



Value creation in an algorithmic world: Towards an ethics of dynamic pricing

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ABSTRACT

Choice of pricing strategy plays a central role in value creation and the effective functioning of markets. Shifts in technology and the growing availability of data are facilitating ever more innovative forms of pricing strategy. Within the emerging literature on pricing ethics, there is a gap in our understanding of the specific challenges of algorithmically generated dynamic pricing. Increasing pricing automation shifts the managerial focus from the selection of prices to the choice of algorithms. This paper expands the literature on pricing ethics by conceptualizing the ethical challenges raised by the contemporary use of dynamic pricing. We propose a governance model for algorithmically generated dynamic pricing, taking into account the role of the customer as a stakeholder in value generation.

1. Introduction

The growing digitalization of modern economies has generated new modes of value creation, both of firm value and customer value (Kannan & Li, 2017). This has created a demand from managers for strategies that allow them to successfully respond to the challenges posed by the digital economy (Verhoef et al., 2021). Pricing plays a critical role in consumer decision-making, and the ability to effectively execute a pricing strategy remains a core factor in determining firm performance (Dutta et al., 2003). Price can help determine perceptions of quality, value and willingness to buy (Dodds et al., 1991). Whilst price discrimination has been long discussed in the literature (Garbarino & Lee, 2003), new technologies have moved dynamic pricing from theory to practical reality. Increasingly novel use of pricing strategies is a core strategy for many fast growing firms, such as the subscription pricing approach adopted by Netflix that is seen as core to its high market capitalization (Sherman, 2021); Uber's use of surge pricing to help generate supply in periods of high demand (Sainato, 2021); and Amazon's combination of a range of pricing approaches, including both subscriptions and dynamic pricing, to help it rapidly build market share. In a global market environment where inflation is rising rapidly, making costs unpredictable, the ability to adjust pricing rapidly to meet market characteristics is key to

maintaining margins (Abdelnour et al., 2021). At the same time, there are concerns over the increasing use of algorithmically generated dynamic pricing to influence consumer perceptions of pricing fairness (Schmidt et al. 2020) and level of trust in brands (Garbarino & Lee, 2003; Stuck & Ezrachi, 2016).

Recent years have seen growing innovations in the applications of pricing. The use of prior purchase history datasets has long been recognized as a strategically valuable use of technology (Acquisti & Varian, 2005). Implementation of algorithmically driven, dynamic pricing has spread far beyond its original use in airlines and travel, through financial services and increasingly more broadly across e-commerce (Chen et al., 2016). Whilst dynamic pricing was once an advanced technology requiring significant capabilities, it is now accessible to a wide range of firms through “off the shelf” solutions (Calvano et al., 2019). The increasing focus on customer-centricity and personalization has grown the possibilities for applications of price discrimination. However, alongside this has emerged increasing consumer awareness and suspicion of such strategies (Gerlick & Liozu, 2020).

We consider conceptual definitions of terms later in the paper, but the literature is aligned with the notion of differential pricing as: “the practice of charging different customers different prices for the same product” (Elegido, 2011, p.633). Within both the academic and

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practitioner literature the terms “differential pricing” and “dynamic pricing” are typically used interchangeably, with “differential pricing” being adopted more by economics and computing scholars, whilst “dynamic pricing” more by marketing and consumer researchers (Li et al., 2007; Talbot, 2018). They all stress how differential pricing has become an essential pricing strategy due to the highly competitive nature of modern commercial life. Firms must seek to generate profits from value wherever they can (Baumol & Swanson, 2003). Shifts towards hyper digitalization have brought rapid technological changes to pricing, including greater real time and personalized pricing, the use of digital price displays and the growing sophistication of data analysis techniques. This has also increased the volume and scope of differential pricing decisions (Chen & Gallego, 2019). This definition is not limited to the direct communication of price changes but includes alternative techniques such as product portfolio strategies or promotional campaigns to generate *de facto* differential pricing approaches to consumers.

Despite the impact of these pricing strategies, there remains relatively little analysis and research on the broader ethical implications of dynamic pricing approaches, and there are calls in the literature to address the gap, in that “ethical concerns about dynamic pricing have received only scant attention” (Seele et al., 2021, p.704). Whilst there has been growing researcher interest in the welfare issues surrounding differential and dynamic pricing (Chen & Gallego, 2019; Elegido, 2011; Seele et al., 2021), these remain grounded in more macro-level debates such as that around the notion of a just price. Whilst there are important broader society and policy issues around the implementation of dynamic pricing approaches, there is also a need for analysis that leads to managerially focussed solutions, particularly given the increasing technical complexity and scope of dynamic pricing approaches.

The potential for digitalization to challenge fixed pricing norms has been a managerial priority since mass internet adoption (Wurman, 2001), due to a potential provided by increased data, technology to facilitate rapid price changes, and analytical capabilities (Elmaghraby & Keskinocak, 2003). This has facilitated approaches such as real-time pricing, greater use of electronic pricing display and more personally targeted pricing but, as with many implementations of technology over this period, ethical issues are also generated that impact consumers. The growing ability for firms to rapidly set and change prices at the level of an individual consumer gives managers access to a powerful competitive tool. At the same time managers need to consider how both consumers and policy makers might respond to such actions. Arguably, the failure of managers to understand the privacy implications of the use of consumer data from social media has played a major role in loss of trust in aspects of digital marketing activity (Cho, 2021). The framing of the public debate on dynamic pricing has been largely negative to date, alongside a lack of trust consumers show in these new technologies (Chen & Gallego, 2019). Understanding how to build consumer confidence in pricing strategies will be core to building trust in brands going forward. This paper contributes to the literature by conceptualizing the ethical dimensions of contemporary dynamic pricing strategies and providing a managerial framework to enable the effective management of these ethical issues.

