LSE Capstone Report for Cambridge Economic Policy Associates

The Social and Distributional Outcomes of Digitalisation in the UK Retail Energy Market in 2025

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Acknowledgements

We would like to thank Cambridge Economic Policy Associates (CEPA) for giving us the opportunity to work on this project.

Our work was greatly assisted by the following individuals:

- Alexander Belsham-Harris, Principal Policy Manager at Citizens Advice;
- Ben Shafran, Principal Consultant at Cambridge Economic Policy Associates;
- Mark Caines, Partner at Flint Global;
- Pantelis Solomon, Principal Advisor at Behavioural Insights Team;
- Phil O'Donnell, Head of Policy at Which?; and
- Tania Burchardt, Director at Centre for the Analysis of Social Exclusion.

We were assisted by two further individuals in the energy industry who wish to remain anonymous.

We would also like to thank the LSE academic staff that supported us during this process. First, Dr Simon Bastow for his thought-provoking ideas, Dr Gharad Bryan for his insightful suggestions during the inception phase of our project and Professor Daniel Sturm for his invaluable advice on the first approach to the modelling. All of them significantly contributed to the project's advancement. We also thank Professor Rafael Hortala-Vallve for serving as our supervisor.

Last, but not least, we are grateful to Lewis Heather and Aidan O'Hare from CEPA, who devoted considerable time and attention to the project, and were always responsive and willing to offer their feedback. It was a pleasure working with them.

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Executive Summary

The 21st century economy will be defined by digitalisation and the exponential growth in consumer data available to firms. With consumers increasingly utilising a range of technological devices in their daily lives, firms are able to access a level of individualised data to hone their knowledge of consumer preferences. Consequently, personalised pricing - the provision of the same or very similar good or service by a firm at different prices to different consumers - is moving from a theoretical to a practical market condition.

As digitalisation disrupts all economic industries, its effects may be most significant in essential goods and services. Electricity is the fuel that drives the economic life of citizens. It is this basal nature of energy that has motivated our decision to focus the Capstone project on this industry. The analysis, modelling and policy recommendations outlined for the energy industry will be relevant to other markets that are touched by digitalisation, such as the supermarket or telecommunications industry. We note, however, that specific sectoral research is required to successfully translate our findings to other contexts.

A digitalised retail energy market will change the nature of this industry and the social and distributional outcomes for consumers and firms. To understand these outcomes, we model a digitalised UK retail energy market in 2025. We combine a stylised consumer market of four simplified consumer types with a data-based model of firm behaviour. Our model characterises consumers along two dimensions: wealth and engagement with the market. This results in four types of consumers: Type 1 (Rich and Passive), Type 2 (Poor and Active), Type 3 (Rich and Active) and Type 4 (Poor and Active).

Our model addresses the issue of consumer passivity when choosing tariffs and suppliers and emphasises that wealth (i.e. ability to pay) is a main driver of a consumer's decision-making. We position data at the centre of firm behaviour with access to data being the key determinant of firm profitability. Big data not only helps firms price individual consumers more accurately on the basis of their wealth and engagement, it also helps them inform profit-maximising pricing decisions for other consumers thanks to its network effects. Consequently, data is both a necessary condition to market participation and a significant barrier to entry. In light of this, the model considers the possibility of firms cross-subsidising between active and passive consumer types, active types below marginal cost in order to increase the volume of data they can then use to price passive consumers. Absent regulation, our model predicts the industry could become less competitive.

This drives our welfare conclusions for each customer type: rich-active and poor-active consumers face a competitive market while rich-passive and poor-passive consumers face a market structure akin to a monopoly. While certain (engaged) customers are well placed to gain from a higher degree of price discrimination, the disengaged stand to be overcharged by their supplier. Given that those most vulnerable in society (e.g. the elderly, those with mental illnesses) are at greater risk of disengagement, they should be protected.

We develop three main hypotheses from the model:

H1: Energy suppliers in the retail market will charge affluent consumers more than poor consumers at the same level of market engagement.

H2: Energy suppliers in the retail market will charge passive consumers more than active consumers; as a result, the former will experience a larger reduction in consumer surplus.

H3: Market engagement is a more salient feature for a firm's pricing decisions than consumer ability to pay.

To validate our hypotheses and enrich our understanding, we conducted interviews with stakeholders including energy suppliers, academics and policy-makers. These interviews revealed an industry that is dominated by a small number of suppliers that have been slow to adopt data-based technologies. Nevertheless, the industry is slowly beginning to embrace technologies such as blockchain, and new business models such as auto-switching companies are creating conditions for market pressure. On the consumer side, there is anxiety about the market not delivering the best consumer outcomes for passive and particularly vulnerable consumers. In terms of our hypotheses, while stakeholders agreed with Hypothesis 2 and 3, there was qualified support for Hypothesis 1 with stakeholders emphasising further factors that influence pricing decisions.

Our model stylises a digital retail energy market in 2025, and we consider some of the key developments that will likely transform it. The Internet of Things is predicted to escalate the development of personalised pricing across all industries, as greater amounts of consumer data are produced. The recognition of the economic value of data has sparked a nascent conversation about data democratisation. We develop this concept within the energy industry when looking at government efforts to extend data availability and improve switching rates. Further, sophisticated pricing algorithms present challenges including the possibility of firm collusion. Governments will need to consider auditing algorithms to prevent price discrimination that produces disproportionate outcomes.

We have considered some potential social and distributional outcomes in a digitalised UK retail energy market in 2025. We affirm the benefits of price discrimination as an improvement to economic efficiency. However, our model predicts that with the rise of data as an economic good, passive and vulnerable consumers will be most at risk of adverse welfare outcomes. Innovation should not be discouraged in this industry so long as the necessary safeguards are in place such that those most vulnerable are supported. Motivated by this rationale, we advocate the following policy recommendations to advance a competitive, equitable and sustainable retail energy industry in the UK in 2025:

- Facilitate switching through public evaluation of suppliers;
- Facilitate growth of the automated switching market;
- Expand local government partnerships with collective switching schemes;
- Address the digital fracture through local government assistance of offline consumers;
- Introduce price collars to limit price spreads;
- Discourage or restrict ‘price walking’;
- Implement government auditing of algorithms; and

- Develop a data access model to promote competition and innovation.

Introduction

The 21st century economy is increasingly being defined by digitalisation. For consumers, product choice is widening and communication barriers are being displaced. For firms, the digital economy has reduced transaction costs and allowed for direct customer engagement. At the heart of these changes has been the exponential growth in consumer data available to firms. With consumers increasingly utilising a range of technological devices in their daily lives, firms are able to access a level of individualised data to hone their knowledge of consumer preferences.

As a result of these developments, the marketplace is observing a growing wave of price discrimination - the provision of the same or very similar good or service by a firm at different prices in different markets. Notable examples of price discrimination being employed by firms include companies such as Amazon, and the ensuing popular discourse has belied a lagged societal unease with the unanticipated costs of this digital revolution, one that collides with the textbook microeconomic benefits of these practices.

The LSE-CEPA Capstone team tackles these issues in this report. We consider the social and distributional outcomes of price discrimination in the digitalised UK retail energy market, providing a future-facing analysis of the retail energy market in 2025. Energy is an essential service, albeit one that perhaps does not capture the public's imagination outside of a pricing context. The UK retail energy market continues to be in focus of the government and regulator in their attempts to foster efficiency and provide beneficial consumer outcomes. As the digital economy advances, digitalisation will revolutionise the provision of this essential good.

This report proceeds as follows. Section 1 provides a literature review of the microeconomic underpinnings of price discrimination, the rise of 'big data', the potential for first-degree price discrimination and the current UK retail energy market. With this context, Section 2 outlines our model to analyse welfare outcomes of a digitalised UK retail energy market in 2025. We model a market with four types of consumers varying in their wealth and market engagement and firms relying on access to consumer data in order to compete successfully. These factors lead to contrasting welfare outcomes.

To validate our hypotheses and refine our model we have conducted interviews with stakeholders in the UK energy market including energy suppliers, consumer advocates and behavioural economists. The methodology of these interviews is outlined in Section 3 and the hypotheses of our model are judged against this qualitative data in Section 4. Being cognisant of technology's inherently unpredictable development path, in Section 5, we analyse how the Internet of Things, "data democratisation" and algorithm collusion may affect price discrimination in 2025. Finally, Section 6 brings these ideas together to advocate for policy recommendations that will help sustain social welfare alongside the exciting digitalisation of the UK retail energy market in coming years.

1. Literature Review

This literature review builds the framework of our analysis by outlining the concepts and developments that will affect the social and welfare outcomes of price discrimination in the digitalised UK retail energy market in 2025. In Section 1.1, we consider the economic framework of price discrimination. Sections 1.2 and 1.3 consider the rise of 'big data' as an enabling condition for more sophisticated price discrimination practices. Section 1.4 brings this discussion together with a focus on current price discrimination practices in the UK retail energy market.

1.1 Microeconomic Foundations of Price Discrimination

1.1.1 Price Discrimination

Price discrimination occurs when the same product is offered by a seller at different prices to either to the same or different consumers. Price discrimination is the practice of a firm trying to "absorb" more of the consumer's willingness to pay (WTP) for a good or service.1 Its characterisation relies on three-degrees:

i. First-degree price discrimination, or personalised pricing, is the most extreme case where a seller can effectively charge a price equal to the consumer's WTP for a given good. Therefore, the consumer surplus is entirely absorbed by the producer, who enjoys the total welfare.

ii. Second-degree price discrimination occurs when the seller offers different units of its product at different prices (i.e. bulk discounts). Every buyer purchasing the same quantity of a given good will pay the same amount. Thus, prices do not differ across people but across units/characteristics of the product sold.

iii. Third-degree price discrimination is the most common form; here, prices are fixed for people within the same group (e.g. student discounts).

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[1] As defined by Varian (2015), the reservation price is any given person's maximum price at which she is indifferent between buying or not the good.

Given that customer information and market segmentation are key preconditions for price discrimination, the developing virtual economy and increasingly digitalised markets have increased suppliers' ability to approximate consumer WTP (Varian, 2010), making price discrimination more widely practiced.

1.1.2 Market Power

The degree to which firms can price discriminate relies to an extent on the market structure. Under a perfectly competitive market, whereby all firms are price takers, the ability to price discriminate is very low as each consumer will be charged the perfectly competitive price, i.e. where price is equal to the marginal cost of firms. On the other end of the market spectrum is the monopoly. The monopoly market is understood as a situation where a single firm is the market-supplier, characterised by its ability to set prices and withhold capacity (Robinson, 1933). The price setting ability of the monopolist, along with various other characteristics such as high barriers to entry, results in it holding significant market power (Varian, 1996). With respect to price discrimination, unlike perfectly competitive firms, a monopoly firm is capable of charging different prices to various segments of consumers based on their WTP due to its price-setting ability (Cowan, 2012).

More generally, when a firm has some price setting ability under imperfect competition, it is able to practise price discrimination. Subsequent welfare outcomes from price discrimination are diverse under different market structures and will largely depend on the firm's ability to obtain customer information and segment the market.

1.1.3 Welfare

There is little consensus among economists on the welfare effect of price discrimination (Cowan, 2012). Theoretically, it depends on a series of factors including cost structures, price demand elasticities and price discrimination strategies (Schwartz, 1990). Varian (2010) underscores the optimality of perfect price discrimination in industries with high fixed costs but low marginal costs, as is the case in the electricity market. Under these assumptions, price discrimination allows for the optimisation of total welfare. Simshauser's (2018) analysis of the removal of a price-cap in Australia's energy retail market supports this view. However, there is no one single price discrimination strategy.

Miller (2014) describes a situation in which firms can customise prices such that they emulate the highest consumer's WTP. In a similar fashion to price fixing, this allows firms to extract a higher portion of the consumer surplus in each transaction and therefore cause a loss in efficiency that is equivalent to the deadweight loss associated to a monopoly market (Miller, 2014).

