

The Effects of Widespread Application of Personalized Pricing Technology

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Abstract. Digital technologies and artificial intelligence enable firms to adopt personalized pricing on an increasing scale. This paper examines the broad consequences if such pricing practices become commonplace, adopting a multi-angle framework covering microeconomics, macroeconomics, social relations and political outcomes. The analysis tracks how market structures may evolve from monopoly towards oligopoly, alongside strategic behavior between buyers and sellers within repeated market exchanges. The analysis confirms that personalized pricing may deliver short-run efficiency gains and higher firm returns at a microeconomic level. In the longer run, however, a wide range of adverse effects emerge: widening wealth gaps, strengthened barriers for new market entrants, weaker innovation incentives, declining consumer confidence and heightened risks of social tension. The paper argues that, without effective oversight, the social and economic burdens of unrestricted personalized pricing exceed its advantages. Targeted governmental oversight and rules governing algorithmic systems are therefore required to reconcile market efficiency with fair outcomes.

Keywords: personalized pricing, market efficiency, economic inequality, social equity, algorithmic regulation

1. Introduction

The development of technology make business easier to implement personalized pricing for different consumers based on browsing history data of consumers' preferences and purchasing behaviors, which sets a price for each consumer based on their maximum willingness to pay [1]. In the short-term, though personalized pricing will bring some benefits to businesses, the benefits are not significant; in the long-term, personalized pricing led to competition among businesses, a crisis of consumer trust in businesses, and unfair distribution of resources in society.

Admittedly, based on microeconomic theory, there are some benefits to personalized pricing such as increasing the profit level and minimizing deadweight loss. AI algorithms can offer discounts to low-income consumers who otherwise could not afford the product. This expands output and improves efficiency. However, these traditional theories assume that there is no business competition and businesses do not try to indulge high-income populations. Personalized pricing heavily relies on the exploitation of private data, thereby raising the concerns about personal privacy and reducing the transparency of information regarding consumers [2]. This structural asymmetric control over data

ultimately provides established businesses with the tool to distort market outcomes rather than enhance efficiency.

2. Microeconomic perspectives: from monopoly to oligopoly

Traditionally, microeconomic baseline models often analyze a monopoly market with a single business. The monopolist sets uniform pricing to each consumer. However, with the development of technology, the business can utilize personalized pricing to enhance its profit because technology can help it eliminate the uncertainty of consumers' purchasing preference and make the first-degree price discrimination possible. In the short-term, the first-degree price discrimination can help the business to charge a higher price to high-income consumers and charge a lower price to low-income consumers, which increases profits [3].

However, dramatic profit of the business is extracted directly from consumers. This extraction eliminates all the consumer surplus and especially, leads to a larger negative impact on low-income consumers. Personalized pricing will exacerbate the wealth inequality between different groups of consumers. Charging the identical percentage-based price might create an asymmetrical marginal impact. For instance, a 10% price imposed on families with £10 income or £100 income might be different in terms of consumer affordability. Negative impacts of personalized pricing in a monopoly market are shown in Figure 1.

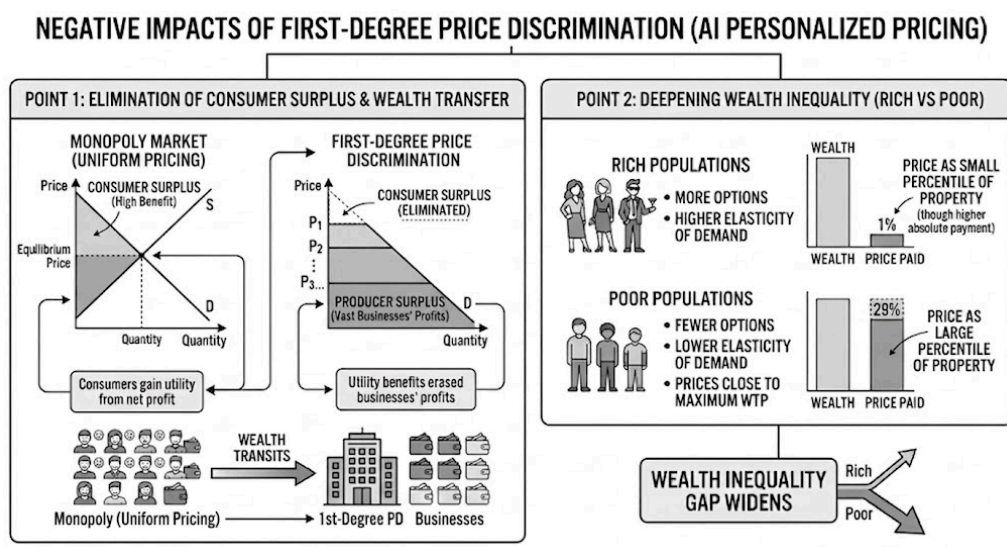


Figure 1. Negative impacts of first-degree price discrimination on consumers

Simultaneously, for the demand side of the monopoly market, personalized pricing triggers a dynamic repeated game between the monopolist and the consumers. Businesses can change the price that is set for consumers based on their past actions, and consumers choose to purchase the goods of that business or not. While asymmetric information exists in the single round of the game, in a recurring market framework, consumers are not information-deficient entities; they rapidly evolve into sophisticated strategic agents who rationally anticipate future price discrimination [4]. Thus, consumers may camouflage themselves as people who are sensitive to the price of the commodity. Some may delete browsing data or deliberately alter online behavior, which leads the AI to make a wrong prediction of the maximum willingness to pay of the consumer [5]. From the game theoretic perspective, this friction triggers a highly inefficient, Pareto inferior outcome which the consumers'

