechanism behind the loyalty penalty and its impact on different consumer groups. When the proportion of vulnerable consumers exceeds a certain threshold, firms are compelled to exploit them the most. Although only the vulnerable suffer directly from the loyalty penalty in such scenarios, they impose a negative externality on all types by driving up the base price in the first period.

A key takeaway from the model is that firms can strategically choose which type of consumer to exploit. This shift changes the nature of the threshold price compared to the results in the previous chapter, making it dependent on the reservation price of vulnerable consumers rather than that of average consumers, as influenced by their proportion in the market. The reservation prices are shaped by differences in engagement costs. There exists a threshold value for average consumers, expressed as the ratio between the reservation prices, where their proportion becomes significant. Moreover, this threshold value can be derived from the model's parameters.

Another key insight is that, in contrast to the classic model where no search occurs in equilibrium, I demonstrate that average consumers pay engagement costs to 'escape' from the loyalty penalty. Specifically, in Case (b), engagement occurs in equilibrium, and average consumers pay the engagement costs, which impacts their consumer surplus. In this scenario, the consumer surplus of all types decreases: savvy shoppers experience a decline due to rising base prices; average consumers, who begin to behave like savvy shoppers, see reduced surplus as they incur engagement costs alongside rising base prices; and vulnerable consumers fare the worst, suffering the sharpest decrease in surplus.

Chapter 4

Policy implications: balancing consumer protection with firms' competitive incentives

This chapter explores a critical trade-off faced by regulators: the need to protect consumers while preserving the competitive incentives of firms. While safeguarding these consumers is essential, it is crucial to recognise that ill-conceived policy interventions may inadvertently diminish firms motivation to compete, which in turn affects consumer engagement. Such unintended consequences can lead to fewer discounts and less attractive offers for consumers. This analysis emphasises that solutions to the loyalty penalty must carefully balance these two objectives. I assess regulatory responses using the theoretical framework developed in previous chapters and explain why some policies might not work.

4.1 Introduction

The concept of the loyalty penalty has been a subject of intense debate between businesses and policymakers in all essential markets in the EU (EIOPA, 2023*b*) and in the UK before and after Brexit (Citizens Advice, 2018*b*; CMA, 2019). For instance, regarding the energy retail market, in response to the super complaint, Professor Stephen Littlechild[1] criticises regulation of the UK retail energy market and the CMA's calculation of customer detriment (Littlechild, 2021, 2019). Particularly, he argues that regulators should "stop digging" and "move on from the incorrect narrative of an uncompetitive and inefficient retail market with significant customer detriment, and develop and communicate more broadly a better understanding of how this competitive market actually works, and why certain regulatory interventions could be beneficial but others could be counterproductive" (Littlechild, 2021, p.1).

The central question of this chapter is to shed light on how certain policies implemented in different markets affect the loyalty penalty and whether they can find the balance between consumer protection and preserving the competitive incentives of firms. To answer this question, I use the theoretical models developed in the previous two chapters and relax or introduce certain assumptions according to the recent regulatory incentives of major regulators such as the Financial Conduct Authority (FCA), the Office for Gas and Electricity Markets (Ofgem), and the Office for Communications (Ofcom). In analysing policy implications, this chapter contributes to the discussion by raising important questions about balancing competitive freedom with regulatory intervention, and avoiding unintended consequences. It seeks to understand the implications of policies the main regulators have implemented and how to balance these contrasting views.

In recent events[2] and forums[3] organised by regulators, particularly those aimed at addressing consumer vulnerability, the question of market fairness is frequently raised. However, each regulator's perspective offers distinct insights into the notion of market fairness. The concept of fairness typically falls within the normative paradigm, which contrasts with the positivist approach so far adopted

[1]Professor Stephen Littlechild, former Director General of Electricity Supply and part of the Energy Policy Research Group at the University of Cambridge. See more on his page at The University of Cambridge. S.Littlechild

[2]Ofwat (2024) *Vulnerability Summit - Post-event reflections.* Available at: https://www.ofwat.gov.uk/vulnerability-summit-post-event-reflections/ (Accessed: May 14, 2025).

[3]Vulnerability Summit (2024) *Vulnerability Summit* Available at: https://www.vulnerabilitysummit.co.uk/ (Accessed: May 14, 2025).

in this thesis. For example, Littlechild (2019) argues that the concept of fairness is ambiguous and "this posed a fundamental difficulty for the promotion of competition because, from this perspective, competition was not the solution to a problem but a problem in itself" (Littlechild, 2019, p. 122). Nevertheless, when I refer to fairness in this thesis, I mean a concept similar to that outlined in the report by the Centre for Competition Policy (CCP, 2018)[4].

Businesses often view the loyalty penalty as a byproduct of a free market and competitive practices. For instance, the consultations with insurance companies and the European Insurance and Occupational Pensions Authority (EIOPA) highlight this stance (EIOPA, 2019, 2022). Particularly, the companies argue that the notion of unfairness as subjective and not clearly defined in European consumer law, which focuses on ensuring contract terms are clear and comprehensible, without necessarily addressing the fairness of the price itself. The business emphasises the freedom to set prices and offer discounts as crucial for a competitive and diverse market, arguing that existing regulations in the mutual insurance sector already address concerns related to the loyalty penalty. The companies also expresses concern that new constraints could lead to hyper-segmentation and demutualisation, making it harder for certain groups to obtain insurance (EIOPA, 2023*b*,*c*).

This perspective underscores a fundamental belief in market competitiveness where companies are free to determine their pricing strategies. It suggests that informed consumers can choose between different offers, implying that the loyalty penalty is ***a result of consumer choice rather than exploitative practices***. The companies' view is that interventions in pricing could lead to a reduction in product and service quality and diversity, ultimately harming consumers.

Contrasting sharply with the business perspective, policymakers and regulatory bodies like Ofgem, FCA, Ofcom, and EIOPA focus on consumer protection

[4]The CCP report points out that the concept of fairness can be ambiguous and complicated. Thus, it requires finding a balance between business efficiency, which increases total benefits, and distributional concerns (CCP, 2018, p.14).

and market fairness. The regulatory approach, particularly in the UK, has been to directly intervene in pricing strategies to prevent the loyalty penalty. Policies have been implemented, such as the FCA's ban on price walking in insurance, requiring renewal quotes to be no more expensive than those offered to new customers.

Policymakers argue that such interventions are necessary to protect consumers, particularly the vulnerable, from exploitative practices that can arise in essential markets. They see the loyalty penalty as an unfair practice that undermines consumer trust and the functioning of a fair market. The regulatory perspective is based on the belief that consumers are not always fully informed or capable of continuously navigating a complex market, and thus require protection.

Regulators also emphasise the importance of transparency and informed decision making (Ofcom, 2022; Ofgem, 2019; Citizens Advice, 2018*b*; FCA, 2018*a*). They aim to create an environment where consumers can make choices based on a clear understanding of their options, not just in terms of price but also service quality and provider reputation.

The concept of fairness in this context is complex. From a business perspective, fairness is aligned with the freedom to compete and set prices according to market competition. They argue that this freedom encourages innovation, diversity in products and services, and ultimately benefits the consumer. On the other hand, policymakers focus on fairness in terms of consumer protection and equitable treatment. They view the loyalty penalty as inherently unfair, exploiting consumer loyalty and potentially trapping consumers in suboptimal contracts.

The challenge lies in balancing these perspectives. Excessive regulation could stifle competition and innovation. Businesses advocate for minimal interference, emphasising market freedom and consumer choice. Policymakers, however, stress the need for consumer protection and equitable market practices. Balancing these perspectives is a complex task that requires careful consideration of the implications for both market competitiveness and consumer welfare. Ultimately, the goal should be to foster a market environment that is both competitive and fair, promoting innovation and diversity while protecting consumers from exploitative practices.

A substantial body of academic literature addresses market competition and consumer protection, focusing on switching and search costs. For example, Giulietti et al. (2014) study consumer search and pricing behaviour in the British electricity market, Armstrong and Vickers (2022) analyse consumers' 'captivity' and consideration sets in their choices and market outcomes, Farrell and Klemperer (2007) explore the effects of both switching and search costs on competition and pricing, Beggs and Klemperer (1992) discuss the long-term implications of switching costs on market power and pricing strategies. In addition, a new research area is emerging on price discrimination based on engagement and search behaviours. For instance, Mauring (2025) investigates how firms use consumer engagement data for price discrimination, while Groh (2021) examines the impact of search behaviour on personalised pricing.

Typically, authors suggest potential policies in the discussion section within the context of their papers. In contrast, this chapter contributes to this body of literature by examining the real policy implications set by major regulators through the lens of a developed theoretical model and how they affect the interplay between market competitiveness, particularly consumer engagement and firms' pricing strategies.

Therefore I begin by investigating the ban of the loyalty penalty in the UK car insurance market, introduced by the FCA in 2022, targeting the loyalty penalty in the form of price walking. This step was expected to herald a new era of fairness in insurance pricing. However, recent investigations suggest that the landscape has changed less than anticipated. Research based on surveys from nearly 2,000 drivers points to a stubborn persistence of the loyalty penalty, revealing a gap between the idealistic goals of regulatory reform and the complex realities of the market.[5] As the FCA prepares for a thorough policy review in 2024, this chap-

[5]Which?Finds. Press Team (2024) *Despite insurance 'loyalty penalty ban', existing customers are*

ter provides microeconomic insights for a deeper examination of the impact on consumers and firms.

Applying this policy to the theoretical model of the loyalty penalty, I demonstrate that banning the loyalty penalty prevents firms from setting a uniform price due to the risk of being undercut. Instead, firms adopt mixed strategies, setting prices from a distribution in each period, leading to price dispersion. That also affects consumer welfare, which I demonstrate in comparison to the model with the loyalty penalty. On average, the prices for those who are able to engage are increasing. This happens because firms are not able to offer special deals and exploit the customers in the subsequent period. Moreover, this policy intervention eliminates the loyalty penalty within a firm by definition[6], but in a broader context the disadvantage to maintain the contract with the current firm can be considered as a loyalty penalty between firms as a result of price dispersion amongst firms (or 'interfirm loyalty penalty'). Additionally, in an extended analysis of a special case, a new form of the loyalty penalty within a firm emerges because regulators allow different pricing for the same services through the type of sales channel, encouraging price discrimination, which from the perspective of a customer who does not engage regularly can be viewed as a penalty for being loyal.[7]

I proceed further by examining the implementation of price caps. Although the solution of price caps might seem simplistic, they are a vital tool in essential markets as they prevent firms from excessively hiking prices, particularly in sectors such as energy and telecommunications. The nature of these services is such that they are indispensable for consumers, who have limited alternatives. By capping prices, regulators aim to protect vulnerable consumers from excessive

still being disadvantaged versus new customers. Available at: https://www.which.co.uk/policy-and-insight/article/despite-insurance-loyalty-penalty-ban-existing-customers-are-still-being-disadvantaged-versus-new-customers-which-finds-atL8s9k5bLmz (Accessed: May 14, 2025).

[6]In the first chapter I defined it as "the disadvantage endured as a result of maintaining a rollover contract or subscription over an extended period, compared to the benefits received by new subscribers or customers for the same product or service."

[7]For instance, such a type of the loyalty penalty may explain the stubborn persistence of the loyalty penalty in auto insurance.

charges and ensure affordability. This regulatory measure helps maintain a balance between fair pricing and the financial viability of service providers, thereby contributing to the overall stability and fairness of the market.

I continue by examining so-called ’social tariffs’ proposed by Ofcom and Ofgem. Under social tariffs, the regulator typically encourages firms that certain groups of consumers must always be offered the cheapest available tariff. The analysis explains why such an initiative may have a negligible effect. For instance, in the UK, only one percent of eligible customers use social tariffs in telecoms, and two-thirds of customers have never heard of them. An effective remedy could involve data-sharing initiatives and auto-switching platforms. The intuition behind this is straightforward: when data-sharing and auto-switching mechanisms are in place, customers are less likely to remain with a single provider. Consequently, firms cannot rely on retaining customers at higher prices over time and must compete for them through auto-switching platforms. This approach helps ensure that a balance between consumer protection and market competitiveness can be achieved.

I proceed by discussing the educational initiatives offered by regulators in the UK and the EU. I explain why it is important to distinguish the concept of consumer education from others, such as consumer information and awareness, and why consumers may exhibit varying propensities to engage with educational initiatives. Then, using the model of the loyalty penalty, I demonstrate the unintended consequences that may arise if policy is not designed with consideration for different consumer needs and their willingness to engage.

In the final part of the chapter I discuss a potential remedy known as competition for the market – this approach could preserve competitive incentives for firms, ensuring that market forces work to reduce the loyalty penalty and protect vulnerable consumers.

4.2 Prohibition of the loyalty penalty

I begin by analysing the policy that prohibits the loyalty penalty. This policy approach is not new and can be seen as the most obvious and straightforward reaction by policymakers. For example, by 2015, five states in the United States had introduced a ban on the loyalty penalty, also known in the U.S. as 'price optimisation' or 'price walking' practices (CFoA, 2015).

These measures faced significant backlash from insurance companies[8] who opposed the ban on loyalty penalties for several reasons. They argued it would limit their competitive pricing strategies and significantly reduce profitability. Insurers also highlighted the administrative burden and cost of implementing new rules. The industry contended that these changes could lead to overall higher prices and reduced market competition, negatively impacting consumers in the long run (FCA, 2021).

Nevertheless, the FCA, in a bold move, prohibited price walking practices. The updated FCA Handbook, effective from 1st January 2022, mandates:

'ICOBS[9] 6B.2.1: A firm must not set a renewal price that is higher than the equivalent new business price.'

Currently, the FCA is preparing a review two years after introducing these measures. Following the FCA's example, the EIOPA issued a supervisory statement in March 2023 to tackle 'unfair price walking' practices (EIOPA, 2023*a*). This makes the analysis through the prism of the theoretical model developed in this thesis timely.

As outlined in the numerous consultations where the new policy was explained to businesses, and which ultimately led to the development of the Con-

[8] FCA (2021) *PS21/11: General insurance pricing practices - amendments.* Available at: https://www.fca.org.uk/publications/policy-statements/ps21-11-general-insurance-pricing-practices-amendments (Accessed: May 14, 2025).

[9] Insurance Conduct of Business Sourcebook

sumer Duty standards in financial services[10], this policy prevents firms from using consumers' varying engagement costs to shape their pricing strategies for renewal contracts. In any given period, firms are required to offer the same price to both 'new' and 'renewing' customers. As a result, firms set prices without the ability to commit to future periods or differentiate based on customer engagement.

Thus, consider the general model developed in the second chapter with two firms i and j, producing goods and/or services at marginal costs normalised to zero and operating over two periods. Both firms offer their goods and/or services in each period to two groups of customers[11] who make purchases based on the optimal reservation price rule (See Section 2.3.2.).

Although the new policy does not prohibit price changes between periods (including increases[12]) per se, new assumptions require that prices for 'old' customers must be the same as for new customers in any given period. This means that if firms decide to increase the price, they must do so for all customers regardless of their ability to engage. In each period firms, considering the customers' engagement rule, aim to discourage the engagement of non-shoppers and do not offer prices exceeding $\bar{p}$. However, they can try to attract shoppers by offering a slightly lower price than their rivals. In contrast with the model of the loyalty penalty, a firm that is able to offer a lower price in the first period has no leverage to exploit this in the subsequent period, and the game 'restarts' in the second period. As a result, the absence of constraining first-period prices and the uncertainty in price setting force firms to mix their strategies, which transforms the model into the setting described by Stahl (1989), played in each period.

Lemma 4.2.1. *If the loyalty penalty is prohibited, then there is a symmetric Nash Equilibrium in mixed strategies. Such that firms mixing over c.d.f. F with lower bound $\underline{p}$ and*

[10] FCA (2024) *Consumer Duty.* Available at: https://www.fca.org.uk/firms/consumer-duty (Accessed: May 14, 2025).

[11] For simplicity, I illustrate the policy using two types of consumers.

[12] Recall, previously, firms could set a lower base price in the first period and increase it in the second period, thus exploiting non-shoppers.

upper bound $\bar{p}$. Where each firms earns expected profit:

$$\mathbb{E}\pi_{noLP} = \underbrace{\mathbb{E}p_1 \left[\lambda(1-F(p)) + \frac{1-\lambda}{2}\right]}_{\text{First period}} + \underbrace{\mathbb{E}p_2 \left[\lambda(1-F(p)) + \frac{1-\lambda}{2}\right]}_{\text{Second period}} \tag{4.1}$$

Proof. The model resembles the general static model 'a-la Stahl' with a unit demand, which was introduced in Section 2.2.1 of this thesis. Due to no price commitment, and inability of firms to raise the price based on consumer's engagement, firms strategy described in this model can be applied in each period. Note, that expected prices in both periods are drawn from the same distribution F, that means in each period firms expect the same payoff. The proof of this Lemma is identical to unit demand version of the Stahl's model in Janssen et al. (2005). □

In equilibrium, firms mix their strategies by drawing prices from the interval $[\underline{p}, \bar{p}]$. The upper bound is endogenously obtained by equating the benefit from engagement and the engagement cost given by the equation: $\int_{\underline{p}}^{\bar{p}} (\bar{p} - p) f(p)\, dp = e$. In each subgame, the firm with the lowest price serves shoppers with probability $(1 - F(p))$. Given that the first sample is free and firms act to discourage further engagement, they do not charge above $\bar{p}$. Therefore, in each subgame, firms obtain an expected payoff: $\mathbb{E}\pi = p(\lambda(1 - F(p)) + \frac{1-\lambda}{2})$, which must be equal to the firm that sets $\bar{p}$.[13] By equating $p(\lambda(1 - F(p)) + \frac{1-\lambda}{2}) = \bar{p}$ and solving for $F(p)$, it is possible to obtain the shape of the c.d.f., which is $F(p) = 1 - \frac{(1-\lambda)(\bar{p}-p)}{2p\lambda}$. Then, by setting $F(p) = 0$ and solving for p, it is possible to obtain the lower bound of the c.d.f., which is $\underline{p} = \bar{p}\frac{1-\lambda}{1+\lambda}$. Finally, the reservation price is obtained by solving the engagement rule equation for $\bar{p}$, which yields an expression for the upper bound: $\bar{p} = \frac{e}{1+\frac{(1-\lambda)}{2\lambda}\ln\left(\frac{1-\lambda}{1+\lambda}\right)}$. The reservation price is calculated as a function of the proportion of shoppers and the engagement costs of non-shoppers. As the proportion of shoppers approaches zero, the reservation price increases and is capped by the consumer's valuation, v. This means that the reservation price is

[13] In equilibrium, any price from the distribution must yield the same expected payoff not greater than $\pi = \bar{p}\frac{1-\lambda}{2}$.

defined as $\bar{p} = \min\{\frac{e}{1+\frac{(1-\lambda)}{2\lambda}\ln\left(\frac{1-\lambda}{1+\lambda}\right)}, v\}$.

By comparing this result to the loyalty penalty model, I assess the welfare impact of the policy change. I define the welfare as gains and losses of market participants by examining consumers' surplus and firms' surplus.

I use a simple concept of welfare analysing consumer surplus and producer surplus which is in line with the academic literature (E.CA Economics, 2020). The analysis also reveals how key parameters of the model (e, λ, v), influence both consumer and producer surpluses.

This comparison reveals how removing the loyalty penalty influences consumer surplus and firm profits. It helps quantify the benefits and drawbacks, showing if the policy promotes a consumer protection without damaging competitive incentives, and provides clear insights into the economic consequences of such a policy.

4.2.1 Comparison with the model of the loyalty penalty

For the sake of tractability, the analysis begins with a duopoly model of the loyalty penalty developed in the second chapter. I compute and analyse the consumer surplus received by each shopper ($CS_{S_{LP}}$) and non-shopper ($CS_{N_{LP}}$) in each period.[14]

$$\begin{aligned} CS_{S_{LP}} &= [v - \tilde{p} + v - \tilde{p}] \\ &= 2(v - \tilde{p}) \end{aligned} \tag{4.2}$$

and

$$\begin{aligned} CS_{N_{LP}} &= [v - \tilde{p} + v - \bar{p}] \\ &= [2v - \tilde{p} - \bar{p}] \end{aligned} \tag{4.3}$$

[14]Note that I do not account engagement cost in the consumer surplus as in the equilibrium they do not engage beyond the first free sample.

The total consumer surplus (TCS_{LP}) over two periods can be obtained as follows as a weighted sum:

$$\begin{aligned} TCS_{LP} &= \lambda CS_{S_{LP}} + (1-\lambda)CS_{N_{LP}} \\ &= 2v + \lambda(\bar{p} - \tilde{p}) - (\tilde{p} + \bar{p}) \end{aligned} \tag{4.4}$$

Given that $\tilde{p} = \bar{p}\frac{1-\lambda}{1+\lambda}$ this simplifies into:

$$TCS_{LP} = 2v + 2\bar{p}(\lambda - 1) \tag{4.5}$$

Given that $\bar{p} = \min\{\tilde{p} + e, v\}$, it takes two forms. When $\lambda \leq \tilde{\lambda}$

$$\begin{aligned} TCS_{LP} &= 2v + 2v(\lambda - 1) \\ &= 2v\lambda \end{aligned} \tag{4.6}$$

and $\lambda > \tilde{\lambda}$

$$\begin{aligned} TCS_{LP} &= 2v + 2e\frac{(1+\lambda)}{2\lambda}(\lambda - 1) \\ &= 2v - e\frac{1-\lambda^2}{\lambda} \end{aligned} \tag{4.7}$$

Lemma 4.2.2. *In the model of the loyalty penalty, the total consumer surplus is either independent of engagement costs or decreases with engagement costs.*

Proof. The first part of Lemma is straightforward from Equation 4.6. To prove the second part, it requires to take the partial derivative from TCS_{LP} with respect to e, which yields:

$$\begin{aligned} \frac{\partial TCS_{LP}}{\partial e} &= -\frac{1-\lambda^2}{\lambda} \\ &< 0 \end{aligned} \tag{4.8}$$

□

For the case when the reservation price is capped by v, the total consumer surplus becomes independent of the engagement cost. Instead, it depends on the fraction of shoppers who can still engage without incurring any cost, thereby driving down the price in the first period.