Furthermore, it is not clear that price discrimination is unambiguously good for all consumers; whilst efficiency in the market is maximised, consumer surplus is reduced. This is a central concern of the 'fairness' analysis of the retail electricity market by the Centre for Competition Policy (2018). They called for increased regulation of price discrimination in the UK as the current market structure has reduced 'household welfare'. Furthermore, Farrell and Katz (2006) suggest a different approach to the policy analysis of price discrimination, one that considers the distributional effects, specifically addressing the conundrum of whether to consider optimising consumer surplus or total surplus for the welfare analysis. As none of these measures present an unambiguous advantage, the best option for policy analysis is to consider both the overall welfare and the distributional effect for consumers, weighing up the comparative results from both analyses (Farrel and Katz, 2006).

Indeed, when analysing price discrimination from the perspective of welfare analysis, the difficulty lies in discerning between the 'pure' economic optimality in terms of total welfare and the potential redistributive outcomes.

1.2 Big Data

Having outlined the economic principles underlying price discrimination, this section considers the rise of big data and discusses how the commodification of consumer data by firms is the foundation of price discrimination. Further, we explore consumer concerns and how regulation has changed the landscape on which price discrimination strategies will be deployed.

1.2.1 The Rise of Data Gathering and Processing

While big data is a relatively new field, it appears set to have a considerable impact on our societies. A common, high-level definition of big data is that it refers to large volumes of structured and unstructured data that cannot be handled by conventional storage and analysis tools. The volume of new data increases by approximately 40 per cent every year. By 2020, it is estimated to grow to 35 zettabytes compared to 1.2 zettabytes in 2010 (McKinsey, 2011).

Organisations and businesses have been accumulating larger volumes of raw data from all kinds of sources: online transactions, emails, social networks, search requests, Internet of Things (IoT) devices, etc. (Tene et al., 2013). Data collected on individuals can be willingly shared by customers (e.g. by specifying date of birth). However, data sharing can also be more obscure (see Figure 1.1), as customers can be identified through their IP address or have cookies installed on their server (Borgesius et al., 2017). Some data brokers specialise in collecting personal information from multiple sources (commercial, government) in order to sell this data to advertising companies.

Volunteered

- Name
- Email address
- Delivery address
- Telephone number
- Date of birth
- Gender
- Survey responses

Observed

- Device and OS
- IP address
- Live user location
- Form of payment
- Speed of click through
- Past purchases

Collected

- Route into website
- Retail purchase
- history
- Browser and search history
- Social media "likes" and posts

Figure 1.1 Mechanisms of data collection

Source: OFT, US Council of Economic Advisors

McKinsey (2011) highlighted that companies store and analyse this data due to the huge added value which can be generated out of it. However, correctly analysing big data to unlock this potential remains the biggest challenge for business and governments.

1.2.2 Price Discrimination in the Age of Big Data

Detailed customer data allows sellers to identify increasingly narrow segments and create price offerings that more precisely approximate a consumer's WTP (i.e. whether it is higher or lower than the listed price). The advent of big data technologies facilitates the collection and analysis of a much larger number of variables describing consumer characteristics and behaviours at a low cost. Firstly, interactions on internet platforms and digital market transactions provide avenues to obtain new types of data (US Council of Economic Advisors, 2015). Secondly, big data enables firms to structure and process high volumes of information so that they can build a complex picture of their customers. Thirdly, sophisticated predictive models have the ability to generate detailed customer segments based on inferences about individuals' valuation of a given product and their level of market engagement (Frontier Economics, 2018). Finally, pricing algorithms are now able to more accurately calculate the optimal price to charge each customer segment.

1.2.3 Big Data and First-Degree Price Discrimination

At present, third-degree price discrimination has been observed to take place on the basis of location, operating system and revealed preferences for luxury products (European Commission, 2018). However, as algorithms increase the level of granularity with which they can identify consumer segments, third-degree price discrimination has begun to evolve towards setting a price for each consumer (Thorne and Wild, 2018). Hannak et al. (2014) used data generated from a controlled experiment and compared it to that of 300 existing users. They found evidence of price discrimination using cookies by four large retailers and five travel sites in the US, with price differences of hundreds of dollars between individual consumers. It is estimated that less than 5 per cent of potentially useful and readily available data is presently employed to inform decision-making (Australian Productivity Commission, 2017). Advances in big data technologies and the introduction of smart devices that generate new data streams will enable firms to refine the precision of price discrimination, to the point where they can closely approximate an individual's reservation price and infer their price sensitivity (Ezrachi and Stucke, 2016).

Experiments have demonstrated the potential to significantly raise profits using behavioural data and pricing algorithms to implement first-degree price discrimination. Shiller (2014) shows that Netflix, under its 2006 DVD home delivery model, could have increased its profitability by 12.2 per cent using customer web browsing data, compared to 0.8 per cent using only standard demographic characteristics. The hypothetical prices calculated range from 22 per cent less than the standard subscription price up to 61 per cent more. He also finds that customers who visited *wikipedia.org* and used the internet during the day on Tuesdays and Thursdays should be charged more. His results highlight the concern that, as data sets grow to encompass more traits, consumers may be unable to identify the factors that single them out as targets for higher prices and modify their behaviour accordingly (Shiller, 2014). The opacity of the criteria used implies that firms may purposefully engage in less transparent forms of discrimination in order to circumvent consumer efforts to avoid detection (Frontier Economics, 2018).

Further, algorithms may lead companies to inadvertently discriminate against protected classes based on seemingly harmless patterns (Bleiberg and West, 2018). Indeed, Ezrachi and Stucke (2016) warn that if the majority of suppliers in any given sector were to develop personalised pricing capabilities, consumers would find it difficult to determine the general market price of a good or service.

1.2.4 Big Data and Competition

Market dominance has been associated with less price discrimination in favour of price-conscious segments, and higher prices for those that are less price-conscious. For example, Bergantino and Capozza (2014) show that Italian airlines offer higher prices to all consumers when there are no available transport alternatives between city pairs, and much lower prices to travellers who plan ahead when facing competition from railways.

Furthermore, disparities in data ownership could create barriers to entry that undermine competitive markets through a distinct mechanism. Lerner (2014) identifies a user-quality feedback loop, where large amounts of data are needed to taylor better services for consumers, and better services in turn attract more users who then provide more data. In the case of price discrimination, firms with market power and a larger share of consumer data could design more sophisticated price discrimination strategies compared to smaller firms. This, in turn, would allow them to offer more competitive pricing structures, effectively creating a barrier to entry because smaller firms with less data would hypothetically be unable to come up with comparably attractive prices. The implication is that big data technologies could turn semi-competitive industries into monopolies.

Recent scholarly analyses of big data and antitrust issues in the context of online platforms argue that data does not create barriers to entry because it is non-rivalrous and non-excludable, and consumers often voluntarily provide several companies in the same industry with their data through simultaneous usage (Lambrecht and Tucker, 2015). However, these arguments may not translate well from online platforms to markets where only a single provider is needed during an extended period of time or products are not sufficiently differentiated. Furthermore, Sokol and Comerford (2016) argue that consumer data is readily available from third party providers, so that new entrants can benefit from insights into consumer preferences even before they start operations. This being said, if data becomes harder to obtain, big data industry experts predict that the cost of quality datasets from third-party providers will rise, which could therefore make it harder for new entrants to compete (Ward, 2018). Overall, the antitrust implications of big data technologies constitute a new issue that the existing literature cannot provide empirical evidence on.

1.3 Obstacles to Implementing Price Discrimination

In spite of the potential profitability of first-degree price discrimination, there is little evidence to suggest that it is widespread in online markets. In 2013, the UK Office of Fair Trading found no indication that first-degree price discrimination was taking place in retail markets at the time, and that companies were more likely to employ search discrimination to show customer segments different goods and services at different price points (Office of Fair Trading, 2013). Indeed, a 2017 e-commerce sector inquiry by the European Commission reported that 87 per cent of retailers surveyed had never employed price discrimination strategies (European Commission, 2017). Moreover, a study conducted by Frontier Economics (2018) found that personalised pricing is not currently taking place in essential markets.

1.3.1 Data Gathering Regulation

Regulation has the ability to disrupt data-gathering efforts, undermining the ability of firms to successfully deploy personalised pricing strategies. Currently, there is widespread use of third-party tracking cookies around the world. Third-party cookies follow user activity across websites to create unique profiles with demographic characteristics and tastes, supporting sophisticated price discrimination strategies. Governments and large tech companies have reacted by restricting such tracking technologies. In April 2016 the European Union published the General Data Protection Regulation (GDPR), aimed at preventing personal data mishandling and restricting the use of tracking tools. This legislation came into force in May 2018. In an initial review, researchers from the Reuters Institute for the Study of Journalism found an associated average decline of 22 per cent in the use of third-party cookies across European news websites between April 2018 and July 2018 (Libert et al., 2018).

Given recent developments, it is likely that acquiring large volumes of high-quality consumer data from third parties will become more difficult. However, companies will still be able to obtain data from other sources including social media, or from first-party cookies that are not subject to GDPR legislation.

1.3.2 Big Data and Privacy

High-profile cases of data mismanagement in recent years, such as the Cambridge Analytica scandal in the US, have fuelled a growing sense of unease among consumers who feel their privacy is being violated and their information is at risk. GDPR responds to this concern by requesting companies to inform their customers in clear and understandable terms exactly how their data will be used (Zuiderveen et al., 2017). Therefore, the new regulation forces sellers to communicate to their customers the existence of personalised pricing strategies. This could deter companies from using personalised pricing. However, the authors note that it might be too early to be optimistic as people may not read privacy notices or companies might decide to proceed with personalised pricing and opt for a "take it or leave it" choice to customers who don't necessarily have a true alternative.

There is arguably a paternalistic need to protect citizens: while consumers dislike price discrimination they are still willing to give up their personal information easily, and the younger generation is the most at risk. In 2015, Accenture found that millennials in the US were more comfortable than baby boomers providing their personal data in exchange for a personalised shopping experience. Young people also seem to value their privacy less than older consumers: 57 per cent of individuals aged 18-24 value their data at less than USD20 compared to 41 per cent of those aged 45-54 (Howe, 2017). McKinsey (2011) urged policymakers to recognize the potential of value creation of big data, and the need to foster an appropriate institutional framework to ensure that firms can create this value without jeopardizing citizens' privacy and data security.

1.3.3 Consumer Backlash Against Personalised Pricing

Different models of inequality aversion exist in the literature on personalised pricing. Fehr et al. (1999) argue that consumers are equally averse to unfairness whether they benefit or suffer from personalised prices, whereas Liaukonite et al. (2015) argue in favour of self-interested inequity aversion, meaning consumers only experience negative feelings when they pay a higher price.

According to Zuiderveen et al. (2017), the general feeling of the public is that personalised pricing is a discriminatory and fundamentally unfair practice; they tend to dislike hidden practices as they feel like they are victims of information asymmetry. They are also likely to suspect that they might be paying a premium on a certain product while completely disregarding the fact that they might actually be enjoying a discount. If consumers do not consider the price as fair, then their level of trust in the company decreases and this can be detrimental for the company's profits (Richards, 2015). Not appearing as unfair will be a challenge of primary importance for companies intending to use personalised pricing.

To conclude, data and algorithms make it possible to construct new price offerings that have made the theoretical model of first-degree price discrimination a reality. How customers, firms and governments adjust to this new world will have significant social and distributional outcomes.

1.4 Price Discrimination in the UK Retail Energy Sector

This section analyses price discrimination in the context of the UK retail energy sector. The sector's market structure is outlined, before analysing current trends and future possibilities for price discrimination.

1.4.1 Market Structure

Although deregulated and opened to competition in the 1990s, given that electricity transmission and distribution are natural monopolies, it has been regulated by Ofgem through price controls. Over the two decades since deregulation, the UK electricity market has been typified by consolidation and vertical integration amongst retailers, customer concerns about rising prices and regulatory interventions to promote competition.

In the subsequent decades following deregulation, the retail energy market has seen firms integrate production and supply through mergers, a process which has resulted in an oligopoly where a few firms each have a 10-20 per cent market share (see Figure 1.2).