counter-strategies distort purchasing behaviors and ultimately reduce the firm's total transaction volumes and profits across repeated interactions [6].

However, though consumers' camouflaging strategy exists, in the long-term, the high profit will still attract many other businesses into the market, thereby transferring the market from a monopoly to an oligopoly. In the new market structure, because the primary business has more consumer data, it retains its first-mover advantage. This might lead to tacit collusion. An aggressive oligopolistic price war will break out because businesses do not choose to cooperate with other businesses [7]. In this situation, all businesses may use a lower price to attract consumers to purchase their products, which is called consumer poaching [8], and a Nash equilibrium occurs, in which all businesses are locked in a mutual cycle of price-cutting that none can independently escape without losing profit. Therefore, consumers will benefit from competition and personalized pricing may harm firms relative to uniform pricing. Consumer poaching can severely erode corporate profitability [9].

3. Macroeconomic perspectives: barriers, misallocation, and innovation crisis

Although the theoretical Nash equilibrium would lead to a decrease in the profits of businesses, due to information asymmetry and AI algorithmic barriers, only a small portion of consumers can strategically manipulate these pricing algorithms to their advantage. Consequently, in most markets, the oligopoly structure remains highly dominant and profitable. Personalized pricing does not merely impact several consumers and businesses; it has some large impacts such as decreasing the aggregate demand of the society and misallocate macroeconomic resources. First, the industry's high economic profits initially entice a second wave of entrants to challenge the original monopoly businesses that hold a first-mover advantage. However, once these early successful entrants create their market share and form a stable oligopoly, those businesses can accumulate a massive consumers base, and those businesses can control more consumers' purchasing information and preference, which build a barrier that making it difficult for other businesses to enter in the market. Using China e-commerce platform as example, platforms engage heavily in such data-driven targeting. Pinduoduo utilizes low-price strategies (such as 9.9-yuan items) tailored to its consumers base in less-developed areas, allowing it to rapidly collect consumer preferences, lock in a stable user base, and solidify its data monopoly.

Moreover, under the pressure of this entry barrier, new businesses can only gain market share by engaging in price wars. Though new businesses may find it difficult to compete because those established businesses can accurately capture consumers who might be attracted by a low price by using AI, and those established businesses can give a discount to those price-sensitive consumers. In summary, the structural expansion of these personalized pricing monopolies will decrease the allocative efficiency at the macroeconomic level by setting an insurmountable barrier to entry. This will cause the lack of "fresh blood" being introduced into the market, which inhibits the innovation of the market. Consequently, the universal adoption of personalized pricing ultimately yields a deadweight loss at the macroeconomic level, meaning that this suppression of entry and innovation permanently restricts the long-term potential productivity growth of the entire economic ecosystem.

Beyond aggregate macroeconomic efficiency, the distributional consequence of personalized pricing also has a large impact on economic equity, because personalized pricing is often more likely to reallocate existing economic surplus rather than create new value, although there occasionally have personalized services that offer distinct consumer utility. Businesses divide consumers to different groups based on consumers' characteristics including education and income level and operate different treatment to different groups of consumers. Businesses are increasingly leveraging individual consumer data to adjust prices. AI frequently exploit loyal, low-elasticity consumers

while extending subsidies to highly elastic, wealthy consumers. Consequently, instead of benefiting the market as a whole, this mechanism allows businesses to systematically extract consumer surplus, thereby an inequality between businesses and consumers had been aggravated. Therefore, businesses achieve a massive, regressive reallocation of wealth by charging different prices to different consumers. Instead of distributing resources efficiently at the allocative efficiency price, this mechanism aggregated purchasing power out of the general public's hands, further leading to inequality between the consumer class and producer class [10, 11].

4. Social and political perspectives: equity, trust, and democratic legitimacy

Beyond its economic effects, personalized pricing also has a large negative social impact including eroding consumer trust, triggering public backlash, and fostering political instability. First, the economic inequality directly erodes social trust [12]. By utilizing personalized pricing, businesses manipulate the price that exposed to different consumers. This is a process that changes the transparent commodity market to a zero-sum game with deception. Crucially, while businesses do not sort consumers by social hierarchy—instead targeting variations in willingness to pay, urgency, and price elasticity—the outcome of algorithmic clustering aligns with the existing social hierarchy. Because high-income populations have more options, each business will offer them discounts to attract them. However, for low-income populations, because of limited options, they will be exposed to a relative higher price. Consequently, low-income populations are understandably resentful to be treated with a higher price even when purchasing identical products as those who pay a lower price.