Lemma 4.2.3. *In the model of the loyalty penalty the total consumer surplus increases with the proportion of shoppers.*

Proof. To understand the effect of the presence of shoppers on the total consumer surplus, it is necessary to take the partial derivative with respect to λ.

For the case when the reservation price is capped by v, it is straightforward from $TCS_{LP} = 2v\lambda$ that consumers surplus increases in the amount of shoppers. For the case $TCS_{LP} = 2v + e\frac{\lambda^2-1}{\lambda}$, take a partial with respect to λ, this yields:

$$\begin{aligned} \frac{\partial TCS_{LP}}{\partial \lambda} &= \frac{\lambda^2+1}{\lambda^2} \\ &> 0 \end{aligned} \tag{4.9}$$

□

The intuition here is that the presence of shoppers provides a positive externality by driving the first-period price down, and as a consequence, also driving down the price in the second period when $\bar{p} < v$.

The next step is to analyse the total producer surplus, TPS_{LP}, which can be obtained as the firm's equilibrium profit in both periods multiplied by the number of firms:

$$TPS_{LP} = 2\bar{p}(1-\lambda) \tag{4.10}$$

Therefore, when $\lambda \leq \tilde{\lambda}$, $\bar{p} = v$:

$$\begin{aligned} TPS &= 2\bar{p}(1-\lambda) \\ &= 2v(1-\lambda) \end{aligned} \tag{4.11}$$

and when when $\lambda > \tilde{\lambda}$, $\bar{p} < v$:

$$\begin{aligned} TPS &= 2e\frac{1+\lambda}{2\lambda}(1-\lambda) \\ &= e\frac{1-\lambda^2}{\lambda} \end{aligned} \tag{4.12}$$

Lemma 4.2.4. *In the model of the loyalty penalty, the total producer surplus is either independent of the engagement costs or increases in the engagement costs.*

Proof. The first part of Lemma is straightforward from Equation 4.11. To prove the second part, it requires to take the partial derivative with respect to e reveals that TPS_{LP} increases as the engagement cost rises:

$$\begin{aligned} \frac{\partial TPS}{\partial e} &= \frac{1-\lambda^2}{\lambda} \\ &> 0 \end{aligned} \tag{4.13}$$

□

Lemma 4.2.5. *In the model of the loyalty penalty the total producer surplus decreases in the proportion of shoppers.*

Proof. Taking the partial derivative with respect to λ reveals that TPS_{LP} decreases with increasing proportion of shoppers, for and $\lambda \leq \tilde{\lambda}$:

$$\begin{aligned} \frac{\partial TPS}{\partial \lambda} &= -2v \\ &< 0 \end{aligned} \tag{4.14}$$

and for $\lambda > \tilde{\lambda}$

$$\begin{aligned}\frac{\partial TPS}{\partial \lambda} &= \frac{-\lambda^2 - 1}{\lambda^2} \\ &< 0\end{aligned} \tag{4.15}$$

□

The underlying intuition is that as the proportion of shoppers increases, firms compete more fiercely. This heightened competition compels them to lower their prices, which in turn leads to a decrease in TPS_{LP}.

Social welfare with the presence of the loyalty penalty is calculated by summing the Total Consumer Surplus (TCS_{LP}) and the Total Producer Surplus (TPS_{LP}). The expression for social welfare is derived as follows:

$$\begin{aligned}SW_{LP} &= TCS_{LP} + TPS_{LP} \\ &= 2v + 2\bar{p}(\lambda - 1) + 2\bar{p}(1 - \lambda) \\ &= 2v - 2\bar{p}(1 - \lambda) + 2\bar{p}(1 - \lambda) \\ &= 2v\end{aligned} \tag{4.16}$$

The total social welfare remains constant at $2v$ in this model, irrespective of variations in the prices. This feature arises because the model assumes zero production cost and two periods. In this setup, any increase in prices that decreases the consumer surplus will correspondingly increase the producer surplus by the same amount, and vice versa. Therefore, the net impact on total societal welfare is zero, keeping SW_{LP} constant at $2v$.

I proceed with the derivation from the model without the loyalty penalty. For that, denote the expected price of non-shoppers as $\mathbb{E}[p]$ and derive the expression for the consumer surplus of non-shoppers in two periods. This will consist of the surplus they gain, $(v - \mathbb{E}[p])$. Recall that $\mathbb{E}[p] = \int_{\underline{p}}^{\bar{p}} p f(p)\, dp$ given that firms are mixing over c.d.f. $F(p)$. Then, the consumer surplus of each non-shopper can be expressed as follows:

Non-shoppers:

$$\begin{aligned} CS_N &= 2(v - \mathbb{E}[p]) \\ &= 2(v - \int_{\underline{p}}^{\bar{p}} pf(p)\,dp) \end{aligned} \tag{4.17}$$

Secondly, let's derive the expression for the consumer surplus of each shopper over two periods. To do this, suppose that a shopper samples both firms in each period and denote the cumulative probability of finding the cheapest price after two samples as $G(p) = 1 - (1 - F(p))^2$ and denote the expected price after sampling two firms as $\mathbb{E}[p]_{min}$. Thus, the consumer surplus of each shopper can be expressed as the sum of surpluses obtained in each period when a shopper expects the price $\mathbb{E}[p]_{min}$, which is:

$$\begin{aligned} CS_S &= 2(v - \mathbb{E}[p]_{min}) \\ &= 2(v - \int_{\underline{p}}^{\bar{p}} pdG(p)) \\ &= 2(v - \int_{\underline{p}}^{\bar{p}} pg(p)dp) \end{aligned} \tag{4.18}$$

Given that $f(p)$ is a density function of c.d.f. $F(p)$, the density of $G(p)$ can be expressed as $g(p) = 2(1 - F(p))f(p)$, then plugging it into expression of CS_S yields:

$$\begin{aligned} CS_S &= 2(v - \int_{\underline{p}}^{\bar{p}} p2(1 - F(p))f(p)dp) \\ &= 2(v - \left[\int_{\underline{p}}^{\bar{p}} 2pf(p)dp - \int_{\underline{p}}^{\bar{p}} 2pF(p)f(p)dp\right]) \end{aligned} \tag{4.19}$$

Note that $f(p) = \frac{dF(p)}{dp}$ and that $2F(p)dF(p) = d[F(p)]^2$ then integrating by parts yields:

$$\begin{aligned} CS_S &= 2(v - \left[2\bar{p} - 2\int_{\underline{p}}^{\bar{p}} F(p)dp + \bar{p} + \int_{\underline{p}}^{\bar{p}} [F(p)]^2 dp\right]) \\ &= 2(v - 3\bar{p} + 2\int_{\underline{p}}^{\bar{p}} F(p)dp - \int_{\underline{p}}^{\bar{p}} [F(p)]^2 dp) \end{aligned} \tag{4.20}$$

Finally, total consumer surplus in the model without a loyalty penalty can be expressed as follows:

$$TCS = (1-\lambda)(v - \mathbb{E}[p]) + \lambda(v - \mathbb{E}[p]_{min}) \tag{4.21}$$

Due to the complexity involved in obtaining a closed-form solution for comparison with the loyalty penalty model, for the sake of simplicity, this chapter opts for a numerical approach to contrast the total consumer surplus across the two models. Numerical method is programmed in Python with the following assumptions presented in Table 4.1.

The results are presented in Table 4.2. It demonstrates that even in this setting non-shoppers consistently pay higher average prices compared to those who actively seek out deals and switch. From the perspective of the customer whose main concern is the price, this situation can be described as *'interfirm loyalty penalty'*. Such type of the loyalty penalty can be quantified by the difference in expected prices paid by shoppers and non-shoppers, as shown in the following equation:

$$\underset{\text{inter}}{LP} = \mathbb{E}[p] - \mathbb{E}[p]_{min} \tag{4.22}$$

This suggests that, although this policy may reduce the magnitude of the loyalty penalty, it is not sufficient to eliminate it entirely.[15] Such a finding has significant implications for policy analysis: interventions aimed at mitigating the

[15] It eliminates the intrafirm loyalty penalty but it does not eliminate the interfirm loyalty penalty.

Table 4.1: Assumptions and Mathematical Expressions

Description	**Mathematical Expression**
Consumer valuation	$v = 30$
Engagement cost	$e = \{5, 10, 15, 20, 25, 30\}$
Consumer surplus of a non-shopper	$CS_N = 2(v - \int_{\underline{p}}^{\bar{p}} pf(p)\, dp)$
Consumer surplus of a shopper	$CS_S = 2(v - \int_{\underline{p}}^{\bar{p}} pg(p)\, dp)$
C.D.F. of expected price of non-shoppers	$F(p) = 1 - \frac{(1-\lambda)(\bar{p}-p)}{2p\lambda}$
Density of expected price of non-shoppers	$f(p) = \frac{(1-\lambda)}{2\lambda}\frac{\bar{p}}{p^2}$
C.D.F. of expected price of shoppers	$G(p) = 1 - (1 - F(p))^2$
Density of expected price of shoppers	$g(p) = 2(1 - F(p))f(p)$
Fraction of shoppers	$\lambda \in [0, 1]$
Optimal reservation price	$\bar{p} = \min\left\{\frac{e}{1+\frac{(1-\lambda)}{2\lambda}\ln\left(\frac{1-\lambda}{1+\lambda}\right)}, v\right\}$
Lower bound	$\underline{p} = \bar{p}\frac{1-\lambda}{1+\lambda}$

loyalty penalty must be robust enough to address the underlying causes that prevent its complete removal. Nevertheless, the interfirm loyalty penalty is always less than the intrafirm penalty. Unlike the intrafirm penalty, which consistently increases with the proportion of shoppers until it reaches its maximum value, the interfirm penalty follows an inverted U-shape pattern. It initially rises with the proportion of shoppers, reaching a peak, and then declines as both types of consumers eventually purchase at the same price, in line with the smooth transition from the Diamond to Bertrand prices (see Table 4.2 and Figure 4.1).

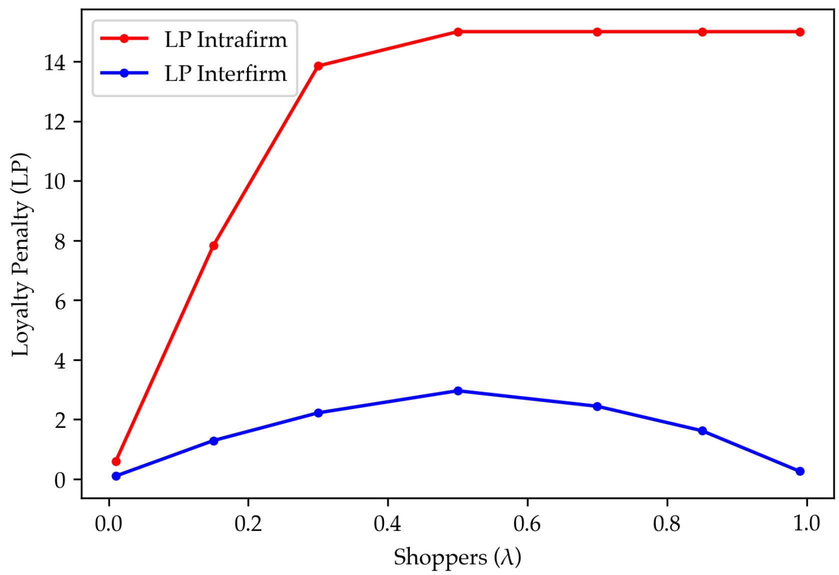


Figure 4.1: Loyalty Penalty (Intrafirm vs Interfirm) for $v = 30$ and $e = 15$.

λ	$\tilde{p}$	$\bar{p}_{LP}$	$p_{N_{LP}}$ average	$\mathbb{E}p$ min	$\mathbb{E}p$	LP intra	LP inter
0.01	29.41	30.00	29.71	29.60	29.71	0.59	0.11
0.15	14.17	19.17	16.67	24.40	25.69	5.00	1.29
0.30	5.83	10.83	8.33	11.67	13.00	5.00	1.33
0.50	2.50	7.50	5.00	5.00	6.09	5.00	1.09
0.70	1.07	6.07	3.57	2.14	2.96	5.00	0.82
0.85	0.44	5.44	2.94	0.88	1.42	5.00	0.54
0.99	0.03	5.03	2.53	0.05	0.14	5.00	0.09

(a) $v = 30$ and $e = 5$

0.01	29.41	30.00	29.71	29.60	29.71	0.59	0.11
0.15	22.17	30.00	26.09	24.40	25.69	7.83	1.29
0.30	11.67	21.67	16.67	19.45	21.67	10.00	2.22
0.50	5.00	15.00	10.00	10.00	12.19	10.00	2.19
0.70	2.14	12.14	7.14	4.29	5.92	10.00	1.63
0.85	0.88	10.88	5.88	1.76	2.85	10.00	1.09
0.99	0.05	10.05	5.05	0.10	0.27	10.00	0.17

(b) $v = 30$ and $e = 10$

0.01	29.41	30.00	29.71	29.60	29.71	0.59	0.11
0.15	22.17	30.00	26.09	24.40	25.69	7.83	1.29
0.30	16.15	30.00	23.08	19.45	21.67	13.85	2.22
0.50	7.50	22.50	15.00	13.52	16.48	15.00	2.96
0.70	3.21	18.21	10.71	6.43	8.87	15.00	2.44
0.85	1.32	16.32	8.82	2.65	4.27	15.00	1.62
0.99	0.08	15.08	7.58	0.15	0.41	15.00	0.26

(c) $v = 30$ and $e = 15$

λ	$\tilde{p}$	$\bar{p}_{LP}$	$p_{N_{LP}}$ average	$\mathbb{E}p$ min	$\mathbb{E}p$	LP intra	LP inter
0.01	29.41	30.00	29.71	29.60	29.71	0.59	0.11
0.15	22.17	30.00	26.09	24.40	25.69	7.83	1.29
0.30	16.15	30.00	23.08	19.45	21.67	13.85	2.22
0.50	10.00	30.00	20.00	13.52	16.48	20.00	2.96
0.70	4.29	24.29	14.29	8.08	11.15	20.00	3.07
0.85	1.76	21.76	11.76	3.53	5.70	20.00	2.17
0.99	0.10	20.10	10.10	0.20	0.55	20.00	0.35

(d) $v = 30$ and $e = 20$

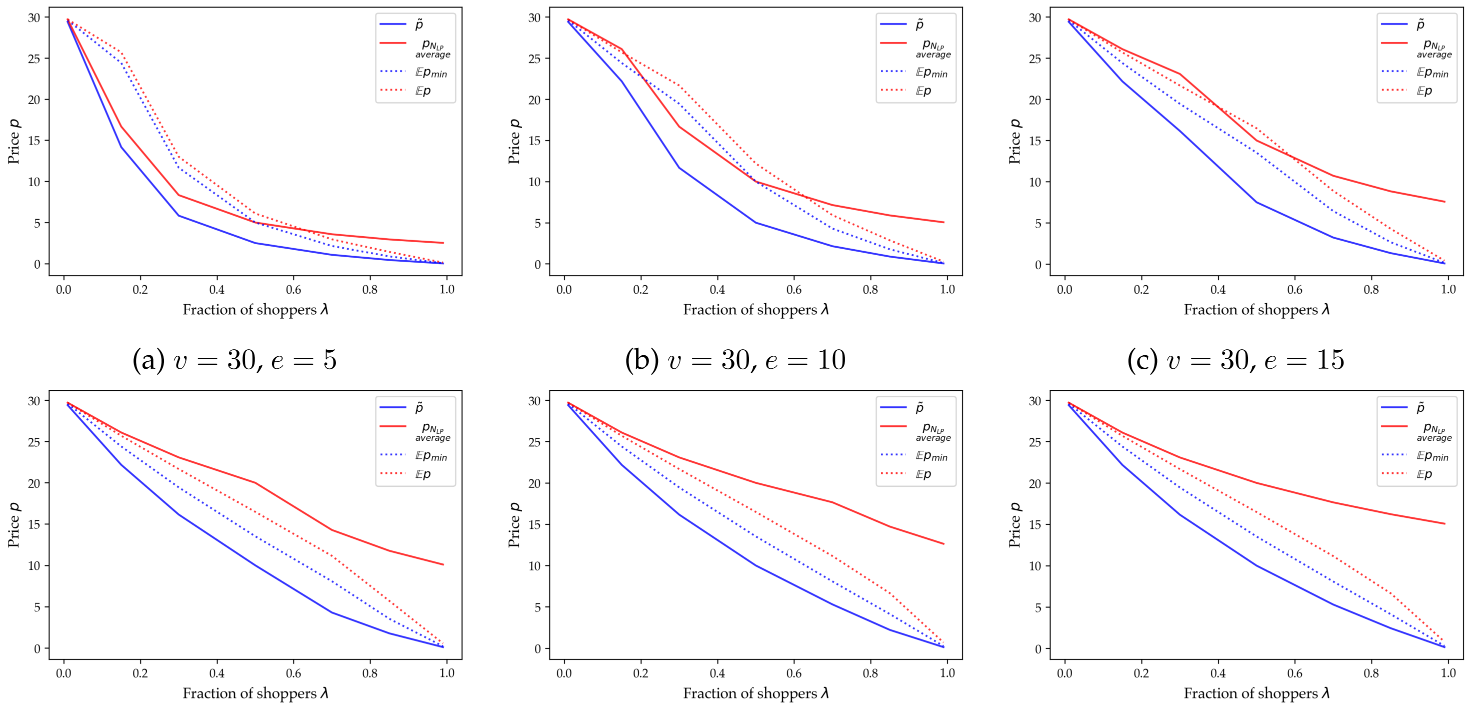
0.01	29.41	30.00	29.71	29.60	29.71	0.59	0.11
0.15	22.17	30.00	26.09	24.40	25.69	7.83	1.29
0.30	16.15	30.00	23.08	19.45	21.67	13.85	2.22
0.50	10.00	30.00	20.00	13.52	16.48	20.00	2.96
0.70	5.29	30.00	17.65	8.08	11.15	24.71	3.07
0.85	2.21	27.21	14.71	4.12	6.65	25.00	2.53
0.99	0.13	25.13	12.63	0.25	0.69	25.00	0.44

(e) $v = 30$ and $e = 25$

0.01	29.41	30.00	29.71	29.60	29.71	0.59	0.11
0.15	22.17	30.00	26.09	24.40	25.69	7.83	1.29
0.30	16.15	30.00	23.08	19.45	21.67	13.85	2.22
0.50	10.00	30.00	20.00	13.52	16.48	20.00	2.96
0.70	5.29	30.00	17.65	8.08	11.15	24.71	3.07
0.85	2.43	30.00	16.22	4.12	6.65	27.57	2.53
0.99	0.15	30.00	15.08	0.29	0.80	29.85	0.51

(f) $v = 30$ and $e = 30$

Table 4.2: Comparison of prices for fixed value of $v = 30$ and different values of e.



(a) $v = 30, e = 5$ (b) $v = 30, e = 10$ (c) $v = 30, e = 15$

(d) $v = 30, e = 20$ (e) $v = 30, e = 25$ (f) $v = 30, e = 30$

Figure 4.2: The average prices of shoppers (blue) and non-shoppers (red) with the loyalty penalty (solid lines) and without the loyalty penalty (dotted lines).

Figure 4.2 illustrates the average prices paid by shoppers and non-shoppers. The solid lines represent prices with the loyalty penalty: the bottom (blue) line shows the base price set in the first period for all customers, which is also the average price paid by shoppers in each period. The top (red) line shows the average price paid by non-shoppers, calculated as $(\tilde{p} + \bar{p})/2$. Both prices increase as the proportion of shoppers in the market decreases.

The dashed lines represent the expected prices (mean of the distributions G and F) in the model without the loyalty penalty: the bottom (blue) dashed line represents the expected price paid by shoppers each period, while the top (red) dashed line represents the expected price paid by non-shoppers each period. Prices in the model without the loyalty penalty also increase as the proportion of shoppers decreases. However, both expected prices are higher than the average price paid by shoppers in the model with the loyalty penalty. For sufficiently low engagement costs, as represented in cases (a) to (c), the average price paid by non-shoppers is lower with the loyalty penalty for certain values of the parameter λ.

Nevertheless, the lesser loyalty penalty happens due to an increase in the base prices (see Table 4.2 and Figure 4.2). This highlights a potential adverse outcome of the model without the loyalty penalty - shoppers who previously benefited from actively seeking better prices become disadvantaged. With the loyalty penalty, proactive shoppers enjoyed lower prices as firms competed to attract them. Without it, these benefits diminish, potentially reducing the drive to seek better deals. Consequently firms might use such reluctance to engage to relax their pricing strategies since they face less pressure to undercut rivals.

The ban of the loyalty penalty affects non-shoppers differently. For high engagement costs, banning the loyalty penalty decreases the average price paid by non-shoppers in both periods. However, for sufficiently low engagement costs, the effect is ambiguous. The average price paid by non-shoppers in the presence of the loyalty penalty decreases as the proportion of shoppers increases, and at certain levels, it becomes lower than the average price paid by non-shoppers in the absence of the loyalty penalty. This suggests that, under certain parameter values, the loyalty penalty may actually benefit non-shoppers[16] (see Table 4.2 (a)-(c) and Figure 4.2 (a)-(c)).

It can be argued that the loyalty penalty implies different mark-ups for various consumers and higher-paying consumers can be seen as 'subsidising' those who pay lower prices. This often raises questions about the fairness of pricing practices, particularly distributive fairness. However, regulators typically focus less on fairness due to its subjective nature[17], and instead prioritise economic considerations. These include: accessibility - ensuring more consumers can access services due to pricing practices; average price changes for specific consumer groups; and the impact on competition, such as potential entry barriers (FCA, 2018*b*).