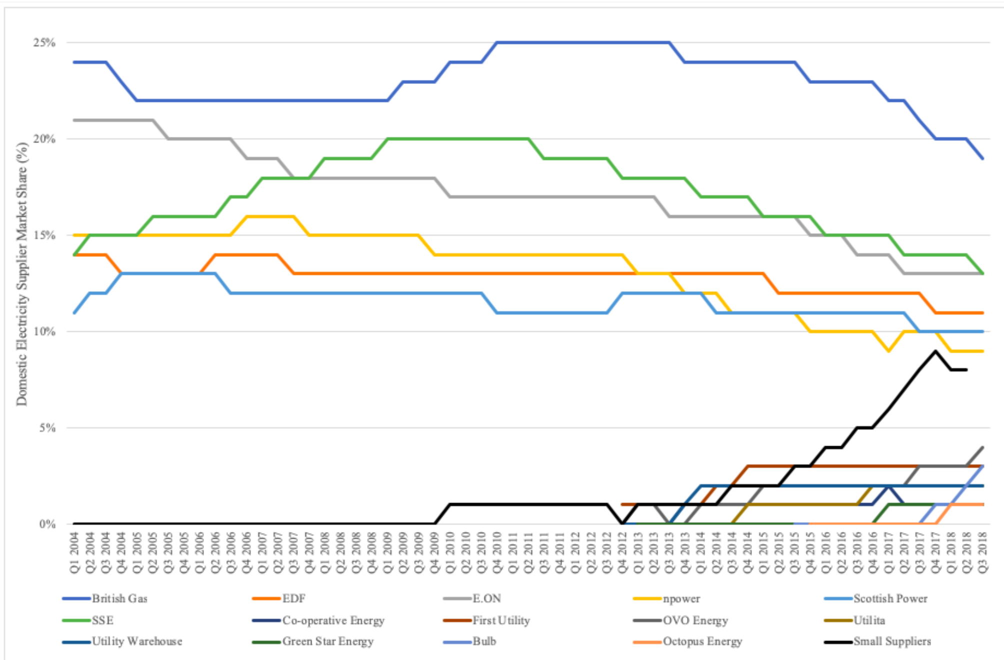

Figure 1.2. Electricity supply market shares by company: Domestic (GB)

Source: Ofgem analysis of electricity distribution reports (information correct as of October 2018)

Rising prices and competitiveness are recurrent concerns that have led the regulator to investigate practices and intervene with varying degrees of success. Between 2003-2008, prices rose 66 per cent which meant that by 2009, 1 in 5 households were spending more than 10 per cent of their income on fuel and were officially ‘fuel poor’. Political pressure resulted in Ofgem’s *Energy Supply Probe*, which found that the big six suppliers were not subject to significant competitive pressure, there was significant differential pricing, and there were barriers to entry and expansion for new suppliers (Ofgem, 2008). Further, ‘vulnerable’ customers made switching mistakes and were largely unable to access the best deals because of difficulties understanding tariff structures (see Figure 1.3). Ofgem proposed the simplification of tariff structures and customer information, and the introduction of smart meters for households to keep track of consumption. In 2014, Ofgem referred the sector to the Competition and Markets Authority (CMA) (Ofgem, 2014). The regulator implemented a price cap in November 2018 to protect default tariff customers.

Vulnerable Consumers

- State pensioners
- Benefit recipients
- Living with child under 5
- Disabled or chronically ill
- Communication, hearing or visually impaired
- Mentally challenged to understand bills

Figure 1.3 Dimensions of vulnerability considered by Ofgem across existing support schemes

Source: Ofgem

On the demand side, policymakers have placed faith in consumers’ ability to switch suppliers in order to increase market competitiveness. Ofgem’s measure of switching rates is based on the percentage of consumers who have compared tariffs or switched energy suppliers in the last 12 months (Ofgem, 2018). Switching is seldom frictionless, as consumers exert effort conducting research and, depending on the product or service, interacting with suppliers to complete the switching transaction. A consumer will switch when the effort cost is lower than the perceived gain. There is a significant number of customers staying on with legacy suppliers resulting in a lessening of competitive pressure. Further, the current 54 per cent of consumers sitting on default tariffs has dismayed policymakers (Ofgem, 2018). Finally, energy tariff comparison websites supposed to help consumers find the best prices are complicated to navigate and are seldom unbiased, which has resulted in a loss of public trust and recent regulator probes (CMA, 2016).

Moreover, consumer inattention to yearly tariff increases allows energy providers to extract growing sums over time in what is known as 'price walking' (CMA, 2018). This results in consumers who don't switch often incurring a 'loyalty penalty', where they stay with the same provider and are subsequently penalised through higher fees in later contracts. This phenomenon is not isolated to the energy industry. Citizens Advice (2017) notes that the loyalty penalty for broadband customers, a good utilised by 86 per cent of UK adults, is GBP113 p/year after the initial contract elapses.

1.4.2 Current Trends of Price Discrimination in the UK Energy Sector

Dynamic pricing[2] in the energy sector is widely considered a more economically efficient pricing scheme than the traditional 'flat rate' pricing method due to the highly variable marginal costs in the energy sector as a result of varying demand. While a huge capacity is required to meet the peak load, this peak load capacity is idle during off-peak periods resulting in a loss in efficiency (Dutta & Mitra, 2017). Indeed, Khan (1970) demonstrated that differential prices reduce peak demand and the need to build enough capacity to meet it, leading to an overall increase in economic welfare. Furthermore, Pagani and Aiello (2015) argue that dynamic pricing enhances total revenue at existing costs and reduces peak loads, producing positive monetary and energy savings.

Whilst the economic argument for dynamic pricing is consistent throughout the literature, the impact on consumer welfare is less clear. Borenstein (2007) finds the impact of switching from a flat rate to dynamic pricing increases consumer bills between 4-8 per cent and compensating transfers are necessary to support those left worse-off. Faruqui et

[2] A particular form of price setting, whereby firms set flexible prices for products and services in response to current market conditions.

al. (2012) that price-responsive individuals benefit from dynamic pricing, but energy bills rise considerably for those with unchanging patterns.

Price penalties for unresponsive customers are worrying given that low-income groups have been found to be less responsive to dynamic pricing, due to their reduced ability to change consumption habits (Wang et al., 2011). Joaskow and Wolfran (2012) cite the fear of inequalities in energy expenditure as the largest impediment to the implementation of dynamic pricing, with less responsive customers essentially subsidising those who are responsive.

Due to the equity and fairness concerns about moving from uniform prices towards price discrimination within the energy sector, there have been a number of attempts to regulate prices. However, Ofgem's attempt to tackle 'unfair' price differentials in 2009 was strongly criticised by academics, on the grounds of adverse effect on competition to the detriment of British consumers (Crampes & Laffont, 2015). The next big reform to the energy market will be the roll-out of smart meters by electricity suppliers to domestic and small business customers by 2020 which is estimated to result in a net benefit of GBP5,476m (Ofgem, 2019). Although there is no personalised pricing in the energy market at this point, market segmentation takes place on the basis of payment methods, length of contract, demand for multiple services and more recently, through the channels by which the customer interacts with suppliers.

With the introduction of smart meters, suppliers may be able to access yet more data about energy consumption from individualised households, thereby increasing their ability to price customers differentially. Indeed, Frontier Economics (2018) predict exactly this outcome as the collected data will provide sophisticated information on usage patterns to suppliers and facilitate greater customer segmentation.

1.4.3 Personalised Pricing in the UK Retail Energy Sector

It is unclear whether suppliers will be able to infer anything further about an individual's willingness to pay from smart meter data alone, given that consumers need to opt-in to share detailed time of use data. However, the scope for personalised pricing greatly increases upon consideration of inter-connected home technologies, such as gateway products like Amazon's Alexa and the increasing home applications of the IoT. Ross

(2018) argues that digitalisation is permeating every aspect of the energy sector, and that technological developments will likely transform how consumers engage and how firms compete.

It is imperative to consider the potential impact of personalised pricing on market competition and consumer outcomes. Thorne and Wilde (2018) find that personalised pricing may lead to lower prices for some consumers, where the suppliers are able to undercut their competitors by charging the lowest possible price for each particular consumer. They also suggest that with an improved ability for companies to assess WTP, previously loss-making firms may be able to enter and turn a profit in the market, offering greater choice and variety to consumers and improving market competition. Frontier Economics (2018) supports the notion that personalised pricing could facilitate competition between energy suppliers.

Nevertheless, there is a risk that personalised pricing negatively affects competition. Personalised pricing will likely be reliant on access to detailed consumer data sets that potential entrants may not have access to and which would limit their ability to effectively price consumers (Thorne & Wilde, 2018). The risk to competition could be exacerbated by the concentration of data within a small number of platforms (e.g. Google and Facebook). The use of smart connected devices in homes tends to rely on one of these providers who, were they to partner with a major energy supplier, could push other energy firms out of the market (Thorne & Wilde, 2018).

There is also a series of concerns regarding consumer outcomes. Currently consumers who do not switch providers tend to be charged a 'loyalty penalty', with 62 per cent of energy providers charging their loyal customers more than their new customers (Citizens Advice, 2017). Thorne and Wilde (2018) suggest that personalised pricing may exacerbate this problem by making it easier to identify those who are less likely to switch, which could be exacerbated by complex bundled contracts. A second consideration is consumer trust which is negatively impacted by fluctuating prices and an increase in the perceived number of tariff deals (Pavlou et al., 2007). A lack of trust may deter consumers from switching providers, further exacerbating the problem of inertia (Thorne & Wilde, 2018). As vulnerable consumers are the most likely to remain with their provider (Plunkett, 2018) and tend to have lower levels of trust in consumer markets there are genuine distributional concerns associated with the impact of personalised pricing on consumer outcomes (Citizens Advice, 2018).

Overall, the potential benefits of personalised pricing include market efficiencies and the potential for increased competition, however the literature highlights legitimate concerns about distributional effects. Whilst there is mixed evidence on the effect of regulation, it is imperative that policies bear in mind those who are more vulnerable and less engaged in the market.

2. Model

We have developed a supply and demand model of the digitalised UK retail energy market in 2025 examine its social and distributional outcomes. This section first outlines the model and then discusses its key outcomes for consumers and firms.

2.1 Model of a Digitalised UK Retail Energy Market

2.1.1 Demand-Side Analysis

The demand-side considers two essential dimensions of consumer characteristics: market engagement and wealth. Market engagement captures the extent to which consumers are active in the market. Active consumers are defined as those that have compared their current tariff to market offers or have switched tariffs in the last 12 months. This definition aligns with Ofgem's view of an engaged customer (Ofgem, 2018). Passive consumers are those unwilling and/or unable to seek better offers, compare them, and change their tariff plan under the same supplier or change supplier altogether. This includes consumers experiencing some dimension of vulnerability that prevents them from engaging.

Wealth differentiates between higher and lower ability to pay. Rich consumers are those whose energy bills constitute a very small proportion of their income, and therefore price is less salient to them. Price is a concern for poor consumers.

These characteristics yield four stylised consumer types to frame our demand-side analysis: Type 1 are rich-passive; Type 2 are poor-active; Type 3 are rich-active; and, finally, Type 4 are poor-passive (see Figure 2.1).