This paper is structured as follows. First, we review and conceptualise the ethical aspects of differential pricing from a multi-stakeholder perspective. Second, we embed discussion of pricing ethics within the wider debate on macro-level implications of algorithmic and AI driven marketing. We propose a stakeholder-based framework for dynamic pricing that enables managers to address and mitigate negative perceptions of dynamic pricing strategies.

2. The ethics of pricing

Pricing is an integral part of marketing and remains at the core of marketing theory, practice, and education (Jedidi et al., 2021), with a shift in pricing research from approaches based on economics (Hauser, 1984), to a growing theoretical base built upon concepts of price

embedded in customer value (Chen & Gallego, 2019). The importance of developing our understanding of pricing theory is also reflected in managers’ longstanding difficulty in determining the right price (Dolan & Simon, 1997; Lancioni, 2005).

The question of pricing ethics has received relatively little attention in business literature when compared to other ethical issues arising from contemporary business practices (Elegido, 2014). In the context of dynamic pricing there are two broad streams of research. The first seeks to address the core question of what constitutes a fair price (Elegido, 2020). The empirical focus many papers in this area relates to the use of differential pricing within highly regulated markets for pharmaceuticals (Danzon, 2018) and electricity generation (Dutta & Mitra, 2017; Faruqui & Sergici, 2010). The second relates to broader ethical issues around consumer facing technologies, including privacy and data collection and the implications of autonomous decision-making (Lee et al., 2011; Priester et al., 2020).

The concept of pricing fairness, the notion of a “just price”, is deeply embedded in the literature (Elegido, 2009; 2020), reflecting the centrality of price in the notion of exchange. Fair pricing is also at the center of equity theory, the notion of the fair allocation of resources (Koehn & Wilbratte, 2012; Lawler, 1994), carrying implications for organizations where allocations of resources are unfair (Hayibor, 2008). It has been long understood that the perception of inequitable pricing in any buyer–seller exchange will drive consumers to choose alternative products or services (Huppertz et al., 1978). Two concepts underline discussion of fair pricing. The first is the notion that a fair price is voluntary, and therefore that any exchange around it must also be voluntary. This implies that not only must both parties be able to walk away from a transaction but also that there is no deception or coercion taking place (Michel, 1999). The second is the concept of equality, in that there is an exchange based on a fair match in compensating the seller for the cost of labor or materials and the value generated from the purchase by the end user (Koehn & Wilbratte, 2012). From an ethical perspective, public perceptions of unfair prices, such as price gouging, are not always supported in the literature (Elegido, 2020; Zwolinski, 2008). In the public mind unfairness in pricing is representative of broader unfairness towards consumers, but this also ignores the question of pricing fairness towards other stakeholders such as those in the supply chain. For example, attempts to mandate minimum prices for suppliers under the Fairtrade brand disadvantaged the smallholder farmers whom the scheme was intended to benefit (Reinecke & Ansari, 2015).

Given consumer concern over the implementation of ever more advanced pricing strategies (Chen & Gallego, 2019; Haws & Bearden, 2006) there is an emerging stream of research on the ethics of these new forms of pricing strategy (Elegido, 2011), with a particular focus on pricing issues in markets with monopolistic characteristics such as utilities (Dutta & Mitra, 2017; Faruqui & Sergici, 2010) and pharmaceuticals (Danzon, 2018). There has been less discussion of wider ethical issues around pricing in mainstream consumer markets. One explanation is based upon the view that freedom to set prices is required for the effective functioning of a market economy (Elegido, 2020). Following this argument, the freedom to vary prices also facilitates product and service differentiation, consumer choice and ultimately maximizes the potential for value creation. Thus, discussion around pricing ethics becomes embedded in discussion of the ethics of markets and the mode of determining value exchanges in markets. The counterargument is that the welfare aspects of pricing mean they are too important to be left to the market (Chen & Gallego, 2019).

We now consider the question of pricing fairness in the context of differential pricing. Through one lens differential pricing can be seen as a form of “covert” marketing activity that damages consumer trust (Milne et al., 2009). Approaches to differential pricing have always generated suspicion from consumers who do not wish to pay higher prices, as well as managerial concerns over the impact of price changes upon brand perception (Chen & Gallego, 2019). However, the use of dynamic pricing presents the opportunity for pricing to be considered as

an intrinsic element of technology-driven service delivery, increasing opportunities for value creation, but also value destruction (Luyen et al., 2021). For example, consumers' knowledge that prices are dynamic and can change during the service and, as a result of their actions, creates a more complex service interaction. The use of price discrimination can also create a sense of unfairness, alongside the uncertainty created by the knowledge that pricing is more fluid.

Whether it is fair to charge individuals' different prices for the same good, differential pricing can deliver a just price. If individuals are willing to pay different market prices, it reflects differing value that individuals derive from the price. From the perspective of cost-based pricing, fairness is established by asserting that differential pricing enables products or services built upon high fixed costs to be shared amongst many users. Taking the example of the electricity market, the use of differential pricing enables the reduction of fixed costs to a level that enables a wider range of individuals to adopt the product or service. For a detailed review of the ethics around differential pricing see Elegido (2011).

It is on this point that we extend the literature, which is thereby significantly developed by this paper. Elegido (2011) suggests that dynamic pricing is one of many contemporary labels for discriminatory pricing. For example, Uber's "surge pricing" approach is simply another form of technology-enabled differential pricing justified by the need to provide an equilibrium between supply and demand. It is a new variation on old pricing strategies, but implemented in a technology-optimized way. By contrast, in this paper we present dynamic pricing as a distinctive concept. Departing from the idea that price differentiation strategies are interchangeable we suggest the strategies that underline contemporary dynamic pricing approaches have different characteristics with a broader impact than traditional pricing. Traditional differential pricing approaches are not typically dynamic, with significant practical limits on the speed and volume of pricing variations that can be implemented. In turn, these pricing decisions are driven through the normal managerial decision-making processes. Furthermore, whilst pricing has previously been regarded as a largely physical or static artefact, the increasingly advanced use of technology to underpin the application of dynamic pricing, together with rapid consumer adoption of technologies, has led to the presentation of pricing as digitized. This changes the notion of pricing and creates the opportunity to disintermediate it from the physical product or service it represents.