The term 'subsidy' is used loosely here, as both groups of consumers may still be paying above the economic cost, as in our models of the loyalty penalty. When this is the case, the practice can be viewed as a necessary competitive tool used by firms to attract a range of customers. Therefore, regulators must be cautious in distinguishing between situations where cross-subsidisation is part of a loss-making strategy (where those paying lower prices might be buying below cost) and cases where it's not. When prices fall below cost for some customers, regulators typically scrutinise such practices more closely, as they may prevent entry and distort competition or harm market efficiency (FCA, 2016). Such changes in market outcomes underscores the importance of policies that maintain incentives for both firms and consumers to actively engage in competitive pricing.

This, also raises another important question for consumers and policymakers: What matters more to consumers - price differentials (hence the loyalty penalty) or

[16]Particularly in the two-periods model. However, If we assume that in $T > 2$ periods non-shoppers will continue to pay the reservation price in each subsequent period, then the average price would increase gradually ($\frac{\tilde{p}+\bar{p}(T-1)}{T}$), diminishing the benefit from the loyalty penalty for them over time.

[17]For example, price differences for flights based on booking time are widely accepted by the public and not perceived as unfair. Or when a wealthier customer accepts a higher renewal price.

price increases? For example, Littlechild (2019) points out that "consumer and fuel poverty groups were most concerned about the price increases. Some groups (but not all) were concerned about some price differentials" (Littlechild, 2019, p.113).

The analysis proceeds by examining and comparing consumer surplus in both models. Table 4.3 summarises the estimated results for the fixed consumer value, along with various proportion of shoppers and engagement costs. Figure 4.3 illustrates consumer surplus for a fixed consumer value with different proportion of shoppers and engagement costs. The solid lines represent consumer surplus in the model with the loyalty penalty, while the dashed lines represent it without the penalty. The blue lines represent shoppers, and the red lines represent non-shoppers.

Firstly, the impact of loyalty penalties on consumer surplus is complex, as demonstrated by the variance in consumer surplus for shoppers $CS_{S_{LP}}$ and non-shoppers $CS_{N_{LP}}$ across different levels of market engagement, represented by λ. The data indicates that non-shoppers bear the burden of the loyalty penalty, experiencing a lower consumer surplus when compared to their more proactive consumers. This discrepancy is especially pronounced at higher values of λ, suggesting that as consumer engagement intensifies, so does the penalty for those remaining passive.

In contrast, shoppers exhibit an increase in consumer surplus under the loyalty penalty. This could be interpreted as a positive outcome of the loyalty penalty, incentivising consumers to become more active participants in the market. This increased engagement could enhance firms' competitiveness, reduce prices, and promote innovation as firms compete to attract shoppers.

λ	CS_N	$CS_{N_{LP}}$	CS_S	$CS_{S_{LP}}$	TCS	TCS_{LP}
0.01	0.60	0.59	0.80	1.19	0.60	0.60
0.15	8.61	26.67	11.20	31.67	9.00	27.42
0.30	34.00	43.33	36.67	48.33	34.80	44.83
0.50	47.81	50.00	50.00	55.00	48.91	52.50
0.70	54.08	52.86	55.71	57.86	55.23	56.36
0.85	57.15	54.12	58.24	59.12	58.07	58.37
0.99	59.73	54.95	59.90	59.95	59.90	59.90

(a) $v = 30$ and $e = 5$

0.01	0.60	0.59	0.80	1.19	0.60	0.60
0.15	8.61	7.83	11.20	15.65	9.00	9.00
0.30	16.67	26.67	21.11	36.67	18.00	29.67
0.50	35.62	40.00	40.00	50.00	37.81	45.00
0.70	48.17	45.71	51.43	55.71	50.45	52.71
0.85	54.30	48.24	56.47	58.24	56.15	56.74
0.99	59.45	49.90	59.80	59.90	59.79	59.80

(b) $v = 30$ and $e = 10$

0.01	0.60	0.59	0.80	1.19	0.60	0.60
0.15	8.61	7.83	11.20	15.65	9.00	9.00
0.30	16.67	13.85	21.11	27.69	18.00	18.00
0.50	27.04	30.00	32.96	45.00	30.00	37.50
0.70	42.25	38.57	47.14	53.57	45.68	49.07
0.85	51.46	42.35	54.71	57.35	54.22	55.10
0.99	59.18	44.85	59.70	59.85	59.69	59.70

(c) $v = 30$ and $e = 15$

Table 4.3: Consumer surplus with fixed value $v = 30$ and various engagement costs

λ	CS_N	$CS_{N_{LP}}$	CS_S	$CS_{S_{LP}}$	TCS	TCS_{LP}
0.01	0.60	0.59	0.80	1.19	0.60	0.60
0.15	8.61	7.83	11.20	15.65	9.00	9.00
0.30	16.67	13.85	21.11	27.69	18.00	18.00
0.50	27.04	20.00	32.96	40.00	30.00	30.00
0.70	37.70	31.43	43.84	51.43	42.00	45.43
0.85	48.61	36.47	52.94	56.47	52.29	53.47
0.99	58.90	39.80	59.60	59.80	59.59	59.60

(d) $v = 30$ and $e = 20$

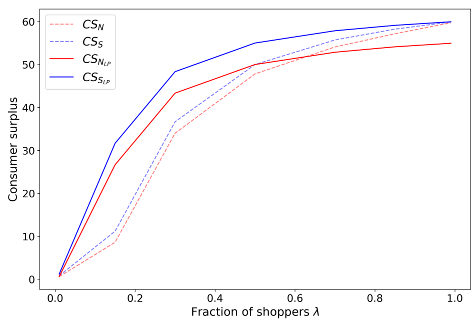
0.01	0.60	0.59	0.80	1.19	0.60	0.60
0.15	8.61	7.83	11.20	15.65	9.00	9.00
0.30	16.67	13.85	21.11	27.69	18.00	18.00
0.50	27.04	20.00	32.96	40.00	30.00	30.00
0.70	37.70	24.71	43.84	49.41	42.00	42.00
0.85	46.70	30.59	51.76	55.59	51.00	51.84
0.99	58.63	34.75	59.49	59.75	59.49	59.50

(e) $v = 30$ and $e = 25$

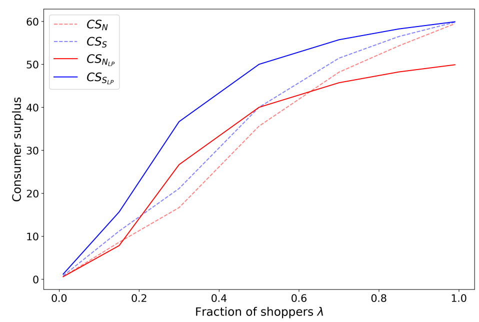
0.01	0.60	0.59	0.80	1.19	0.60	0.60
0.15	8.61	7.83	11.20	15.65	9.00	9.00
0.30	16.67	13.85	21.11	27.69	18.00	18.00
0.50	27.04	20.00	32.96	40.00	30.00	30.00
0.70	37.70	24.71	43.84	49.41	42.00	42.00
0.85	46.70	27.57	51.76	55.14	51.00	51.00
0.99	58.40	29.85	59.41	59.70	59.40	59.40

(f) $v = 30$ and $e = 30$

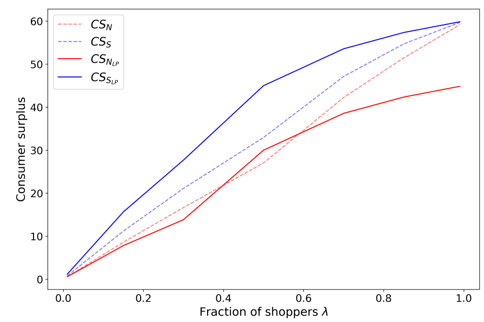
Table 4.3: Consumer surplus with fixed value $v = 30$ and various engagement costs



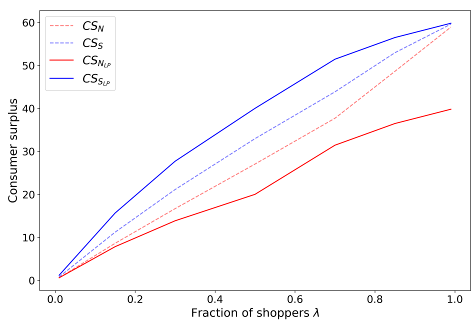
(a) $v = 30$, $e = 5$



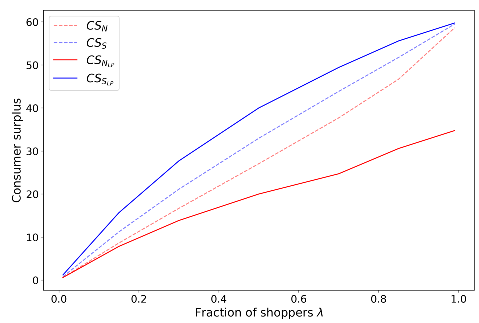
(b) $v = 30$, $e = 10$



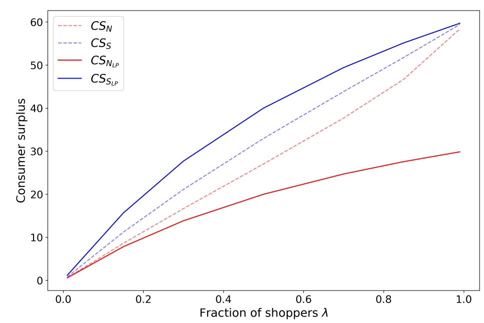
(c) $v = 30$, $e = 15$



(d) $v = 30$, $e = 20$



(e) $v = 30$, $e = 25$



(f) $v = 30$, $e = 30$

Figure 4.3: Consumer suprlus for fixed value $v = 30$ and various engagement costs

Secondly, the illustrative numerical example shows that total consumer surplus (TCS) is higher when the loyalty penalty is allowed compared to when it is not. This suggests that the loyalty penalty may not be as harmful to overall welfare as previously thought. However, this initial assessment overlooks the differences between various consumer groups and the distributive effects of the penalty.

Thirdly, the loyalty penalty's differentiated impact on various consumer segments presents a conundrum for policymakers. If the goal is to enhance the consumer protection, the removal of the loyalty penalty appears advantageous, particularly for less engaged consumers. Yet, such a policy shift may have unintended consequences, potentially dampening the competitive spirit among firms and consumers that has been shown to lead to better deals and more favourable market outcomes. A policy that only targets the abolition of loyalty penalties may miss the complex interactions between consumer engagement and firm behaviour.

Fourthly, another challenge lies in balancing the encouragement of an active consumer base against the promotion of market fairness in terms of redistribution consumer surplus. While the loyalty penalty may drive a portion of consumers to engage more deeply with the market, potentially enhancing competition and efficiency, they can also lead to a disparity in welfare distribution. This raises the question of whether the benefit to active consumers is worth the cost to those who are penalised for their loyalty or lack of engagement.

The final part of the analysis of this policy involves examining and comparing the effect of the loyalty penalty on producer surplus.

Total producer surplus in the model with the loyalty penalty can be obtained as follows:

$$\begin{aligned} TPS_{LP} &= 2\left(\tilde{p}\frac{1}{2} + \bar{p}\frac{1-\lambda}{2} + \tilde{p}\frac{\lambda}{2}\right) \\ &= \tilde{p}(1+\lambda) + \bar{p}(1-\lambda) \end{aligned} \tag{4.23}$$

and total producer surplus in the model without the loyalty penalty can be expressed as follows:

$$
\begin{aligned}
TPS &= 2[(1-\lambda)\mathbb{E}[p] + \lambda\mathbb{E}[p]_{min}] \\
&= 2[(1-\lambda)\int_{\underline{p}}^{\bar{p}} pf(p)dp) + \lambda \int_{\underline{p}}^{\bar{p}} pg(p)dp]
\end{aligned}
\tag{4.24}
$$

Figure 4.4 and Table 4.4 illustrate that consumer surplus is higher and producer surplus is lower under the loyalty penalty then without it. Therefore, a policy of banning the loyalty penalty to protect consumers seems to have the opposite effect. With the loyalty penalty, consumers are able to save more surplus due to lower prices for active shoppers. Additionally, for certain parameter values, when e and λ are small enough, non-shoppers also pay better prices on average because they can pay a lower base price in the first period.

It is apparent that the market of firms operating even within homogeneous product landscapes are not as simple as it could appear at the first glance. Firms persistently employ the loyalty penalty as a tool to build a subscriber base. Such behaviour is especially evident during the user acquisition stage. This strategy resembles the well-known pattern of 'investing then harvesting' (or 'bargains then rip-offs') particularly in the early stages of a firm's life cycle.

λ	TCS	TCS_{LP}	TPS	TPS_{LP}
0.01	0.60	0.60	59.40	59.40
0.15	9.00	27.42	51.00	32.58
0.30	34.80	44.83	25.20	15.17
0.50	48.91	52.50	11.09	7.50
0.70	55.23	56.36	4.77	3.64
0.85	58.07	58.37	1.93	1.63
0.99	59.90	59.90	0.10	0.10

(a) $v = 30$ and $e = 5$

0.01	0.60	0.60	59.40	59.40
0.15	9.00	9.00	51.00	51.00
0.30	18.00	29.67	42.00	30.33
0.50	37.81	45.00	22.19	15.00
0.70	50.45	52.71	9.55	7.29
0.85	56.15	56.74	3.85	3.26
0.99	59.79	59.80	0.21	0.20

(b) $v = 30$ and $e = 10$

0.01	0.60	0.60	59.40	59.40
0.15	9.00	9.00	51.00	51.00
0.30	18.00	18.00	42.00	42.00
0.50	30.00	37.50	30.00	22.50
0.70	45.68	49.07	14.32	10.93
0.85	54.22	55.10	5.78	4.90
0.99	59.69	59.70	0.31	0.30

(c) $v = 30$ and $e = 15$

λ	TCS	TCS_{LP}	TPS	TPS_{LP}
0.01	0.60	0.60	59.40	59.40
0.15	9.00	9.00	51.00	51.00
0.30	18.00	18.00	42.00	42.00
0.50	30.00	30.00	30.00	30.00
0.70	42.00	45.43	18.00	14.57
0.85	52.29	53.47	7.71	6.53
0.99	59.59	59.60	0.41	0.40

(d) $v = 30$ and $e = 20$

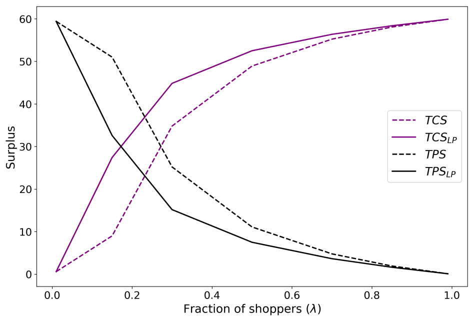
0.01	0.60	0.60	59.40	59.40
0.15	9.00	9.00	51.00	51.00
0.30	18.00	18.00	42.00	42.00
0.50	30.00	30.00	30.00	30.00
0.70	42.00	42.00	18.00	18.00
0.85	51.00	51.84	9.00	8.16
0.99	59.49	59.50	0.51	0.50

(e) $v = 30$ and $e = 25$

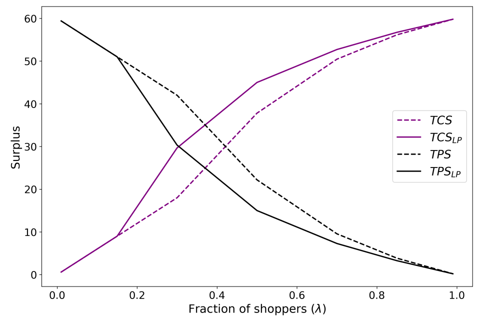
0.01	0.60	0.60	59.40	59.40
0.15	9.00	9.00	51.00	51.00
0.30	18.00	18.00	42.00	42.00
0.50	30.00	30.00	30.00	30.00
0.70	42.00	42.00	18.00	18.00
0.85	51.00	51.00	9.00	9.00
0.99	59.40	59.40	0.60	0.60

(f) $v = 30$ and $e = 30$

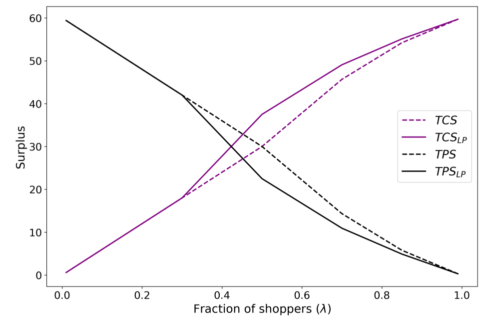
Table 4.4: Total surpluses for fixed value of $v = 30$ and different values of e. Note, as it has been stated above the total social welfare remains constant in this model ($2v = 60$), irrespective of variations in the prices due to assumed zero production cost and only two types of consumers and two firms.



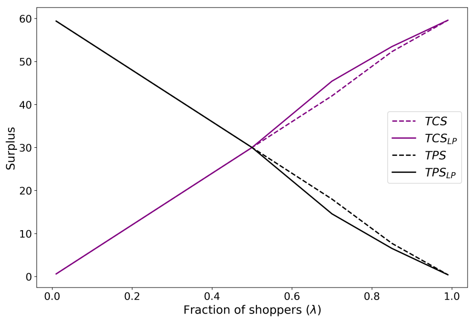
(a) $v = 30$, $e = 5$



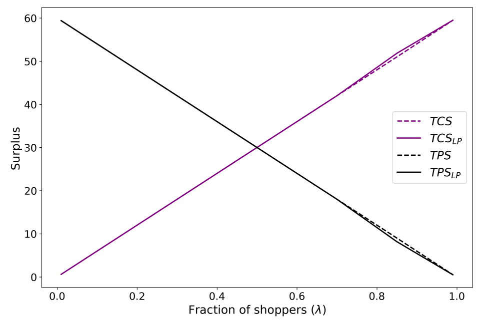
(b) $v = 30$, $e = 10$



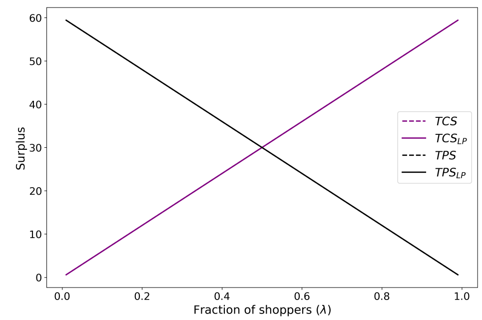
(c) $v = 30$, $e = 15$



(d) $v = 30$, $e = 20$



(e) $v = 30$, $e = 25$



(f) $v = 30$, $e = 30$

Figure 4.4: Total consumer suprlus and total producer surplus for fixed value $v = 30$ and various engagement costs

Intuitively, the equilibrium with the loyalty penalty from the firms perspective can also be viewed as follows: while a situation without a loyalty penalty might promise greater expected payoffs and producer surplus, the risk of being undercut by competitors - leading to customer loss and reduced surplus - drives firms to the safer, albeit less profitable, strategy of imposing the loyalty penalty, competing fiercely to attract consumers in the hope that then some of them stick. This behaviour is substantiated by the table's figures, which show a consistent total welfare irrespective of the loyalty penalty, suggesting that penalties are a strategic tool for surplus distribution rather than welfare enhancement. This means that the observed firm behaviour, in light of the table's data, underscores a market environment where the loyalty penalty is an optimal response to competitive uncertainty.[18]

Banning the loyalty penalty, which typically aims to protect consumers from unfair pricing practices over time, might inadvertently reduce the motivation for firms to compete aggressively. Without the ability to offer loyalty discounts or differentiated pricing based on consumer behaviour, firms may find fewer avenues through which they can attract and retain customers. This reduced competition might lead to prices at higher levels, diminishing the incentive for firms to lower prices or innovate in cost-saving measures. Consequently, while the intent of the regulation is to protect consumers, the overall effect could paradoxically make all consumers worse off by leading to higher average prices across the board. The delicate balance required in regulatory frameworks thus necessitates a nuanced approach that considers both the short-term benefits and long-term impacts on market outcomes.

[18]This is highly reminiscent of a prisoners' dilemma-type situation. For instance, in a loyalty penalty setting firms could choose not to engage in the loyalty penalty behaviour, but competition drives them to do so even though they make less profit than if they could agree to collectively not engage in a loyalty penalty behaviour.

4.2.2 Special case: price discrimination via different sales channels

In this section, I briefly address the issue described in a recent survey, which revealed that despite the FCA's ban in 2022, the loyalty penalty still persists. Taking a closer look at the FCA's Handbook, the new updates mandate that renewal prices must not exceed the price of 'the equivalent new business'; however, with the reservation that the purchase must be done through the same channel[19]. The FCA defines a channel as:

'The distribution method through which the customer purchases a policy. Examples of channels include: (a) direct sales, where the customer and insurer communicate directly without a third partys involvement. This would include (as separate channels) sales: (i) by telephone; (ii) via the internet; (iii) through a branch; (b) sales through a specific price comparison website; (c) sales through a specific insurance intermediary; and (d) sales via a specific affinity/partnership scheme.'

This exemption encourages firms to implement third-degree price discrimination. This concept can also be explained using the model of the loyalty penalty developed in this thesis. Consider two firms, denoted as i and j, that sell their products through two distinct channels, A and B. Suppose it is the case that channel A is a price comparison website, used exclusively by active consumers or shoppers, who buy at price p_A; and channel B involves direct sales, utilised by consumers what we have called as 'non-shoppers', who do not engage and will only buy a product if it is at or below their reservation price, denoted p_B.

Assuming a symmetric case, each firm captures half of the demand from non-shoppers, or $\frac{1-\lambda}{2}$. Meanwhile, on the price comparison website, competition among firms is only for those who always engage.

Suppose both firms play pure strategy (p_A, p_B). This yields the following

[19] FCA Handbook (2024) *ICOBS 6B.2 Setting renewal prices* Available at: https://www.handbook.fca.org.uk/handbook/ICOBS/6B/2.html (Accessed: May 14, 2025)

payoff:

$$\pi = \underbrace{p_A \frac{\lambda}{2} + p_B \frac{1-\lambda}{2}}_{\text{First period}} + \underbrace{p_A \frac{\lambda}{2} + p_B \frac{1-\lambda}{2}}_{\text{Second period}} \tag{4.25}$$

It is straightforward to see that in the non-shoppers' channel, firms will set the maximum possible price subject to not prompting consumers to engage further, which is the reservation price, $p_B = \bar{p}$ (the Diamond paradox). There is no point in undercutting such a price because it will not attract any additional consumers.