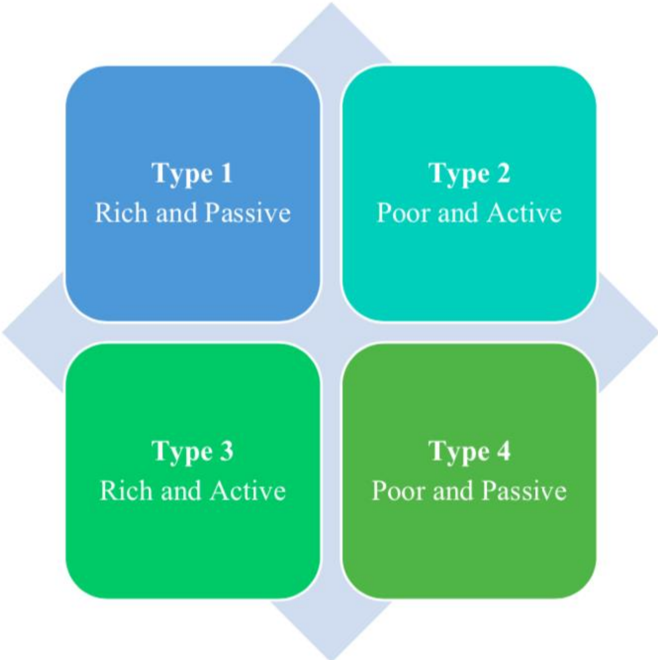

Figure 2.1. Consumer categorisation

2.1.2 Supply-Side Analysis

The supply-side analysis focuses on the role of data and how it allows firms to price customers in 2025. We make the following assumptions:

- Perfect price discrimination: sufficient data exists for each customer that firms can perfectly price discriminate at the individual level on the basis of wealth and market engagement;
- Increasing returns to scale to data/algorithms: being a network economy, firms' use of data and algorithms exhibits initially increasing returns whereby obtaining data on the 51st customer (and hence pricing them perfectly) is easier than the 50th customer; this effect exists initially until it desists at point x;
- Customer group sizes are not equal: Types 1-4 are not of the same size;
- Two types of data - D_r is data from rich people and D_p is data from poor people: a rich customer's data helps the firm price both rich-active (T1) and rich-passive

(T4) and a poor customer's data helps the firm price both poor-active (T2) and poor-passive (T3). This means that the value of data is wealth-based;

- Two types of firms - incumbent and new entrants: both of which have standard upward-sloping supply curves;
- Energy product is homogeneous: all suppliers provide the same energy product with similar level of services such that price is the only criterion for consumer decision-making; and
- Marginal cost of supplying each customer type is uniform.

Firms gain rent (R) from each customer type. This is equal to price (P) - marginal cost (MC). The price charged is a function of the data (D) gathered from each type of customer; as such, the price charged to rich customers is higher than that charged to poor customers.

(1) $R = P(D) - MC$

(2) $P_r = F(D_r); P_p = F(D_p)$

Therefore, e.g., $R_r = P(D_r) - MC$

Firms derive value (V) from each customer type.

(3) $V_1 = \text{value from Type 1} = R_1(D_r) + D_r$

(4) $V_2 = \text{value from Type 2} = R_2(D_p) + D_p$

(5) $V_3 = \text{value from Type 3} = R_3(D_r) + D_r$

(6) $V_4 = \text{value from Type 4} = R_4(D_p) + D_p$

Importantly, the value of data from a rich customer is greater than the value from a poor customer due to the higher price a firm can charge a rich customer.

(7) $V(D_r) > V(D_p)$

Firm profit is the cumulative of the consumer rents; profit maximisation is the first derivative of the profit equation (8).

(8) $\boldsymbol{\pi} = \sum R = R_1 + R_2 + R_3 + R_4$

(9) *Max* $\boldsymbol{\pi}$ when $\partial \boldsymbol{\pi} = 0$

As the subsequent analysis of the consumer types demonstrates, we assume the market for Type 2 and 3 customers will be perfectly competitive due to their engagement levels, while the market for Type 1 and 4 customers will be characterised by economic rents.

2.2 Consumer Outcomes

2.2.1 Type 1 - Rich and Passive

When considering the price and welfare outcomes for Type 1 consumers we utilise a standard monopoly model. The intuition is that whilst there is not literally one monopoly electricity supplier in the market, given the characteristics of our Type 1 consumer, they will remain loyal to their supplier and therefore essentially face just one firm.

The standard monopoly market is where one firm dominates the market for a good that has no close substitutes and where barriers to entry exist. Assuming the monopoly is a profit maximiser, quantity supplied tends to be lower than the perfectly competitive amount, and prices higher.

An electricity supplier that has perfect information from the available data (Dr) is able to identify Type 1 consumers as those able to afford premium prices and to not actively compare prices to others in the market; thus unlikely to reject marginally higher prices. While additional firms do exist in the market and substitutes are available (energy from another provider), the Type 1 consumer is passive and does not consider alternative options. The supplier is therefore able to act as if they have monopoly power when making pricing decisions for Type 1 consumers; prices can be hiked above the competitive market level.

Higher prices under a monopoly structure naturally benefit producers to the detriment of consumers. The degree to which producers gains at the expense of consumers can be understood by using the concept of consumer and producer surplus. Figure 2.2a shows consumer and producer surplus for the perfectly competitive market, reaching equilibrium where supply and demand intersect at Q_{pc} and charging P_{pc}. Consumer surplus is shown by area a and producer surplus by area b. In Figure 2.2b, output is restricted to Q_m, and the price has increased to Pm. As a result, aggregate consumer surplus shrinks from A to a much smaller area V. Producer surplus on the other hand expands from B under perfect competition to the much larger area of *W+Y*.

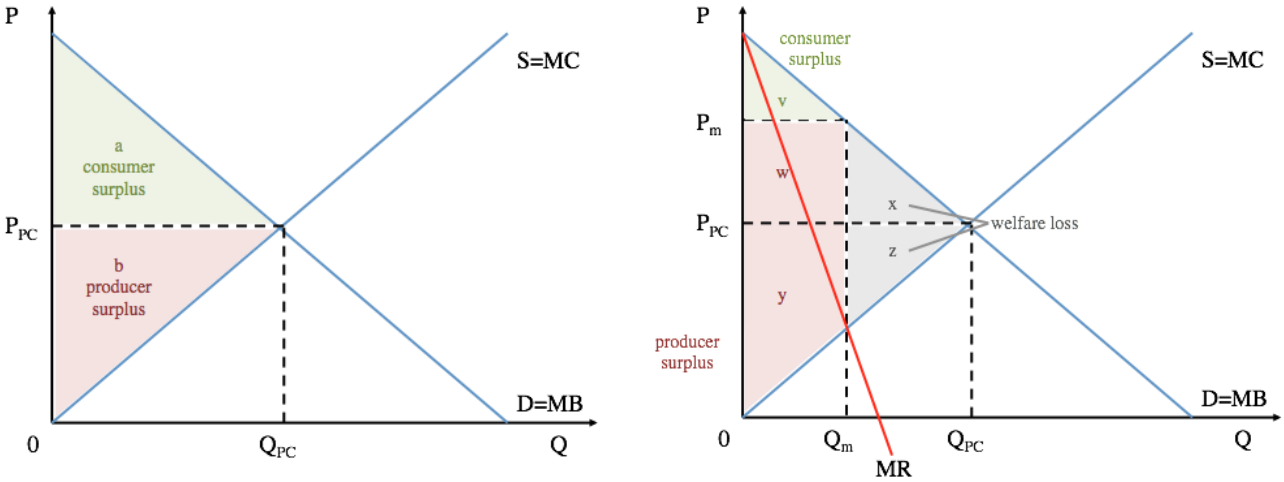

Figure 2.2 a) Surplus in a perfectly competitive market; b) Surplus and welfare loss in a monopoly

The more data this firm is able to collect, the more easily it will be able to separate its customers and estimate individual elasticities of demand. As such it will become possible for the firm to charge each individual their own reservation price; a personalised price for electricity without fear of losing market share.

In terms of consumer surplus, this is the worst possible outcome. Figure 2.3 demonstrates how, when a firm is able to charge different consumers individual prices, consumer surplus is essentially eradicated. All consumer surplus is transferred to producers, who enjoy greater producer surplus. Also shown in Figure 2.3 is the complete reduction of deadweight loss; this is in contrast to a standard monopoly model whereby welfare loss to society exists as a result of restricted supply.

Overall, then, whilst personalised pricing for Type 1 consumers could result in an overall reduction in welfare loss to society, Type 1 consumers are clearly disadvantaged in terms of a complete reduction in the consumer surplus.

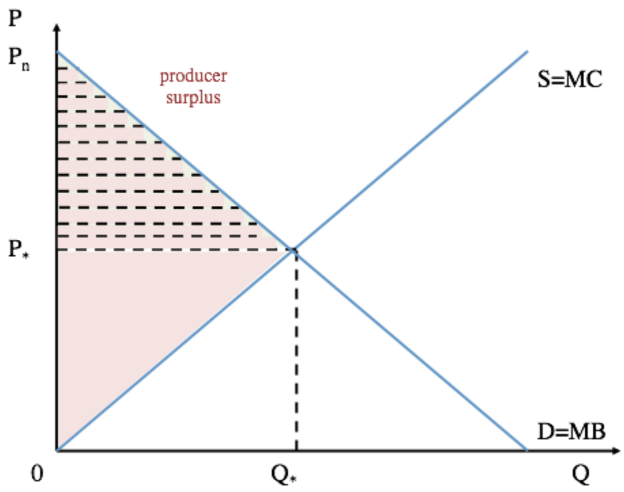

Figure 2.3 Producer surplus of supplying Type 1 consumers

2.2.2 Type 2 - Poor and Active

Looking at Type 2 consumers, the energy market theoretically behaves as if it were perfectly competitive. Indeed, it is assumed that there is no barrier to switching provider and that the consumer dynamically chooses which company will sell them electricity.

The firms know the preferences of the consumers and their propensity to switch. Consumers actively compare providers, are fully aware of the market price, and will not accept to be charged any higher. Producers therefore charge a price equal to the marginal cost. Despite not being able to obtain any monopoly rents off the Type 2 consumers, Type 2 consumers are still valuable from the point of view of the firm due to the data they generate (D_p) which can be directly used to extract rents from Type 2's passive countertype: Type 4.

In the case of poor-active consumers, welfare is shared between producers (b) and consumers (a) (Figure 2.4) and the share is based on the elasticity of the demand and supply curves.

Overall, Type 2 consumers have the potential to obtain consumer surplus, as do producers, and there exists no deadweight loss to society.

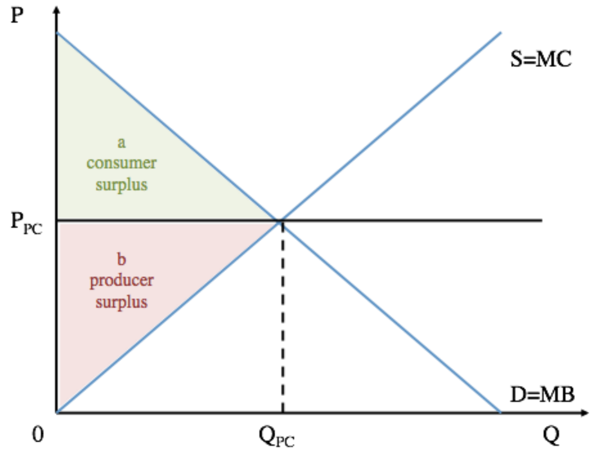

Figure 2.4 Welfare outcome for Type 2 consumers

2.2.3 Type 3 - Rich and Active

Type 3 consumers are characterised by their high ability to pay and high levels of engagement with the energy market, so that they recurrently compare tariffs and switch plans offered by the same provider or switch providers altogether. They are able and willing to research tariffs, understand the information they read and spend time interacting with providers to access the lower per unit tariff. These consumers are less concerned about prices than poorer consumers because energy bills do not represent a significant proportion of their budgets, so their demand curve will differ from that of Type 2 individuals.

Type 3 consumers will face a near perfectly competitive market. Their ability to pay exerts an upward pressure on the price suppliers will offer, whereas their high level of engagement means the threat of switching exerts a downward pressure. The prices they face, therefore, converge towards the prices that Type 2 consumers face. However, data allows firms to classify them as rich (D_r), so they may be able to charge somewhat higher prices compared to the price Type 2 consumers face, reflecting differences in ability to pay. While there is little economic rent from Type 3 customers, their D_r data allows the firm to extract rents from Type 3's passive countertype: Type 1.

The relatively competitive nature of the market faced by Type 3 consumers limits the extent to which the firm can appropriate consumer surplus. As compared to their passive counterparts (Type 1 consumers), Type 3 will have greater consumer surplus. As with Type 2 consumers, firms still gain some value from Type 3 consumers, despite the relative inability to extract rents. Type 3 consumers provide valuable information on Type 1 consumers, and enable firms to extract further rents from this passive subgroup.

2.2.4 Type 4 - Poor and Passive

Type 4 customers are typified by a low ability to pay and low activity in the energy market, due to their unwillingness and/or inability to engage. The model predicts disadvantaged-passive individuals will also face a monopoly-like market structure where their provider can offer uncompetitive prices, knowing they will fail to test them against the market and so will not switch to different tariffs or providers.