3. Conceptualizing dynamic pricing

To understand the ethical issues associated with dynamic pricing, an exploration of the specific sectors' contexts in which it is applied is required, together with a clear theoretical and conceptual underpinning.

There are sector specific differences to the way that customers perceive and respond to price changes. This difference is based on the extent to which revenue management approaches are possible within an industry, the roles that price plays in determining perceptions of value and consumers' strategic responses to changing prices (Chen et al., 2019). Whilst digitally driven services, such as Uber, can implement an array of pricing options (Sainato, 2021), other sectors are exploring the application of more dynamic pricing approaches. For example, the combination of subscription and dynamic pricing approaches to improve access to pharmaceuticals in developing and middle-income countries (Cherla et al., 2020).

In services such as hospitality with high fixed costs and low marginal costs, using dynamic pricing for advanced bookings is a key strategic driver of profitability (Bigne et al., 2021). In such cases, consumers expect dynamic pricing and are therefore able to respond to it (Viglia et al., 2016). In highly regulated industries, such as energy supply and healthcare, the use of dynamic pricing must be weighed against greater regulatory oversight and the need to protect consumers from rapid price changes (Danzon, 2018). There are also inverse incentives, such as the potential for pricing to be a driver for prosocial consumption such as

reducing energy use (Dutta & Mitra, 2017). In retail, the use of electronic store labels provides opportunities for dynamic pricing in physical retail contexts, mitigating the challenges with omnichannel approaches to pricing such as showrooming (Boden et al., 2020). However, whilst attempts have been linked to improvements in consumer experience, customers responses are characterized by skepticism and low levels of adoption (Cochoy & Soutjis, 2020).

Conceptually, consumer perceptions of the fairness of dynamic pricing are driven by normative perceptions of fairness of price rather than past experience, due to the presence of multiple reference points (Priester et al., 2020). Perceptions of pricing unfairness, an unreasonable unacceptable or unjustifiable price (Xia et al., 2004), can lead to lower consumer satisfaction and negative actions towards a brand (Lee et al., 2011). From a consumer's perspective, perception and thus acceptance of pricing fairness can be driven by the extent to which they feel that they have some control over the pricing and the extent to which a consumer compares their price to that paid by others (Lee et al. 2011). There is some support in the literature that the ability to provide consumers with an illusion of control over pricing and greater transparency in both presentation and framing of pricing can mitigate negative perceptions of dynamic pricing (Priester et al., 2020).

Whilst "differential pricing" is a widely adopted term in the practitioner literature, the less positive sounding "price discrimination" is used within the academic literature, a term that has a long history within economics (Varian, 1985). In defining these terms there is a lack of conceptual agreement. For example, the literature states that discriminatory pricing is a subset of dynamic pricing (Garbarino & Maxwell, 2010); that discriminatory and differential pricing are the same as dynamic pricing (Elegido, 2011); and that dynamic pricing is a subset of differential pricing (Netessine, 2006). Our contention is that the *in-use* forms of dynamic pricing generate distinctive ethical issues that require clear conceptualization.

Other than changes in price, what might frame the concept of dynamic pricing? Taken to its conclusion, a dynamic pricing strategy facilitates completely flexible prices, embedded through digital provision of pricing. These prices are informed by effective use of data and AI-driven decision-making models. To better conceptualize dynamic pricing, we use two theoretical lenses: equity theory and stakeholder theories. These theories bring together the notion of consumers operating as a group with that of consumers as stakeholders who take action. Whilst equity theories originally focussed on employer/employee relationships (Hayibor, 2008), more recent studies focus on buyer–seller relationships. Perceptions of equity are not simply established through evaluation of a single dyadic buyer–seller relationship, but by comparison with other consumers in a similar relationship (Festinger, 1957; Hayibor, 2008). The technologies that allow firms to develop and implement dynamic pricing approaches also allow consumers to communicate and share their experiences, for example through social media and rate and review sites. The concept of fairness in dynamic pricing is therefore embedded in the notion of perceived fairness *between* consumers and considers consumers as groups rather than just as individuals.

The second lens is that of stakeholder theory. The growth of stakeholder theories within marketing has been constrained by the dominance of firm-centric views of marketing (Bhattacharya & Korschun, 2008). This firm-centric view, with its focus on profit maximisation, has particular application in the context of pricing. Even within the field of stakeholder marketing, the consumer appears as just one of many stakeholders, alongside suppliers, communities, regulators, employees and shareholders (Hult et al., 2011). What is crucial is that the consumer is considered not a passive stakeholder but one who is able to take action to strengthen their position (Hayibor, 2008). In an effective stakeholder-based model of dynamic pricing, value creation takes place when consumers, as individuals and as groups, are able to respond to perceptions of inequitable pricing. Conversely, ethical issues occur where the technical implementations or characteristics of dynamic pricing prevent consumers from generating value.

This section has outlined the characteristics of dynamic pricing. In the next section we explore the specific characteristics of contemporary technology-driven use of dynamic pricing that is the source of the ethical issues explored in this paper.

