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Optimal Recommendation System with Competing Sellers

Many e-commerce platforms that connect buyers and sellers employ recommendation systems to help customers find products and services. Such platforms seek to maximize their profits which mainly comes from a commission on sales made via the platform. This may create incentives for platforms to use a recommendation strategy that suppresses competition among sellers and keeps prices and the resulting commission high.

At the same time, the huge success of platforms such as Amazon suggests that they also care about customer satisfaction. Thus, the platform has an incentive to recommend goods that are cheaper and a better match for customer's tastes. This requires not only sufficient competition between sellers but also that sellers act to improve the fit of their product to customer needs. Since these actions are typically costly, a high commission may disincentivize sellers to undertake them, thereby negatively affecting customers. Therefore, in designing the recommendation system and deciding on commissions, the platform should carefully balance the pro-competitive care about customers and anti-competitive incentives to keep high prices and profits.

Introduction

When we search for a product on an e-commerce platform, such as Amazon or AliExpress, the default search outcome contains a list of recommended products sold by vendors that are selected by the platform. The order of these sellers is, of course, not random - the platform's decision on which sellers to recommend is strategic and there could be different forces driving such a strategy. For example, since the platform charges commission on sales, it may have an incentive to recommend the most expensive seller among those who sell similar products. At the same time, such a recommendation strategy, and high(er) prices in general, may negatively affect customer satisfaction from the marketplace and lead to a loss of its customer base. This is not in the best interest of the platform, especially if it wants to achieve long-term sustainability and growth.

The behavior of sellers adds a further layer to these considerations. Indeed, sellers are likely to adjust their pricing behavior and competitive strategies in response to a platform recommendation system.

These considerations give rise to two questions: First, how should an e-commerce platform design its recommendation system, or in other words, how does it optimally choose which sellers to recommend, which commission rate to set, etc.? Second, how does the presence of this system affect the competition and prices?

Further, a seller's strategy may depend not only on the presence of recommendations but also on the commission rate set by the platform. Sellers usually have an option to perform costly actions in order to improve the match of their product to customers' needs. For example, sellers may disclose more information on the characteristics of a good they are selling: spend time and money on detailed descriptions of their goods, or provide high-resolution photos. Though these actions are usually left at sellers' discretion, they may substantially increase a customer's satisfaction by improving the match between the purchased product and customer's preferences.

In turn, a better fit may create a more loyal customer base for the seller, giving her more market power and increased profits. However, if the platform sets a high commission rate, sellers will have less incentive to undertake such costly actions (since the platform eats up a large share of the return to this action). This raises the questions - what is the optimal commission rate chosen by the platform, and how does the optimal commission rate affect sellers' incentives to disclose information about their goods?

Another issue that arises here concerns the optimal precision of the recommendation system, that is, its ability to pin down customers' tastes correctly. When the e-commerce platform deals with heterogeneous buyers, it should assess buyer's preferences prior to making a recommendation. Although almost all research in Computer Science regarding recommendation systems focuses on how to make the precision as high as possible, I show that the highest level of precision may not be optimal from the platform's perspective. Intuitively, this is because highly precise recommendation systems differentiate customers effectively, which in turn could give sellers local monopoly power and translate into higher prices. At the same time, an inaccurate recommendation system cannot distinguish customers with different preferences and views, which intensifies the competition by allowing sellers to compete for all customers.

In Fedchenko (2020), I address the abovementioned and other related issues on recommendation systems of e-commerce platforms. This brief summarizes the main findings of the study.

Model description and findings

In my model, I consider a platform that is designing a recommendation system. That is, for each seller, the platform chooses what share of customers end up receiving a recommendation to buy from this seller. This choice depends on the seller's price, the quality of the good (if disclosed



by the seller), and the buyers' tastes. The platform also sets the commission rate on sales it charges the vendors. I focus only on direct recommendations (i.e., the platform gives each buyer a unique recommendation). Although, in reality, platforms usually provide users with a ranking of alternatives, I assume that buyers always choose the top-ranked alternative which is equivalent to a single recommendation.

The model also assumes that a platform seeks to maximize the weighted sum of its profit (driven by commissions) and aggregate consumer surplus (motivated by the platform's willingness to build a steady customer base). The (exogenous) weight assigned to the aggregate consumer surplus is referred to as the platform's degree of consumer orientation (DCO). DCO is a measure of how much the platform cares about customer satisfaction and it plays an important role in determining the platform's optimal recommendation strategy. In turn, customers have higher satisfaction if they buy a good that better fits their tastes, has higher quality, and is sold at a lower price.