Due to the salience of electricity bills as a proportion of the budget of a Type 4 consumer, it is highly likely that the prices they face will be lower than those that Type 1 (rich-passive) consumers face. Firms know that they can only pay limited amounts, and will set reservation prices within a range that is not sufficiently high to spark consumer concern and activate behavioural change. However, it is also very likely that the prices that poor-passive consumers face will be higher than the prices that rich-active individuals will have access to because these two types of consumers transact within different market structures. As a result, consumer surplus for this group is lower than for their active counterparts (Type 2 consumers) and firms supplying these consumers capture a large producer surplus.

2.3 Firm Outcomes

Our model predicts a number of significant outcomes for suppliers. First, access to data is a necessary condition to supply. New entrant firms must have data to compete but this will not be sufficient for them to remain competitive in the market. This also means that data is a barrier to entry, which has important consequences for market structure.

Second, firms will supply all customers. For example, firms will supply Type 2 customers even though $R_2 = 0$, since this market is perfectly competitive. The benefit to supplying Type 2 customers comes for the data on poor customers (D_p) that will be gathered, meaning that $V_2 > 0$, and allows the firm to better price Type 4 customers (poor-passive, $V_4>0$). This reasoning applies equally to the Type 1 and Type 3 pair of customers. While all customers receive access to tariffs and therefore energy supply, this does not prevent the exploitation of customers through higher pricing.

Third, firms might try to price their Type 2 and Type 3 customers below price in order to win these competitive markets characterised by active consumers. This will have several effects. First, while the tariff price-gap between active and passive customers will be larger than present, the extent of this pricing strategy is naturally limited by the size of the rents captured from passive customers to cross-subsidise the active customers. Second, if incumbent firms engage in this strategy, it will prevent new entrants from establishing a market share. Incumbent firms that are able to win the Type 2 and Type 3 markets with below-cost pricing will have access to data that negates firm entry (new entrant firms find it difficult to gain passive customers due to their lack of market engagement). Third, an incumbent firm pricing below-cost also has negative outcomes for other existing firms; they will lose active customers and, importantly, their data, which allows them to price their passive counterparts more effectively. Below-cost pricing can affect market concentration, resulting in an unambiguously worse outcome for all consumers if the market moves towards an oligopolistic or even monopolistic structure that can also extract rents from Type 2 and 3 consumers.

2.4 Model Hypotheses

Based on this model, we formulated the following three hypotheses which were tested through our qualitative data gathered from energy industry stakeholder interviews:

H1: Energy suppliers in the retail market will charge affluent consumers more than poor consumers at the same level of market engagement.

H2: Energy suppliers in the retail market will charge passive consumers more than active consumers; as a result the former will experience a larger reduction in consumer surplus.

H3: Market engagement is a more salient feature for a firm's pricing decisions than consumer ability to pay.

3. Methodology

In order to test the model and improve our understanding of market dynamics, we conducted a series of interviews with stakeholders working in the UK energy sector. This section outlines our interview methodology and qualitative data.

3.1 Methods of Data Collection

Interviews took place over a two-week period in early February. A total of eight interviews were conducted (see Table 3.1); each interview last between 30-60 minutes, was recorded with audio equipment and transcribed using software. This was done in compliance with LSE Research Ethics and Data Management procedures.

We structured the interviews using Yale University's guidance on qualitative research methods and collected a mix of both quantitative and quantitative results (Yale University, 2015). Ahead of the interview, each interviewee was provided with a brief summary of the project and its research objectives. This document was carefully drafted to give the interviewee sufficient information about the project but did not include information about the model to avoid biasing their answers.

Interviews were conducted in three parts:

1. In Part 1, all interviewees were asked a series of four standardised generic questions on price discrimination in the UK energy sector to obtain insights on the broad themes of the project (outlined in Section 3.2). The four questions were designed such that interviewees were asked to firstly answer freely, and subsequently answer on a scale of 1 to 4. Asking standardised questions on a scale allowed us to quantify our understanding of stakeholders' positions across interviewees.

2. In Part 2, interviewees were asked a list of 6 to 8 open questions based on their expertise. The objective was to cover the key issues we identified in order to enrich the model, including regulation, data, market structure, consumer types, welfare effects, IoT and algorithms.

3. In Part 3, we sought the interviewees' feedback on the model. Interviewees were provided with a one-page summary of the model. This allowed us to have an in-

depth discussion of the market structures that consumer types face, and the relative importance of economic status and engagement in pricing decisions.

Quantitative data collected in Part 1 of the interview is analysed in Section 3.2. Data collected in Parts 2 and 3 has been used to inform our discussion of the model's implications in Sections 4 and 5. A summary of the interviewees, their organisation and the main themes discussed is presented below:

Interviewee	Position and Organisation	Themes
Mark Caines	Partner, Flint Global	Data democratisation, consumer types, regulator behaviour
Source (Individual 1)	Senior academic in energy policy	Regulation, market structure, role of digitalisation
Tania Burchardt	Director, Centre for Analysis of Social Exclusion (CASE)	Welfare effects, consumer types, regulation
Source (Individual 2)	Leading UK energy supplier	Price discrimination, data democratisation, smart meters/IoT
Ben Shafran	Principal Consultant, CEPA	Welfare effects, regulation, smart meters/IoT
Alexander Belsham-Harris	Principal Policy Manager, Citizens Advice	Switching, consumer types, regulation
Phil O'Donnell	Head of Policy, Which?	Regulation, consumer behaviour, welfare effects
Pantelis Solomon	Principal Advisor, Behavioural Insights Team	Consumer behaviour, switching, welfare effects

Table 3.1 Interviewed stakeholders

3.2 Quantitative Data

The following questions were asked to all interviewees in Part 1 of the interviews:

1. How advanced will price discrimination in the UK energy market be by 2025?

- On a scale of 1-4, 1 = very poorly; 2 = poorly; 3 = advanced; and 4 = very advanced

2. How competitive is the market current?

- On a scale of 1-4, 1 = monopolistic; 2 = oligopolistic; 3 = competitive; and 4 = perfectly competitive

3. How positive in terms of welfare are the effects of price discrimination?

- On a scale of 1-4, 1 = very detrimental; 2 = detrimental; 3 = beneficial; 4 = very beneficial

4. How well will the regulator be able to affect the market in 2025?

- On a scale of 1-4, 1 = very poorly; 2 = poorly; 3 = well; 4 = very well

The panel below summarises the mean score and standard deviation for each question.

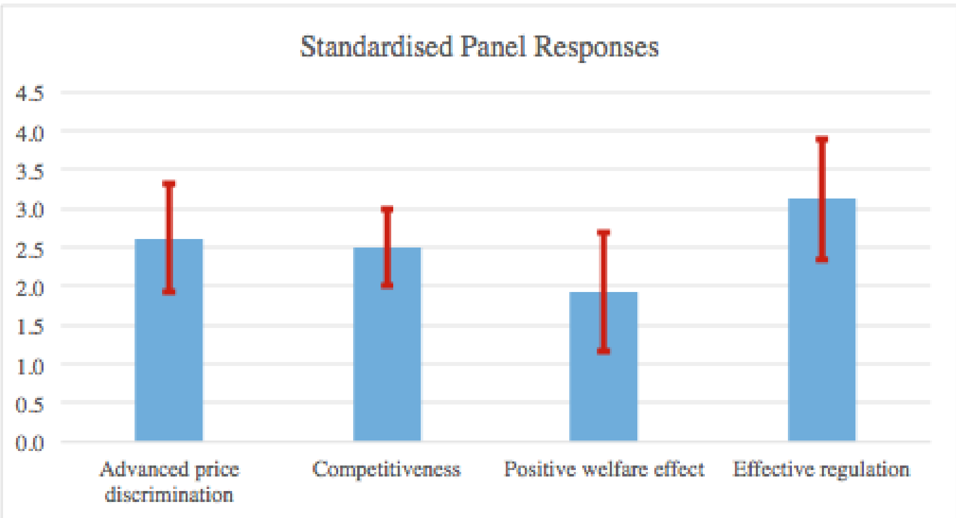

Figure 3.1 Quantitative analysis of Part 1 answers

Several conclusions can be drawn from this quantitative analysis. First, the panel globally expects price discrimination to be quite advanced by 2025. While this will not necessarily be a very sophisticated type of price discrimination, energy providers should be able to discriminate based on the inferred level of engagement of consumers. The less an individual is likely to be able or willing to switch provider, the higher the price they will face. Indeed, most interviewees agreed that there is already a fair amount of price discrimination in the energy retail market in 2019 and that this phenomenon will only increase.

Second, the panel views today's market as quite competitive. This is an interesting result: interviewees consider that consumers have some ability to switch which makes the market rather competitive. Remarkably, most stakeholders have a similar view on that question and the standard deviation is the smallest amongst all questions. Ben Shafran, from CEPA, argued that while "[transmission and distribution] were a natural monopoly, the wholesale market is reasonably competitive" (07.02.19; 10:00).

Third, the overall welfare effects of price discrimination are largely seen as negative by the interviewees. Several stakeholders highlighted the vulnerability of certain segments of the market with no ability to switch providers. For Ben Shafran, some groups of consumers "have got [a] really good deal" while other groups "have got less favourable deals" (07.02.19; 10:00). For Mark Caines, Partner at Flint Global, "the benefit is great for the customers that have switched, [they] get lower prices. For them [the overall welfare effect] is 4 [very beneficial], but for the ones who haven't switched it's 1 [very detrimental]" (31.01.19; 16:00).

Finally, another remarkable result is the high level of trust expressed by the panel in the regulator's ability to intervene in the market by 2025. This is also an important result: if price discrimination is enabled by powerful algorithms to treat data efficiently, it is notable that stakeholders believe that the regulator will be able to keep pace with well-endowed energy companies. When asked about whether the public regulator will be able to intervene in the market in 2025, Tania Burchardt, Director of CASE at LSE, answered without any ambiguity that "they always have done" and [she] "fully anticipate[s] they will be able to do so in the future" (05.02.19; 10:00). This is an encouraging conclusion which highlights the importance of well-designed policy recommendations.

4. Qualitative Analysis

This section tests our model hypotheses with the qualitative data from stakeholder interviews. This allows us to draw conclusions about the social and distributional outcomes of digitalisation across consumer types and energy suppliers.

4.1 Responses to Model Hypotheses

4.1.1 Response to Hypothesis 1

Energy suppliers in the retail market will charge affluent consumers more than poor consumers.

To our surprise, based on our interview data, we can neither confirm nor deny Hypothesis 1, indeed there is no straightforward answer to this question. On one hand, one could think that consumers with a higher ability to pay would be targeted by energy providers to pay a higher price; as predicted by our model. On the other hand, the interviews revealed that poor consumers may be considered a burden to firms who have a duty to supply them.

Alex Belsham-Harris, from Citizens Advice, highlighted the importance of fixed costs in the energy market: “If you're a poor consumer living in exactly the same house as next door, the network costs are the same. That fixed element will be the same [while] using fewer units of energy. And generally, if you're richer and you’re a higher energy user than you might get a better deal” (08.02.19; 09:00).

Questioning whether poor-active consumers (Type 2) will face a competitive market, a senior academic in energy policy observed that this would only happen “if and only if, more companies are willing to offer the minimum tariff because many companies just won’t want [poor consumers] because they can't take a margin off them” (Individual 1; 04.02.19; 15:30). Another interesting point raised by this academic is that poorer consumers do not necessarily look for the lowest price but rather for the most stable one: consumers who face difficulties paying their bills need to be sure their energy bill will not fluctuate. Hence, poor consumers might be willing to pay a premium for price security.

Tania Burchardt highlighted the risky profile of poorer customers, suggesting that they might end up paying more than rich ones. Risks include customers either being repeatedly late in paying bills or simply failing to pay. (05.02.19; 10:00). In her opinion, “energy companies for a long time have used prepayment meters where consumers have been judged to be on low income and perhaps not able to reliably pay bills... Those are often set at much higher rates. [They are] presented as a discount for direct debit but in effect it is a charge for paying in advance” (05.02.19; 10:00).