4. Characteristics of contemporary dynamic pricing in use

Dynamic pricing approaches are long established. However, contemporary dynamic driving use is defined by five core characteristics. These characteristics emerge from both the academic literature and from examples of applications of dynamic pricing approaches, which are next explored. We label these characteristics as: i) Dynamic Value Orientation ii) Data Quality, iii) Digitalization of Pricing. iv) Algorithmic-driven Decision-making and v) Reduction in Cost of Changing Prices. Each characteristic is interlinked, and without the availability of new technologies and datasets these approaches would be impossible to implement. Conversely, without the managerial willingness to innovate in pricing and consumer acceptance of new pricing approaches, new technologies alone would not be enough. We now conceptualize and expand upon each of these characteristics.

The first, “Dynamic Value Orientation”, reflects the core role of value in pricing, whether value creation or value extraction (Kannan & Li, 2017). The ability of traditional pricing approaches to match price to value is constrained, either by the ability to rapidly change prices to match value or the ability to collect and analyze data to determine what value is. Dynamic pricing approaches facilitate rapid and accurate matching of pricing to value. In its purest sense this can be seen in “pay what you want” and other participative kinds of pricing strategies that allow rapid, real-time, and thus dynamic pricing driven by consumer preferences (Viglia et al., 2019). The forms of surge pricing adopted by Uber are another example, dynamically aligning price with value creation on a personal level in a way that can create supply.

“Data Quality”, the second characteristic, reflects the need for pricing strategies to be based around high quality underlying data if they are to be used to support decision-making (Elmaghraby & Keskinocak, 2003). In practice, setting prices is part of the process through which value is determined, not the endpoint. The ability to effectively understand how consumers respond to pricing decisions has been one of the most challenging market research problems (Garbarino & Maxwell, 2010). The growing volume of training data available on which to make pricing decisions also increases dynamic pricing algorithms’ quality and effectiveness (Najafabadi et al., 2015).

Alongside “Data Quality”, the “Digitalization of Pricing” is changing the way in which pricing information is delivered to the consumer. The growth in online retail, digital travel-purchasing and online marketplaces has drastically increased the volume of prices delivered in a digital form. The impact of the COVID pandemic on encouraging touchless purchasing and ready availability of mobile devices led to a growth in the ability to offer digital pricing in almost every environment. This facilitates the real time generation of personalized, and context specific, prices. For example, the use of electronic shelf labels in grocery stores to allow physical store prices to be rapidly changed to match online prices (Boden et al., 2020). Although just one aspect of the digital economy, the digitalization of the price, disintermediates the price from product or service delivery, it provides the platform that supports an almost unlimited choice of pricing approaches. This also facilitates the real-time setting and changing of prices, which underpin the provision of dynamic pricing approaches.

The fourth characteristics, “Algorithmic-driven Decision-making”, reflects the growth in the widespread use of algorithms to determine prices, which presents a shift away from managerial decision-making to one of machine-based decisions. As these algorithms become more advanced, so does the autonomy they exert and the distance between the human and the actual decision made (Boddington, 2017). Under dynamic pricing approaches, pricing agents can autonomously co-ordinate prices without human intervention (Ittoo & Petit, 2017), no longer being

reliant on a mechanistic rules-based system (Calvano et al., 2019).

These characteristics support the “Reduction in Cost of Changing Prices”, driven by the increasingly accessible technologies and the low cost of implementation, both in terms of the technologies themselves and the extent to which dynamic pricing approaches can more easily be integrated into business processes (Calvano et al., 2019). As has been seen with the growth of Big Data, it was reduction in cost and ease of implementation that were key drivers of widespread adoption of these technologies.

5. Exploring the ethics of dynamic pricing

Having conceptualized dynamic pricing, we now explore broader ethical issues arising from the application of dynamic pricing. For managers there needs to be an awareness of consumers’ negative perceptions and a general lack of trust in the benefits of data-driven new technologies for consumers (Chen & Gallego, 2019). This negative view ignores the potential for dynamic pricing to have a range of benefits for stakeholders. For example, in the electricity market the use of dynamic pricing can also be seen as a tool to help reduce prices and manage demand around scarce resources. Also, the technology required to deal with significant peaks of demand is expensive and would increase overall costs (Faruqui & Sergici, 2010). Use of dynamic pricing techniques, such as increasing electricity prices at peak times, not only serves to manage demand, but also reduces overall service costs to consumers (Faruqui & Sergici, 2010). However, the effectiveness of dynamic pricing is not simply dependent on technological availability, but also on the willingness of consumers and other stakeholders to buy into the concept (Dutta & Mitra, 2017). It is also the case that the effective implementation of dynamic pricing requires a high degree of sophistication, including advanced customer segmentation approaches, which may be beyond the capabilities of many organizations (Dutta & Mitra, 2017). However, although energy and pharmaceutical items are important examples of critical goods, they also represent public goods that cannot be easily substituted. In both cases the use of dynamic pricing encourages conservation rather than substitution (Allcott, 2011), which is different from consumer markets where there is a high level of competition, and substitution is readily available.

As such, whilst the previous literature is useful to inform the debate, there has been insufficient discussion of the specific ethical issues that relate to the contemporary use of dynamic pricing (Seele et al., 2021). In the next section we bring together this prior research, combine them with literature on ethical issues over emergent technologies, and generate five distinct dimensions of ethical issues relating to dynamic pricing.

5.1. Customer effort & intensity

As notions of pricing have shifted from one of financial transaction to one of value exchange, applications of pricing strategies will generate an increasingly complex range of responses from consumers, particularly where there is a perceived cost to consumers. While some of these costs are direct and financial (i.e. the consumer being charged a higher price), others are reflected in the increased effort a consumer must make to determine the appropriateness of the price. These are the “hassle costs” involving both non-monetary effort as well as the inconvenience that a customer incurs when prices change (Lambrecht & Tucker, 2012). Whilst customer effort is often associated with switching costs, it can also apply to non-switching costs such as produce or service price changes (Lambrecht & Tucker, 2012), such as when customers compare current price of each brand to reference price based on previous purchase experience (Moon & Voss, 2009). Consumers are more likely to accept price changes when they have a higher level of trust in the firm setting the prices (Garbarino & Maxwell, 2010), although trust can be lowered if consumers lack understanding of the mechanisms behind price changes.