Meanwhile, intense competition for the shoppers will drive the price in channel A down to the competitive level, reaching a Bertrand equilibrium. Firms do not have an incentive to increase the price in this channel because they will lose shoppers.

Thus, firms operate in two channels with Bertrand prices and Diamond prices. Although there is no loyalty penalty per se, because there is no price walking, the situation from the perspective of a loyal customer who never engages and uses the more expensive channel could still be perceived as a penalty for being loyal.

Nevertheless, let's re-write the payoff as follows:

$$\begin{aligned} \pi &= \underbrace{0\frac{\lambda}{2} + \bar{p}\frac{1-\lambda}{2}}_{\text{First period}} + \underbrace{0\frac{\lambda}{2} + \bar{p}\frac{1-\lambda}{2}}_{\text{Second period}} \\ \pi &= \bar{p}\frac{1-\lambda}{2} + \bar{p}\frac{1-\lambda}{2} \\ \pi &= \bar{p}(1-\lambda) \end{aligned} \tag{4.26}$$

Channel A yields zero profits; therefore, the incentive for a firm to use it and offer special prices might be questionable. A firm that decides to use only one channel and focus on non-shoppers would yield the same payoff:

$$\begin{aligned} \pi &= \underbrace{\bar{p}\frac{1-\lambda}{2}}_{\text{First period}} + \underbrace{\bar{p}\frac{1-\lambda}{2}}_{\text{Second period}} \\ \pi &= \bar{p}(1-\lambda) \end{aligned} \tag{4.27}$$

However, such a large discontinuity in prices is rarely observed in real-life settings. This occurs because there is still a probability that different types of customers can approach different types of channels during the first sample, and firms might use new technologies to identify consumer types. This situation gives firms an opportunity to deviate and price above zero in the clearinghouse channel. Another real-life situation is that some cheap channels eventually cease to exist. For instance, in insurance, this can include partner deals with other businesses like Tesco Clubcard or Sky Smart Home. In such cases, FCA rules mandate offering renewal deals that match the price of the most commonly used channel, which may not necessarily be the cheapest.

A good example in this area was recently published by Mauring (2025), where she presents a static model also based on Stahl (1989). In contrast to my model, where firms cannot identify the type of consumers in the first period, she argues that firms can do so (e.g., by using browser cookies) with a certain probability and offer them different prices. In equilibrium, firms mix between a common price for all types of consumers and specific prices for shoppers but set a single discriminatory price for non-shoppers. Despite the absence of a price-walking pattern due to the lack of dynamics, such a pattern can be seen as a potential cause of the loyalty penalty or the penalty for trust. Future research in this direction, particularly if this setting can be extended to more than one period, might be fruitful in shedding light on the link between the loyalty penalty and price discrimination based on engagement.

This example shows that policymakers need to develop strategies that directly tackle the root cause of the loyalty penalty. It's important to implement policies that specifically target this issue, rather than relying on partial measures with reservations. Such superficial approaches can lead to unintended consequences or even encourage other discriminatory practices.

4.3 Price cap

Due to the nature of essential markets (especially in energy and telecommunications), regulators often consider price caps as a control tool [20]. Also, they appear to be the most obvious solution to protect vulnerable customers. Price caps could also be used to mitigate the loyalty penalty by limiting the maximal price raises. However, despite their apparent simplicity, price caps are a complex solution that requires careful consideration, especially during challenging times like the global pandemic, energy crisis, and geopolitical instability. For example, imposing price caps in the energy sector during the energy crisis eliminated competition between firms, leaving consumers better off with a strategy of 'doing nothing' rather than engaging.

When implementing a price cap, regulators typically ensure that firms can still invest, improve efficiency, compete effectively, and maintain incentives for customers to shop around and switch if necessary. For instance, Ofgem mandates that the cap must "reflect an efficient level of costs and enable suppliers to compete and maintain incentives for domestic customers to switch."(Ofgem, 2018*a*, p.1)

For instance, Ofgem uses several main approaches to estimate an efficient level of costs to set the initial price cap, as summarised in Figure 4.5.

Estimating the efficient level of cost is quite challenging task, therefore regulators use 'price versus cost' benchmark (an arrow at the top of the diagram).

The first approach involves linking the allowance for costs to a basket of com-

[20]The nature of essential products imply that consumers cannot simply exit the market and avoid purchases, such as parking their cars or stopping heating their homes. For instance, in 2022, the increase in fuel prices led to riots in France and Italy. Therefore, policymakers should be cautious and maintain control.

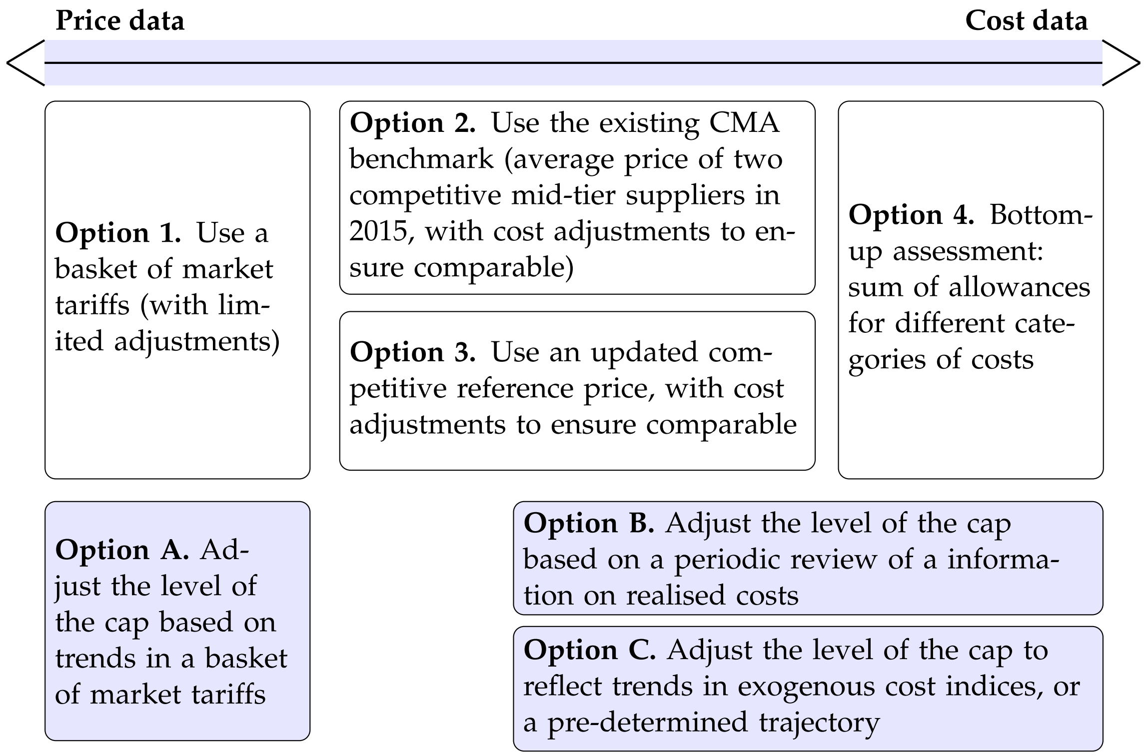


Figure 4.5: Approach to design the price cap. Options 1-4 are for setting initial price cap. Options A-C in shaded blocks are for subsequent adjustment. Source Ofgem 2018a

petitive market tariffs, potentially excluding the smallest suppliers. The second method uses the existing safeguard tariff benchmark, based on the average prices of two mid-tier suppliers from 2015, with adjustments made for market differences. The third - suggests updating the competitive reference price by recalculating it using average prices from select competitive suppliers, adjusted for comparability. Lastly, a bottom-up cost assessment could be used, where each cost element is estimated and summed to form the overall benchmark (Ofgem, 2018*a*).

For example, the price cap on default deals during the energy crisis was set as a temporary measure, intended to end by 2023. Recognising that some households, particularly those that are vulnerable, may continue to struggle with market engagement, Ofgem is considering maintaining price protection for these groups even after the wider price cap is withdrawn. This underscores the ongoing need for protections to ensure fairness and accessibility in a competitive energy market (Ofgem, 2024).

Price caps are usually set as temporary measures for several reasons. They allow time for market adjustments without causing long-term supply and demand issues. Permanent caps could deter new entrants and stifle innovation, reducing competitiveness. In contrast, temporary caps balance immediate consumer protection with the goal of fostering a competitive market, that can eventually offer better services and prices without regulatory intervention. By setting caps temporarily, regulators encourage firms to improve efficiency and customer service.[21] Temporary measures also prompt both consumers and suppliers to adapt to market conditions more actively. This reduces reliance on prolonged governmental intervention (Ofgem, 2018*a*,*c*).

The policy examples outline mechanisms to protect individuals on standard variable or 'default' tariffs, ensuring fair prices. Governed by the Domestic Gas and Electricity (Tariff Cap) Act 2018, the energy price cap reflects fair pricing that covers the costs of supplying energy, including customer service improvements. The cap adjusts based on underlying costs, rising to allow suppliers to recover increased costs and falling when costs decrease, aiming to minimise the risk of supplier insolvency.

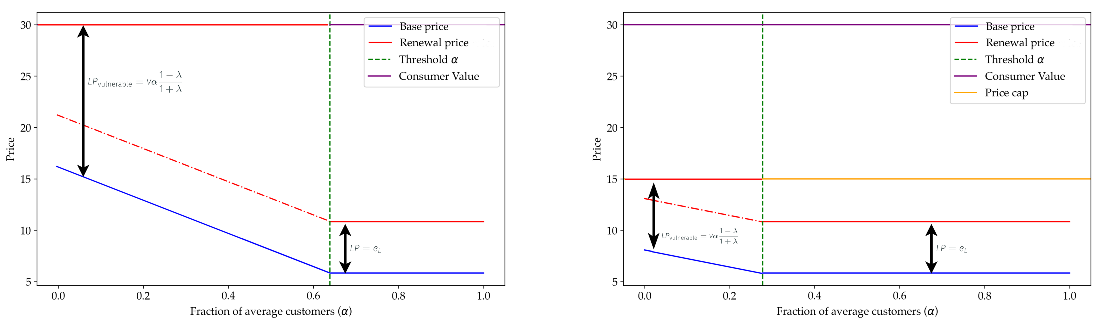
Implemented on 1 January 2019, the cap is reviewed and adjusted quarterly - in January, April, July, and October. Announcements are made about a month before each new cap period. Adjustments consider changes in costs and cap design, potentially altering the calculation methods used. When significant changes are proposed, feedback is solicited from interested parties to inform policy decisions. The policy usually provides guidance for each sector on the components of all price cap levels. In the energy sector, for households, it details typical cap

[21] In a sense to simulate the competition, sending firms the signal that they cannot rely on indefinitely high prices.

levels, including standing charges, though actual rates vary by location, payment method, and meter type (Ofgem, 2024).

Regulators typically require all firms to apply the price cap uniformly, without exceptions for specific companies. This sets a fixed maximum amount that any firm can charge a customer on a standard tariff. The cap ensures a strict limit on prices, preventing overcharging. Uniform application is essential to provide equal protection for all customers, especially those who are less active in the market, ensuring everyone receives the same level of price protection.

I demonstrate the application, which is quite straightforward, of a price cap to the model of the loyalty penalty developed in chapter three with three types of consumers. Suppose that the regulator, in order to decrease potential price hikes, regulates the maximum price firms can charge customers. In such a case, the price cap would be set below consumer valuation v, as demonstrated in Figure 4.6 (b).



(a) The loyalty penalty before price cap (b) The loyalty penalty after price cap

Figure 4.6: The effect on placing a price cap to protect vulnerable consumers

This measure would not completely eliminate the loyalty penalty and would not affect the market at all when there are sufficient proportions of savvy-shoppers and average shoppers, as the loyalty penalty for vulnerable customers would be the same as for the average customers. However, when firms find it profitable to abandon the average customers and condition their prices based on vulnerable customers, this measure would significantly decrease the loyalty penalty paid by them.

Such a policy would affect the necessary 'critical mass' of average customers (Type L) in order for a firm to make a decision on its pricing strategy, which is represented by the threshold value $\tilde{\alpha} = 1 - \frac{\bar{p}_L}{\bar{p}_H}$. This intuition is illustrated in Figure 4.6. Suppose that the actual proportion of average customers is $\alpha = 0.4$, the proportion of savvy-shoppers is $\lambda = 0.3$, and the low engagement cost is $e_L = 5$. In this case, the base price is $p_1 = 9.69$, the renewal price is $p_2 = 30$, and the loyalty penalty is $LP = 20.31$; however, only vulnerable customers are affected by it. After the policy is implemented, the base price becomes $p_1 = 5.83$, the renewal price is $p_2 = 10.83$, and the loyalty penalty becomes $LP = 5$. In this case, the loyalty penalty affects all non-shoppers - both average and vulnerable. And the average price for Type L customers is $p_{\text{average}} = 10.26$. It is evident that, for this set of parameters, the price cap makes all types of consumers better off.

Although implementing price caps may impose the loyalty penalty on average consumers, the average consumers would pay the exact engagement cost in the presence of a higher base price, obtaining a consumer surplus of $CS_{\text{Type L}} = 35.62$ in situations where firms condition their base price on vulnerable consumers. Therefore, the price caps can make them better off, even if they become subject to the loyalty penalty, as they can obtain a greater surplus of $CS_{\text{Type L}} = 43.34$.

4.4 Social tariffs and auto-switching

Another remedy to protect customers from the price rises and consequently from the loyalty penalty used by regulators are social tariffs. These are generally defined as acceptable cheaper tariffs for certain groups of customers. However, most of the time they are on a voluntary basis, which means their implementation relies on the willingness of firms to participate [22]. Consequently, questions often

[22] Ofcom (2023) *Ofcom response to the House of Lords* Available at: https://committees.parliament.uk/publications/41616/documents/206811/default/ (Accessed: May 14, 2025).

arise about how to fund such initiatives. For instance, intense debates are ongoing regarding energy social tariffs [23].

For example, in 2018 the UK's energy regulator, Ofgem, has introduced temporary social tariffs for energy[24], ensuring that vulnerable and fuel poor customers - those who spend over 10% of their income on energy - receive equitable access to the most affordable energy deals. This regulatory enhancement mandated that social tariffs must match the lowest tariff available in a customers area, including online offers, thus promising the best possible rates for those who struggle the most to pay their energy bills (Ofgem, 2018*b*).

Such social tariffs should be at least comparable to the direct debit tariffs offered by suppliers, which may not always have been the most cost-effective options available. However, usually these tariffs needed to be as competitive as the lowest available tariffs, ensuring they are genuinely beneficial to the intended recipients.

Ofgem's refined definition of social tariffs also stipulated that these must be distinct from other support measures like the Warm Home Discount and the Default Tariff Price Cap, as these serve different purposes and are not to be conflated with social tariffs. A crucial aspect of the guidelines was that they required universal adoption across all suppliers, ensuring no eligible consumer is disadvantaged by their choice of provider. The focus was particularly directed towards aiding low-income and vulnerable households, especially those utilising prepayment meters, who are often at a disadvantage in the market.

Additionally, to efficiently target and assist the most vulnerable, Ofgem proposed that social tariffs should automatically enrol eligible consumers, leveraging existing customer data from suppliers or through data-sharing initiatives with the Department for Work and Pensions (DWP).

[23] Parliament Debates (2023) *Energy Social Tariffs* Available at: https://hansard.parliament.uk/Commons/2023-11-23/debates/EC36E16E-A09D-42C1-A3C5-88C30FAC2A0D/EnergySocialTariffs (Accessed: May 14, 2025).

[24] Currently, the social tariffs for energy are phased out.

Reflecting on earlier initiatives, the concept of a social tariff is not novel. In the 2000s, it was introduced on a voluntary basis as a government effort to shield the poorest consumers from escalating fuel prices without heavy market intervention or significant public expenditure. However, this approach met with limited success due to poor targeting and the voluntary nature of the program, which led to inconsistent benefits across the consumer base (Ofgem, 2018*b*).

The voluntary social tariff eventually gave way to the Warm Home Discount scheme in 2011, a legislated initiative providing a yearly £150 rebate to low-income households, set to continue until 2026. This scheme has significantly improved targeting and support consistency compared to its predecessor (Ofgem, 2022).

A similar incentive was proposed by Ofcom. They suggest that telecom firms should provide the cheapest available deals to their eligible customers (e.g., credit union members). These voluntary social tariffs aim to protect the most vulnerable customers from price hikes, penalty fees for early termination, and ensure cost-free switching (Ofcom, 2024).

Nevertheless, such initiatives still have a low impact. According to Uswitch.com, only two-thirds of the most vulnerable individuals are aware of the existence of these tariffs, and only one percent of those currently receiving benefits and are eligible to sign up for the social tariff have done so.[25]

Our model explains why such initiatives have such a negligible effect. For instance, to obtain a social tariff from BT, the customer must call the company's hotline and go through an eligibility check, which includes providing information about current government benefits and undergoing a credit score check[26]. At the end of the period, the customer must call again and go through the eligibility assessment once more to get the deal in the subsequent period. It is no wonder

[25]Uswitch (2024) *Broadband social tariff deals how to get low income broadband on universal credit* Available at: https://www.uswitch.com/broadband/guides/broadband-deals-for-low-income-families/ (Accessed: May 14, 2025).

[26]BT (2024) *Home Essentials Stay connected with our low-cost broadband and phone plans.* Available at: https://www.bt.com/broadband/home-essentials (Accessed: May 14, 2025).

that the most vulnerable customers do not take advantage of such opportunities because social tariffs have a high engagement cost, perhaps even higher than engaging normally in the market. As such, the vulnerable are unlikely to engage and on this basis firm behaviour will not change.

For example, a simple comparison between tariffs on a price comparison website reveals that a regular customer who shops around could find a better deal than a customer trying to get a social tariff from BT without going through the hassle of eligibility check. For example, the BT Essential Fibre 2 social broadband tariff with an average speed of 67 Mbps costs £24, whereas Pop Telecom offers a similar deal for everyone at £23.34. (See Figure 4.7).

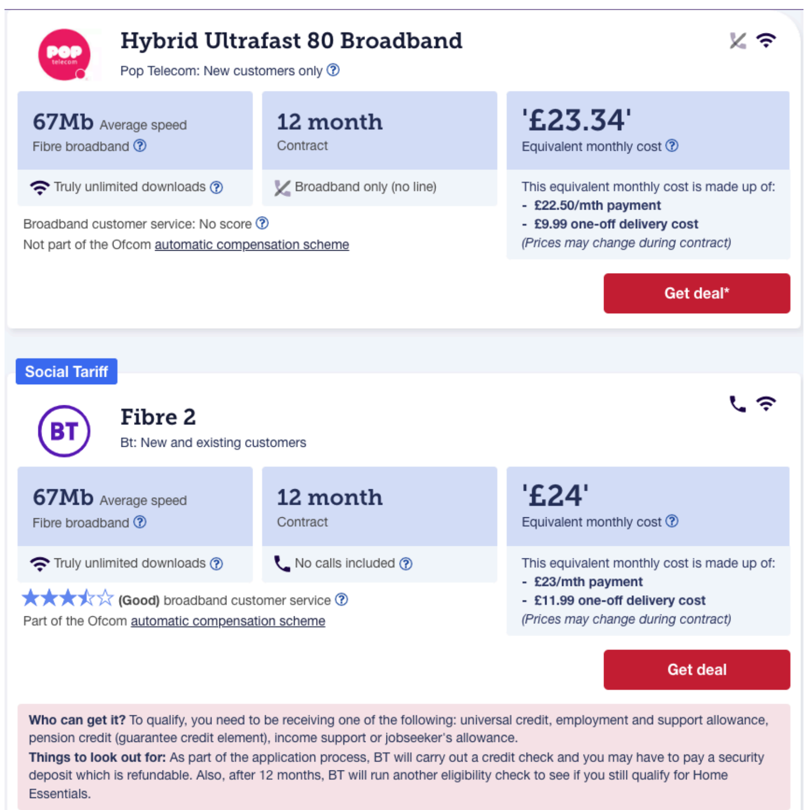


Figure 4.7: Broadband tariffs comparison. Source: moneysavingexpert.com

The best regulatory policies should aim to simulate or substitute for a lack of competition rather than 'manually' manage the market. Therefore, when considering potential policy remedies related to offering vulnerable customers low-cost tariffs through the lens of the loyalty penalty model, the regulator must craft policies that eliminate or substantially decrease the engagement costs. On firms level[27] in can be made through a data-sharing initiative. Firms should disclose information about those who never switch, allowing other firms to compete for these customers stimulating the competition for the market through auto-switching services. One example of such services operating in the UK is Switch Craft.[28]. These services use sophisticated algorithms to monitor the market and offer the best deals, automatically switching customers at the end of their contracts. Currently, such services are enhanced with AI tools and work with firms that pay a commission fee to acquire new customers. Interestingly, even when auto-switching platforms charge a small fee to customers, as discussed in a recent paper by Garrod et al. (2023), who is the first to explicitly examine such platforms, consumers still benefit from them. The study presents an intriguing finding: despite serving only a fraction of consumers who pay the fee, the presence of these services benefits all consumers.

To illustrate this consider the model of the loyalty penalty with three types of consumers. Suppose that the consumer value of the product is $v = 30$, engagement cost is $e = 10$, 30 per cent ($\lambda = 0.3$) of customers are savvy shoppers (Type 0), and the rest 70 per cent ($1 - \lambda = 0.7$), are non-shoppers, 80 per cent of whom are average customers (Type L), with the remaining 20 per cent being vulnerable. This means that the market consists of the following fractions: Type 0 - 30 per cent, Type L - 56 per cent, and Type H - 14 per cent. In such a case, the prices in the first and the second periods, the consumer surplus of non-shoppers, and total producer surplus will be as follows:

[27] On consumer level it can be done through the education, which I address in the subsequent section of this chapter.