Overall, it seems that evidence is mixed regarding Hypothesis 1, and that disadvantaged consumers with a lower ability to pay are not necessarily charged less than affluent consumers.

4.1.2 Response to Hypothesis 2

Energy suppliers in the retail market will charge passive consumers more than active consumers; as a result, the former will experience a larger reduction in consumer surplus.

Our interview process underscored the salience of market engagement as a driving factor for firms undertaking sophisticated price discrimination strategies. Alex Belsham-Harris discussed how “energy companies have been trying to price their disengaged customers to a level where they’re getting more money from them, but not to the point they want to leave.” This situation has improved in recent years, with larger firms losing market share due to increased customer engagement. However, “we'll still be seeing obviously quite a large number [of consumers] who don’t engage.” (08.02.2019; 10:00).

When discussing the dynamics of loyalty penalties, Ben Shafran acknowledges that “you can imagine a scenario where because a large segment of the market is disengaged that things can happen to them without them realizing.” (07.02.19; 10:00) For example, failing to re-evaluate tariffs at the end of a 12-month contract could cause a passive consumer to be moved to a “less favorable deal”. Furthermore, a senior academic in energy policy clearly foresaw firms delivering a “full-fat-gold-package” to Type 1 (rich-passive) consumers; taking advantage of their disengagement and their high ability to pay (04.02.19; 15:30). Consequently, in terms of welfare outcomes, as highlighted by Mark Caines, “customers that have switched have benefited from lower prices, whereas those who aren’t switching have not.” (31.01.19; 16:00).

Indeed, market disengagement was one of the recurrent concerns from the different interviewees, regarding the effects of price discrimination and its potential pernicious effect on consumer welfare. Phil O'Donell from Which? provided a consumer protection perspective, stressing that "what we tend to see in the data is that those people who have switched find it quite easy and convenient...and those who haven't switched tend to perceive it to be very difficult and very risky" (13.02.19; 09:00). Suppliers can increasingly exploit this latter view on switching, as they will be better able to identify passive consumers using data.

In an increasingly digitalised market, Ben Shafran noted that the benefits might not reach the "second group of consumers who tend to be financially less stable and less interested in the energy sector" and so "personalisation and all the new services that digitisation can offer, [will be available] to just that one engaged segment of the market." (07.02.2019; 10:00). Thus, the potential transformative benefits of market digitalisation go hand-in-hand with market engagement.

4.1.3 Response to Hypothesis 3

Market engagement is a more salient feature for a firm's pricing decisions than consumer ability to pay.

An important result from our model establishes that consumer engagement is potentially a stronger determinant of the price offers that suppliers make than ability to pay. Passive consumers interact with their suppliers under a monopoly-like structure, whereas active consumers do so under a competitive market structure that keep prices low. This means that firms can raise prices for passive consumers regardless of their wealth status up to the point where they infer individuals will be incentivised to engage.

When asked whether engagement is a more salient factor in pricing decisions than ability to pay, Alex Belsham-Harris coincided that "[market activity is] what's driven companies to price the way they have, having much higher prices for disengaged customers than engaged [ones]" (08.02.2019; 10:00). Moreover, Mark Caines explained that "the [pricing] choice is driven by passive versus active, [and] social considerations are driven by rich versus the poor." He added, "while it may be true that you would expect poor customers to get slightly lower prices, I'm not convinced that they necessarily would if they are passive” (31.01.19; 16:00).

While engagement may be a more salient feature in the pricing decision than ability to pay, there is an interaction that makes poor and passive consumers vulnerable to exploitation. Tania Burchardt points out there is a significant correlation between low engagement and disadvantage. This means that those targeted by price discrimination strategies will not only be those who don’t engage out of choice even if they have every opportunity to do so (05.02.19; 10:00).

4.2 Engagement and Ability-to-Pay Implications for Consumer Types

The interviewees identified a relationship between rich and active status, predicting Type 3 consumers will be better positioned to engage with the digitalised markets of the future. For instance, Citizens Advice emphasized that "better-off consumers are actually much more active and they are more interested in switching and even though it's a very small saving for them comparatively" (08.02.19; 09:00).

Mark Caines underscored the importance of the wider socio-political argument around market engagement as a factor in price discrimination. He questioned the sustainability of this approach: "Is it okay that somebody who is well paid and educated and is capable of switching… pays 20 per cent less for energy, [while] somebody who isn't so well off doesn't switch because they find it difficult? That's not a good outcome for society" (31.01.19; 16:00).

The stakeholders interviewed shed light on various reasons why, in practice, poor-passive (Type 4) consumers face significant barriers to engaging with the market and so are adversely affected by price discrimination. Ben Shafran observed that even though "price discrimination is probably net positive for consumers in total", "price discrimination in the energy sector, with energy being an essential service, has adversely affected the consumer groups who are most vulnerable." (07.02.19; 10:00).

Ms Burchardt highlighted that some of the main reasons why consumers don't engage with the market are closely related to various dimensions of vulnerability (05.02.19; 10:00). Whereas some passive consumers are simply bored by the idea of contacting their supplier and "don't want to make the time", others are effectively time poor because they are "working extremely long hours or multiple jobs or juggling childcare". Moreover, she explained that "older consumers are less likely to engage in switching behaviours and may be less competent in dealing with some of the internet-based interfaces than some of the younger consumers." Given that a large proportion of pensioners in the UK live on limited incomes and are significantly affected by rises in energy prices, she expressed concern about them as a group that would particularly suffer from personalised pricing strategies (05.02.19; 10:00).

Alex Belsham-Harris agreed, saying that "poor consumers are less likely to switch. They generally are probably paying too much for their energy and... they're less likely to engage in the market… [or] to switch than their better off neighbours." He stressed the importance of the internet as an instrument to effectively engage with the energy market. Firstly, he explained that "there's a significant minority of the population who don't have Internet access or wouldn't know how to use a comparison website, and they're not really designed with those consumers in mind" (08.02.2019; 10:00). According to him, this includes older people, individuals from lower socio-economic groups and rural populations with low levels of internet penetration. Director Burchardt also mentioned that the lack of access to the internet from a computer can act as a barrier, given that many websites are too complicated to navigate from a smartphone and many poor consumers do not own computers.

Further, Alex Belsham-Harris speculated that customers will "probably see even more requirements to be online to really successfully engage in the energy market" (08.02.19; 09:00), including the use of smart time-of-use tariffs and IoT devices. This represents a challenge for vulnerable consumers due to the fact that "energy is a service with a universal service obligation, everyone has a right to access that service, whereas we don't have universal service obligation yet for the Internet." The connection between these two markets implies that without a "base level" of internet access, consumers who are not online will increasingly struggle to become active in the future because of technological advances they can't access.

Overall, Type 4 consumers experience significant difficulties to engage with the market because their passivity can be largely explained by their socio-economic status. Based on our interviews, it is possible to say that these barriers will be exacerbated by future technological developments.

4.3 Overall Outcomes for Consumers and Suppliers

Consumer Outcomes	Supplier Outcomes
All consumers will be serviced and have access to energy.	All consumer types will be serviced as firms will gain some market benefits from full provision. This is due to the positive value gained from Types 2 and 3's data despite not being able to extract rents due to perfect competition.
Active consumers (Types 2 and 3) are best placed to achieve the most competitive price and best welfare outcomes in terms of consumer surplus from a digitalised energy market.	Producer surplus is positive, though not maximised, for firms when servicing active consumers as they operate in a perfectly competitive market structure. Firms may even choose to run at a loss to service these consumers as they provide valuable information on their passive countertypes (Types 1 and 4). This may reduce competition in the market. Their ability to price at a loss will depend on their size and relative power in the market, as well as the regulatory restrictions put in place.
Passive consumers (Types 1 and 4) will be charged a price above the competitive price and will have less consumer surplus than their active countertypes.	Firms will price customers with low engagement right up to the point before switching, thereby maximising their producer surplus.
The gap between the prices faced by active consumers and passive consumers will rise in light of the additional data available to firms.	Firms will charge increasingly different prices to their active and passive consumers.
Rich-passive consumers (Type 1) will face the highest prices based on their high ability to pay and low	Firms will gain the most profit and producer surplus from servicing affluent-passive (Type 1) consumers. Firms will try to increase their pool of Type 1 consumers, as well as Type 3

engagement in the market. Their consumer surplus will be reduced to essentially zero.	consumers given that their data will better inform the preferences and characteristics of Type 1.
Vulnerable customers stand to lose the most from digitalisation as they are less able to engage and thus reap the potential benefits.	Innovation and increased data harnessing capabilities are rewarded in our model. Data processing and accurate pricing closer to the maximum WTP of disengaged customers could trigger a rearrangement of the market structure.

Table 4.1 Overall outcomes for consumers and suppliers

4.4 Summary of Prices Faced by Consumer Types

As per our model's predictions and the qualitative data gathered from industry experts, the prices faced by each consumer type - ranked from highest to lowest - are summarised below. Perhaps unsurprisingly, Type 1 consumers will face the highest prices as firms can identify their lack of engagement and motivation to shop around for a better deal, as well as their high ability to pay. At the other end of the pricing spectrum, Type 2 consumers will face the lowest prices in the market. Their low ability to pay is communicated to firms through the available data, and their engagement in the market ensures they will not be priced above the point at which they deem acceptable. With prices that fall between these two types, Type 4 will be (unfairly) charged more than Type 3 due to their lack of engagement in the market. It will be of key policy concern to ensure that these disadvantaged Type 4 consumers are protected in the market and receive a fairer price.

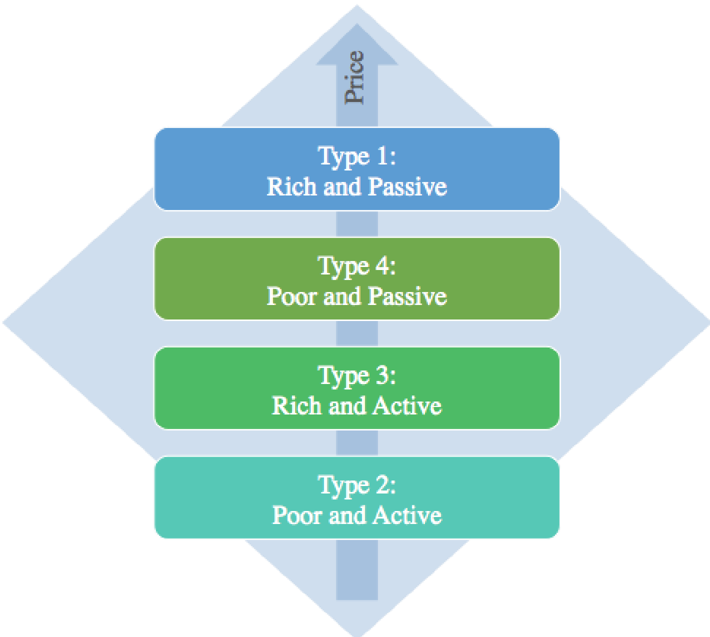

Figure 4.1 Consumer types ranked in order of those facing the highest to lowest price

5. Future Developments

Our model approximates a description of the digitalised energy market in 2025. To bridge the gap between the present industry and its future, we utilised stakeholder interviews and academic research to consider technological factors that may accelerate or stymie price discrimination practices. In Section 5.1 we first discuss how the nascent Internet of Things could allow for a greater quantity of data to be generated by each individual. This could be utilised by energy companies to create more sophisticated price discrimination techniques while also providing greater personalisation of energy services. Section 5.2 considers how data-based barriers to entry into the energy market can be reduced with publicly available data or technology-based entrepreneurship. Finally, Section 5.3 notes that firms may collude with each other through algorithms to create uncompetitive market outcomes.

5.1 Internet of Things

The proliferation of IoT products provides scope to both benefit and harm energy consumers, affecting their social and distributional outcomes as discussed above. The adoption of IoT within homes is on the rise, with IoT technology expected to be in 95 per cent of new product designs of home appliances by 2020 (Panetta, 2017). Indeed, the general consensus from the stakeholders interviewed is that IoT products will be adopted in the vast majority of households within the next 10 years. It is therefore relevant to consider the potential welfare outcomes for energy consumers that may result from the widespread adoption of IoT.