There is wide evidence in the literature that increasing the cognitive load required for consumer decisions has negative impacts on consumer decision-making (Dewitte et al., 2005), and can result in decision deferral (Anderson, 2003). Implicitly, the use of dynamic pricing will create a higher level of customer engagement when evaluating pricing decisions. However, too great a need for an intensity of engagement, in terms of their subjective perception of extent of time and effort needing to be invested, can result in lower levels of customer satisfaction (Haumann et al., 2015). This intensity, due to frequent and/or unexpected pricing changes, can drive value co-destruction (Luyen et al., 2021) and generate consumers' avoidance behavior. For example, in dynamic pricing situations, consumers can be found to behave strategically when they believe it is to their advantage, such as putting off purchasing decisions and waiting for a lower price (Su, 2007). A customer's knowledge that they have not paid more than they need to is also an important factor in determining satisfaction with dynamic pricing strategies (Milman et al., 2021). The intensity of customer engagement in such circumstances is not just driven by frequency or unexpectedness of pricing changes but also the extent of ease of access to information on which to base a judgement over whether the dynamic price was a fair price.

Taking these factors into account, it is important to consider the impact of the intensity of engagement required from the consumer's perspective, separate from the price. Providing the transparency, co-creation and communication required by consumers to help reduce this intensity is a major aspect of the model and managerial recommendations made later in this paper.

5.2. Agency and control

When a price is set dynamically, through an algorithm that runs and is generated autonomously, who has control? The problem of control is one of the central ethical issues relating to uses of AI. The more powerful AI becomes, the more difficult it is to control it and the more influential decisions made by the AI system become (Boddington, 2017). Much of the discussion around pricing ethics embeds the tacit concept that control is embedded in consumers (they can decline to purchase at a particular price) or managers setting a price (they can control the price at which a product or service is sold). With control comes responsibility for ownership of the outcome. The potential of dynamic pricing and its embedding of autonomous algorithms raises several questions about individual moral agency. The question of agency, the capacity of managers to make choices and own decisions made by the systems they control, has been given growing importance within the hyperconnected digital era (Zwitter, 2014). The kinds of problems of control with dynamic pricing can be seen as new variations on longstanding moral dilemmas relating to pricing (Johnson, 1985). The extent of AI's impact requires a more formal consideration of ownership of pricing decisions made by algorithms and reflection on the management processes involved in setting prices.

5.3. Autonomy and co-ordination of algorithms

One aspect of algorithmically driven dynamic pricing is the extent of coordination between algorithms. Whilst pricing algorithms can utilize pre-existing customer data, in an active market algorithms that understand price changes by competitors can be a highly effective part of a pricing strategy (Brown & MacKay, 2021). This reflects trends in dynamic pricing where, instead of choosing prices, companies choose pricing algorithms - and therefore it is algorithms rather than prices that compete with each other. The challenges raised in the prior discussion on collusion suggest areas with specific legal issues around control and co-ordination. However, algorithms do not operate in isolation. Dynamic pricing algorithms are based not just on consumer demand but on prices from alternative suppliers. If these algorithms compete against each other, what is the outcome? Several examples of algorithms

resulting in "runaway prices" have occurred on Amazon. For example, a textbook about flies being listed for more than \$23 million (Solon, 2011), and an out-of-print fiction book listed for \$2630 (Streitfeld, 2018), were the result of imperfect dynamic pricing algorithms competing against each other. The impact of this direct algorithmic competition differs from standard price competition. Even when one firm has a superior pricing technology and algorithms than another, research indicates that both firms can benefit from increased prices (Brown & MacKay, 2021). At the same time, this kind of algorithmically driven competitiveness can be harmful for consumers if price increases become detached from market demand.

5.4. Bias in pricing algorithms

A core concern in pricing fairness and in the use of differential pricing is the extent to which setting different prices to different target groups might be seen as exploitative. Perhaps the most common ethical concern with the use of algorithms and AI-driven decision-making is the extent to which biases can be embedded in the decision-making process and then propagate into real world bias (Knight, 2017; Manyika et al., 2017). Forms of bias can be difficult to identify where they occur due to the presence of hidden biases embedded in training datasets (Richardson et al., 2019). Such bias might include charging different prices to vulnerable groups, individuals with disabilities, or based on race. Knowledge that prices can be used to discriminate against individuals is not new, but algorithmically determined bias is more difficult to identify than those individuals using price as a mechanism to transmit discriminatory views and policies (Elegido, 2011). The most problematic aspect is that these forms of bias can only be identified in use, with the technical complexity of algorithms making it difficult to identify harm caused *a priori*.

There is an ethical counterargument that, by being more effective at seeking economic value, algorithms can help eliminate bias in decision-making. Taking examples unrelated to pricing, Netflix estimates that its use of machine-learning to provide more useful, customized and accurate search results saves it more than \$1 billion per year in cancellation rates (Bughin et al., 2017). Some European banks have used algorithmic machine-learning techniques to better identify risks and therefore more appropriately price loans (Pyle & San Jose, 2015). Other examples include researchers integrating machine-learning into recruitment and selection by selecting candidates through the examination of résumés. They claim that these algorithms were less susceptible to gender discrimination and helped eliminate hidden human biases (Fechey-Lippens et al., 2015).