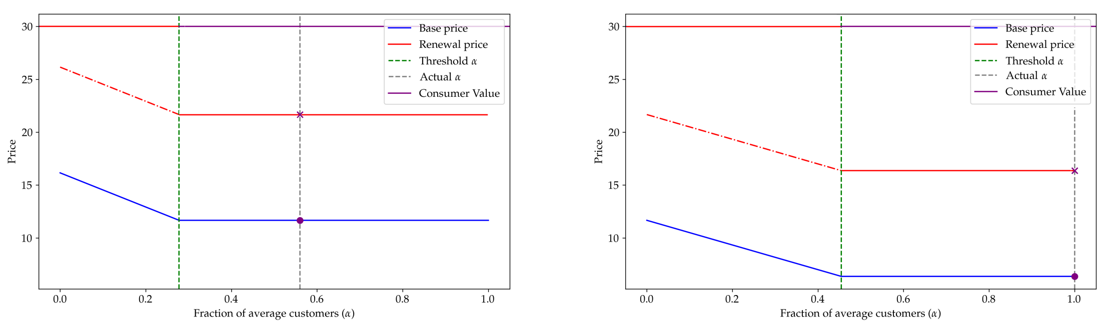
[28] Switch Craft (2024) *Switching made easy* Available at: https://www.switchcraft.co.uk/ (Accessed: May 14, 2025)

λ	α	$\tilde{p}_L$	$\bar{p}_L$	v	LP	CS Type L	TPS
0.30	0.56	11.67	21.67	30	10	26.67	30.33

Suppose, that due to data-sharing initiative firms compete for those 14 per cent of Type H customers offering them the similar prices as for savvy-shoppers. In such a case, the prices in the first and the second periods, the consumer surplus of non-shoppers, and total producer surplus will be as follows:

λ	α	$\tilde{p}_L$	$\bar{p}_L$	v	LP	CS Type L	TPS
0.44	1.00	6.36	16.36	30	10	37.28	18.33

Note that Type H customers become informed and therefore are treated as savvy shoppers (increase in the value of λ). The remaining non-shoppers are average customers ($\alpha = 1$) who still suffer from the same loyalty penalty between periods but are able to save more consumer surplus over two periods due to lower base and renewal prices.



(a) The prices at Type 0 $= 0.3$, Type L $= 0.56$, Type H $= 0.14$

(b) The prices at Type 0 $= 0.44$, Type L $= 1.00$

Figure 4.8: The effect from applying auto-switching to protect vulnerable consumers.

Figure 4.8 illustrates the change in prices. The solid blue line represents base prices, with a purple round marker indicating the actual base price for the given parameter values. The solid red line represents renewal prices, with a purple cross marker indicating the actual renewal price for the given parameter values. The green dashed line represents the threshold value for average consumers, while the grey dashed line represents the actual proportion of average consumers for the given parameter values.

Increasing the fraction of consumers who become informed makes firms fiercely compete for them, which drives the base price down. Thus firms would be better off not to do disclose information about their social tariffs with other firms or auto-switching platforms, but to ensure engagement costs are high to avoid the Type H customers becoming informed.[29] From the firm's perspective, social tariffs prevent them from exploiting a larger share of non-shoppers, thereby decreasing producer surplus. This means that firms may be willing to increase engagement costs for customers, which can be done through a complicated process of checking eligibility and credit scores. However, small or new companies that are in the user acquisition stage could find it beneficial and it can be fruitful direction for the further research.

This scenario illustrates that the policy which is aiming to enhances competitive incentives by requiring the disclosure of information even with the presence of the loyalty penalty, can yield better outcomes. The challenge for policymakers is to design social tariff schemes that balance the need to protect vulnerable consumers with the preservation of market incentives for active shoppers. Therefore, the introduction of effective social tariffs requires careful consideration.

4.5 Educating consumers

A more nuanced approach to tackle the loyalty penalty could include measures to support and educate consumers, encouraging an environment where informed decision-making is common and the market is accessible and just for ev-

[29] For instance, like in the model of obfuscation by Ellison and Wolitzky (2012) discussed in the first chapter.

eryone. In other words, regulators should focus on lowering consumer engagement costs and encouraging more active participation in the market.

Currently, there are various education initiatives offered by regulators and competition authorities in order to significantly increase consumer engagement in the marketplace while simultaneously reducing the costs associated with searching for information and making informed decisions. These initiatives aim to improve consumer knowledge, enhance financial literacy, and ensure that consumers can make informed decisions in an increasingly complex marketplace.

When consumers are better educated about their rights, available products, and market conditions, they are more likely to engage actively. For example, the recent European Commission report provides a comprehensive study on consumer education initiatives in EU member states (European Commission, 2024). This report suggests differentiating consumer education from other concepts such as consumer information, consumer advice, and consumer awareness. It defines consumer education as *"measures that aim to provide consumers with the knowledge, skills, and understanding they need to participate effectively in the market economy"* (European Commission, 2024, p.15). This includes offline and online workshops, such as conferences, forums, webinars, direct mails, nudging notifications, etc. The report argues that improving consumer information alone is not sufficient, as consumers must possess specific skills to use this information effectively. While consumer advice can be helpful in certain situations, it can be challenging to guide consumers continuously. Therefore, education is key to cultivating independence and confidence among consumers in the complex environment of the modern digital era. The desired outcome is to enhance consumer awareness, helping them become savvy and discerning shoppers.

The report highlights that while all consumers need education on consumer topics, certain groups require more attention or specialised education. The consumers in specific socio-demographic groups are often more vulnerable and require tailored educational approaches. It indicates that diverse consumer needs are influenced by factors like age, financial situation, educational level, and digital skills. Stakeholders agree that the elderly, young people (children and teenagers), and those living in remote or rural areas are particularly in need of education (See Figure 4.9).

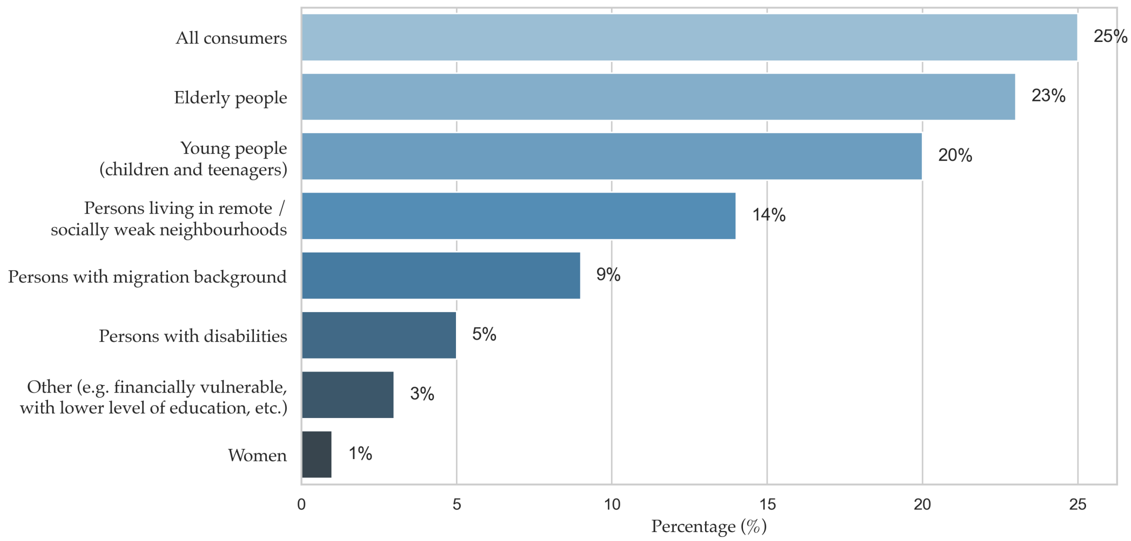


Figure 4.9: Stakeholder survey - multiple answer question (n = 511 responses). Question: In your experience, who are the consumer groups that are most in need of consumer education initiatives? Source: (European Commission, 2024)

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The overall conclusion of the survey showed that about half of the screened initiatives target the general public, with a quarter focusing on younger consumers (European Commission, 2024, p.74). However, groups such as the financially fragile, persons with disabilities, migrants, and the elderly are less frequently targeted, leading to gaps in available educational activities.

In the UK, the main provider of consumer education is Citizens Advice Bureau[30]. They offer numerous educational resources and activity packs that help consumers navigate complex markets.

The FCA has been proactive in rolling out initiatives aimed at improving fi-

[30]Citizen Advice (2024) *Consumer education* Available at: https://www.citizensadvice.org.uk/about-us/information/consumer-education/ (Accessed: May 14, 2025).

nancial literacy among consumers. The goal is to ensure that individuals are well-informed about their financial rights and the regulatory changes that affect them. For instance, the FCAs Regulatory Initiatives Grid[31] outlines ongoing projects that target consumer protection and education, helping consumers navigate the complexities of financial products and services more effectively.

Effective consumer education builds trust in the market. When consumers feel they have the knowledge to understand financial products or digital services, they are more likely to engage with those services. The FCA's initiatives in the UK aim to build this trust by educating consumers about their financial rights and the changes in regulations, which can reduce hesitation and increase participation in financial markets.

Ofcom has been proactive in addressing digital inclusion and literacy, particularly as the UKs communications landscape becomes increasingly digital. They periodically launch campaigns and call for inputs from stakeholders to improve digital literacy, ensuring that vulnerable groups like the elderly, low-income households, and those living in rural areas have access to affordable broadband and the skills to use digital services effectively. Ofcom's initiatives provide information to help consumers switch providers, find better deals, and understand their rights, which is crucial for those who may feel overwhelmed by complex contracts or technology.[32]

Ofgem has also focused on improving energy literacy among consumers. Through various partnerships with consumer groups and charities, Ofgem supports initiatives that educate consumers about their energy usage, bills, and how to switch providers. This is particularly important for older adults, low-income households, and non-English speakers who may find the energy market difficult to navigate. Programs like the Energy Best Deal, run in collaboration with Cit-

[31] FCA (2023) *Regulatory Initiatives Grid* Available at: https://www.fca.org.uk/publication/corporate/regulatory-initiatives-grid-nov-2023.pdf (Accessed: May 14, 2025).

[32] Ofcom (2017) *Call for inputs: Helping consumers to engage in communications markets* Available at: ttps://www.ofcom.org.uk/phones-and-broadband/switching-provider/helping-consumers-engage-communications-markets/ (Accessed: May 14, 2025).

izens Advice, aim to empower consumers with the knowledge to manage their energy costs effectively.[33]

Nevertheless, despite numerous initiatives, raising awareness and driving consumer participation in educational programs remain significant challenges. Most consumers in the EU (63%) have not participated in such initiatives in the past five years (European Commission, 2024). The difference in participation is also differs by age groups: in the same period only 26% of elderly consumers (over 65) have participated in such initiatives at least once, while 62% of younger consumers (aged 15 to 24) have engaged in at least once (See Figure 4.10). The lowest level of participation is notably lower among those living in rural areas and with lower levels of education.

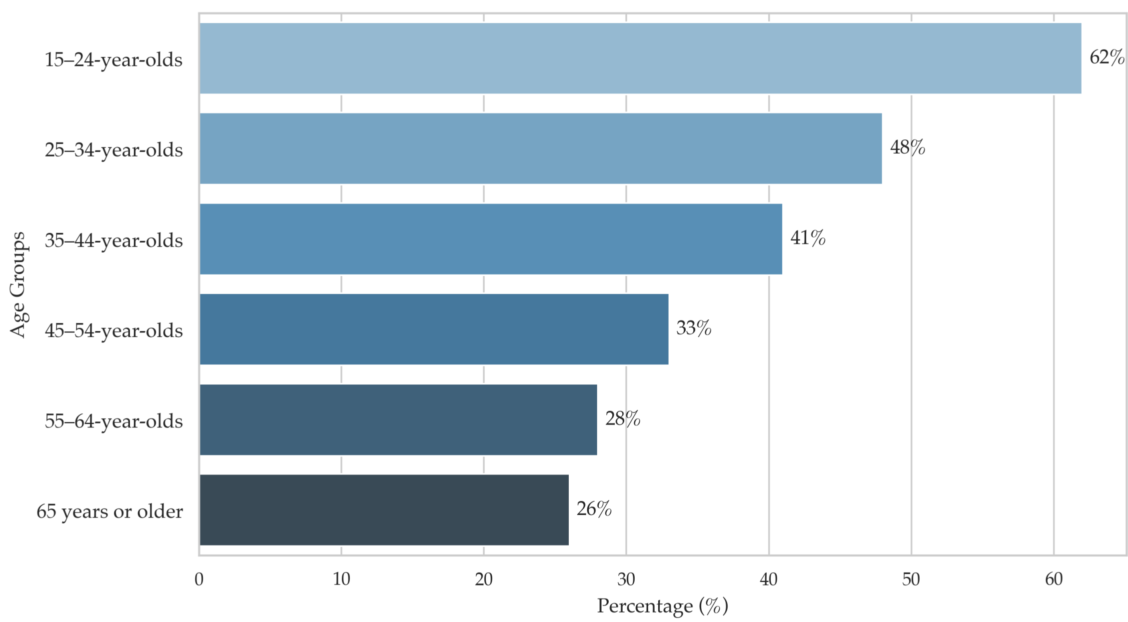

Figure 4.10: Age groups participation in the educational initiatives at least once in the past five years. Source: (European Commission, 2024)

[33]Citizen Advice (2018) *Energy Best Deal: A guide to help you understand energy and make savings* Available at: https://www.citizensadvice.org.uk/Global/Public/BESN%2018-19/Booklet%2018-19.pdf (Accessed: May 14, 2025).

Many consumers, especially those with higher education and digital skills, feel they do not need these initiatives, leading to an underestimation of consumer education's preventive value and only starting to participate when problems arise. Additionally, 22% of consumers did not know how to sign up, and 13% found it difficult to find clear information about available activities (See Figure 4.11). A further barrier is that many, particularly the elderly and those with low digital skills, do not know how to sign up for these educational programs.

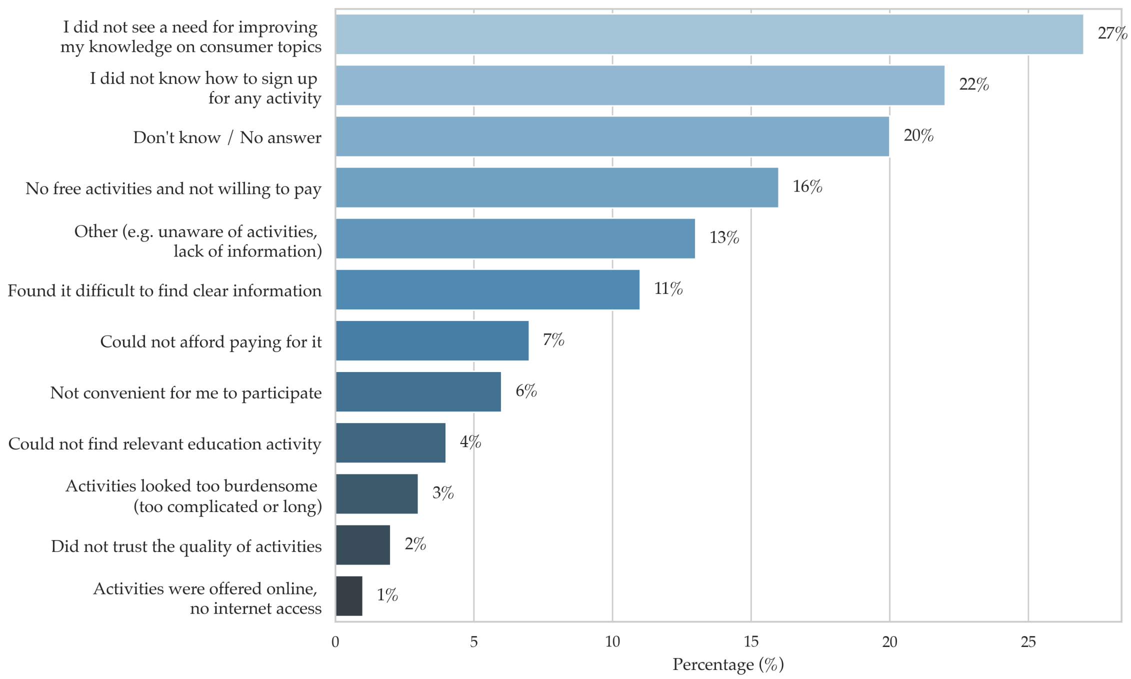

Figure 4.11: Reasons for not participating in consumer education activities. (n = 4,557 responses). Source: (European Commission, 2024)

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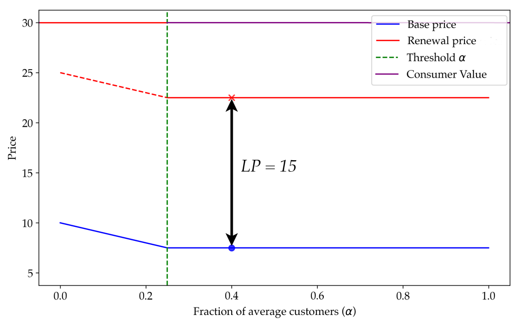
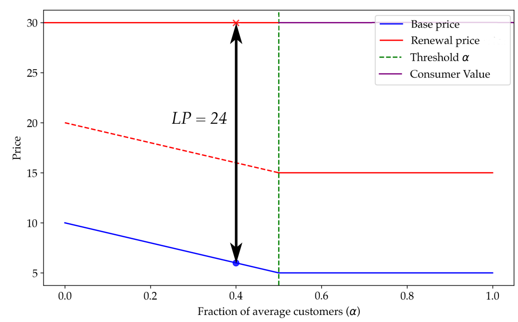
Our model can capture the types of issues and unexpected consequences that may arise if the level of participation among different groups varies and policy adjustments are made. To illustrate this, consider again the duopoly with three types of consumers. Suppose that 50% of consumers are savvy shoppers ($\lambda = 0.5$), 40% of non-shoppers are the average consumer ($\alpha = 0.4$) with an engagement cost of $e_L = 15$. With the value of all consumers set at $v = 30$, the equilibrium prices and the loyalty penalty will be:

e_L	λ	$\tilde{\alpha}$	$\tilde{p}$	$\bar{p}_L$	$\bar{p}_H = v$	LP
15	0.50	0.25	7.50	22.50	30	15

Notice that the threshold value of average consumers is $\tilde{\alpha} = 0.25$, which means that base price and renewal price are based on average consumers, and as a result all non-shoppers - both average and vulnerable - are subject to the same loyalty penalty of $LP = 15$ (see Figure 4.12 (a)).



(a) The prices at $\lambda = 0.5$, $e_L = 15$



(b) The prices at $\lambda = 0.5$, $e_L = 10$

Figure 4.12: The effect from the education of average customers

Now suppose that, due to educational initiatives, only the average consumers have lowered their engagement costs to $e_L = 10$. Then the equilibrium prices and the loyalty penalty will be:

e_L	λ	$\tilde{\alpha}$	$\tilde{p}$	$\bar{p}_L$	$\bar{p}_H = v$	LP
10	0.50	0.50	6.00	16.00	30	24

Notice that such a policy had an effect not only on the engagement costs of average consumers but also increased the threshold value of average consumers, which has now become $\tilde{\alpha} = 0.50$. As a result, the base price became lower for everyone ($\tilde{p} = 6.00$); however, due to the new threshold value, firms change their strategy and prefer to condition their pricing strategy on the vulnerable consumers, setting the renewal price at v. Now, the average consumers behave like savvy-shoppers and are able to find the cheapest price and switch in the second period, avoiding the loyalty penalty, while the vulnerable consumers became worse off. The loyalty penalty for them increased by 9, becoming $LP = 24$ (see Figure 4.12 (b)).

This illustrates that a one-size-fits-all approach to consumer education is not effective. Instead, tailored efforts and strategies are required to address the specific needs of each group. For example, younger consumers might benefit from digital literacy programs, while older consumers may need more traditional forms of education and support, including regulatory interventions. This highlights the importance of recognising these differences to ensure that all consumers can effectively participate in the market, regardless of their background or circumstances.

These efforts must ensure that vulnerable groups, who are most reluctant to engage in education, are not left behind in the evolving marketplace. The overarching goal is to balance educational initiatives and regulatory interventions to empower those consumers who are able to become active participants, engaging confidently and responsibly in the market, while protecting those who have a much lower propensity to do so.

4.6 Discussion on competition for the market

The loyalty penalty arises from consumers' lack of proactive engagement in markets. Many individuals - whether by choice or incapacity - do not actively seek the best deals. Consequently, they often pay more than necessary, especially after discounted periods or standard offers expire.

Moreover, the issue of 'choosing not to choose' is exacerbated by the complexity of markets, particularly digital ones. The current system allows retailers to offer both introductory and renewal offers, requiring consumers to engage and adding extra pressure to their already burdened lives amid economic instability and geopolitical concerns. This situation enables retailers to exploit consumers' disengagement by providing attractive initial deals, followed by expensive default tariffs once the initial contracts expire.

Regulators must address this issue not by simply banning the loyalty penalty - which can be a useful tool for price competition - but by focusing on educational initiatives alongside robust regulatory measures. One such measure could involve *competition for the market*, which differs from traditional *competition in the market* by partially shifting engagement costs from consumers to firms.[34] Below, I clarify how this approach could be applied in essential markets.

For instance, consider the energy market. A periodic auction could be held to select default suppliers, introducing a form of 'competition for the market'. This method could help reduce the high loyalty penalty, especially for vulnerable consumers, by limiting the choices they must make and ensuring that the default supplier offers a competitive deal (Klemperer, 1999; Milgrom, 2004).[35]

An auction-based default supplier selection could function as follows: every two to three years, an auction would determine which retailer offers the lowest margin over wholesale and network costs. This ensures that consumers on default tariffs receive the best possible deal without needing to search for or switch providers themselves.

Billing would be conducted under a neutral or 'vanilla' brand, and customer records would be fully portable at the end of the contract. This portability allows consumers to be approached by firms and switch easily at contract end, preventing lock-in effects and shifting some engagement burdens from consumers to

[34]For example, the 'competition for the market' approach is often discussed as a tool to regulate natural monopolies. See more here.