IoT products in homes can contribute to 'smarter' home management, making consumers aware of their energy usage. For example, IoT products and apps are already being designed to communicate with consumers how much energy they are utilising. The saliency of energy usage and the timely feedback can engage passive consumers; personalised feedback is widely recognised as an important behavioural change tool (Goodwin & Miller, 2012). The proliferation of IoT could therefore help consumers better understand their energy patterns, limit their overall usage and thus reduce their energy bills. It could also be the case that in the future consumers will not need to be active to engage, if IoT and other technologies enable loads to be managed externally. A senior academic in energy policy explains that it may no longer matter whether consumers are active or passive if their usage is being controlled on their behalf (04.02.19; 14:00). However, these developments rely on consumers being able to change their consumption habits and afford these products to begin with; as our interviewees pointed out, it is often harder for consumers experiencing some dimension of vulnerability to do both of these things.

Despite the potential benefits, IoT devices collect highly personalised data that could be abused by firms that are able to harness and process it. This would result in higher prices for those who are more easily identified from the additional volumes of data as having a higher ability to pay, and exacerbate customer inertia due to complicated bundling of offers and services, such that even engaged consumers find it difficult to obtain the best deal (Plunkett, 2018). Further concerns relate to data serving as a potential barrier to entry into the industry, as described in Section 2.3. There is a risk to competition from the concentration of data within a small number of smart platforms (e.g. Google or Amazon). The use of IoT devices tend to rely on one of these providers, and if energy providers could access it, it is even more likely that a small number of firms could monopolise the market. All consumer prices may rise as a result, reducing consumer surplus for all.

Nevertheless, our stakeholders on the whole thought it quite unlikely, at least in the foreseeable future, that these concerns would be realised. This is for two key reasons; a) personal - 'sensitive' - data generated from these smart products is encrypted and b) the current data management infrastructure of energy suppliers is simply not adequate to store, analyse and manipulate the data as described above. According to one of our interviewees, data held by energy suppliers is "very piecemeal", with many not even having the accurate addresses of their consumers (04.02.19, 14:00).

Due to the rapid pace of technological advancements, it remains relevant for policy-makers and regulators to be wary of the potential effect IoT may have on the retail energy market and to be proactive in their response. The regulatory challenge is to prevent consumer harm without discouraging innovation and its associated benefits.

5.2 Democratising Data

Our model demonstrates that firms must have access to data in order to compete. Given the network characteristics of a data-based economy lend it to oligopolistic outcomes and high barriers to entry, it may be difficult to create a competitive energy industry with a sufficient number of suppliers and fluid market entry. These concerns are highlighted by our model's predictions of a monopolistic market if a firm is to price Type 2/3 customers below-cost.

Concerns about the powerful effects of data monopolisation have given rise to conversations about the proprietary nature of consumer data (Srnicek, 2018). The ability of firms to obtain and restrict access to consumer data has been identified by policy-makers as an inhibition on market competition (Posner, 2018). Policy reforms that liberalise access to consumer data may provide the pathway to an effectively competitive market.

Regulatory agencies are cognisant of these issues and are working at the coalface of these developments. Ofgem has not gone far enough to spread the agglomerating effects of data networks. In Australia, the government legislated a "Consumer Data Right" in 2018 which extends to several essential goods, including electricity. The Australian Competition and Consumer Commission has published a consultation paper recently which posits three models of data liberalisation in the energy industry (ACCC, 2019). These range from the creation of a centralised network operated by a government regulator, from which accredited data recipients can access consumer data, to a pure consumer-data-recipient relationship absent of regulator involvement. The Australian reform process is to be commended as it recognises the value of data and seeks to mediate its distribution to firms in order to facilitate market competition.

On the demand side, stakeholders were optimistic about the role of business entrepreneurship in countering customer passivity through switching, and the intersecting opportunities for blockchain technologies in the energy market. The industry seems keen to experiment with private initiatives to decrease consumer passivity. For example, with auto-switching companies, customers pay a lump sum and hand over their data which allows companies to switch their tariffs automatically to the best available option. This development may be furthered by the application of 'open banking' ideas through application program interface (API) technologies, so that customers can share their energy data seamlessly between suppliers. However, it remains to be seen whether auto-switching companies will be able to effectively engage and serve disengaged and vulnerable customers. Moreover, the challenge of turning entrepreneurism into large-scale mechanisms to energise passive customers is substantial.

With public consumer data, the introduction of blockchain technologies, and the shrinking cost of renewable energy, the energy industry may witness i) an increased number of micro-generators who undercut the monopoly power of current suppliers; and ii) reduced transaction costs of switching. Blockchain technologies allow for peer-to-peer transactions in energy so that individuals can sell energy back into the grid. Stakeholders informed us that energy providers are already investing in research and development around blockchain technologies. Centrica has invested GBP19m in Project Cornwall to investigate the opportunities around flexible demand, storage and generation by micro-generation suppliers (Centrica, 2019).

Besides, blockchain has the ability to cut the transaction costs that time-poor consumers incur to switch suppliers by reducing switching time to a matter of seconds. For example, Electron, a UK blockchain company, is developing a nationwide energy platform which it claims can switch customers in 15 seconds, which compares favourably to government efforts to introduce next-day switching - itself an upgrade from the current 21-day process.

While exciting, the yardstick for measuring the success of these technological and market developments should include the degree to which they ameliorate the negative welfare outcomes for disengaged and vulnerable customers.

5.3 Algorithm Collusion

Pricing algorithms pose a potential risk to consumers if firms make strategic use of price discrimination with the purpose of undermining competition and dissuading new firms from entering the market (Miller, 2014). To build on our Section 2 analysis, we acknowledge an underlying problem of pricing strategies: if pricing is generated by algorithms, these strategies may lead to anticompetitive tactics such as collusion (CMA, 2018). This avenue for the future of consumer welfare in the retail energy market was highlighted by our interviewed stakeholders, some of whom foresee potential scenarios where consumers could face exploitation.

Collusive behaviour in digitalised markets under automated pricing strategies can arise both deliberately and by chance. Firstly, from the competitor's perspective, pricing algorithms can promote collusion as their construction offers more stable pricing agreements amongst firms (CMA, 2018). Once the explicit agreement is carried out, deviations are less likely as they are easier to detect and punish. Furthermore, accidental deviations are substantially less likely, meaning the pricing collusion is more precise. The OECD Competition Division identifies the number of firms and barriers to entry as factors that may poise a neutralising effect on collusion, however market transparency and a high interaction frequency have been identified as factors that substantially increase the likelihood of collusive strategies (OECD, 2017).

Secondly, the CMA points to three core scenarios through which pricing algorithms produce a tacit anti-competitive outcome: hub-and-spoke, predictable agent and autonomous machine (Ezrachi & Stucke, 2015). As firms use similar algorithms or the same data pool, a more collusive algorithmic-pricing strategy prevails. Recognising this, Mehra (2015) coins the term, 'robo-sellers', describing the innate characteristics that make algorithms substantially more efficient than humans in terms of 'achieving supracompetitive pricing' with no explicit communication between them. Furthermore, smart algorithms, driven by artificial intelligence, can easily exploit the so-called 'interaction frequency' whereby greater data is generated through increased interaction with one specific provider. This might be especially relevant when considering Types 2/3 consumers who are engaged in the market and therefore generate higher amounts of data through repeated interaction with suppliers. Given our assumption that the data generated by these consumers can be used to inform their passive counterparts, this poses a serious risk to all consumer types; the interaction frequency may lead to a greater ability for algorithms to tacitly collude and raise prices for all. Under the dystopian scenario of algorithm collusion, the predicted outcomes are higher prices and a reduction of welfare, regardless of our envisioned consumer types.

6. Policy Recommendations

We affirm the benefits of price discrimination as an improvement to economic efficiency. Digitalisation in the energy market also promises to bring a higher degree of personalised services. Nevertheless, we are concerned that without proactive government measures, these benefits will be outweighed by negative outcomes for certain consumers. Innovation should not be discouraged in this industry so long as the necessary safeguards are in place such that those most vulnerable are supported. This section outlines policy recommendations to address the social and distributional outcomes of forthcoming digitalised energy market; from enhancing consumer engagement, to making price regulation more stringent, to data-based innovation. We advocate the following demand and supply-side policy recommendations to advance a competitive, equitable and sustainable UK retail energy industry in 2025.

6.1 Demand-Side Recommendations

6.1.1 Facilitate Switching Through Public Evaluation of Providers

Price comparison websites help digitally aware consumers compare prices between providers and determine the best deal depending on their needs. However, as of today, there are 11 private price comparison websites accredited by Ofgem. We argue there is a need for a more complete and official government service which would serve as a more efficient reference point. A central source of concern is that price comparison websites can drive a race to the bottom in terms of service quality because of a narrow focus on price. Two additional considerations are the loss in consumer confidence on these websites and the often-cited difficulty in navigating them.

The NHS, through the MyNHS website, provides an extensive range of data for patients to compare the quality of healthcare services. A similar tool could be developed to encourage retail energy consumers to switch suppliers with a higher degree of confidence. We suggest that beyond price, indicators such as reliability of supply, consumer service quality and the availability of debt repayment plans for vulnerable consumers should be included to track supplier performance.

6.1.2 Facilitate Growth of Automated Switching Market

Automated switching prevents consumers from being categorised as passive, avoiding loyalty penalties and substandard tariffs. As such, the proliferation of these firms should be encouraged in order to promote market competition. For example, Ofgem can assist in raising awareness of the existence of auto-switching services by providing information on its website, in the same way as it provides links to price comparison sites. However, additional measures should be taken to ensure efficient outcomes across consumer types. At the moment, there is a limited number of these companies and it is hard for consumers to discern which ones are trustworthy. Reporting requirements can be put in place to facilitate service rating and stimulate innovation, including information on how much customers have saved in simple terms. In addition, firms should be required to consider only energy providers with customer service ratings above a certain level to prevent a race to the bottom. Finally, energy firms have been reported to reject auto-switching customers, so the law should be clarified to give customers access to all firms.

6.1.3 Expand Local Government Partnerships with Collective Switching Schemes

Collective switching schemes are usually run by for-profit organisations that conduct an auction where energy providers can bid for a contract to supply large groups of consumers. This transfers the burden of searching for tariffs from consumers to third parties, thus benefiting vulnerable individuals less likely to use computers and switching sites including the poor, elderly and disabled. Local governments in London and around the UK have previously partnered with these schemes with positive results. A small budget can be allocated to help them utilise existing channels with disadvantaged groups to more actively promote participation in schemes.

However, firms participating in auctions don't always put forward the best tariffs available, and these tend to be prepayment tariffs of lower value to consumers. Energy firms should be required to show that their offer is among their most competitive to participate given the added benefit of obtaining large amounts of consumer data. Furthermore, energy firms should include guarantees that they will not significantly raise prices for customers acquired through schemes in the near future as a prerequisite for participation, given that consumers are revealing a propensity for passivity. It also follows that scheme organisers should be encouraged to re-engage with past customers to help them avoid loyalty penalties after a number of years.

6.1.4 Address the Digital Fracture Through Local Government Assistance of Offline Consumers

It is difficult to make switching decisions without having access to a computer and the internet, and this will likely be exacerbated by 2025. Addressing the digital fracture is therefore of primary importance in order to protect offline consumers. Local government offices should facilitate switching by offering information and assistance through existing social services infrastructure. Social services have established networks with communities and already help vulnerable people with a variety of issues such as budgeting, job search and disabilities. They could provide switching assistance with minimal training and at a relatively low cost to taxpayers.

6.2 Supply-Side Recommendations

6.2.1 Introduce Price Collars to Limit Price Spreads

Rich and engaged consumers are more likely than passive and poor consumers to hire auto-switching services, understand how switching sites work and respond to engagement campaigns. For this reason, demand-side interventions can potentially increase price differentials between groups and aggravate unfair social outcomes. The popular regulatory response, price caps, are only implemented on the basis of per unit costs, so they do not account for the outcomes of price discrimination below the cap. This results in supplier tariff offers coalescing just under the regulated price cap. They do not directly tackle the issue of increasing divergences in the tariffs offered to different customers.