Recommendation system affects competition

My model demonstrates that the presence of a recommendation system that charges sellers commission on sales (i.e. makes the platform have a stake in sellers' profits) "softens" competition, and, in turn, increases prices. This effect is stronger the more a platform cares about its profits relative to customer satisfaction. The force that drives this result has already been touched upon in the introduction: if the platform has a stake in sellers' profits, it will occasionally recommend sellers with higher prices. However, since the platform also cares about consumer surplus (which decreases if the price goes up) these high-priced recommendations will not go to all buyers, and therefore, the overall price level will not become too high. Still, the sellers are encouraged to set higher prices in this scenario, as compared to the

hypothetical case in which customers know about the sellers without the platform.

Optimal commission vs. information disclosure

The relationship between the commission rate and the seller's decision on how much information to disclose is nontrivially affected by the DCO. If the DCO is high, then a higher commission rate causes the seller to disclose less information about their goods in equilibrium. If the DCO is low, the relationship is reversed: a higher commission rate increases the amount of disclosed information. This result stems from the interplay between two counteracting forces. On one hand, an increase in the commission rate decreases a seller's return to providing disclosure, and hence, discourages sellers from making the effort to disclose. On the other hand, a higher commission rate increases the platform's stake in the sellers' profits and, as a result, softens competition, increases sellers' prices and profits, and thus makes it more worthwhile for sellers to provide disclosure of their goods.

An interesting implication of this result is that for a high DCO, the optimal commission rate for a platform should be as small as possible (just enough for the platform to cover the operational cost).

Optimal precision

Next, I show that a lower precision (i.e., ability of the recommendation system to pin down buyers' tastes) weakens the effect of the presence of a recommendation system on competition. This happens since less precise recommendations effectively increase the share of "undecisive" customers and, thereby, the appeal to capture that market share. As a result, the competition for those customers will intensify.

Imprecision also affects the amount of product information sellers choose to disclose in equilibrium. However, the direction of this effect depends on the cost of disclosure: if the cost is low, a more precise recommendation system may



increase the amount of disclosed information, while the result is reversed if the cost is high. The reason for that is as follows: The platform has two sources of information to infer whether a particular seller fits a certain buyer – the buyer's preferences and the seller's information on the quality of the product (if disclosed). If the buyer's taste is measured imprecisely, while the seller's information is more precise, it is optimal for the platform to focus on the latter when designing a recommendation system. This, in turn, would motivate sellers to disclose more information about their products. In the case of low disclosure costs, this positive effect on disclosure more than offsets the direct negative effect of imprecision brought about by harsher competition and lower profits. In the case of high costs, the direct effect dominates.

I also show that some imprecision, in fact, can be optimal for the platform. Perfect precision softens the competition and results in increased prices for consumers. This negative effect on consumer satisfaction outweighs the benefits of a perfect match between seller and buyer. So, consumers prefer a certain degree of imprecision over perfect precision, which in turn, makes the platform unwilling to implement perfect precision. In other words, it is optimal to "sacrifice" some customers (i.e., not recommending them the best fitting alternative) in order to intensify the competition among sellers and, eventually, benefit all customers through lower prices.

Conclusion

The presence of a recommendation system on an e-commerce platform that charges sellers commissions on sales may cause softer competition and lead to higher prices and profits of sellers, as well as increased earnings for the platform. At the same time, it can sometimes be optimal for a platform to set a low commission rate since it would guarantee that sellers disclose more information about their goods which would improve the match between customers' tastes and the goods they buy. If customer satisfaction is important for a platform, the indirect positive effect on customer satisfaction of a low commission rate, via sellers' decisions, may outweigh the direct negative effect on the platform's and sellers' profits. Similarly, a recommendation system with some degree of imprecision can be beneficial for customers since it does not allow sellers to get local monopoly power. So, increasing the precision in the measurement of customers' tastes - which seems to be the focus of many ongoing computer science studies devoted to recommendation systems, - may actually not be in the best interest of a platform.

In the modern era of digitalization, the use of e-commerce platforms is on the rise. Moreover, the ongoing COVID-19 pandemic has increased the use of such platforms even further. Understanding the implications of the strategies used by these platforms, such as recommendation systems, on prices, competition, and societal welfare is, thus, a necessary component for developing efficient regulation principles.



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