[35]Klemperer (1999) discusses how auction theory can be applied to competition policy, particularly in areas where the market does not automatically result in optimal competition, like utilities where consumers do not frequently switch providers. Milgrom (2004) elaborates on the efficiency of auctions in markets with information asymmetries, similar to retail energy markets where consumers often lack full knowledge of pricing structures.

firms (Stigler Center, 2019).[36]

While ’competition for the market’ ensures fair default options, ’competition in the market’ would still allow for innovation and value-added services. Other energy providers could differentiate themselves by offering tailored deals or additional services, such as energy management plans or community battery services. The loyalty penalty might persist but at a lower level, and the redistribution effect would be seen as a fairer practice, similar to widely accepted discounts for early bookings.

By encouraging retailers to bid for the lowest margin over wholesale costs, the auction system would reduce overall prices for consumers, especially those who do not actively seek the best deals. This system simplifies the market, making it easier for consumers to understand their options without navigating complex marketing tactics.

In other industries, such as telecommunications and insurance, where price caps or regulated default tariffs are less common, a commercially based ’competition for the market’ approach can still reduce the loyalty penalty and improve outcomes for consumers, particularly vulnerable ones who tend to remain disengaged.

One solution could involve auctioning group contracts. Instead of relying on providers to voluntarily offer the cheapest deals, regulators could require them to compete through auctions to provide the most competitive plans to specific customer segments or regions, depending on vulnerability conditions. By bidding to serve these at-risk groups for a set period, companies would be incentivised to offer lower prices and better terms for customers who don’t actively engage, with services provided under a neutral ’vanilla’ brand. This should be coupled with a less daunting eligibility verification process, achievable through data-sharing initiatives.

[36] The Stigler Center (2019) report discusses how increased data transparency could allow new entrants to better target disengaged consumers, thus reducing the loyalty penalty. This recommendation aligns with the idea of requiring firms to disclose information about long-term customers.

In both sectors, data-sharing and transparency can play a crucial role (Stigler Center, 2019). By mandating firms to disclose information on long-term customers after a certain period, competing companies can target these vulnerable consumers with competitive offers, allowing them to escape the loyalty penalty once they have benefited from an initial deal. As the model illustrates, for certain parameter values, the average price paid by non-shoppers can be lower over two periods. This would shift part of the engagement burden from consumers to providers, fostering a more competitive environment where firms actively compete for these consumers.

Additionally, supporting auto-switching platforms and automated comparison tools can further reduce engagement costs, making it easier for non-shoppers to stay on better deals.[37] This approach would preserve competitive incentives for firms, ensuring that even without regulated tariffs, market forces work to reduce the loyalty penalty and protect vulnerable consumers.

4.7 Conclusion

This chapter highlights the delicate balance regulators must strike between protecting consumers and maintaining market competitiveness. While it is essential to shield consumers from exploitative practices, policies must be carefully designed to avoid dampening firms' competitive drive, which could result in fewer discounts and less attractive offers.

An analysis of key regulatory policies in the UK market reveals that, despite good intentions, these efforts may not always achieve their desired outcomes. I analysed key regulatory policies using the models of the loyalty penalty developed in Chapter 2 and Chapter 3. The general model of the loyalty penalty developed in Chapter 2, due to its tractability, allowed me to examine the recent

[37]The rise of new comparison websites with auto-switching capabilities could decrease engagement costs, similar to what Brown and Goolsbee (2002) describe, providing empirical evidence that online comparison tools lower engagement costs for consumers and exert downward pressure on prices in the life insurance market.

policy implemented by the FCA, which intended to ban the loyalty penalty. As I demonstrated, such a policy did not fully address the issue, as the interfirm loyalty penalty persists; moreover, on average, prices became higher. Additionally, the policy's reservation about different channels leaves a gap for firms to implement price discrimination akin to the interfirm loyalty penalty. The persistence of the loyalty penalty, even after its ban, illustrates the complexity of the issue and the gap between regulatory objectives and actual market behaviour. This suggests that policies need continuous review and adjustment to better align with real-world conditions.

Using the model with three types of consumers developed in Chapter 3, I analysed more fine-tuned policy measures intended to protect vulnerable groups of consumers. Firstly, I examined the implementation of price caps, particularly in essential markets such as energy and telecommunications, underscoring their importance in preventing excessive pricing. Though simple in concept, price caps are crucial for ensuring affordability and protecting consumers. They help balance firms' pricing strategies with the financial viability of consumers, shielding them from excessive loyalty penalties while contributing to overall market stability and competitiveness.

Secondly, the low uptake of social tariffs, with only one percent of eligible customers taking advantage of them, reveals why this initiative has struggled to protect consumers. This is largely due to a lack of engagement, driven by the high engagement costs of participation, such as the hassle of applying and undergoing eligibility checks. A more effective policy could be one that enhances engagement - for instance, by automatically switching the most vulnerable consumers to the cheapest available tariffs through special services where firms compete for this segment of customers.

Thirdly, efforts to educate consumers must ensure that vulnerable groups, who are often reluctant to engage in educational initiatives, are not left behind in the evolving marketplace. The noble goal of consumer education could inadvertently raise the loyalty penalty for certain groups if not carefully designed and implemented.

Finally, the potential remedy known as ’competition for the market’ has been discussed, implying that effective regulatory interventions require a nuanced understanding of market outcomes and a careful balance between consumer protection and competitive incentives.

Chapter 5

Thesis conclusion

The loyalty penalty remains persistent across essential markets. While some consumers benefit from competitive pricing, it disproportionately affects vulnerable individuals. In 2018, in response to a super-complaint, the CMA suggested that regulators should tackle the loyalty penalty in five essential markets. Although some progress has been made, many potential fixes remain at the consultation stage, with some yet to even reach that point. Isolated examples of providers taking action are insufficient to address this systemic issue. Past efforts to address the problem have largely failed due to incomplete solutions. Thus, this thesis provided theoretical grounds to understand and address the loyalty penalty more effectively.

In the first chapter, the context for the loyalty penalty is introduced, and the academic literature is reviewed, highlighting gaps in current research. The chapter outlined key concepts related to the loyalty penalty, preparing the reader for the complexities discussed in the following chapters.

The second chapter explained the nature of the loyalty penalty by constructing an explicit economic model, drawing on theories from Industrial Organisation. It examined how firms interact with consumers in a duopoly market over two periods, dividing consumers into two groups: 'shoppers', who actively engage with market, and 'non-shoppers', who do not engage. The analysis showed that firms can exploit non-shoppers lack of engagement by raising renewal prices in the second period. Unlike static mixed-strategy models, this novel result demonstrated that firms prefer pure strategies, leading to the loyalty penalty.

The third chapter extended this analysis by focusing on consumer vulnerability. The model categorised consumers into three types: 'average' consumers, who have low engagement costs; 'vulnerable' consumers, with high engagement costs; and 'savvy shoppers', who face no engagement costs. This refined model explored how the loyalty penalty may disproportionately impact vulnerable consumers, as firms adjust their pricing strategies based on the proportion of each consumer type. A key finding is that when firms identify a critical mass of vulnerable consumers, they increase prices for this group. Additionally, the chapter highlighted that vulnerable consumers not only suffer the most from the loyalty penalty but also create a negative externality for others by driving up overall prices. This insight underscored the need for additional protection for vulnerable groups.

The final chapter discussed potential regulatory and policy solutions to mitigate the loyalty penalty, building on the models developed in earlier chapters. Several policies implemented by regulators, such as Ofcom, Ofgem, and the Financial Conduct Authority, are examined.

First, the ban on the loyalty penalty, which prohibits firms from charging existing customers more than new ones, is analysed. While this policy prevents 'intrafirm' loyalty penalty, it does not eliminate 'interfirm' penalty. Also, it leads to higher average prices. Second, it evaluated price caps, which limit the maximum price firms can charge. While these caps do not completely eliminate the loyalty penalty, they help protect vulnerable consumers from excessive loyalty penalty and maintain affordability. This balance shields consumers while also preserving market competitiveness. Third, it discussed voluntary social tariffs proposed by regulators, which encourage firms to offer their lowest prices to vulnerable consumers. Despite these efforts, only 1% of eligible customers take advantage of social tariffs. It showed that this low uptake is likely due to high engagement costs, as firms often complicate the qualification process. This means that policies should focus on reducing these engagement barriers by encouraging data-sharing initiatives and automatic switching services to help customers access the best tariffs more easily. Fourth, it reviewed educational initiatives aimed at increase consumers engagement with the market. It cautions against a one-size-fits-all approach, as this could unintentionally increase the loyalty penalty for certain groups. Instead, it recommends tailored educational efforts that address the specific needs of different consumer groups. Fifth, a potential remedy in a form of 'competition for the market' has been discussed, concluding that regulators must carefully design policies that balance consumer protection with maintaining competitive market incentives.

This was one of the first attempts to explicitly model the loyalty penalty through the prism of microeconomic theory. Despite these contributions, significant scope remains for future research to deepen our understanding of the loyalty penalty and develop more effective solutions. One promising direction is to incorporate endogenous engagement costs and behavioural aspects into the analysis. Behavioural economics suggests that consumers do not always act rationally due to biases and heuristics, such as inertia, status quo bias, and limited attention. Understanding how these behavioural factors contribute to consumer disengagement could help in designing interventions that more effectively reduce the loyalty penalty. For instance, 'nudges' that simplify decision-making or highlight the costs of inaction might encourage more consumers to engage with the market.

Experimental design, similar to the work conducted by Byrne et al. (2022), offers another avenue for future research. Controlled experiments in the field can test how consumers respond to different policy interventions or market conditions. Such experiments can provide empirical evidence on the effectiveness of various strategies, such as bargaining, renegotiating, automatic switching services or simplified tariff structures, in reducing the loyalty penalty. By observing actual consumer behaviour in response to experimental manipulations, researchers can refine theoretical models and inform policy recommendations with greater precision.

Furthermore, exploring the role of auctions in 'competition for the market' presents an interesting area for further study. Designing effective auction mechanisms that encourage firms to bid competitively for the right to serve disengaged consumers could lead to better outcomes. Research could focus on the optimal design of these auctions, considering factors like auction format, frequency, and the incentives for firms to innovate and maintain service quality. Additionally, studying how auctions interact with existing market dynamics and regulatory frameworks would provide valuable insights for policymakers considering this approach.

11 March 2025

Appendix A

Proofs from Chapter 3

A.1 Firms' strategy

Proof of Lemma 3.2.1. The proof of this lemma consists of the following steps:

Step 1: I identify a threshold value of average consumers, $\tilde{\alpha}$, used by the firm that was undercut in the first period. This threshold value informs its strategy in the second period – whether to set the renewal price at $\bar{p}_L$ (Case (a)) or at $\bar{p}_H$ (Case (b)).

Step 2: I analyse the continuation strategies of an undercutting firm and identify three potential continuation strategies in both cases.

Step 3: I analyse Case (a) to identify the continuation strategies of the undercutting firms and find that the undercutting firm also uses $\tilde{\alpha}$ to make decisions about its continuation strategies and a base price.

Step 4: Similar analysis as in Step 3 but for Case (b).

Step 1:

Claim 1. *Consider a two-period game where all three types of consumers are present ($\lambda \in (0,1)$ and $\alpha \in (0,1)$), and two firms (i and j) play a pure strategy by setting the base price $p_1^{i(j)}$ in the first period. Suppose one firm decides to undercut this price by setting $p_1^{j(i)} < p_1^{i(j)}$. Then there exists a threshold value, denoted $\tilde{\alpha}$, of Type L consumers, which determines whether* ***the higher-priced firm*** *will increase its price to $\bar{p}_L$ or $\bar{p}_H$ in the second period after being undercut. This threshold satisfies:*

$$\tilde{\alpha} = 1 - \frac{\bar{p}_L}{\bar{p}_H}$$

The choice of strategy depends on the following:

(i) If $\alpha > \tilde{\alpha}$, set the renewal price at $\bar{p}_L$;

(ii) If $\alpha < \tilde{\alpha}$, set the renewal price at $\bar{p}_H$;

(iii) If $\alpha = \tilde{\alpha}$, the firm is indifferent, in which case we assume the tie-breaking rule is the firm sets $\bar{p}_H$

Proof. Suppose Firm j was undercut by Firm i in the first period. As a result, in the first period, Firm j serves only its Type L and Type H customers. Anticipating that its rival can set the renewal price to retain savvy shoppers, Firm j must decide between two options: setting the renewal price at $\bar{p}_L$ (since any price below $\bar{p}_L$ would result in a lower payoff), yielding a payoff:

$$\begin{aligned}\pi &= \underbrace{p_1^j \left[\frac{\alpha(1-\lambda)}{2} + \frac{(1-\alpha)(1-\lambda)}{2} \right]}_{\text{payoff in the first period}} + \underbrace{\bar{p}_L \frac{1-\lambda}{2}}_{\text{payoff in the second period}} \\ &= p_1^j \frac{1-\lambda}{2} + \bar{p}_L \frac{1-\lambda}{2}\end{aligned}$$

or setting the price at $\bar{p}_H$, which leads to the loss of Type L customers and yields a payoff:

$$\pi = \underbrace{p_1^j \left[\frac{\alpha(1-\lambda)}{2} + \frac{(1-\alpha)(1-\lambda)}{2} \right]}_{\text{payoff in the first period}} + \underbrace{\bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2}}_{\text{payoff in the second period}}$$
$$= p_1^j \frac{1-\lambda}{2} + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2}$$

By equating these payoffs I obtain a threshold value of average consumers in the market, denoted as $\tilde{\alpha}$, when Firm j becomes indifferent between these two options:

$$p_1^j \frac{1-\lambda}{2} + \bar{p}_L \frac{1-\lambda}{2} = p_1^j \frac{1-\lambda}{2} + \bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2}$$
$$\tilde{\alpha} = 1 - \frac{\bar{p}_L}{\bar{p}_H}$$

This threshold value implies that if $\alpha > \tilde{\alpha}$, the firm will set the renewal price at $\bar{p}_L$; and if $\alpha < \tilde{\alpha}$, the firm will set the renewal price at $\bar{p}_H$. □

The Figure A.1 illustrates the main logic of such a thought experiment. Firm i decides to deviate and undercut its rival by setting the first-period price[1] $p_1^i < p_1^j$ to attract all savvy-shoppers. Then Firm j makes a decision about its renewal price in the second period (see also Figure A.2).

[1] Assume that in the first period, firms cannot offer different prices; therefore, they try to attract all types of consumers by setting the price below $\bar{p}_L$.

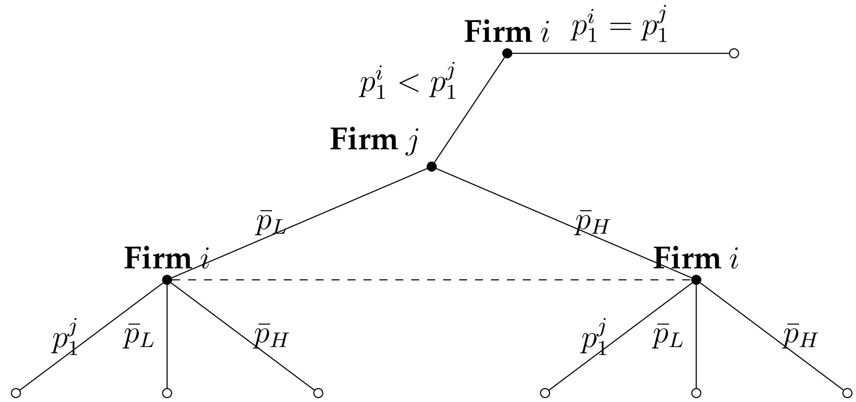


Figure A.1: Hypothetical undercutting game: Firm i deviates by undercutting Firm j in the first period. Then anticipating a Firm j's response in the second period decides to either the match its base price or increase up to a certain reservation price

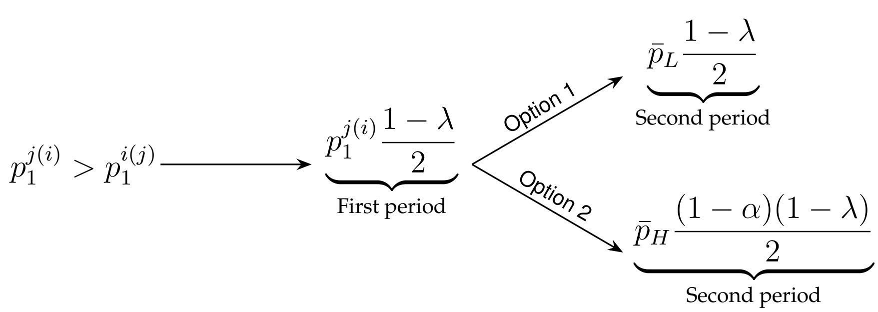


Figure A.2: Payoffs of a firm which has been undercut. Such a firm has two options in the second period: Option 1 - set the renewal price at $\bar{p}_L$; Option 2 - set the renewal price at $\bar{p}_H$. By equating payoffs from both options it is possible to obtain a threshold value of a parameter α, when such a firm becomes indifferent which option to choose.

Step 2:

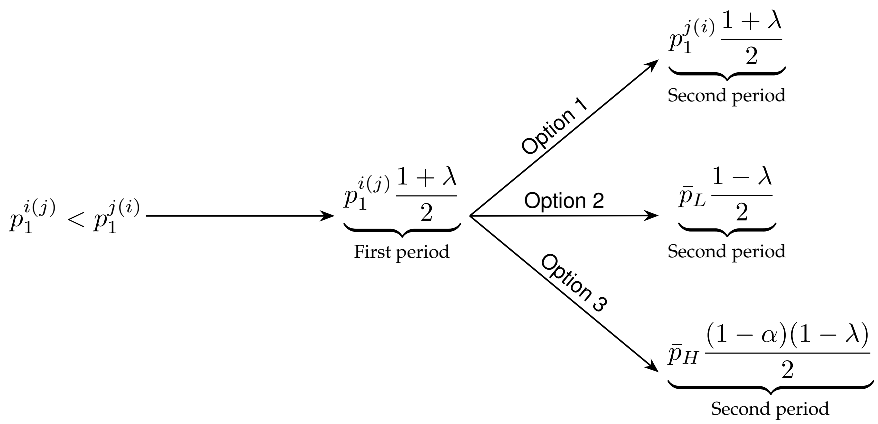
The undercutting firm (Firm i) anticipating the continuation strategy of Firm j must make a decision about its renewal price by choosing one of the options (Figure A.3):

Option 1: Match Firm j's base price to keep Type 0 consumers;

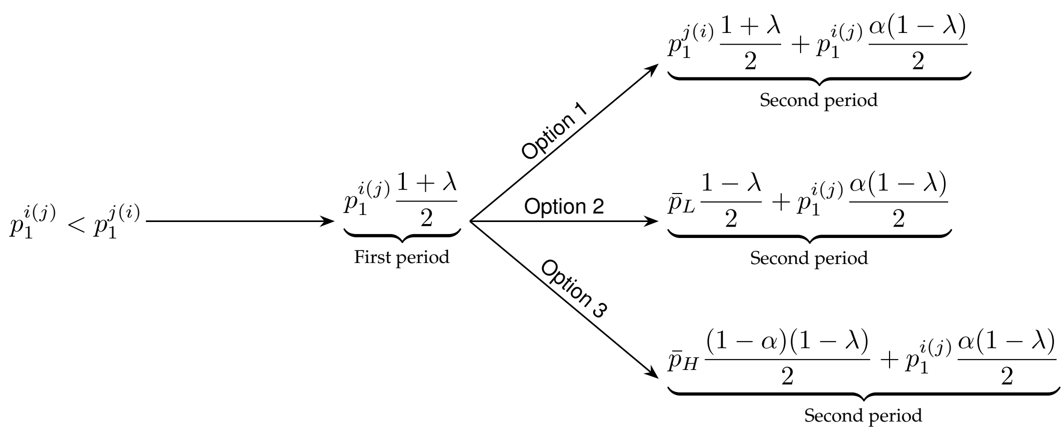
Option 2: Set the renewal price at $\bar{p}_L$ to retain its share of Type L consumers (Type H will also buy at this price, but Type 0 will switch away);

Option 3: Set the renewal price at $\bar{p}_H$ to fully exploit its share of Type H consumers (Type L will behave like Type 0 and switch to the rival's base price).

Figure A.3 illustrates possible outcomes of the undercutting game when Firm i undercuts Firm j in the first period, and Firm j sets the second-period price at either $\bar{p}_L$ (Case (a)) or $\bar{p}_H$ (Case (b)). The latter case adds complexity to the thought experiment, as a fraction of Type L customers will switch to Firm i and purchase at its base price. Therefore, I proceed by analysing the two cases separately, beginning with Case (a), where $\alpha \in (\tilde{\alpha}, 1]$ and Firm j sets the renewal price at $\bar{p}_L$.