Instead, regulators should consider implementing price collars to limit the per cent by which the highest tariffs on offer can differ from competitive tariffs (Osborne Clarke, 2018). Price collars still allow the benefits of price discrimination to be realised but provide a protective mechanism for inequitable social outcomes. Price collars also protect passive consumers from rising loyalty penalties by limiting the extent to which crosssubsidisation takes place, even when firms have a large pool of passive consumers to fund this practice. Additionally, price collars would also act as an indirect barrier to market concentration based on data ownership as firms are less able to amass consumers with offers priced below cost.

6.2.2 Discourage or Restrict 'Price Walking'

Passive consumers subjected to loyalty penalties are unlikely to know precisely how much their tariffs increase each year. Regulators should employ reputational measures like publishing reports that show the size of the total loyalty penalty and price differentials of each provider to discourage them from engaging in this 'price walking'. This would require firms to disclose new kinds of data that will be increasingly accessible as market digitalisation advances. If reputational measures were ineffective, regulators should consider limiting 'price walking' by establishing caps on the percentage by which tariffs can rise every year and over 5-year periods due to factors other than inflation and market conditions.

6.2.3 Implement Government Auditing of Algorithms

Regulation should be implemented to prevent the negative effects on consumers' welfare induced by algorithm collusion and biases through the use of black-box algorithms. These also raise ethical concerns. We argue that algorithm auditing should be developed by the regulator once the technology is in place. The challenge lies in being able to monitor behaviour that is illegal or detrimental to overall welfare, while respecting the proprietary rights of firms who have invested money in developing the algorithms to avoid compromising incentives to innovate.

We recognise this is a technically complex issue: algorithms work as black boxes, and there is presently no real way to monitor their functioning without the goodwill of the companies owning them. A difficulty of auditing algorithms comes from their level of predictability: algorithms involve machine learning and use tools such as trial and error functions, which means that, given an identical set of input data, perfectly identical results cannot be replicated.

The regulator will need cooperation from the providers at development stage of the algorithm, requiring them to build algorithms such that external auditors can analyse their performance, in a similar way that financial results are audited for listed private companies while respecting their proprietary data. Alternatively, the regulator could choose to audit algorithms at all stages of their conception and beyond implementation. In particular, tests should be performed on the dataset used to train the algorithm to make sure it is unbiased. Furthermore, the performance of the algorithm should be reviewed continuously to make sure that the new data absorbed does not lead to any new bias.

Depending on technological developments in the coming years, one of these two options would prove more efficient and should be implemented by the regulator.

6.2.4 Develop a Data Access Model to Promote Competition and Innovation

Access to and ownership of data has been identified doubly as an economic good and a potential barrier to entry for new market entrants. The increasing returns to data also lead to a reduction in the number of existing firms that are able to effectively compete in the market thereby increasing market concentration.

To address these concerns, we propose that Ofgem should be the sole holder of a centralised data set. This includes all types of consumer data that will create value to firms in the energy market by providing personal information that can be used to inform personalised pricing strategies. A centralised dataset will provide individuals and businesses the ability to efficiently access specific consumer data held by energy supplier firms. To do so, energy data holders (which would include energy retailers, distributors and Ofgem) would be expected to build APIs to provide consumer data to Ofgem for centralised storage. Ofgem would in turn be required to build open APIs to provide that data to the accredited data recipients. Consumers will be explicitly asked to provide consent, and accredited data recipients would subsequently be able to contact Ofgem and request their data.

Under a centralised model of consumer data, consumers will have greater access to data which will improve their ability to compare and switch between providers and consequently serve to promote greater market competition. This heightened competition will provide more competitive prices and more product and service innovation.

Importantly, the centralised data set removes a significant barrier to entry in the form of firms needing the technological capacity to store large data sets. Although removing this particular barrier to entry by improving access to consumer data is important, firms will also need to improve their internal technological capabilities so that they can process public data sets and harness their economic value.

We recognise that there is a security risk to centralising data, not to mention the high initial costs of infrastructure investment. However, a centralised model of consumer data enables infrastructure costs to be limited to one entity: Ofgem, rather than being borne by all firms that wish to effectively compete in the market.

7. Conclusion

Markets across the economy are rapidly digitalising, creating risks and opportunities for consumers and firms alike. The retail energy market is no exception; consumers are generating new kinds of valuable personal data that firms will increasingly exploit to inform their pricing decisions. In this report, we have analysed the social and distributional outcomes of a digitalised UK retail energy market in 2025.

Our model predicts that with the rise of data as an economic good, certain customer will gain from personalised pricing strategies in a more efficient economy while others incur welfare losses due to personal characteristics. Passive and vulnerable consumers will be most at risk of adverse welfare outcomes. These distributional outcomes have the potential to cause social disquiet and define the case for political and policy action. We affirm the benefits of price discrimination as an improvement to economic efficiency. Digitalisation in the energy market also promises to enable a higher degree of personalised services. Nevertheless, we are concerned that without proactive government measures, these benefits will be overcome by negative outcomes for certain consumers.

Motivated by this rationale, we advocate a series of policy recommendations to advance a competitive and equitable retail energy industry in the UK in 2025. On the demand side, it is important to promote government, private and public-private partnership initiatives that facilitate the switching process to re-engage passive consumers. On the supply side, the regulator should employ reputational measures to increase firm accountability to consumers and introduce pricing restrictions such as collars and 'price walking' caps. Given the centrality of data and algorithms expected in 2025, we put forward two future-facing recommendations; algorithm auditing and a centralised model of data access. Our analysis indicates that these policy recommendations will prevent disproportionate losses in consumer surplus, promote market competition and incentivise innovation.

Our project has limitations. First, our model is based on the assumption technological development will allow energy suppliers to perfectly discriminate, which is by no means inevitable. Second, contrary to our hypothesis, Type 4 (poor-passive) customers may be priced more than Type 1 (rich-passive) as outlined in our evaluation of hypothesis.

In summary, we call on relevant stakeholders to address the issues raised by our report. The digitalised 21st century economy is a likely outcome of technological progress and while price discrimination promises theoretical economic efficiency, governments must be forward-looking and proactive in countering negative social outcomes. This will require engagement between government, businesses and consumer advocates to maximise both social and economic welfare.

8. List of Figures

9. List of Tables

10. References

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11. Appendix

CEPA Terms of Reference

1. Background

CEPA is an economic and financial policy consulting business. We advise both private and public- sector clients on economics, and public policy issues including regulation, competition, etc. Our work spans the energy, water, transport, health, agriculture, communications, and international infrastructure sectors. In our work with UK regulators we aim to ensure regulated markets run smoothly and efficiently while protecting the interests of both the taxpayer and the consumer. The proliferation of big data and the increasing prevalence of digitalised transactions has already, and will continue to, fundamentally impact the way UK markets work. Our aim is to understand some of the effects of these changes in more detail in order to better advise our clients.

2. Questions and Objectives

The question we would like students to respond to is: "What are the social welfare and distributional effects of increasingly digital markets? Where negative consumer impacts may exist (either collectively or for certain groups of consumers), what actions might Government/policy makers want to consider?

We wish to better understand what happens for whom when markets and transactions become increasingly digitalised – e.g. based on personal data and making use of personalised or dynamic offerings, etc. Based on analysis of these effects, we would also like to understand what options the government may want to consider in response.

3. Context/Debate: Why is this Issue Important?

Companies are increasingly making use of personal data to target and personalise their business strategies. This includes pricing strategy, marketing and targeting of products. This personal data may be provided by individuals voluntarily or it may be developed based on customer profiling and assumptions around behavioural characteristics made using big datasets. On the one hand, certain markets have always been personalised to some extent, to cater to the individual cost of providing a service or to better target an individual's willingness to pay. Classic examples of this include the market for insurance or third-degree price discrimination such as concession prices such as the Young Person's Railcard.

However, digitalisation makes these practices increasingly relevant for markets that have traditionally dealt with their consumers as a relatively homogeneous group. This is allowing companies in many markets to move towards first degree price discrimination in a way that was previously impossible. For example, in the electricity market, smart meters in combination with new technologies such as 'internet of things' devices allow consumers to be more responsive and to benefit from personalised and dynamic offerings.

Digitalisation of markets will undoubtedly bring a number of benefits for consumers which are important to consider. For example, more personalised and dynamic offerings allow consumers to make purchases which are more aligned with their interests and behaviours. Understanding the heterogeneity of consumers can ensure that offers can become more reflective of the costs that they impose on the company. Once again taking electricity as an example, personalised and dynamic offerings allow those who are able to do so to modify their demand patterns by using electricity at times when it is cheaper (and greener). This benefits the consumer and the system as a whole by redistribution of demand away from those times when it is most difficult to meet.

However, there are also a number of potential sources of consumer harm, and there may be winners and losers from such developments. While economic theory suggests that perfect price discrimination often has beneficial welfare effects (by eliminating deadweight loss), it entails a transfer of surplus from consumers to producers. In addition, while some consumers benefit from access to a good at lower prices, other consumers face higher prices (at their time and context specific level of willingness to pay). Depending on the characteristics of these consumers, this could lead to certain socioeconomic groups losing out. In addition to economic theory regarding surplus and welfare, distributional effects and fairness are increasingly important considerations. This may particularly be the case where the socioeconomic groups are perceived to be more vulnerable – e.g. the poor or elderly, or where there appears to be some form of discrimination – e.g. based on religion, gender or race.

The potential for consumer harm is being taken very seriously by politicians, competition authorities and economic regulators across Europe. For example, the UK Competition and Markets Authority recently held a roundtable on the issue.

4. Key Activities

The goal of this Capstone project is to provide CEPA with a rigorous, evidence-based report documenting:

A high-level review of existing literature and studies on social and distributional effects of digitalisation (e.g. personalised pricing). This may also include some preliminary consideration of empirical work such as the paper “An Empirical Analysis of Algorithmic Pricing on Amazon Marketplace”.7 The consideration of other empirical papers and studies is encouraged.

Take the results of the literature review and previous empirical work and use them to create a simplified theoretical model for use as part of at least one case study. We suggest that the case study is taken from the transport or energy sectors where these topics are currently highly relevant. However, we will consider alternative suggestions from students if supported by a clear case for selection of a different market.

Quantitative and qualitative analysis of this case study/studies. We would expect students to supplement their theoretical model using at least one of the following analytical approaches: a. Empirical analysis of publicly available data; b. Key stakeholder interviews; c. In-depth review of relevant literature and other documents

Based on evidence generated from this project, students should develop a set of policy recommendations for relevant Government and policy makers.

5. Scope

The case studies should be taken from either the transport or energy sectors (or a market selected and justified by the students). These are two of CEPA’s key markets and areas where we believe there is wide scope to analyse the effects of big data, personalised pricing and digitalised transactions. We expect analysis and policy recommendations to be presented as if being provided to UK Government departments, regulators, and competition authorities. However, this should not limit the scope of the literature review and interviews which should be informed by as wide a variety of stakeholders as possible.

6. Availability of Data

The literature cited in the paper refers to a number of the issues we think are important for this project and should act as a useful starting off point to inform development of initial hypotheses. We do not have particular datasets in mind beyond this, and note that alternative methods such as interviews and literature reviews can be used to inform the theoretical model developed by students. However, students may wish explore and make use of other datasets where they consider this to support or evidence their findings. We will support the consideration of which datasets may be of most relevance as students develop their initial hypotheses for evaluation.

We will facilitate certain key informant interviews where possible, but students should be prepared to also identify, contact and interview key stakeholders through their own channels and based on their own research. Note also that CEPA is unable to pass on confidential data due to client confidentiality and because it would limit the practical use and application of any potential results from the project.

7. Sources

We expect this project to draw on published academic economic and social welfare literature, regulatory reports, key informant interviews, the students' own analysis and other information that may become relevant over the course of the project. We have listed a preliminary list of journal and web articles that cover the issues discussed in this TOR. These should provide a starting point for the initial high-level literature review.