Furthermore, the widespread adaption of personalized pricing significantly intensifies social friction between consumers and businesses. After consumers break through the information asymmetry, they discover that even their friends or neighbors are paying lower prices for identical goods, leading consumers feel that they have been treated unfairly. Moreover, consumers will also feel that their privacy has been stolen and exploited, which further intensifies their anger toward businesses. Take online retail and airline booking platforms utilizing tracking cookies as an example; they impose a 'loyalty tax' based on their frequency of checking the platforms to exploit consumers' urgency [13]. Such actions raise the anger of consumers and public's condemnation. When individuals realize that they suffer from inequity and being exploited by businesses, they are likely to punish the people who infringe upon their equal rights and boycott businesses. As this "algorithm tax" structurally exploits the lower classes, their anger toward businesses may cause the social instability. When consumers realize this economic injustice is systemic, their retaliation might expand to the political sphere [14].

The practice of businesses using personalized pricing to make a difference between high-income populations and low-income populations is a process that businesses exploit all consumers based on their social hierarchy. Based on Laurin et al. (2013), individuals have a psychological defense mechanism that rationalizes existing social disparities, sustaining a belief in the inherent fairness and stability of the system. However, when AI algorithms convert the economic surplus extracted from low-income populations into discounts for high-income populations', this psychological defense collapses under the social inequality and injustice. The specific dynamics of this conversion and the subsequent reactions of low-income populations are detailed in Figure 2.

THE SPILLOVER EFFECT OF ALGORITHMIC INJUSTICE (REVISED CAUSAL CHAIN)

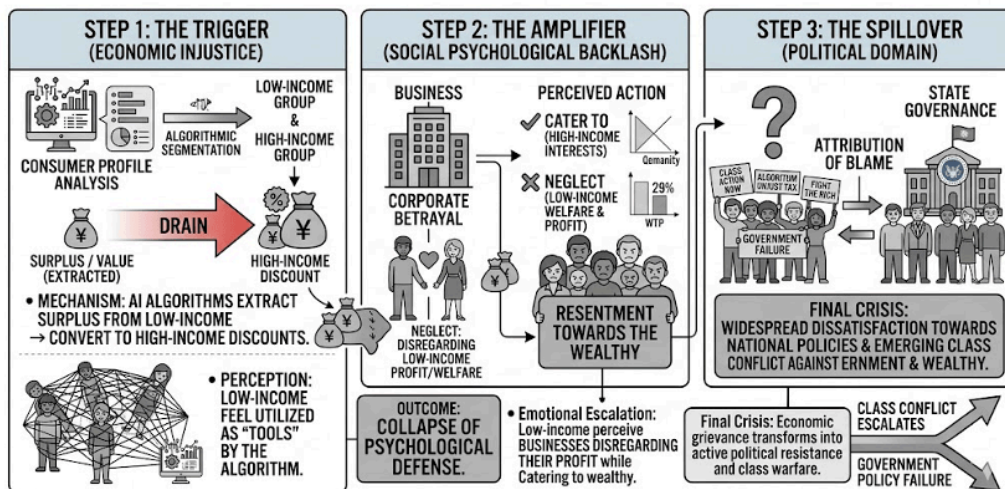


Figure 2. How personalized pricing cause the social instability

Government failure to regulate businesses' monopolies triggers a profound crisis of democratic legitimacy. Low-income populations realize that the country's laissez-faire attitude is indulging businesses to exploit low-income populations' profit, thereby transforming consumer anger into a political disillusionment [15].

Those established businesses in the commodity market used their technology to monopolize the industry. Thus, low-income populations have not benefited from the development of technology. Instead, businesses maintain the personalized pricing mode by draining the consumer surplus of low-income populations and even subsidize the discounts for the high-income populations. Therefore, in order to prevent such situation and to ensure the efficiency of the market, the government must start to regulate businesses. Only when the government start to control over these businesses, can the efficiency brought by personalized pricing be transformed into benefits for society. For instance, the government can expose corporate taxes on those businesses to collect the huge profits that they earned by eliminating deadweight losses and use them for redistributing social welfare. Furthermore, the government can enforce algorithmic transparency, independent auditing, and anti-discrimination protocols, or enact anti-trust law to force those businesses to invest their excessive profits in research and development, thereby achieving long-term dynamic efficiency.

5. Conclusion

Ultimately, the negative impact of personalized pricing in macroeconomic and its societal costs significantly outweigh benefits that in microeconomics model. Since government regulations have not been fully implemented globally, their regulatory policies are difficult to understand the AI algorithms used by enterprises, thereby further reducing the positive impact of personalized pricing [16]. To limit regulatory failure, personalized pricing should not be widely permitted without strict regulatory safeguards.

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