(a) If Firm j sets the renewal $p_2^{j(i)} = \bar{p}_L$, Firm i has three options in the second period: (1) match the base price of Firm j; (2) set the renewal price at $\bar{p}_L$; (3) set the renewal price at $\bar{p}_H$



(b) If Firm j sets the renewal $p_2^{j(i)} = \bar{p}_H$, Firm i has similar options as in the Case (a), however notice, that Type L consumers which where attached to Firm j will switch to Firm i and buy at its base price

Figure A.3: Two possible scenarios of an undercutting game depend on parameters

Step 3: Case (a): $\alpha \in [\tilde{\alpha}, 1]$

Claim 2. *Let $\lambda \in (0,1)$ and $\alpha \in [\tilde{\alpha}, 1]$ and consider a two-period game, where two firms (i and j) play a pure strategy by setting the base price $p_1^{i,j}$ in the first period. Suppose one firm decides to undercut this price by setting $p_1^{j,i} < p_1^{i,j}$. Then there exists a threshold value of α, which determines the continuation strategy ($p_2^{i,j} = \bar{p}_L$ or $p_2^{i,j} = \bar{p}_H$) of* ***the undercutting firm*** *and such value coincide with $\tilde{\alpha}$.*

Proof. By comparing payoffs from options two and three, an undercutting firm can identify a threshold value of α:

Option 2: Give up Type 0 and raise its price up to $\bar{p}_L$. This yields the following payoff:

$$\pi^i = \underbrace{p_1^i \left(\lambda + \underbrace{\frac{\alpha(1-\lambda)}{2}}_{\text{fraction of Type L}} + \underbrace{\frac{(1-\alpha)(1-\lambda)}{2}}_{\text{fraction of Type H}} \right)}_{\text{First period}} + \underbrace{\bar{p}_L \left(\underbrace{\frac{\alpha(1-\lambda)}{2}}_{\text{fraction of Type L}} + \underbrace{\frac{(1-\alpha)(1-\lambda)}{2}}_{\text{fraction of Type H}} \right)}_{\text{Second period}}$$
$$= p_1^i \left(\lambda + \frac{1-\lambda}{2} \right) + \bar{p}_L \left(\frac{\alpha(1-\lambda)}{2} + \frac{(1-\alpha)(1-\lambda)}{2} \right)$$

Option 3: Give up Type 0 and Type L and raise its price up to $\bar{p}_H$. This yields the following payoff:

$$\pi^i = \underbrace{p_1^i \left(\lambda + \underbrace{\frac{\alpha(1-\lambda)}{2}}_{\text{fraction of Type L}} + \underbrace{\frac{(1-\alpha)(1-\lambda)}{2}}_{\text{fraction of Type H}} \right)}_{\text{First period}} + \underbrace{\bar{p}_H \underbrace{\frac{(1-\alpha)(1-\lambda)}{2}}_{\text{fraction of Type H}}}_{\text{Second period}}$$
$$= p_1^i \left(\lambda + \frac{1-\lambda}{2} \right) + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2}$$

Equating payoffs from Option 2 and Option 3 to find $\tilde{\alpha}$:

$$p_1^i \frac{1+\lambda}{2} + \bar{p}_L \frac{1-\lambda}{2} = p_1^i \frac{1+\lambda}{2} + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2}$$
$$\alpha = 1 - \frac{\bar{p}_L}{\bar{p}_H}$$

This threshold value implies that if $\alpha > \tilde{\alpha}$, the undercutting firm will prefer Option 2 over Option 3. □

Ruling out Option 3, the undercutting firm still has to decide to set the renewal price by matching the rival's base price or setting it at $\bar{p}_L$. The following claim addresses the logic of such a decision.

Claim 3. *Let $\lambda \in (0,1)$ and $\alpha \in [\tilde{\alpha}, 1]$ and consider a two-period game where two firms (i and j) play a pure strategy by setting the base price $p_1^{i,j}$ in the first period. Suppose one firm decides to undercut this price by setting $p_1^{j,i} < p_1^{i,j}$. Then there exists a threshold price of $\tilde{p}_L$, which makes the undercutting firm indifferent between setting the renewal price by matching the rival's base price on setting it at the reservation price of Type L consumers. Such a price satisfies:*

$$\tilde{p}_L = \bar{p}_L \frac{(1-\lambda)}{(1+\lambda)}$$

Proof. By comparing payoffs from options one and two, an undercutting firm can identify a threshold price:

Option 1: Keep all types in the second period and raise its price to match firm's

j price to keep them in the second period. This yields the following payoff:

$$\pi^i = \underbrace{p_1^i \left(\lambda + \underbrace{\frac{\alpha(1-\lambda)}{2}}_{\text{fraction of Type L}} + \underbrace{\frac{(1-\alpha)(1-\lambda)}{2}}_{\text{fraction of Type H}} \right)}_{\text{First period}} + \underbrace{p_1^j \left(\lambda + \underbrace{\frac{\alpha(1-\lambda)}{2}}_{\text{fraction of Type L}} + \underbrace{\frac{(1-\alpha)(1-\lambda)}{2}}_{\text{fraction of Type H}} \right)}_{\text{Second period}}$$

$$= p_1^i \left(\lambda + \frac{1-\lambda}{2} \right) + p_1^j \left(\lambda + \frac{1-\lambda}{2} \right)$$

Option 2: Give up Type 0 and raise its price up to $\bar{p}_L$. This yields the following payoff:

$$\pi^i = \underbrace{p_1^i \left(\lambda + \underbrace{\frac{\alpha(1-\lambda)}{2}}_{\text{fraction of Type L}} + \underbrace{\frac{(1-\alpha)(1-\lambda)}{2}}_{\text{fraction of Type H}} \right)}_{\text{First period}} + \underbrace{\bar{p}_L \left(\underbrace{\frac{\alpha(1-\lambda)}{2}}_{\text{fraction of Type L}} + \underbrace{\frac{(1-\alpha)(1-\lambda)}{2}}_{\text{fraction of Type H}} \right)}_{\text{Second period}}$$

$$= p_1^i \left(\lambda + \frac{1-\lambda}{2} \right) + \bar{p}_L \left(\frac{\alpha(1-\lambda)}{2} + \frac{(1-\alpha)(1-\lambda)}{2} \right)$$

Equating Option 1 and Option 2 and solving for p_1^j I obtain the threshold price and denote it as $\tilde{p}_L$:

$$\tilde{p}_L = \bar{p}_L \frac{(1-\lambda)}{(1+\lambda)}$$

□

Step 4: Case (b): $\alpha \in [0, \tilde{\alpha}]$

Claim 4. *Consider a two-periods game where fractions of consumers are presented by parameters $\lambda \in (0,1)$ and $\alpha \in [0, \tilde{\alpha}]$, and two firms ($i$ and j) play a pure strategy by setting the base price $p_1^{i,j}$ in the first period. Suppose one firm decides to undercut this price by setting $p_1^{j,i} < p_1^{i,j}$. Then there exists a threshold value of α, which determines the* *continuation strategy of the undercutting firm and such value coincide with $\tilde{\alpha}$.*

Proof. The proof of this claim is similar to the proof of Claim 2; however, note that the payoff functions are different due to the fraction of Type L consumers attached to the firm with the higher price in the first period, who will switch in the second period to the undercutting firm and purchase at its base price. (See A.3 (b)).

By comparing payoffs from options two and three, an undercutting firm can identify a threshold value of α:

Option 2: Give up Type 0 and raise its price up to $\bar{p}_L$. This yields the following payoff:

$$\pi^i = \underbrace{p_1^i \frac{(1+\lambda)}{2}}_{\text{First period}} + \underbrace{\bar{p}_L \frac{(1-\lambda)}{2} + \underbrace{p_1^i \frac{\alpha(1-\lambda)}{2}}_{\text{Type L from the rival}}}_{\text{Second period}}$$

Option 3: Give up Type 0 and Type L and raise its price up to $\bar{p}_H$. This yields the following payoff:

$$\pi^i = \underbrace{p_1^i \frac{(1+\lambda)}{2}}_{\text{First period}} + \underbrace{\bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2} + \underbrace{p_1^i \frac{\alpha(1-\lambda)}{2}}_{\text{Type L from the rival}}}_{\text{Second period}}$$

Equating payoffs from Option 2 and Option 3 to find $\tilde{\alpha}$:

$$p_1^i \frac{1+\lambda}{2} + \bar{p}_L \frac{1-\lambda}{2} + p_1^i \frac{\alpha(1-\lambda)}{2} = p_1^i \frac{1+\lambda}{2} + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2} + p_1^i \frac{\alpha(1-\lambda)}{2}$$
$$\alpha = 1 - \frac{\bar{p}_L}{\bar{p}_H}$$

This threshold value implies that if $\alpha < \tilde{\alpha}$, the undercutting firm will prefer Option 3 over Option 2. □

Ruling out Option 2, the undercutting firm still has to decide to set the renewal price by matching the rival's base price or setting it at $\bar{p}_H$. The following claim addresses the logic of such a decision.

Claim 5. *Consider a two-period game where fractions of consumers are presented by parameters $\lambda \in (0,1)$ and $\alpha \in [0, \tilde{\alpha}]$, and two firms ($i$ and j) play a pure strategy by setting the base price $p_1^{i,j}$ in the first period. Suppose one firm decides to undercut this price by setting $p_1^{j,i} < p_1^{i,j}$. Then there exists a threshold price of $\tilde{p}_H$, which makes the undercutting firm indifferent between setting the renewal price by matching the rival's base price on setting it at the reservation price of Type H consumers. Such a price satisfies:*

$$\tilde{p}_H = \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{(1+\lambda)}$$

Proof. By comparing payoffs from options one and two, an undercutting firm can identify a threshold price:

Option 1: Keep all types in the second period and raise its price to match firm's j price to keep them in the second period. This yields the following payoff:

$$\pi^i = p_1^i \frac{1+\lambda}{2} + p_1^j \frac{1-\lambda}{2} + p_1^i \frac{\alpha(1-\lambda)}{2}$$

Option 3: Give up Type 0 and Type L and raise its price up to $\bar{p}_H$. This yields the following payoff:

$$\pi^i = p_1^i \frac{1+\lambda}{2} + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2} + p_1^i \frac{\alpha(1-\lambda)}{2}$$

Equating Option 1 and Option 3 and solving for p_1^j I obtain the threshold price and denote it as $\tilde{p}_H$:

$$\tilde{p}_H = \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{(1+\lambda)}$$

□

Given that a threshold value of parameter α is used by both firms, the undercutting game simplifies into the two cases, each associated with a distinct price profile consisting of a base price and a renewal price. □

Proof of Corollary 3.2.2. Case (a):

Part (i): Assume firms set their base prices at $p_1^i = p_1^j < \tilde{p}_L$. Now, suppose that Firm i undercuts by setting $p < p_1^j < \tilde{p}_L$. In the second period, it can match the rival's base price or it set at the reservation level. Finding the optimal continuation strategy requires to compare the payoffs from these strategies. Let π_{match} be 'matching' payoff and π_{res} be 'reservation' payoff. Assume for contradiction that $\pi_{\text{match}} > \pi_{\text{res}}$. Then: $p(\frac{1-\lambda}{2} + \lambda) + p_1^j(\frac{1-\lambda}{2} + \lambda) > p(\frac{1-\lambda}{2} + \lambda) + \bar{p}_L(\frac{1-\lambda}{2})$, which simplifies to $p_1^j > \bar{p}_L \frac{1-\lambda}{1+\lambda}$. However, $p_1^j < \bar{p}_L \frac{1-\lambda}{1+\lambda}$ by assumption, thus proving Part (i) by contradiction.

Part (ii): Assume $p_1^i = p_1^j > \tilde{p}_L \leq \bar{p}_L$. If Firm i undercuts by setting $p < p_1^j > \tilde{p}_L$, then in the second period it can set the renewal price either matching the rival's base price or setting at the reservation level. Denoting the payoffs as π_{match} and π_{res}, and assuming that $\pi_{\text{match}} < \pi_{\text{res}}$ obtain: $p(\frac{1-\lambda}{2} + \lambda) + p_1^j(\frac{1-\lambda}{2} + \lambda) < p(\frac{1-\lambda}{2} + \lambda) + \bar{p}_L(\frac{1-\lambda}{2})$, this simplifies to: $p_1^j < \bar{p}_L \frac{1-\lambda}{1+\lambda}$. Which contradicts the initial assumption that $p_1^j > \bar{p}_L \frac{1-\lambda}{1+\lambda}$, thus proving Part (ii) by contradiction.

Case (b):

Part (i): Assume firms set their base prices at $p_1^i = p_1^j < \tilde{p}_H$. Now, suppose that Firm i undercuts by setting $p < p_1^j < \tilde{p}_H$. In the second period, it can match the rival's base price or it set at the reservation level. Finding the optimal continuation strategy requires to compare the payoffs from these strategies. Let π_{match} be 'matching' payoff and π_{res} be 'reservation' payoff. Assume for contradiction that $\pi_{\text{match}} > \pi_{\text{res}}$. Then: $p(\frac{1-\lambda}{2} + \lambda) + p_1^j(\frac{1-\lambda}{2} + \lambda) > p(\frac{1-\lambda}{2} + \lambda) + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2}$, which simplifies to $p_1^j > \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{(1+\lambda)}$. However, $p_1^j < \bar{p}_L \frac{(1-\alpha)(1-\lambda)}{1+\lambda}$ by assumption, thus proving Part (i) by contradiction.

Part (ii) consist of two cases. Firstly, assume firms set their base prices at $p_1^i = p_1^j >$

$\tilde{p}_H \leq \bar{p}_L$. Assume that Firm i undercuts by setting $p < p_1^j$. Let π_{match} be 'matching' payoff and π_{res} be 'reservation' payoff. In this case, Firm i when decides to match the rival's price also acquires a fraction of Type L which switches from Firm j and buys at Firm's i base price in the second period. Assume for contradiction that $\pi_{\text{match}} < \pi_{\text{res}}$. Then: $p(\frac{1-\lambda}{2} + \lambda) + p_1^j(\frac{1-\lambda}{2} + \lambda) + p\frac{\alpha(1-\lambda)}{2} < p(\frac{1-\lambda}{2} + \lambda) + \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{2}$, which simplifies to: $p_1^j + p\frac{\alpha(1-\lambda)}{(1+\lambda)} < \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{(1+\lambda)}$. Since $p_1^j > \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{(1+\lambda)}$ by assumption and $p^*\frac{\alpha(1-\lambda)}{(1+\lambda)} \geq 0$, thus proving by contradiction.

Secondly, assume firms set their base prices at $p_1^i = p_1^j > \bar{p}_L < \bar{p}_H$. Assume that Firm i undercuts by setting $p < p_1^j$. Let π_{match} be 'matching' payoff and π_{res} be 'reservation' payoff. In this case, Firm i obtains the entire fraction of Type L consumers in the first period and if matches then retains it in the second period. Assume for contradiction that $\pi_{\text{match}} < \pi_{\text{res}}$. Then: $p(\frac{1-\lambda}{2}+\lambda+\alpha(1-\lambda))+p_1^j(\frac{1-\lambda}{2}+\lambda+\alpha(1-\lambda)) < p(\frac{1-\lambda}{2}+\lambda+\alpha(1-\lambda))+\bar{p}_H\frac{(1-\alpha)(1-\lambda)}{2}$, which simplifies to: $p_1^j + p_1^j\frac{\alpha(1-\lambda)}{(1+\lambda)} < \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{(1+\lambda)}$. Since $p_1^j > \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{(1+\lambda)}$ by assumption and $p_1^j\frac{\alpha(1-\lambda)}{(1+\lambda)} \geq 0$, thus proving by contradiction. □

A.2 Case (a)

A.2.1 Symmetric equilibrium

Proof of Lemma 3.3.1. To prove the lemma, I need to demonstrate that no profitable unilateral deviation exists from these strategies. To do so, assume $\tilde{p}_L = \bar{p}_L\frac{1-\lambda}{1+\lambda}$ is identified as the symmetric SPNE. Two potential unilateral deviations exist for this candidate: (1) by undercutting, where a deviating price $p = \tilde{p}_L - \epsilon < \tilde{p}_L$ allows a firm to attract demand from all customer types in the first period; (2) by increasing the price to $p = \bar{p}_L > \tilde{p}_L$. Note that deviating by increasing the price means setting the base price at the reservation price level, as any increase in the first period would result in the firm losing its Type 0 customers. In the subsequent period, the competing firm sets the renewal price by matching this price, retaining the Type 0 customers (see Corollary 3.2.2). As a result, the deviating firm serves only non-shoppers in both periods. Any deviation greater than $\bar{p}_L$ will lead to losing both - Type 0 and Type L customers, as it was established, rival finds it optimally choose $\bar{p}_L$ over $\bar{p}_H$ for $\alpha \in [\tilde{\alpha}, 1)$ therefore they are ruled out. Figure A.4 illustrates possible strategies:

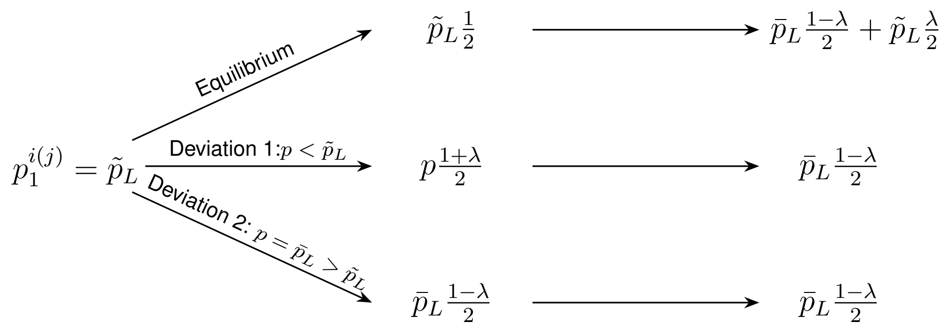


Figure A.4: A candidate equilibrium $p_1 = \tilde{p}_L$

I compare the payoff of each possible deviating strategy (denote π_D) with a payoff from an equilibrium strategy candidate (denote π_E), which can be simplified as: $\pi_E = \bar{p}_L(1-\lambda)$

Undercutting deviation: yields: $\pi_D = \bar{p}_L(1-\lambda) - \epsilon\frac{1+\lambda}{2}$. Since $\bar{p}_L(1-\lambda) > \bar{p}_L(1-\lambda) - \epsilon\frac{1+\lambda}{2}$ such a deviation is not profitable.

Increasing deviation: The threshold price implies that a firm with lesser base price will match the rival's first period price if it is greater than $\tilde{p}_L$ and increase up to the reservation price if it is less than $\tilde{p}_L$. Therefore, a payoff from increasing deviation yields: $\pi_D = \bar{p}_L(1-\lambda)$, which is not profitable. □

A.2.2 Other equilibrium candidates

Proof of Lemma 3.3.2. To prove this lemma it requires to demonstrate a profitable unilateral deviation for each case.

Case 1: Assume firms set the base price at $p_1^{i(j)} = p \in [0, \tilde{p}_L)$ and the renewal price at $p_2^{i(j)} = \bar{p}_L$. This yields the following payoff: $\pi = p\frac{1+\lambda}{2} + \bar{p}_L\frac{1-\lambda}{2}$. According to Corollary 3.2.2 and a tie-breaking rule, deviating to $\tilde{p}_L$ yields: $\pi_D = \tilde{p}_L \frac{(1-\lambda)}{2} + \bar{p}_L \frac{1-\lambda}{2} + \tilde{p}_L \lambda$, which simplifies to $\pi = \tilde{p}\frac{1+\lambda}{2} + \bar{p}_L \frac{1-\lambda}{2}$. Since $p < \tilde{p}_L$ by assumptions, $\pi < \pi_D$, thus profile of prices is not a symmetric SPNE.

Case 2: Assume firms set the base price at $p_1^{i(j)} = p \in (\tilde{p}_L, \bar{p}_L]$ and the renewal price at $\bar{p}_L$. This yields a payoff: $\pi = p\frac{1+\lambda}{2} + \bar{p}_L \frac{1-\lambda}{2}$. Assume one firm deviates $p - \epsilon$, where ϵ in infinitesimal positive number. The deviating firm attracts all savvy shoppers and then matches the rival's price for the renewal. This yields: $\pi_D = p\frac{1+\lambda}{2} + p\frac{1+\lambda}{2} - \epsilon\frac{1+\lambda}{2}$. To compare π_D and π I can omit the first term from both equations and re-write p in the latter equation as $\tilde{p}_L + k$, where k is a positive arbitrary number, s.t. $p = \tilde{p}_L + k \leq \bar{p}_L$. Recall that $\tilde{p}_L = \bar{p}_L \frac{1-\lambda}{1+\lambda}$, this gives $\bar{p}_L \frac{1-\lambda}{2} + k\frac{1-\lambda}{2} - \epsilon\frac{1+\lambda}{2}$. Comparing it to the remaining term in the former equation, I conclude that there exists an ϵ small enough to make $\pi_D > \pi$. Therefore, the deviation is profitable, and this profile of prices is not a symmetric SPNE. □

Proof of Lemma 3.3.3. Consumers' engagement is myopic and have no recall between periods, thus in each sub-game, all consumers have free information and the ability to find the cheapest offer. Firms engage in fierce competition, driving prices down to marginal costs. Firms have no incentives to deviate by increasing the price as it will not attract consumers. Moreover, a firm that decides to increase the price in the first period will not be able to attract demand from savvy-shoppers in the second period because the rival will match the renewal price to prevent the switching and keep the savvy-shoppers, making the deviation unprofitable. □

Proof of Lemma 3.3.4. Consider the payoff which yields such a profile of prices: $\pi_E = \bar{p}_L \frac{1}{2} + \bar{p}_L \frac{1}{2}$. Let one firm deviate slightly by undercutting the base price such that $p_1^{i(j)} = \bar{p}_L - \epsilon$, where ϵ is an infinitesimally small positive number. Such deviation will not attract any savvy-shoppers, thus a payoff: $\pi_D = (\bar{p}_L - \epsilon)\frac{1}{2} + \bar{p}_L \frac{1}{2}$. Since $\bar{p}_L > \bar{p}_L - \epsilon\left(\frac{1}{2}\right)$, where $p_1^{i(j)} = p_2^{i(j)} = \bar{p}_L$ is a symmetric SPNE. Now consider the expression for the renewal price: $\bar{p}_L = e_L \frac{1+\lambda}{2\lambda}$. It is evident that as $\lambda \to 0$, $\bar{p}_L \to \infty$. Therefore, $\bar{p}_L$ approaches $\bar{p}_H = v$ as $\lambda \to 0$. □

A.3 Case (b)

A.3.1 Symmetric equilibrium

Proof of Lemma 3.3.5. To prove this Lemma I compare deviations from the payoff when firms set their base prices at $\tilde{p}_H$ and the renewal price at $\bar{p}_H$. There are three potential unilateral deviations from this candidate: (1) a deviating price $p = \tilde{p}_H - \epsilon < \tilde{p}_H$, in such a case a deviating firm obtains the demand from all types of customers in the first period; (2) $p = \bar{p}_L > \tilde{p}_H$ in such a case[2] a deviating firm loses all Type 0 in the first period but keeps Type L; (3) or $p = \bar{p}_H > \tilde{p}_H$ in such a case a deviating firm loses all Type 0 and Type L in the first period. Figure A.5 below illustrates payoff from these strategies.

