Personalized Pricing: Blessing or Curse?

Abstract

The rapid expansion of digital technologies and the widespread availability of granular consumer data have fundamentally transformed firms' pricing strategies. Personalized pricing—once largely theoretical—has become an increasingly common and feasible practice across digital markets. By leveraging detailed information on consumers' location, purchasing behavior, and willingness to pay, firms are now able to tailor prices at an unprecedented level of precision. While the economic literature has extensively examined the implications of price discrimination for firm profitability and consumer welfare, important gaps remain. In particular, existing models often rely either on perfectly inelastic demand or on homogeneous consumers, limiting their ability to capture the joint effects of demand heterogeneity and price sensitivity.

This paper addresses this gap by developing a unified framework that simultaneously incorporates consumer heterogeneity in purchase quantities and linear price-sensitive demand. Specifically, we analyze a spatial duopoly model with two symmetric firms located at the endpoints of a Hotelling line. Consumers are uniformly distributed along the unit interval and incur transportation costs proportional to distance. Crucially, consumers differ along two dimensions: (i) their baseline demand level and (ii) their responsiveness to price. We assume the presence of two consumer types: low-demand consumers with demand $q_L = 1 - p$, and high-demand consumers with demand $q_H = a - p$, where $a > 1$ measures the degree of demand heterogeneity. This formulation allows price elasticity to vary endogenously with both price and the heterogeneity parameter, generating richer strategic interactions than models with unit inelastic or constant-elasticity demand.

Within this setting, we compare three pricing regimes that reflect increasing degrees of informational sophistication: (i) uniform pricing, in which firms charge a single price to all consumers; (ii) group pricing, where firms observe consumer demand type and set distinct prices for low- and high-demand segments; and (iii) fully personalized pricing, where firms observe both demand type and location and can tailor prices at the individual level. The analysis focuses primarily on the comparison between uniform pricing and group pricing, highlighting how the interaction between elasticity and heterogeneity reshapes established results from the literature.

Under uniform pricing, firms face a trade-off: they must set a single price that balances surplus extraction from high-demand consumers against the risk of losing low-demand consumers. When demand heterogeneity is low, the market is relatively homogeneous and equilibrium profits are modest. As heterogeneity increases, average demand rises and firms initially benefit from higher profits. However, as a continues to increase, high-demand consumers become more price sensitive in relative terms. Because firms cannot differentiate prices, their ability to extract surplus becomes constrained. As a result, profits display a non-monotonic relationship with heterogeneity: moderate heterogeneity enhances profitability, but excessive heterogeneity dampens the gains from uniform pricing.

When firms are allowed to implement group pricing, they can tailor prices to each demand segment. Standard intuition suggests that such discrimination should increase profits. However, our results reveal a

more nuanced pattern. For intermediate levels of demand heterogeneity, group pricing may actually yield lower profits than uniform pricing. The intuition is that segmentation intensifies competition within the high-demand segment, eroding potential gains. Uniform pricing, by contrast, partially softens competition by forcing firms to internalize the trade-offs across segments. Only when heterogeneity becomes sufficiently large does group pricing regain its profitability advantage.

Turning to consumer surplus, the welfare implications are similarly non-linear and distributionally complex. For low levels of heterogeneity, low-demand consumers benefit from group pricing because the segment-specific price they face is lower than the uniform price. Conversely, high-demand consumers are worse off, as firms exploit their stronger willingness to pay. As heterogeneity increases, the relative ranking of prices changes, leading to shifting welfare effects across consumer groups. For intermediate values of a, total consumer surplus can exceed that under uniform pricing if gains to high-demand consumers outweigh losses to low-demand consumers. For higher levels of heterogeneity, overall consumer surplus under group pricing declines again.

Aggregating profits and consumer surplus, we analyze total welfare under both pricing regimes. The results reveal a non-monotonic welfare ranking. For low levels of demand heterogeneity, uniform pricing dominates from a social perspective. For intermediate levels, group pricing can enhance overall welfare. For sufficiently high heterogeneity, uniform pricing once again becomes socially preferable, even though firms may privately prefer group pricing. This divergence between private incentives and social welfare highlights potential regulatory concerns.

By integrating heterogeneous and price-sensitive consumers into a unified spatial competition framework, this study contributes to the growing literature on data-driven pricing and personalized strategies in digital markets. It provides a more nuanced understanding of who gains and who loses under discriminatory pricing regimes and offers a foundation for future research on fully personalized pricing, dynamic competition, and regulatory design in increasingly data-intensive environments.