5.5. Price collusion

A major concern occurs where dynamic pricing facilitates a form of price collusion, thus facilitating value extraction and monopolistic or oligopolistic practices. This has already resulted in legal cases relating to use of pricing algorithms on online marketplaces. The first prosecution, the "Poster Cartel" case, occurred in 2015 against a director of a company selling online posters on Amazon. This was based upon the use of algorithm that ensure parity in prices between different vendors on the platform (Yaholnyk & Zeleniuk, 2020). Whilst the algorithm was autonomous, these online vendors had met previously to determine the specifications of the algorithm. Typical strategies involve vendors agreeing not to undercut or match each other when raising prices. Other instances have occurred where travel platform operators set maximum discounts, and control of the platform creates *de facto* collusion between participants.

These examples deal with overt collusion. More problematic is tacit collusion, which is unplanned collusion, where algorithmically driven pricing approaches enable pricing agents to autonomously co-ordinate prices without human intervention (Ittoo & Petit, 2017). This possibility occurs because of a shift from mechanistic rule-based algorithms to

those based on reinforcement learning (Calvano et al., 2019), enabling *de facto* collusion to occur without any communication between parties. This is particularly problematic for two reasons. Firstly, the legal framework that surrounds the concept of collusion is built upon the notion of human collusion. With algorithmically driven collusion there is no direct interaction between parties, and therefore no direct human intervention (Calvano et al., 2019; Harrington, 2018). Second, price collusion is difficult to identify even when there are human actors. In algorithmically generated pricing environment where dynamic pricing results in rapid shifts in pricing, understanding the rationale behind pricing decisions is highly complex and requires huge analytical effort (Byrne & de Roos 2019).

6. A stakeholder-based framework for dynamic pricing

The core tension that managers face is in implementing dynamic pricing strategies in a way that creates value and avoids alienating consumers (Lastner et al., 2019). Given the financial motivations driving dynamic pricing, embedded competitive advantage (Lastner et al., 2019), and consumer dissatisfaction when they become aware of dynamic pricing approaches, it would be understandable if managers sought to avoid scrutiny. However, this assumes firms can avoid transparency in a world of greater regulatory interest and consumers' ability to share information amongst themselves. Parallels can be drawn with research into consumer privacy where attempts to minimize risks around the use of data resulted in negative regulatory outcomes, reduced consumer trust, and increased defensive consumer behavior (Bandara et al., 2021). At the same time, providing consumers with a sense of choice and control over their data can reduce the perception of risk and improve purchase intention (Bornschein et al., 2020). Recent literature has sought to move beyond notions of pricing strategy as a choice between cost and market value towards a more stakeholder-based approach. For example, Koehn and Wilbratte (2012) introduce the concept of a "just person price", taking into account the well-being of the individual transactors and the good of the entire community. While questions of stakeholder management have in the past been relegated to a non-financial or social capacity, there is growing acceptance of the value of stakeholder theory in corporate strategy, particularly in shifting ethics from an abstract discussion to one taking into account the "managerial mindset" and the need to influence managers who make decisions on the ground (Parmar et al., 2010).

Addressing the governance issues around dynamic pricing will become more important as enabling technologies, particularly those driven by the growing capabilities of AI, create increasing accessibility of off-the-shelf technologies that facilitate dynamic pricing approaches. However, to date the governance issues around such autonomous or semi-autonomous pricing approaches have not been fully explored from a consumer perspective. Consumer trust in new technologies is built upon systems that possess transparency, accountability, and explainability (Gasser & Virgilio Almeida, 2017). Many scholars are exploring the important role of those new autonomous technologies, such as the application of human-like service robots (Wirtz et al., 2018) in terms of transforming the customer experience. This includes discussions around the appropriate level of autonomy to grant robots, while protecting consumer safety and privacy (van Wynsberghe & Donhauser, 2018). However, there is little research on the implications of the dynamic context of pricing and the steps that managers should take to ensure that pricing approaches do not damage relationships with customers. In the rush to adopt new digital platforms over the last two decades, the lens of "the double identity of the online consumer as a shopper and a computer user" (Koufaris, 2002, p.205), associated with the adoption and use of consumer-facing technologies, has dominated research. The question of how managers address the negative consequences of new technologies has been less explored, and the broader literature on the governance of such technologies is driven by macro regulatory and policy frameworks that tend to be far from managers' minds (Flyverbom et al., 2019;

Susskind, 2020).

Managers might argue that these kinds of impacts are difficult, if not impossible, to analyze and exist at a level beyond their control. Nevertheless, effective governance of new consumer-facing technologies goes beyond regulatory or legal compliance, as laws and regulations are typically made with a retrospective, "rear view" mirror. Managers need to take a strategic view of how consumers will respond to the use of dynamic pricing, not simply in terms of direct purchase decisions but also less direct factors.

Many different governance models are being developed by researchers to better support the use of new forms of autonomous technologies, such as those that underpin dynamic pricing strategies. However, applying these to managerial decision-making is difficult due to the focus of these models on macro-level consequences that are often catastrophic in nature. For example, consequences include the potential for autonomous technologies to restructure the workplace and eliminate jobs (Brynjolfsson & McAfee, 2014; Frey & Osborne, 2013), or concerns over harm to human skill acquisition and problem-solving abilities (Carr, 2014). Scholarly discussions around the ethics of autonomous technologies can be framed around the threats to humanity (Crotoft, 2014), with suggested remedies centered on limiting the usage of such technologies (Shrivastava et al., 2009). Scholarly research does "little more than reiterate the need for machine ethics and argue[s] about which set of moral convictions would be the right ones to implement in our artificial progeny" (Yampolskiy, 2012, p.289). In other words, the debate on ethics and autonomous decision-making remains focused on hypothetical technologies, or hypothetical applications of existing technologies, rather than the very context specific applications such as dynamic pricing that are used in business today.