[2] The intuition for the increasing deviation is similar to the Case 1

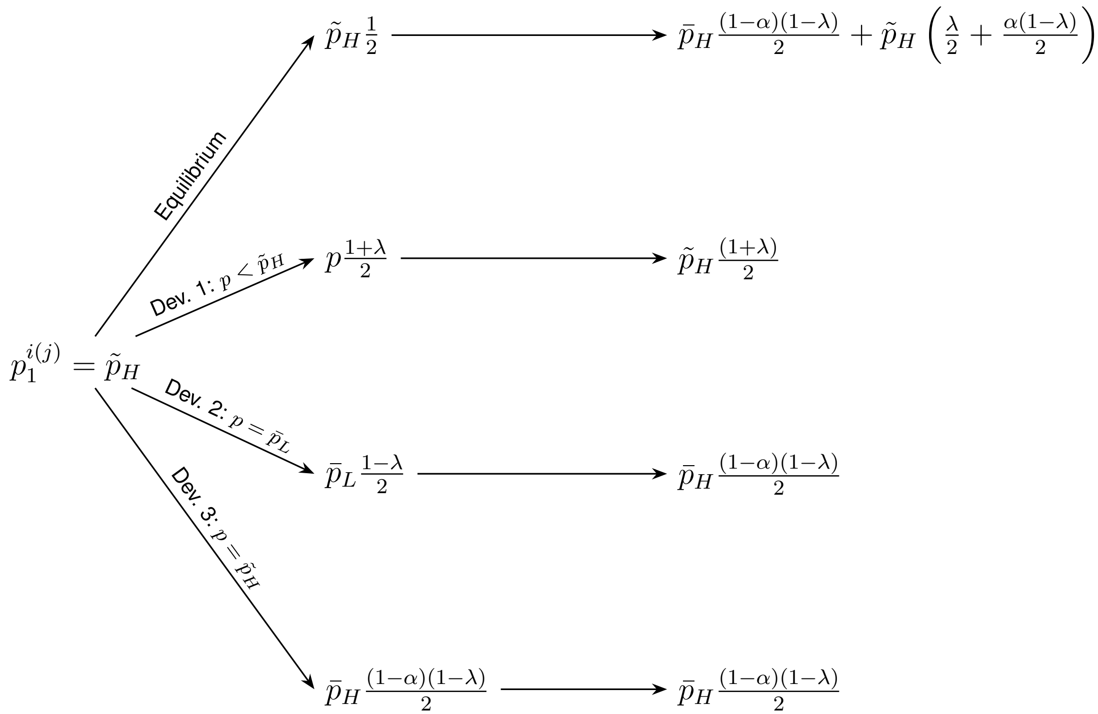


Figure A.5: Potential deviations from a candidate equilibrium $\tilde{p}_H = \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{1-\lambda}$. There are three potential deviations from the candidate equilibrium: (1) undercutting the base $\tilde{p}_H$, (2) increasing the base price by setting it at $\bar{p}_L$, and (3) increasing the base price by setting it at $\bar{p}_H$.

First, consider a payoff that yields the equilibrium candidate:

$$\pi_E = \tilde{p}_H \frac{1}{2} + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2} + \tilde{p}_H \left[\frac{\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right]$$
$$= \tilde{p}_H \left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2}$$

Undercutting deviation: Deviation 1:

$$\pi_D = (\tilde{p}_H - \epsilon)\frac{1+\lambda}{2} + \tilde{p}_H \frac{1+\lambda}{2} + (\tilde{p}_H - \epsilon)\frac{\alpha(1-\lambda)}{2}$$
$$= \tilde{p}_H \left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2} - \epsilon \left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right]$$

Comparison reveals that a such deviation is unprofitable:

$$\tilde{p}_H \left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2} >$$
$$\tilde{p}_H \left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2} - \epsilon \left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right]$$

Increasing deviation: The next step is to examine if there is a unilateral deviation by increasing the price. There are two potential increasing option for the undercutting firm: $\bar{p}_L$ and $\bar{p}_H$.

Deviation 2:

$$\pi_D = \bar{p}_L \frac{1-\lambda}{2} + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2}$$

To compare, re-write the payoff when both firms play $\tilde{p}_H = \bar{p}_H \frac{(1-\lambda)(1-\alpha)}{(1+\lambda)}$ in the first period as follows:

$$\pi_E = \bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2} + \tilde{p}_H \frac{\alpha(1-\lambda)}{2} + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2}$$

The last term in both equations is identical and can be omitted from the comparison. Also, both equation can be multiplied by $\frac{2}{(1-\lambda)}$. This gives the final terms which should be compared:

$$\bar{p}_H(1-\alpha) + \tilde{p}_H\alpha \qquad \text{and} \qquad \bar{p}_L$$

The term $\tilde{p}_H\alpha$ is positive for all values of $\alpha > 0$. The term $\bar{p}_H(1-\alpha)$ is equal to $\bar{p}_L$, when $\alpha = \tilde{\alpha}$ and greater than $\bar{p}_L$, when $\alpha < \tilde{\alpha}$.[3] Therefore, such a deviation is not profitable.

Deviation 3: Such deviation yields:

$$\begin{aligned}\pi_D &= \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{2} + \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{2}\\ &= \bar{p}_H(1-\alpha)(1-\lambda)\end{aligned}$$

and it must be compared to:

$$\begin{aligned}\pi_E &= \bar{p}_H\frac{(1-\lambda)(1-\alpha)}{2} + \tilde{p}_H\frac{\alpha(1-\lambda)}{2} + \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{2}\\ &= \bar{p}_H(1-\alpha)(1-\lambda) + \tilde{p}_H\frac{\alpha(1-\lambda)}{2}\end{aligned}$$

The term $\bar{p}_H(1-\alpha)(1-\lambda)$, being the only term in π_D, is identical in both equations and, thus, can be omitted from the comparison. Furthermore, the term $\tilde{p}_H\frac{\alpha(1-\lambda)}{2}$ in the payoff π_E is greater than zero, which indicates that such a deviation would not be profitable. □

A.3.2 Other equilibrium candidates

Proof of Lemma 3.3.6. To prove this lemma, I consider a payoff which yields a profile of prices $(p, \bar{p}_H)$ and demonstrate that there is a profitable unilateral deviation from it.

[3] Recall that $\tilde{\alpha} = 1 - \frac{\bar{p}_L}{\bar{p}_H}$

The payoff from the strategies $(p, \bar{p}_H)$ yields:

$$\begin{aligned}\pi &= p\frac{1}{2} + \bar{p}_H\frac{(1-\lambda)(1-\alpha)}{2} + p\left[\frac{\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] \\ &= p\left[\frac{(1+\lambda)}{2} + \frac{\alpha(1-\lambda)}{2}\right] + \bar{p}_H\frac{(1-\lambda)(1-\alpha)}{2}\end{aligned}$$

Suppose that one firm deviates by setting the price at $\tilde{p}_H$. In the first period, this firm loses Type 0 consumers but serves its share of Type L and Type H consumers. However, in the second period, it acquires all Type 0 consumers and a share of Type L consumers from the rival, as the rival's optimal strategy, according to Corollary 3.2.2 and a tie-breaking rule, is to set its renewal price up to $\bar{p}_H$. Thus, such a deviation yields a payoff:

$$\begin{aligned}\pi_D &= \tilde{p}_H\left[\frac{\alpha(1-\lambda)}{2} + \frac{(1-\lambda)(1-\alpha)}{2}\right] + \bar{p}_H\frac{(1-\lambda)(1-\alpha)}{2} + \tilde{p}_H\left[\lambda + \frac{\alpha(1-\lambda)}{2}\right] \\ &= \tilde{p}_H\left[\frac{(1+\lambda)}{2} + \frac{\alpha(1-\lambda)}{2}\right] + \bar{p}_H\frac{\alpha(1-\lambda)(1-\alpha)}{2}\end{aligned}$$

$p < \tilde{p}_H$ by assumption, therefore $\pi < \pi_D$, thus such a deviation is profitable. □

Proof of Lemma 3.3.7. The proof of this lemma consist of the following steps:

Step 1: I begin by verifying whether the reservation price of average consumers, when set as a base price, constitutes an equilibrium in the subgame, given that it serves as a cutoff price in the decision-making process of average consumers.

Step 2: I extend the analysis to the interval $(\tilde{p}_H, \bar{p}_L)$ by expressing any price within this range as $\bar{p}_L - k$, where k is an arbitrary number such that $k < e_L$.

Step 3: I consider the remaining interval $(\bar{p}_L, \bar{p}_H]$.

Step 1: First, consider a payoff when both firms set the base price $p_1^{i,j} = \bar{p}_L$ and the renewal price $p_2^{i,j} = \bar{p}_H$. This yields:

$$\begin{aligned}\pi &= \bar{p}_L \frac{1}{2} + \bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2} + \bar{p}_L \left[\frac{\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] \\ &= \bar{p}_L \left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] + \bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2}\end{aligned}$$

The proof requires demonstrating that there is a profitable unilateral deviation. Thus, suppose that a firm deviates by slightly undercutting its rival. According to Corollary 3.2.2, in the second period, the undercutting firm finds it optimal to match the rival's price. This yields:

$$\begin{aligned}\pi_D &= (\bar{p}_L - \epsilon)\frac{1+\lambda}{2} + \bar{p}_L \frac{1+\lambda}{2} + (\bar{p}_L - \epsilon)\frac{\alpha(1-\lambda)}{2} \\ &= \bar{p}_L \left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] + \bar{p}_L \frac{1+\lambda}{2} - \epsilon \left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right]\end{aligned}$$

For the comparison the term $\bar{p}_L \left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right]$ can be omitted as equal, then it is sufficient to compare the terms:

$$\bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2} \quad \text{and} \quad \bar{p}_L \frac{1+\lambda}{2} - \epsilon \left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right]$$

Recall, that $\bar{p}_L = \bar{p}_H \frac{(1-\lambda)(1-\alpha)}{(1+\lambda)} + e_L$ when $\alpha \leq \tilde{\alpha}$ then re-write the term $\bar{p}_L \frac{1+\lambda}{2}$ can be re-written as $\bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2} + e_L \frac{1+\lambda}{2}$

Now compare the remaining terms:

$$\bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2} \quad \text{and} \quad \bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2} + e_L \frac{1+\lambda}{2} - \epsilon \left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right]$$

Given that the term $\bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2}$ is identical, the term $e_L \frac{1+\lambda}{2}$ is positive for $\lambda > 0$, and ϵ is infinitesimal, such deviation is profitable: $0 < e_L \frac{1+\lambda}{2}$.

Step 2: Denote any price in the interval $(\tilde{p}_H, \bar{p}_L)$ as $\bar{p}_L - k$, where k is an arbitrary number such that $k < e_L$. Suppose both firms set the base price $\bar{p}_L - k$ in the first period and renewal price $\bar{p}_H$ in the second period. This yields:

$\pi = (\bar{p}_L - k)\left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] + \bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2}$

Suppose that a firm deviates by slightly undercutting its rival and obtains a payoff: $\pi_D = (\bar{p}_L - k)\left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] + (\bar{p}_L - k)\frac{1+\lambda}{2} - \epsilon\left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right]$

For the comparison the term $(\bar{p}_L - k)\left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right]$ can be omitted as equal, then it is sufficient to compare the remaining terms: $\bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2}$ and $(\bar{p}_L - k)\frac{1+\lambda}{2} - \epsilon\left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right]$

The term $(\bar{p}_L - k)\frac{1+\lambda}{2}$ can be re-written as $\bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2} + e_L \frac{1+\lambda}{2} - k\frac{1+\lambda}{2}$

Now compare the remaining terms: $\bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2}$ and $\bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2} + e_L \frac{1+\lambda}{2} - k\frac{1+\lambda}{2} - \epsilon\left[\frac{1+\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right]$.

Given that the term $\bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2}$ is identical, and the term $e_L \frac{1+\lambda}{2}$ is positive and greater than $k\frac{1+\lambda}{2}$ by assumption, there exists an ϵ small enough such that this deviation is profitable.

Step 3: Let p be a price, s.t. $\bar{p}_L < p < \bar{p}_H$. Suppose both firms set the base price p in the first period and renewal price $\bar{p}_H$ in the second period. In the first period the demand from all types of consumers is split in half. In the second period, Type 0 and Type L sample both firms, and switch, and Type H stays and buys at renewal price $\bar{p}_H$. Such a strategy yields the following payoff:

$$\begin{aligned}\pi &= \underbrace{p\left[\frac{\lambda}{2} + \frac{\alpha(1-\lambda)}{2} + \frac{(1-\alpha)(1-\lambda)}{2}\right]}_{\text{First period}} + \underbrace{\bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2} + p\left[\frac{\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right]}_{\text{Second period}} \\ &= p\left[\lambda + \alpha(1-\lambda) + \frac{(1-\alpha)(1-\lambda)}{2}\right] + \bar{p}_H \frac{(1-\lambda)(1-\alpha)}{2}\end{aligned}$$

Suppose one firm deviates by slightly undercutting its rival by an infinitesimal amount ϵ. In such a case, the deviating firm attracts Type 0 and Type L customers who sample both prices and pick the cheapest. To keep them in the second period the deviating firm should increase the price such that it matches the rival's price in the first period, otherwise it loses both types, which makes the deviation unprofitable. Therefore, I need to verify the following deviating payoff is profitable:

$$\pi_D = (p-\epsilon)\left[\lambda + \alpha(1-\lambda) + \frac{(1-\lambda)(1-\alpha)}{2}\right] + p\left[\lambda + \alpha(1-\lambda) + \frac{(1-\lambda)(1-\alpha)}{2}\right]$$
$$= 2p\left[\lambda + \alpha(1-\lambda) + \frac{(1-\lambda)(1-\alpha)}{2}\right] - \epsilon\left[\lambda + \alpha(1-\lambda) + \frac{(1-\lambda)(1-\alpha)}{2}\right]$$

The proof requires to demonstrate that $\pi < \pi_D$.

The term $p\left[\lambda + \alpha(1-\lambda) + \frac{(1-\lambda)(1-\alpha)}{2}\right]$ in a payoff equation π cancels out with one of similar terms in π_D, and the remaining can be simplified as $p\left[\lambda + \frac{(1-\lambda)(1+\alpha)}{2}\right]$.

So, we need to compare the following terms:

$$\bar{p}_H\frac{(1-\lambda)(1-\alpha)}{2} \;\text{ and }\; p\left[\lambda + \frac{(1-\lambda)(1+\alpha)}{2}\right] - \epsilon\left[\lambda + \frac{(1-\lambda)(1+\alpha)}{2}\right]$$

We can ignore the term $\epsilon\left[\lambda + \frac{(1-\lambda)(1+\alpha)}{2}\right]$ as infinitesimal and compare the rest.

For that recall that $\bar{p}_L < p < \bar{p}_H$, thus it can be re-written as $p = \bar{p}_L + k < \bar{p}_H$ where k is some positive real number. Also, recall that if $\alpha < \tilde{\alpha}$ then $\bar{p}_L = \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{(1+\lambda)} + e_L$. Therefore, let's re-write the term $p\left[\lambda + \frac{(1-\lambda)(1+\alpha)}{2}\right]$ as $(\bar{p}_H\frac{(1-\alpha)(1-\lambda)}{(1+\lambda)} + e_L + k)\left[\lambda + \frac{(1-\lambda)(1+\alpha)}{2}\right]$ or $\bar{p}_H\frac{(1-\alpha)(1-\lambda)}{(1+\lambda)}\left[\lambda + \frac{(1-\lambda)(1+\alpha)}{2}\right] + (e_L + k)\left[\lambda + \frac{(1-\lambda)(1+\alpha)}{2}\right]$.

The next step is to multiply terms for comparison by $\frac{2}{\bar{p}_H(1-\lambda)(1-\alpha)}$, which leave us to compare the following terms:

$$1 \;\text{ and }\; \frac{2}{1+\lambda}\left[\lambda + \frac{(1-\lambda)(1+\alpha)}{2}\right] + \frac{2(e_L+k)}{\bar{p}_H(1-\lambda)(1-\alpha)}\left[\lambda + \frac{(1-\lambda)(1+\alpha)}{2}\right]$$

Re-write the terms for the comparison as follows:

$$1 \text{ and } \frac{2\lambda}{1+\lambda} + \frac{(1-\lambda)(1+\alpha)}{1+\lambda} + \frac{2(e_L+k)}{\bar{p}_H(1-\lambda)(1-\alpha)}\left[\lambda + \frac{(1-\lambda)(1+\alpha)}{2}\right]$$

Re-write two terms $\frac{2\lambda}{1+\lambda}+\frac{(1-\lambda)(1+\alpha)}{1+\lambda}$ as $\frac{2\lambda+1-\lambda+\alpha-\alpha\lambda}{1+\lambda}$, which simplifies into $\frac{(1+\lambda)+\alpha(1-\lambda)}{1+\lambda}$ or $1+\frac{\alpha(1-\lambda)}{1+\lambda}$.

Re-write again the term for comparison as follows:

$$1 \text{ and } 1 + \frac{\alpha(1-\lambda)}{1+\lambda} + \frac{2(e_L+k)}{\bar{p}_H(1-\lambda)(1-\alpha)}\left[\lambda + \frac{(1-\lambda)(1+\alpha)}{2}\right]$$

The term 1 cancels out and the remaining terms for comparison can be re-written as:

$$0 \text{ and } \frac{\alpha(1-\lambda)}{1+\lambda} + \frac{2(e_L+k)\lambda}{\bar{p}_H(1-\lambda)(1-\alpha)} + \frac{(e_L+k)(1+\alpha)}{\bar{p}_H(1-\alpha)}$$

The terms on the RHS remain positive in the given intervals, therefore, we can conclude that there exists an ϵ small enough such that $\pi < \pi_D$. Thus, such a deviation is profitable. □

Proof of Lemma 3.3.8. Part (i): The proof follows from the engagement rule: all consumers are informed, which leads to fierce competition and a race to the bottom. Additionally, no firm can deviate upwards to exploit savvy shoppers due to the absence of renegotiation, as the rival will match this price in the second period.

Part (ii): Assume firms set a base price at $\bar{p}_H$ in the first period and at a renewal price at $\bar{p}_H$ in the second period. This yields:

$$\begin{aligned}\pi_E &= \bar{p}_H\frac{1}{2} + \bar{p}_H\frac{1}{2} \\ &= \bar{p}_H\end{aligned}$$

The undercutting by infinitesimal ϵ yields $\pi_D = \bar{p}_H - \epsilon\frac{1}{2}$, thus making such deviation unprofitable. □

Proof of Lemma 3.3.9. To prove the first part is sufficient to demonstrate that both continuations yield the same payoff. For that consider that both firms are playing $\tilde{p}_L$ in the first period and $\bar{p}_L$ in the second period:

$$\begin{aligned}\pi_E &= \tilde{p}_L\frac{1}{2} + \bar{p}_L\frac{1-\lambda}{2} + \tilde{p}_L\frac{\lambda}{2} \\ &= \tilde{p}_L\frac{1+\lambda}{2} + \bar{p}_L\frac{1-\lambda}{2}\end{aligned}$$

Suppose that one firm in the second period changes its strategy and sets the price at $\bar{p}_H$.

$$\begin{aligned}\pi_D &= \tilde{p}_L\frac{1}{2} + \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{2} + \tilde{p}_L\frac{\lambda}{2} \\ &= \tilde{p}_L\frac{1+\lambda}{2} + \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{2}\end{aligned}$$

Given that $\tilde{p}_L = \tilde{p}_H$ and $\bar{p}_L = \bar{p}_H(1-\alpha)$, the strategy raising the price at $\bar{p}_H$ yields the same payoff.

Now consider that both firms are playing $\tilde{p}_H$ in the first period and $\bar{p}_H$ in the second period:

$$\begin{aligned}\pi_E &= \tilde{p}_H\frac{1}{2} + \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{2} + \tilde{p}_H\left[\frac{\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] \\ &= \tilde{p}_H\frac{1+\lambda}{2} + \bar{p}_H\frac{(1-\alpha)(1-\lambda)}{2} + \tilde{p}_H\frac{\alpha(1-\lambda)}{2}\end{aligned}$$

Suppose that one firm changes the strategy in the second period by setting the price at $\bar{p}_L$.

$$\begin{aligned}\pi_D &= \tilde{p}_H \frac{1}{2} + \bar{p}_L \frac{1-\lambda}{2} + \tilde{p}_H \left[\frac{\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] \\ &= \tilde{p}_H \frac{1+\lambda}{2} + \bar{p}_L \frac{1-\lambda}{2} + \tilde{p}_H \frac{\alpha(1-\lambda)}{2}\end{aligned}$$

Given that $\tilde{p}_L = \tilde{p}_H$ and $\bar{p}_L = \bar{p}_H(1-\alpha)$, the strategy raising the price at $\bar{p}_H$ yields the same payoff.

To prove the second part of the Lemma, I compare payoffs from different strategies. Let's denote the payoff from the first strategy as π_L:

$$\begin{aligned}\pi_L &= \tilde{p}_L \frac{1}{2} + \bar{p}_L \frac{1-\lambda}{2} + \tilde{p}_L \frac{\lambda}{2} \\ &= \tilde{p}_L \frac{1+\lambda}{2} + \bar{p}_L \frac{1-\lambda}{2}\end{aligned}$$

and the payoff from the second strategy as π_H:

$$\begin{aligned}\pi_H &= \tilde{p}_H \frac{1}{2} + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2} + \tilde{p}_H \left[\frac{\lambda}{2} + \frac{\alpha(1-\lambda)}{2}\right] \\ &= \tilde{p}_H \frac{1+\lambda}{2} + \bar{p}_H \frac{(1-\alpha)(1-\lambda)}{2} + \tilde{p}_H \frac{\alpha(1-\lambda)}{2}\end{aligned}$$

Given that $\tilde{p}_L = \tilde{p}_H$ and $\bar{p}_L = \bar{p}_H(1-\alpha)$, the strategy raising the price at $\bar{p}_H$ yields a greater payoff by the term $\tilde{p}_H \frac{\alpha(1-\lambda)}{2}$.

□

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