From the perspective of managing pricing strategies, developing existing governance mechanisms is problematic for two reasons. First, the high degree of variability around definitions of the underlying technology (Bryson & Theodorou, 2019), and the ambiguity of core concepts such as "fairness" in terms of consumers, create the risk that misunderstandings occur when trying to implement these guidelines (Theodorou & Dignum, 2020). The second is the narrow range of stakeholders represented in the discussion of ethical issues and the customer's absence in this literature. Within the literature on pricing ethics, the customer is often either absent or viewed as a passive actor represented via a willingness to accept or decline the market price. In the context of dynamic and personalized pricing, we suggest this leads to an imperfect view on pricing where the perspective of the consumer is not sufficiently taken into account. Given the key role of pricing in determining value and growing role of co-creation in contemporary marketing strategy, it is necessary to consider dynamic pricing from a full stakeholder perspective.

As this paper highlights, understanding of value in pricing is shifting from being a purely financial one to one embedded in customer value (Chen & Gallego, 2019). A core aspect of the determination of customer value is the perception of fairness or equity, and the avoidance of inequity in pricing evaluations is an important goal for managers. The characteristics of dynamic pricing outlined earlier in this paper, including issues around agency, autonomy, bias, and the overarching issue of transparency that inhabits all AI systems, increases the potential for inequity. At the same time, if issues of inequity can be addressed, contemporary dynamic pricing approaches provide substantial potential for creating value for both firms and customers. It is important that these areas are addressed as consumer responses to the use of "covert" marketing techniques have been consistently negative (Milne et al., 2009), although this can be mitigated through communication and building consumer awareness of how technologies are used (Wei et al., 2008).

In addressing this challenge of inequity, we build upon prior stakeholder governance models (e.g. Abraham et al., 2019; Schneider et al., 2020), but also provide a framework that is customer-centric and therefore managerially useful. When evaluating ethical frameworks around AI, the level of individual risk is a key driver of perceived ethical

importance in terms most specifically of the risk of immediate harm. This creates a greater focus on the ethical challenges in areas such as health, defence and security but, in turn, underplays consumer-focused contexts. However, this ignores the aggregate, widespread and often indirect impact of pricing decisions upon everyday lives. Pricing decisions influence not only how people purchase, but also what they purchase.

In Fig. 1 we present a model that highlights the sources of perceived inequity that are generated through use of dynamic pricing approaches. An understanding of inequities created by the use of dynamic pricing needs to be supported by a corresponding understanding of consumer concerns (Shabbir et al., 2019). This model recognises that price inequity is not only driven by a dyadic relationship between firm and customer, but also by more complex relationships between stakeholders. The importance of stakeholder-based models of management decision-making that take account of the consumer perspective is becoming more recognised and widespread (Polonsky & Hyman, 2007). Marketing occurs within a broader framework of institutions (Hunt, 2007), and relationships between different groups of stakeholders play an important role in determining marketing outcomes (Hult et al., 2011). In this case stakeholder relationships include both within firm and between customer relationships.

Four drivers of perceived inequity are identified: agency, communication (both to and from consumers), transparency and co-creation. The concepts of agency and transparency are related to overall control of decision-making within organisations. Perceived inequity driven by communication failures relates to the consumer’s lack of ability to influence pricing decisions and by the firm’s inability to anticipate the behavioural consequences of the algorithm’s changing prices. If consumers don’t understand what is driving price changes and cannot communicate their findings, the chances for perceptions of inequity increase. Finally, there are interactions between consumers. This could include both market-based competition among consumers and forms of consumer co-creation where consumers are able to share information about pricing via social media to “beat” the algorithm. Whilst co-creation is typically framed as a route to value creation (Grönroos & Voima, 2013), this can also create information asymmetries that reduce value for certain consumers. For example, individuals have different “social graphs” and different levels of engagement with online information. Groups with lower access to information, including vulnerable groups, might inadvertently end up paying higher prices.

A goal of this paper was to provide a managerial framework to address the effective management of the ethical issues generated by the implementation of dynamic pricing strategies. These ethical issues manifest themselves through stakeholder resistance to dynamic pricing approaches. Due to the complexity of dynamic pricing, perceptions of reference price are driven by perceptions of fairness rather than

experiences of prior purchases (Priester et al., 2020). In addressing the challenges of dynamic pricing, managers need to adopt strategies that address these perceptions of fairness.

In Table 1, adopting the stakeholder model in Fig. 1, approaches managers can take to address this resistance are suggested. Five sources of resistance are identified: i) Consumers perceive lack of control over pricing; ii) Limited agency within firms; iii) Absence of firm to consumer price communication; iv) Ignoring consumer to consumer communication and v) Societal perception. For each we provide characteristics, specific examples and approaches managers can take to address these challenges. Failure to take account of stakeholder perceptions is likely to result in a range of negative outcomes, ranging from negative customer experience through to pressure from competitors or policy makers.

This table highlights how managers have tools available to address issues around the use of dynamic pricing. For example, consumers are more willing to accept use of their data for dynamic pricing if they have been able to opt-in, such as through a cookie style notice (Schmidt et al., 2020). For managers this requires acceptance of a trade-off; providing customers with a level of control over the data collected and the way that it will lead to some customers opting out. At the same time, this will increase the level of trust that customers have in dynamic pricing approaches. Managers who do not accept this trade-off should consider the cautionary tale when consent is not sought from consumers, involving declining trust from consumers, and growing regulatory oversight around data collection on social media (Nunan & Yenicolgu, 2013).

These forms of resistance differ between companies and industries. Whilst dynamic pricing involves an important role for nearly every industry, the way in which dynamic pricing is implemented and the speed of adoption are dependent on sector-specific characteristics. A more granular approach is required to reflect the different challenges that managers face in depending on the sector in which they operate. The value of this table is in recognising the range of stakeholders that can impact dynamic pricing. Addressing resistance to dynamic pricing means recognising that consumers are (tacitly) playing an increasing role in the determining of prices (Wang et al., 2021); then it stands that they need to have greater awareness of the ways in which prices are developed. Managers should learn that efforts to impose technologies on consumers, where control creates significant power-imbalance, end up destroying trust (Milne et al., 2009; Taddeo & Floridi, 2018), and therefore value.

7. Conclusion and further directions for research

The growing availability of technology, data and analytical tools, stands to dramatically increase the scope and use of dynamic pricing strategies. This paper reconceptualizes the notion of pricing ethics, taking account of the increasingly algorithmic and AI driven tools that

Sources of Perceived Pricing Inequity

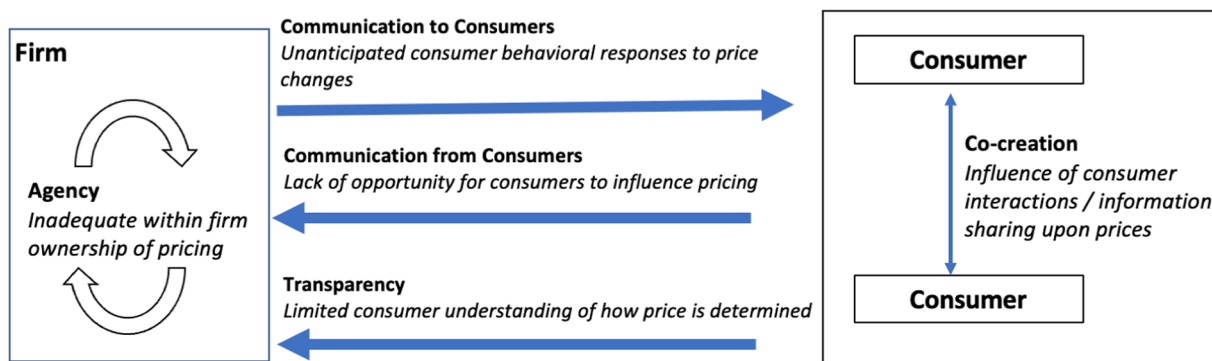


Fig. 1. A Stakeholder Model for Perceived Inequity in Dynamic Pricing.

Table 1
Addressing Stakeholder Resistance to Dynamic Pricing.

Source	Characteristics	Example	Mitigations
Consumers perceive lack of control over pricing.	Consumers ability to control price impacts perceptions of fairness (Vaidyanathan and Aggarwal, 2003)	Consumers adopt information searching behaviour designed to minimise accurate information collection, such as clearing cookies or use of a VPN or adblockers.	<ul style="list-style-type: none"> • Informed consent: Provide consumers with details on which data points influence price, and options to opt-out. • Illusion of control: Provide variables that consumers can manipulate (e.g. time-based pricing) or suggest approaches that consumers can use to change pricing.
Limited agency within firms	Failure of employees to understand impact of dynamic pricing / algorithmic decision making on consumers. Lack of multi-stakeholder perspective.	Unwillingness to implement dynamic pricing due to fears of consumer backlash (Priester et al. 2020).	<ul style="list-style-type: none"> • Approaches to use of dynamic pricing should take a customer lifetime value approach. • Carry out market research & customer insight work on consumer perceptions to dynamic pricing before implementing pricing changes.
Absence of firm to Consumer Price Communication	Consumers use heuristics to determine motivations behind algorithmic pricing and techniques being.	Many consumers believe use of dynamic pricing-based on person data is illegal (Turow & Hennessy, 2015)	<ul style="list-style-type: none"> • Develop policies to communicate where dynamic pricing approaches are used to consumers and explain approaches in terms of value creation. For example, that dynamic pricing maximises capital investments and keeps prices down overall.
Ignoring Consumer to Consumer Communication	Consumers determine reference price-based on lateral consumer relationships.	Consumer perceptions of price information-based on information on comparative information available on social media (Lee et al. 2011)	<ul style="list-style-type: none"> • Counter misinformation about dynamic pricing. Where consumers share pricing information be proactive in providing transparency via accurate information. For example, airlines that share the range of prices that consumers have paid for a flight on particular days.
Societal perception	Dynamic pricing used to exploit customers and maximise profitability.	Greater regulatory focus on dynamic pricing (Borgesius and Poort, 2017)	<ul style="list-style-type: none"> • Engage with policy makers in a transparent way, and frame dynamic pricing as maximising investment. Ensure that unfair aspects of dynamic pricing are identified and mitigated through manual adjustments.

drive pricing decisions. From the perspective of strategic management this presents a significant change over traditional pricing strategies, based upon management of price, to increasingly algorithmic pricing strategies, based upon the management of the algorithms and technologies that drive pricing. We suggest that this presents a new set of ethical issues, with potentially serious consequences if managers are not able to effectively address them. We present a framework model highlighting governance mechanisms to support managers in their desire to implement these algorithmically driven pricing approaches going forward.

This research suggests for further study several streams that go beyond improvements to algorithms and maximizing short-term revenue from pricing decisions. One promising area is in developing understanding of how to gain consent from consumers for the use of dynamic pricing techniques, and knowledge of the forms of consumer communication that will develop trust in dynamic pricing. Research could also explore the role of consumer-to-consumer interactions around dynamic pricing, such as on social media or rate and review sites, in driving both consumer perceptions and decision-making processes. Furthermore, scholars could explore how firms can build a culture where dynamic pricing strategies are developed to fully take stakeholder views into account. This culture includes developing the capabilities of non-technical managers to understand the impacts of dynamic pricing across a broad range of stakeholders. Finally, in the context of growing policy interest around the ways that customer data is collected and used, scholars could consider policy directions, bearing in mind comparisons with other data driven marketing strategies and potential regulatory responses. We hope this paper will encourage other scholars to consider exploration of this important topic.

CRediT authorship contribution statement

Daniel Nunan: Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **MariaLaura Di Domenico:** Writing – review & editing, Writing – original draft, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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